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(54) **FLOATING STRUCTURE**

(57) The object of the present invention is to provide a floating structure that is configured to have a size readily expanded horizontally and to readily obtain a buoyancy supporting a heavy load. The floating structure 10 floated on water surface WL by buoyancy, includes a plurality of blocks, the plurality of blocks include first blocks 11, second blocks 11, and floating blocks 12a (12b), in which each of the floating blocks 12a (12b) includes a first portion that is positioned vertically below a portion of at least

one of the first blocks 11 such that the first portion is restricted in movement with a first portion of another floating block, and a second portion that is positioned vertically below a portion of at least one of the second blocks 11 such that the second portion is restricted in movement with a second portion of another floating block, each of the first blocks and each of the second blocks are alternately arranged adjacent to each other in a horizontal direction, and the plurality of blocks being integrated without directly fixing the first blocks 11 and the second blocks 11 to one another.

FIG.1

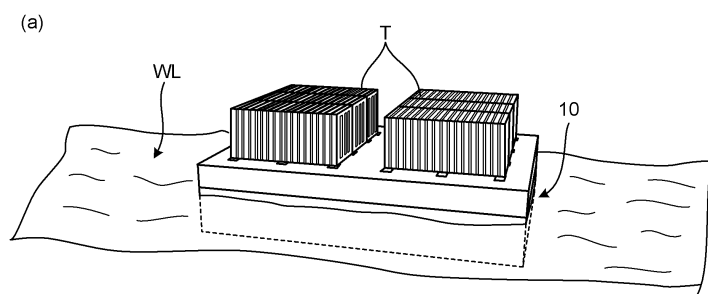


FIG.1

(b)

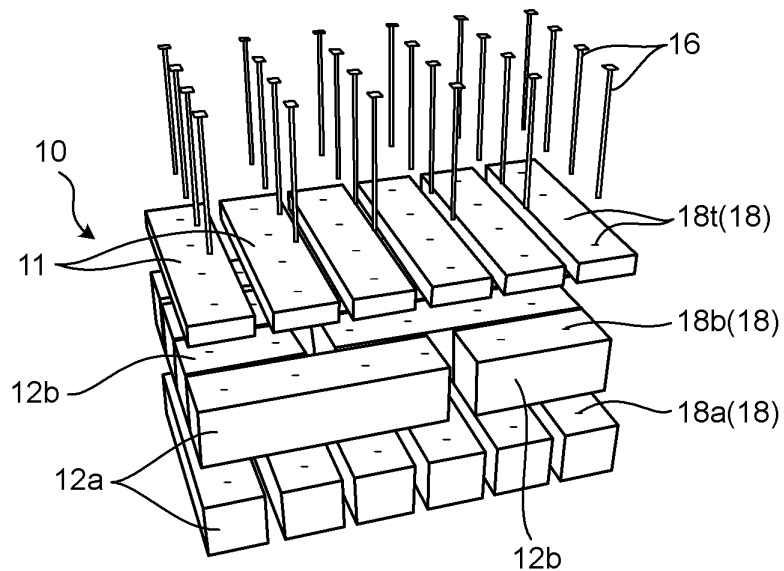
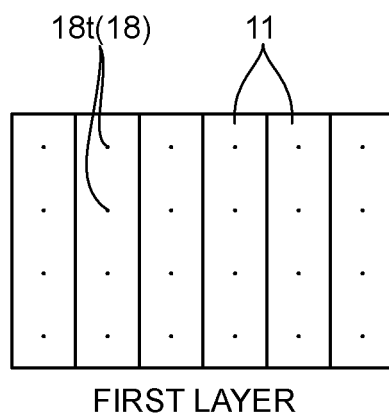


FIG.1

(c)



Description

Field

[0001] The present invention relates to a floating structure suitable for, for example, mounting a container or the like or constructing an aquatic facility such as an off-shore wind power facility or an offshore city. Background

[0002] Known conventional floating structures floating on water are, for example, floating structures disclosed in Patent literatures 1 and 2.

[0003] In Patent Literature 1, a floating structure having a large horizontal area is achieved by horizontally connecting rectangular parallelepiped unit floating bodies with metal fittings attached to side surface portions of the floating bodies and a locking bar.

[0004] In Patent Literature 2, a floating structure having a large horizontal area is obtained by horizontally connecting a plurality of floating bodies. In the technology described in Patent Literature 2, a large number of floating blocks are stacked horizontally and vertically to form a rectangular parallelepiped floating body, the floating body is covered with a box-shaped frame body to form a floating structure, and the floating structures are connected horizontally via vertical bars of side frames of the frame bodies.

Citation List

Patent Literature

[0005]

Patent Literature 1: JP 4586049 B2

Patent Literature 2: JP 2007-247185 A

Summary

Technical Problem

[0006] The floating structure of Patent Literature 1 has a structure to fix horizontally adjacent floating blocks, and cannot obtain sufficient buoyancy enough to support a heavy load. Furthermore, in Patent Literature 2, although the heavy load can be supported, a large frame body is required to connect the floating bodies to each other. Furthermore, upon increasing the size of the entire floating structure by connecting the floating bodies to each other, it is necessary to perform two-step work of binding the floating blocks by the frame body and connecting the side frames of the floating bodies to each other, causing a problem that the manufacturing process is complicated.

[0007] The present invention has been made in view of the above, and an object of the present invention is to provide a floating structure that is configured to have a size readily expanded horizontally and to readily obtain a buoyancy supporting a heavy load.

Solution to Problem

[0008] To solve the problem and achieve the object, a floating structure floated on water surface by buoyancy according to the present invention includes a plurality of blocks that include first blocks, second blocks, and floating blocks, wherein each of the floating blocks includes: a first portion positioned vertically below a portion of at least one of the first blocks such that the first portion is restricted in movement with a first portion of another floating block; and a second portion positioned vertically below a portion of at least one of the second blocks such that the second portion is restricted in movement with a second portion of another floating block, each of the first blocks and each of the second blocks are alternately arranged adjacent to each other in a horizontal direction, and the plurality of blocks being integrated without directly fixing the first blocks and the second blocks to one another.

Advantageous Effects of Invention

[0009] The present invention has been made in view of the above, and it is an object of the present invention to provide a floating structure whose size is readily expanded horizontally and whose buoyancy supporting a heavy load is readily obtained.

Brief Description of Drawings

[0010]

FIG. 1 is a schematic view illustrating a floating structure according to an embodiment of the present invention.

FIG. 2 is a diagram illustrating a block and floating blocks constituting the floating structure according to the embodiment of the present invention.

FIG. 3 is a schematic perspective view of a joining member used for the floating structure according to the embodiment of the present invention.

FIG. 4 is a diagram illustrating floating blocks each constituting the floating structure according to a modification of the embodiment of the present invention.

FIG. 5 is a schematic perspective view of a joining member used for the floating structure according to a modification of the embodiment of the present invention.

FIG. 6 is a diagram illustrating a part of a joining member used for the floating structure according to a modification of the embodiment of the present invention.

FIG. 7 is a diagram illustrating an exemplary application of the floating structure according to an embodiment of the present invention.

Description of Embodiments

[0011] Hereinafter, embodiments of a floating structure according to the present invention will be described in detail with reference to the drawings. Note that the present invention is not limited to these embodiments.

[0012] As illustrated in a schematic perspective view of FIG. 1(a), a floating structure 10 according to an embodiment of the present invention is a structure that is provided to float on sea surface WL (water surface) by buoyancy. The floating structure 10 includes a plurality of floating blocks that is stacked vertically. The floating structure 10 is configured to be mounted with a loaded object T (mounted object) such as a container or a building.

[0013] The configuration of the floating structure 10 will be described with reference to FIGS. 1(b) to 1(e). FIG. 1(b) is an exploded schematic diagram of the configuration of the floating structure 10, illustrating blocks 11 and floating blocks 12a and 12b spaced for the understanding of a relative position between members. In the present embodiment, the floating structure 10 of rectangular shape is described. The floating structure 10 has a three-layer structure of upper, intermediate, and lower layers in a vertical direction, and is referred to as the first layer, the second layer, and the third layer from the top, in the following description. FIGS. 1(c) to 1(e) are diagrams illustrating configurations of the first layer, the second layer, and the third layer, as viewed from vertically above. In the following description, a horizontal direction in each of the plan views of FIGS. 1(c) to 1(e) is defined as a first direction, and a vertical direction orthogonal to the first direction is defined as a second direction. The floating structure 10 includes a plurality of the blocks 11 (first block and second block) arranged in the first layer, and a plurality of the floating blocks 12a and 12b arranged in the second layer and third layer. Each of the blocks 11 has a rectangular shape to have a ratio of the lengths of orthogonal sides of 1 : 4, when viewed from vertically above. Similarly to the block 11, the floating block 12a has a rectangular shape to have a ratio of the lengths of the orthogonal sides of 1 : 4 when viewed from vertically above, and has a vertical thickness larger than that of the block 11. Each of the floating blocks 12b has a rectangular shape to have a ratio of the lengths of orthogonal sides of 1 : 2 when viewed from vertically above, and has a vertical thickness larger than that of the block 11 and the same as that of the floating block 12a.

[0014] As illustrated in FIG. 1(c), the first layer includes only the blocks 11. The plurality of the blocks 11 is arranged in the first direction so as to have a transverse direction (a side extending transversely) extending in the first direction when viewed from vertically above. In other words, any of the blocks 11 is arranged so as to have a longitudinal direction (a side extending longitudinally) extending in the second direction orthogonal to the first direction. In the present embodiment, six blocks 11 are configured to be arranged so that the sides of adjacent

blocks 11 extending longitudinally face each other, forming a rectangular surface extending horizontally.

[0015] As illustrated in FIG. 1(d), the second layer includes the floating blocks 12a and the floating blocks 12b. The floating blocks 12a and 12b are each arranged in the first direction so as to have a longitudinal direction (a side extending longitudinally) extending in the first direction when viewed from vertically above. More specifically, a row in which the floating block 12b and the floating block 12a are sequentially arranged in the first direction from one end side (left side in FIG. 1(d)), and a row in which the floating block 12a and the floating block 12b are sequentially arranged in the first direction from the one end side are alternately provided in the second direction orthogonal to the first direction. In other words, the floating blocks 12a and 12b are arranged in the second direction so that the transverse directions (sides extending transversely) thereof extend in the second direction. Therefore, the floating blocks each positioned at an end portion near the one end side (left side in FIG. 1(d)) and an end portion near the other end side (right side in FIG. 1(d)) in the first direction, the floating blocks 12a and 12b are alternately arranged in the second direction. Meanwhile, the floating blocks positioned in a center part in the first direction (center part in FIG. 1(d)) have only the floating blocks 12a arranged in the second direction, and more specifically, one end portion of each floating block 12a and the other end portions of each floating block 12a are alternately arranged. Note that in the present embodiment, four rows are arranged in the second direction according to the aspect ratio of 1 : 4 of the floating block 12a and block 11.

[0016] As illustrated in FIG. 1(e), the third layer is configured similarly to the first layer except that the floating blocks 12a each having a thickness different from that of the block 11 are used instead of the blocks 11. In other words, the third layer includes only the floating blocks 12a, and the plurality of the floating blocks 12a is arranged in the first direction so as to have a transverse direction (a side extending transversely) extending in the first direction when viewed from vertically above. In the present embodiment, six floating blocks 12a are configured to be arranged so that the sides of adjacent floating blocks 12a extending longitudinally face each other, forming a rectangular surface extending horizontally.

[0017] As illustrated in FIG. 1(b), the three-layer structure including the blocks 11 and the floating blocks 12a and 12b, arranged as described above, is provided with a plurality of joining members 16 penetrating the first layer and second layer to the third layer, and is formed into the floating structure 10.

[0018] Specifically, two blocks in an upper layer whose transverse directions (sides each extending in the transverse direction) extend in the same direction and that are adjacent transversely on a horizontal plane are secured by a specific block arranged in a lower layer (layer adjacent to the upper layer) so as to be restricted in horizontal movement. In other words, one of the blocks in the upper

layer overlaps a first portion of the specific block positioned in the lower layer, and the other of the blocks in the upper layer is arranged to overlap a second portion of the specific block positioned in the lower layer. In other words, the first portion and the second portion are arranged in the longitudinal direction of the specific block. In this state, one of the blocks in the upper layer and the first portion of the specific block positioned in the lower layer, and the other of the blocks in the upper layer and the second portion of the specific block positioned in the lower layer are joined by inserting the joining members 16 into holes 18 included in the respective blocks. Therefore, the two blocks in the upper layer are integrated by the specific block in the lower layer, and the two blocks in the upper layer are secured to each other so as to be restricted in horizontal movement.

[0019] More specifically, in the first layer and the second layer, two blocks 11 and 11 in the first layer whose transverse directions extend in the same direction and that are adjacent transversely are positioned vertically above specific floating blocks 12a and 12b in the second layer. In other words, the first portions of the specific floating blocks 12a and 12b are positioned below one of the two blocks 11 and 11 in the first layer and the second portions of the specific floating blocks 12a and 12b are positioned below the other of the two blocks 11 and 11 in the first layer. Note that each of the specific floating blocks 12a and 12b positioned in the second layer has a longitudinal direction intersecting (orthogonal to) the longitudinal direction of each of the two blocks 11 positioned in the first layer, and therefore, the first portions and the second portions are aligned in the longitudinal direction of the specific floating blocks 12a and 12b. In this state, the first portions of the specific floating blocks 12a and 12b and one of the two blocks 11 in the first layer, and further the second portions of the specific floating blocks 12a and 12b and the other of the two blocks 11 are joined together by inserting joining members 16 into holes 18 of the respective blocks. Therefore, the two blocks 11 in the first layer are integrated by the specific floating blocks 12a and 12b in the second layer, and the two blocks 11 in the first layer are secured to each other so as to be restricted in horizontal movement.

[0020] Furthermore, in the second layer and the third layer, floating blocks 12a and 12b or two floating blocks 12a in the second layer whose transverse directions extend in the same direction and that are adjacent transversely are positioned vertically above the specific floating block 12a in the third layer. In other words, the first portion of the specific floating block 12a is positioned below one of the floating blocks positioned in the second layer, and the second portion of the specific floating block 12a is positioned below the other of the floating blocks positioned in the second layer. Note that the specific floating block 12a positioned in the third layer has a longitudinal direction intersecting (orthogonal to) the longitudinal direction of each of the floating blocks positioned in the second layer, and therefore, the first portion and the

second portion are aligned in the longitudinal direction of the specific floating block 12a. One of the floating blocks positioned in the second layer and the first portion of the specific floating block 12a, and the other of the floating blocks positioned in the second layer and the second portion of the specific floating block 12a are joined by inserting the joining members 16 into holes 18 of the respective blocks. Therefore, the two blocks in the second layer are integrated by the specific floating block 12a in the third layer, and the two blocks in the first layer are secured to each other so as to be restricted in horizontal movement.

[0021] In this way, the blocks 11, the floating blocks 12a, and the floating blocks 12b of the respective layers are secured to each other with the joining members 16, thereby forming the floating structure 10.

[0022] Therefore, in the floating structure 10 according to the present embodiment, it is not required to join the floating blocks 12a and 12b, the blocks 11, or the floating blocks 12a adjacent horizontally in the first direction and the second direction in each layer. In other words, inserting the joining members 16 downward through the blocks 11, the floating blocks 12a, and the floating blocks 12b from vertically above makes it possible to constitute the floating structure 10. Therefore, the blocks 11, the floating blocks 12a, and the floating blocks 12b are allowed to be joined without requiring underwater work, facilitating the constitution of the floating structure 10. Meanwhile, the floating structure 10 according to the present embodiment is readily disassembled into the individual floating blocks 12a and 12b and the blocks 11 by removing the joining members 16 from vertically above the floating structure 10, facilitating removal and relocation.

[0023] Next, the configuration of each of the blocks 11 and the floating blocks 12a and 12b will be described in detail with reference to FIG. 2. The block 11 and the floating blocks 12a and 12b can use concretes such as normal concrete, resin concrete, and lightweight concrete, metals such as steel and aluminum, plastics such as a fiber-reinforced plastic (FRP), urethane resin, and ethylene vinyl acetate (EVA) resin, rubber, wood, and the like. Note that when a material susceptible to impact (e.g., concrete or the like) is used, a shock absorbing material may be attached at least partially to the outer sides of the block 11 and the floating blocks 12a and 12b so as to be interposed between the blocks 11 and between the floating blocks 12a and 12b, arranged vertically or horizontally. For the shock absorbing material, for example, an elastic material such as rubber or silicon can be used.

[0024] The block 11 is used as a finishing member constituting a vertically upper surface of the floating structure 10. Therefore, the block 11 is not necessarily required to generate buoyancy. Therefore, in the present embodiment, as illustrated in FIG. 2(a), the block 11 including a concrete flat plate having the rectangular shape when viewed from vertically above is used. The block 11 is provided with four holes 18t that are arranged in the longitudinal direction of the block 11 to penetrate vertically.

The holes 18t are provided at positions so that a distance between adjacent holes 18t is twice a distance from an end portion to a hole 18t nearest to the end portion, in the longitudinal direction of the block 11, and at positions so that a distance from each hole 18t to one end is equal to a distance from the hole 18t to the other end, in the transverse direction of the block 11. Note that in the present embodiment, each hole 18t is configured so that an opening portion of the hole 18t is provided at the bottom of a recessed portion (not illustrated) provided in the block 11, and a part of the joining member 16 is prevented from protruding vertically upward upon fixing the joining member 16.

[0025] The floating block 12a is a member that is provided vertically below the block 11 to generate buoyancy. As illustrated in FIG. 2(b), the floating block 12a has a box shape having the rectangular shape when viewed from vertically above. Note that similarly to the block 11, the floating block 12a is configured so that one of the orthogonal sides has a length four times the length of the other of the orthogonal sides, when viewed from vertically above, while the floating block 12a has a larger vertical thickness unlike the block 11. Similarly to the block 11, the floating block 12a is also provided with four holes 18a that are arranged in the longitudinal direction of the block 11 to penetrate vertically. The holes 18a are provided at positions so that a distance between adjacent holes 18a is twice a distance from an end portion to a hole 18a nearest to the end portion, in the longitudinal direction of the floating block 12a, and at positions so that a distance from each hole 18a to one end is equal to a distance from the hole 18t to the other end, in the transverse direction of the floating block 12a.

[0026] In the present embodiment, the floating block 12a uses concrete as a material, and therefore the floating block 12a is configured to be hollowed inside to obtain buoyancy. More specifically, each of a top surface positioned vertically above and a bottom surface positioned vertically below is provided with a through-hole to be the hole 18a, four side surfaces are provided between the top surface and the bottom surface in the vertical direction, and the floating block 12a having a box-shaped closed space is formed. Note that FIG. 2(d) is a perspective view illustrating an internal structure of the floating block 12a with the top surface omitted. Therefore, the floating block 12a has a structure in which the structure illustrated in FIG. 2(d) is provided with the top surface which is not illustrated. Furthermore, in the present embodiment, the floating block 12a is provided with three inner walls 13 extending transversely to form four air chambers. In addition, the floating block 12a further includes a pipe 19a connected to each through-hole provided in the top surface and each through-hole provided in the bottom surface. Therefore, a hollow portion of the floating block 12a (the air chambers of the floating block 12a) is formed into a completely closed space, preventing entrance of water into the floating block 12a (the air chambers of the floating block 12a) through the through-holes

provided in the top surface and the bottom surface. Furthermore, the pipe 19a also functions as a reinforcing member capable of transmitting part of a load received on the top surface to the bottom surface. This configuration makes it possible for the top surface and the bottom surface to receive the load applied to the top surface, and therefore, the plate thickness of the top surface can be reduced as compared with a configuration without the pipe 19a, and the floating block 12a can be reduced in weight. Note that the floating block 12a may be constituted by horizontally connecting four box bodies having substantially the same size and structure.

[0027] Furthermore, the floating block 12b is a member that is provided vertically below the block 11 to generate buoyancy. As illustrated in FIG. 2(c), the floating block 12b has a box shape having the rectangular shape when viewed from vertically above. Note that the floating block 12b is configured so that one of the orthogonal sides has a length twice the length of the other of the orthogonal sides, when viewed from vertically above, and the floating block 12b has a vertical thickness equal to the thickness of the floating block 12a. The floating block 12b is provided with two holes 18b that are arranged in the longitudinal direction of the block 11 to penetrate vertically. The holes 18b are provided at positions so that a distance between the holes 18b is twice a distance from an end portion to a hole 18b nearest to the end portion, in the longitudinal direction of the floating block 12b, and at positions so that a distance from each hole 18b to one end is equal to a distance from the hole 18t to the other end, in the transverse direction of the floating block 12b.

[0028] In the present embodiment, the floating block 12b uses concrete as a material, and therefore the floating block 12b is configured to be hollowed inside to obtain buoyancy. More specifically, each of a top surface positioned vertically above and a bottom surface positioned vertically below is provided with a through-hole to be the hole 18, four side surfaces are provided between the top surface and the bottom surface in the vertical direction, and the floating block 12b having a box-shaped closed space is formed. Note that FIG. 2(e) is a perspective view illustrating an internal structure of the floating block 12b with the top surface omitted. Therefore, the floating block 12b has a structure in which the structure illustrated in FIG. 2(e) is provided with the top surface which is not illustrated. Furthermore, in the present embodiment, the floating block 12b is provided with one inner wall 13 extending transversely to form two air chambers. The floating block 12b further includes a pipe 19b connected to each through-hole provided in the top surface and each through-hole provided in the bottom surface. Therefore, a hollow portion of the floating block 12b (the air chambers of the floating block 12b) is formed into a completely closed space, preventing entrance of water into the floating block 12b (the air chambers of the floating block 12b) through the through-holes provided in the top surface and the bottom surface. The pipe 19b also functions as a reinforcing member capable of transmitting part of a

load received on the top surface to the bottom surface. This configuration makes it possible for the top surface and the bottom surface to receive the load applied to the top surface, and therefore, the plate thickness of the top surface can be reduced as compared with a configuration without the pipe 18, and the floating block 12b can be reduced in weight. Note that the floating block 12b may be constituted by horizontally connecting two box bodies having substantially the same size and structure.

[0029] Note that each of the floating blocks 12a and 12b according to the present embodiment have the hollow portion. Injecting ballast such as water into the hollow portions of the floating blocks 12a and 12b, the floating structure 10 may stabilize the attitude, for example, when the attitude of the floating structure 10 becomes unstable due to the load of the loaded object T installed on the floating structure 10 after the floating structure 10 is formed. In this case, each of the floating blocks 12a and 12b is configured to have an opening portion, which is not illustrated, to the hollow portion, and the opening portion is closed by a closing member unless the ballast is injected or removed, preventing the entrance of water into the hollow portion.

[0030] Next, the joining member 16 that is used to restrict relative horizontal movement of the floating blocks 12a and 12b and the block 11, that is, used to secure the floating blocks 12a and 12b and the block 11 will be described with reference to FIG. 3. FIG. 3(a) is a perspective view of the entire configuration of the joining member 16, and FIG. 3(b) is a partially enlarged view of an X portion of FIG. 3(a) illustrating the X portion enlarged. The joining member 16 includes a movement restriction portion 26 that is formed of a rectangular plate, and an inserted portion 28 that extends from the movement restriction portion 26 in a direction orthogonal to a plane on which the movement restriction portion 26 extends. The inserted portion 28 is a portion to be inserted into holes 18 (18t, 18a, and 18b) of the floating blocks 12a and 12b and the block 11, and has a cylindrical shape extending in an insertion direction, that is, a pipe shape, in the present embodiment. Note that the inserted portion 28 may have, not limited to the cylindrical shape, a columnar shape or a prismatic shape, in addition to a cylindrical shape whose cross-section is not limited to a circular shape. The movement restriction portion 26 is configured to restrict the movement of the inserted portion 28 inserted into the holes 18 of the floating blocks 12a and 12b and the block 11, and arranged on the block 11. Note that in the present embodiment, as illustrated in FIG. 3(b), the movement restriction portion 26 has four corners provided with holes 30 vertically penetrating and is configured to be fixed to the block 11 on which the movement restriction portion 26 is placed with bolts or the like passing through the holes 30. In this way, the movement restriction portion 26 is operable to not only restrict the movement of the inserted portion 28 through the holes 18 in the insertion direction (vertically downward), but also prevent the movement of the inserted portion 28 in a removal

direction (vertically upward) from the hole 18. At this time, it is preferable for the block 11 to have a configuration in which the recessed portion recessed vertically downward having an opening of the hole 18t at the bottom is provided in a surface of the block 11 facing vertically upward so as to store the movement restriction portion 26 in the recessed portion, preventing the movement restriction portion 26 and the like from protruding from the surface of the block 11 facing vertically upward. Furthermore, also in each of the holes 30 provided in the movement restriction portion 26, it is preferable to provide a recessed portion (counterbore) recessed vertically downward to have an opening of the hole 30 facing vertically upward at the bottom portion so as to store the head of each of the bolts fastened to the block 11 through the hole 30 in the recessed portion, preventing the head from protruding.

[0031] As described above, the floating blocks 12a and 12b, the block 11, and the joining member 16 have mass-producible configurations. Therefore, the floating structure 10 is configured to change the number of stacked layers of the mass-produced floating blocks 12a and 12b and blocks 11 by the mass-produced joining members 16 on-site to generate any buoyancy, readily forming the floating structure having any horizontal size.

[0032] Note that for changing the number of stacked layers, the structure of a stacked body arranged vertically below the first layer is preferably changed as a structure in which the structure of the second layer and the structure of the third layer are alternately stacked by changing the number of stacked layers, for example, by providing a layer having a configuration similar to that of the second layer below the third layer. In this way, in the odd-numbered layers and the even-numbered layers, the floating blocks 12a and 12b and the blocks 11 constituting the respective layers preferably have longitudinal directions intersect, more specifically, longitudinal directions orthogonal to each other. In this way, adjacent blocks 11, adjacent floating blocks 12a, and adjacent floating blocks 12a and 12b can be integrated by floating blocks 12a and 12b positioned therebelow.

[0033] In addition, when increasing the horizontal size into any size, for example, the third layer and subsequent odd-numbered layers may be constituted by the floating blocks 12a and the floating blocks 12b. Furthermore, the second and subsequent even-numbered layers may include only the floating blocks 12a or only the floating blocks 12b. When a layer is formed by using the floating blocks 12a and the floating blocks 12b, the layer is preferably configured so that the floating blocks 12a and the floating blocks 12b are preferably configured to be arranged in one direction so as to have the longitudinal directions (sides extending longitudinally) extending in the one direction and so as to make portions where sides extending transversely are opposed separate in a direction orthogonal to the one direction, when viewed from vertically above. In this configuration, as the finishing member constituting the vertically upper surface of the

floating structure 10, a block having an aspect ratio of 1 : 2, in addition to the block 11 having an aspect ratio of 1 : 4, when viewed from vertically above is preferably used to form the first layer similarly to the third and subsequent odd layers. The block having an aspect ratio of 1 : 2 also includes a concrete flat plate, and is provided with two holes that are arranged in the longitudinal direction of the block 11 to penetrate vertically. The holes are provided at positions so that a distance between the holes is twice a distance from an end portion to a hole nearest to the end portion, in the longitudinal direction of the block, and at positions so that a distance from each hole to one end is equal to a distance from the hole to the other end, in the transverse direction of the block.

[0034] Note that, this configuration uses the blocks 11 and the floating blocks 12b having an aspect ratio of 1 : 4 and the finishing blocks and the floating blocks 12a having an aspect ratio of 1 : 2, all of which have the same transverse length. Therefore, in each layer, the number of the blocks 11 and the like or the floating blocks 12a and 12b arranged along the sides thereof extending transversely, that is, the number of rows is preferably an even, that is, a multiple of 2.

<Modifications>

[0035] In the above embodiments, the block 11 including the concrete flat plate has been used as the finishing member forming a vertically upper surface layer of the floating structure 10, but the present invention is not limited to this configuration. For example, the floating block 12a may be used as a member forming the vertically upper surface layer of the floating structure 10. In other words, as the finishing member forming the vertically upper surface layer of the floating structure 10, a structure internally including a hollow portion for generation of a buoyancy may be provided. Note that the block 11 including a lump of concrete without a hollow portion and having a vertical thickness smaller than that of the floating block 12a to reduce the weight is used, but is not limited to this configuration.

[0036] In addition to the block 11, each of the floating blocks 12a and 12b is configured to have any vertical thickness, and may have a thickness that is an integral multiple or an integral fraction of the thickness of each of the block 11 and floating blocks 12a and 12b constituting the other layers. The floating structure 10 can be formed by using the floating blocks 12a and 12b having different thicknesses to generate a desired buoyancy.

[0037] Furthermore, in the above embodiments, the floating blocks 12a and 12b and the block 11 are configured to be secured using only the joining members 16, but the present invention is not limited to this configuration. One of a protruding portion and a recessed portion may be provided on a vertically downward surface of each of the floating blocks 12a and 12b and the block 11, and the other of the protruding portion and the recessed portion may be provided on the vertically upward

surface of each of the floating blocks 12a and 12b. In this way, the protruding portion and the recessed portion may be engaged with each other to restrict horizontal movement. In this configuration, the relative horizontal movement may be restricted only by the protruding portions and the recessed portions provided in the floating blocks 12a and 12b and the block 11, eliminating the joining members 16. In addition, a configuration may be provided in which the protruding portions and the recessed portions provided in the floating blocks 12a and 12b and the block 11 are engaged with each other so that the blocks are brought into a temporarily positioned state, and then the joining members 16 are mounted to the floating blocks 12a and 12b and the block 11 to restrict the relative movement of the respective blocks more reliably.

[0038] FIG. 4 shows modifications of the floating block 12b that is provided with a protruding portion and a recessed portion. In the present modification, the top surface of the floating block 12b is provided with the protruding portion protruding vertically upward, and the bottom surface of the floating block 12b is provided with the recessed portion recessed vertically upward.

[0039] For example, FIGS. 4(a) and 4(b) show an example of the floating block 12b. FIG. 4(a) is a perspective view of the floating block 12b according to a modification, and FIG. 4(b) is a perspective view of the floating block 12b according to the modification that is inverted vertically so that the bottom surface can be visually recognized. The floating block 12b includes a protruding portion 36 that is provided on the top surface (one end) to have a quadrangular frustum shape, and a recessed portion 34 that is provided in the bottom surface (the other end) to have a shape corresponding to the shape of the protruding portion 36 having the quadrangular frustum shape. In the recessed portion 34 provided on the bottom surface, the contour of an opening portion of the recessed portion 34 and the contour of a bottom surface of the recessed portion 34 are similar in shape concentric with the hole 18b, and the recessed portion 34 has a shape obtained by connecting the opening portion of the recessed portion 34 and the bottom surface of the recessed portion 34 with surfaces each extending in a direction intersecting the vertical direction. In the configuration as described above, the protruding portion 36 has a vertical cross-section having a tapered shape and the recessed portion 34 has a vertical cross-section having a shape expanding from the bottom portion toward the opening, facilitating insertion of the protruding portion 36 into the recessed portion 34. Moreover, with the shape as described above, the protruding portion 36 is allowed to enter the recessed portion 34 while being guided by the surfaces constituting the recessed portion 34, setting the protruding portion 36 and the recessed portion 34 to a predetermined position, facilitating stacking of the floating blocks on the water. In addition, in the present modification, the protruding portion 36 has the quadrangular frustum shape and the recessed portion 34 has the shape corresponding to the shape of the protruding portion 36,

and the protruding portion 36 and the recessed portion 34 are provided with sides whose surfaces are fitted to each other. Therefore, when the protruding portion 36 and the recessed portion 34 are engaged with each other, not only restriction in horizontal movement of the protruding portion 36 and the recessed portion 34 but also prevention of the rotation of the protruding portion 36 and the recessed portion 34 about a vertical axis can be achieved. Note that in the present modification, similar effects can be obtained with the protruding portion 36 having the quadrangular frustum shape and the recessed portion 34 having a prismoid shape or a polygonal pyramid shape, other than the quadrangular frustum shape, being a shape corresponding to the shape of the protruding portion 36.

[0040] In addition, the floating block 12b as illustrated in FIGS. 4(c) and 4(d) may be used. FIG. 4(c) is a perspective view of the floating block 12b according to a modification, and FIG. 4(d) is a perspective view of the floating block 12b according to the modification that is inverted vertically so that the bottom surface can be visually recognized. The floating block 12b includes a protruding portion 42 that has a top surface (one end) with a dome shape formed of a curved surface, and a recessed portion 40 that has a bottom surface (the other end) formed of a curved surface recessed vertically upward, corresponding to the protruding portion 42. In the configuration as described above, the protruding portion 42 has a vertical cross-section having a tapered shape and the recessed portion 40 has a vertical cross-section having a shape expanding from the bottom portion toward the opening. Therefore, when the protruding portion 42 is inserted into the recessed portion 40, the protruding portion 42 is allowed to enter the recessed portion 40 while being guided by the surfaces constituting the recessed portion 40, setting the protruding portion 42 and the recessed portion 40 to a predetermined position, facilitating stacking of the floating blocks on the water. Note that, in the configuration according to the present modification, when a load is applied vertically downward to the floating structure 10 from vertically above, the force can be dispersed and transmitted from the recessed portion 40 to the protruding portion 42. Therefore, when a heavy load is mounted on the floating structure 10, it is possible to better prevent concentration of a load on a specific place and breakage of the floating block.

[0041] Furthermore, although not illustrated, one or a plurality of rod-shaped protruding portions extending vertically upward may be provided on a floating block arranged on a vertically lower side. In this configuration, a floating block positioned vertically above the floating block or a block used as the finishing member is provided with recessed portions and the holes 18. The number of recessed portions corresponds to the number of the protruding portions and each of the recessed portions is provided in a vertically downward surface recessed vertically upward, and each of the holes vertically penetrates the floating block or the block used as the finishing member.

When the recessed portions are provided in the floating block positioned vertically above the floating block or the block used as the finishing member, the protruding portions are preferably inserted into the recessed portions. Meanwhile, when the holes 18 are provided in the floating block positioned vertically above the floating block or the block used as the finishing member, the protruding portions may be inserted into the holes 18, or the protruding portions may penetrate the floating block or the block for finishing.

[0042] Furthermore, in the above embodiments, the floating blocks 12a and 12b internally include the hollow portions to generate buoyancy. Therefore, when the floating blocks 12a and 12b are formed, it is preferable to integrally mold each of the floating blocks 12a and 12b so as not to form a seam in a material constituting the floating blocks 12a and 12b to prevent the entry of water into the floating blocks 12a and 12b. Therefore, in the integral molding, the floating blocks 12a and 12b may each be formed using, for example, a mold made of foamed plastic (expanded polystyrene) for forming the hollow portion.

[0043] In addition, in the above embodiments, an impermeable material as a material constituting the floating blocks 12a and 12b is used to prevent entrance of water into the floating block 12a and generate buoyancy. However, the present invention is not limited to this configuration. The floating block 12a may be configured not to have the hollow portion inside the floating block 12a as long as the buoyancy can be maintained. Therefore, for example, instead of providing the hollow portions inside the floating blocks 12a and 12b, a structure internally including foamed plastic (expanded polystyrene) may be adopted. In this configuration, the problem of entry of water into the floating blocks 12a and 12b does not caused, and thus, a permeable material can be adapted, the pipes 19a and 19b each connected to the through-hole provided in the top surface and the through-hole provided in the bottom surface are not required to be provided, and further, when concrete or the like is used as the material of the floating blocks 12a and 12b, the foamed plastic itself functions as the mold, facilitating formation of the floating blocks 12a and 12b.

[0044] In addition, in the present embodiment, the joining member 16 is configured to be fixed to the block 11 with the bolts or the like inserted into the holes 30 provided at the four corners of the movement restriction portion 26, but the present invention is not limited to this configuration. For example, as illustrated in FIG. 5, the joining member 16 may be configured to include the movement restriction portion 26 having the plate shape, at one end of the inserted portion 28 extending in the vertical direction, similarly to the above embodiment, and further a hook portion 32 that engages with the block when inserted into the block, at the other end portion of the inserted portion 28. FIG. 5(a) is a perspective view of the entire configuration of a joining member 16A configured as described above, and FIG. 5(b) is a partially

enlarged view of a Y portion of FIG. 5(a) illustrating the Y portion enlarged. As illustrated in FIG. 5(b), the hook portion 32 is a triangular plate member, and four hook portions are arranged at equal intervals in the circumferential direction of the inserted portion 28. The hook portion 32 is biased by a spring mechanism or the like, which is not illustrated, so as to protrude from the inserted portion 28. In this state, the hook portions 32 are configured to radially extend in four directions from the inserted portion 28 on planes orthogonal to an extending direction of the inserted portion 28 (the insertion direction of the inserted portion 28), and have radial lengths about the inserted portion 28 each gradually increasing, maximized at the tip, and being zero or dropping, from an upstream side to the downstream side in the insertion direction of the inserted portion 28. In other words, in the present modification, each of the hook portions 32 includes a guide surface that extends away from the inserted portion 28, from the upstream side to the downstream side in the insertion direction, and the guide surface is configured to be pressed by an inner wall of a hole 18 when the inserted portion 28 is inserted, and then, retracted into the inserted portion 28 against a biasing force.

[0045] Meanwhile, in a state where not only the inserted portion 28 but also the joining member 16A have been inserted into the holes 18 through the floating blocks 12a and 12b and the block 11, the hook portion 32 protrudes outward from a peripheral surface of the inserted portion 28 by the biasing force of the spring mechanism.

Therefore, the hook portion 32 is caught by the bottom surface of the floating block 12a or 12b in the lowermost layer, and even when a vertically upward pulling force acts on the joining member 16A, vertically upward movement of the joining member 16A is restricted (locked). Note that insertion and removal of the hook portion 32 may be remotely controllable to release the lock. This configuration makes it possible to readily pull out the joining member 16A upon disassembling and removing the floating structure 10.

[0046] Furthermore, the joining member 16 according to the above embodiment is provided at a stable position in a rigid place of each of the floating blocks 12a and 12b and the block 11. Therefore, it is preferable to have a configuration by which a load is supported with the joining members 16, and in construction of a building, it is preferable to construct a foundation on the joining members 16 (movement restriction portions 26) with the joining members 16 as piles. Note that, in this configuration, each of the joining members 16 can be provided with a retaining configuration for the floating blocks 12a and 12b and the block 11 to construct a building at a more stable place.

[0047] In addition, when the loaded object T such as the container is mounted on the floating structure 10, it is preferable to mount the loaded object T on the movement restriction portions 26 of the joining members 16, and further, it is preferable to include a fastening device 50 that fixes the loaded object T to the movement restric-

tion portion 26 of each joining member 16. The fastening device 50 is a so-called twistlock or the like. The fastening device 50 includes a support portion 50a that supports the loaded object T such as a container, a protrusion 50b that protrudes vertically upward from the support portion 50a, a retaining portion 50c that is provided vertically above the protrusion 50b, and a lever 50d that rotates the retaining portion 50c. Meanwhile, the loaded object T such as the container has a bottom surface portion that includes a plate-shaped member provided with an elongated hole.

[0048] The protrusion 50b is configured to have a vertical distance from a vertical lower end of the retaining portion 50c to the support portion 50a is equal to or larger than a thickness of the plate-shaped member provided with the elongated hole through which at least the retaining portion 50c is inserted. The protrusion 50b is configured to have a length extending in one direction is longer than a length extending in the other direction orthogonal to the one direction when viewed from vertically above. Similarly, the retaining portion 50c is also configured to have a length extending in one direction is longer than a length extending in the other direction orthogonal to the one direction when viewed from vertically above, in a state before the container is fixed (FIG. 6(a)). Furthermore, the retaining portion 50c has a shape tapered vertically upward. Therefore, the retaining portion 50c is allowed to be readily inserted into the elongated hole of the container. Then the lever 50d is configured to rotate the retaining portion 50c relative to the support portion 50a, and is configured to rotate the retaining portion 50c by 90° by operating (moving) the lever 50d (FIG. 6(b)).

[0049] When the container is fixed with the fastening device 50, the lever 50d is operated as necessary to align a longitudinal direction of the protrusion 50b with a longitudinal direction of the retaining portion 50c first, when viewed from vertically above. In this state, the retaining portion 50c is inserted into the elongated hole of the container to mount the container to the support portion 50a. After the container is mounted to the support portion 50a, the lever 50d is operated to rotate the retaining portion 50a by 90°. Therefore, fixing the container by the fastening device 50 is completed. Providing the fastening device 50 at the movement restriction portion 26 of the joining member 16 in this way, the loaded object T such as the container is allowed to be readily fixed to the floating structure 10.

[0050] In a state where the container is fixed with the fastening device 50, the protrusion 50b penetrates the elongated hole of the container, thus, making it possible to restrict horizontal movement of the container and rotation of the container about the vertical axis. A longitudinal length of the retaining portion 50c is longer than a transverse length of an elongated hole portion of the container. Therefore, the rotation of the retaining portion 50c makes it possible to prevent removal of the elongated hole portion of the container from the protrusion 50b at the retaining portion 50c and further restrict vertical

movement of the container. Note that in this configuration, the joining member 16 can be provided with the retaining configuration for the floating blocks 12a and 12b and the block 11 to further stabilize the container.

[0051] Furthermore, in the above embodiment, an example of the floating structure 10 on which the container is mounted as the loaded object T (mounted object) has been described (FIG. 1(a)), but a plurality of containers T1 may be mounted as the loaded objects T as illustrated in FIG. 7(a). Furthermore, the floating structure 10 of the present invention is used to, but is not limited to, mount the container. For example, a solar panel T2 may be mounted on the floating structure 10 (FIG. 7(b)), a building T3 may be mounted on the floating structure 10 (FIG. 7(c)), or a city T4 including a high-rise building may be mounted on the floating structure 10. The floating structure 10 is not limited to the configurations according to the above embodiments, and various floating blocks can be connected vertically and horizontally to readily constitute a structural form for obtaining necessary buoyancy, as illustrated in FIG. 7. Therefore, a floating structure according to use can be readily constructed.

[0052] In addition to the above description, the floating structure of the present invention may be used as, for example, a floating platform, a floating scaffold, an evacuation float, or a rest space for a diver or for swimming in the sea. Furthermore, in addition to various buildings such as an off-grid facility, a renewable energy power generation facility, a hydrogen storage facility, and a high-rise building, a wide range of facilities up to cities including combinations of the various buildings may be provided as the loaded object T, on the floating structure 10.

[0053] In addition, if a local government and the like always have the blocks, temporary housing of container type, and the like, it is possible to quickly install life support facilities such as temporary housing for a damaged area and facilities necessary for reconstruction, by combining the blocks in conformity with the shape of water surface available, such as sea of coastal area, river, lake, and reservoir, when natural disaster or the like occurs. Furthermore, the floating structure can be transported by sea even against disasters, and is useful for disaster relief and reconstruction support. In addition, the floating structure can be used as a precast foundation for a ground building provided for a short-time event such as an international exhibition.

Reference Signs List

[0054]

10 FLOATING STRUCTURE
11 BLOCK
12a, 12b FLOATING BLOCK
16, 16A JOINING MEMBER
18, 18a, 18b, 18t, 30 HOLE
19a, 19b PIPE

26 MOVEMENT RESTRICTION PORTION
28 INSERTED PORTION
32 HOOK PORTION
34, 40 RECESSED PORTION
36, 42 PROTRUDING PORTION
T LOADED OBJECT (MOUNTED OBJECT)
WL SEA SURFACE (WATER SURFACE)

10 Claims

1. A floating structure floated on water surface by buoyancy, the floating structure comprising

a plurality of blocks that include first blocks, second blocks, and floating blocks, wherein each of the floating blocks includes:

a first portion positioned vertically below a portion of at least one of the first blocks such that the first portion is restricted in movement with a first portion of another floating block; and

a second portion positioned vertically below a portion of at least one of the second blocks such that the second portion is restricted in movement with a second portion of another floating block,

each of the first blocks and each of the second blocks are alternately arranged adjacent to each other in a horizontal direction, and the plurality of blocks being integrated without directly fixing the first blocks and the second blocks to one another.

2. The floating structure according to claim 1, wherein

the first portion of each of the floating blocks includes a hole penetrating vertically, and each of the first blocks includes a hole penetrating vertically, and

the floating structure further comprises first joining members, each of the first joining members being inserted into the hole provided in the first portion and the hole of each of the first blocks to restrict horizontal movement between the floating blocks and the first blocks.

3. The floating structure according to claim 2, wherein each of the first joining members includes, at a vertically upper end, a movement restriction portion that is engaged with the first block to restrict vertically downward movement of each of the first joining members.

4. The floating structure according to claim 3, wherein each of the first joining members includes, at a ver-

tically lower end, a hook portion that is engaged with the floating block to restrict vertically upward movement of each of the first joining members.

5. The floating structure according to any one of claims 2 to 4, wherein

the second portion of each of the floating blocks includes a hole penetrating vertically, and each of the second blocks includes a hole penetrating vertically, and
the floating structure further comprises second joining members, each of the second joining members being inserted into the hole provided in the second portion and the hole of each of the second blocks to restrict horizontal movement between the floating blocks and the second blocks.

6. The floating structure according to any one of claims 1 to 5, wherein

the first portion of each of the floating blocks has a surface facing vertically upward provided with one of a protruding portion vertically protruding and a recessed portion vertically recessed, each of the first blocks has a surface facing vertically downward provided with the other of a protruding portion vertically protruding or a recessed portion vertically recessed, and
each of the first blocks is arranged vertically above the first portion of the floating blocks in order to engage the protruding portion with the recessed portion, restricting horizontal movement between the floating blocks and the first blocks.

7. The floating structure according to any one of claims 1 to 5, wherein

the first portion of each of the floating blocks has a surface facing vertically upward provided with a protruding portion vertically protruding, each of the first blocks has a hole penetrating vertically, and
each of the first blocks is arranged vertically above the first portion of the floating blocks in order to insert the protruding portion into the hole of each of the first blocks, restricting horizontal movement between the floating blocks and the first blocks.

8. The floating structure according to any one of claims 1 to 7, wherein

the first blocks, the second blocks, and the floating blocks each have a shape in which a length extending in one direction is larger than a length

extending in a direction intersecting the one direction when viewed from vertically above, a longitudinal direction of the first blocks and a longitudinal direction of the second blocks extend in the same direction, and
a longitudinal direction of the floating blocks extend in a direction intersecting the longitudinal direction of the first blocks and the longitudinal direction of the second blocks.

9. The floating structure according to any one of claims 1 to 8, wherein
the floating blocks internally includes a hollow portion.

10. The floating structure according to any one of claims 1 to 9, wherein
each of the first blocks and each of the second blocks does not internally include a hollow portion.

11. The floating structure according to any one of claims 1 to 9, wherein
each of the first blocks and each of the second blocks is a floating block internally including a hollow portion.

FIG. 1

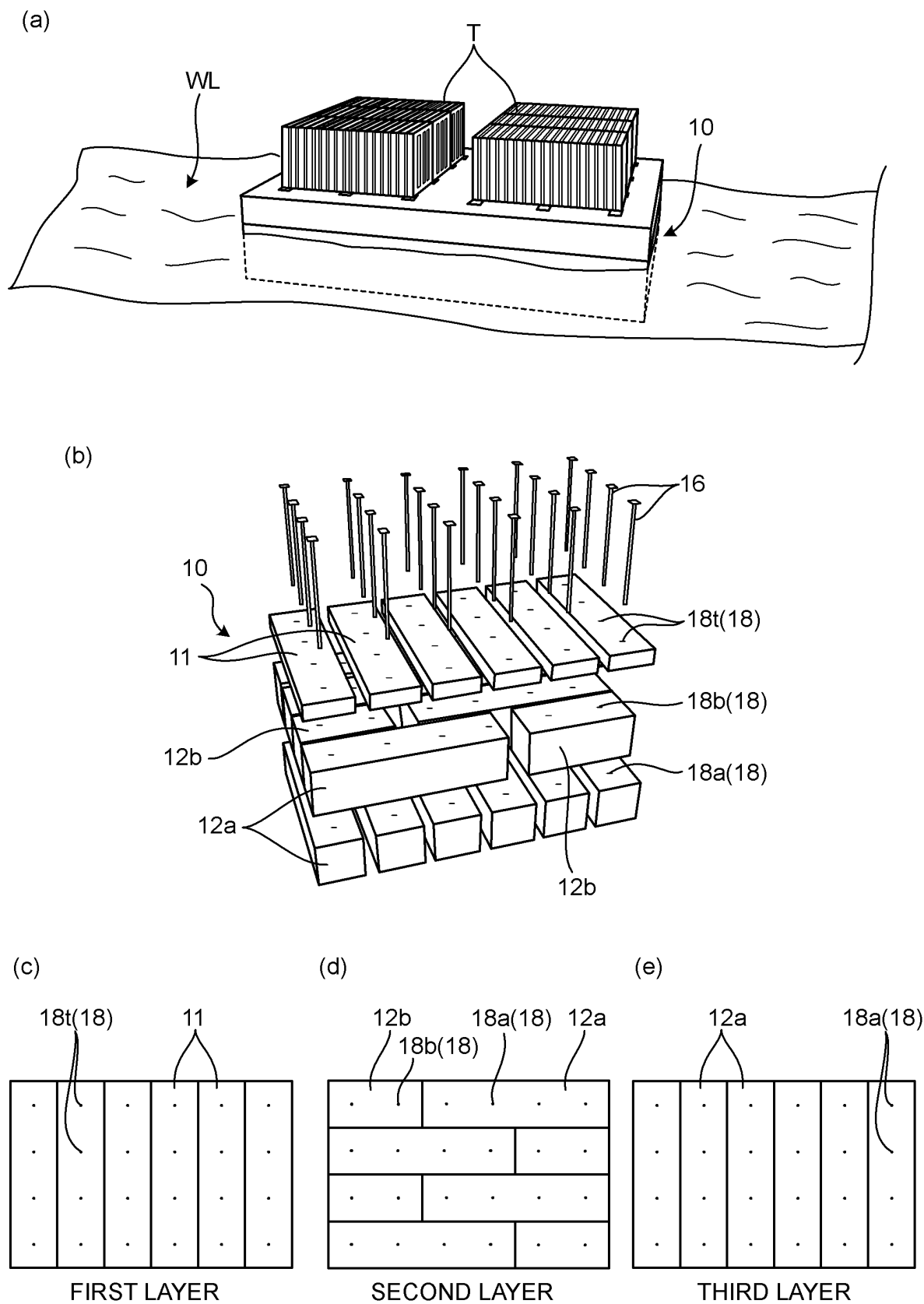


FIG.2

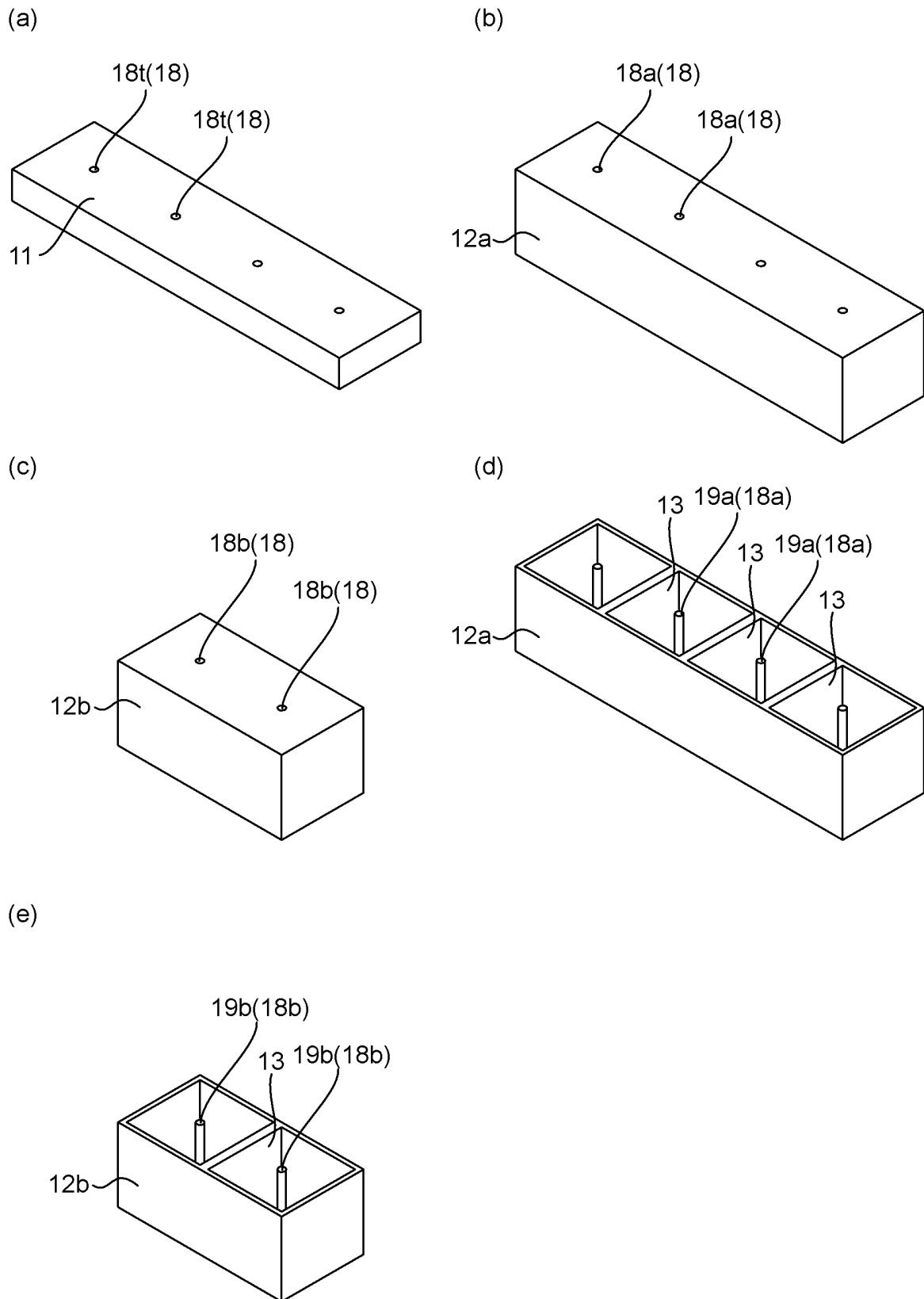


FIG.3

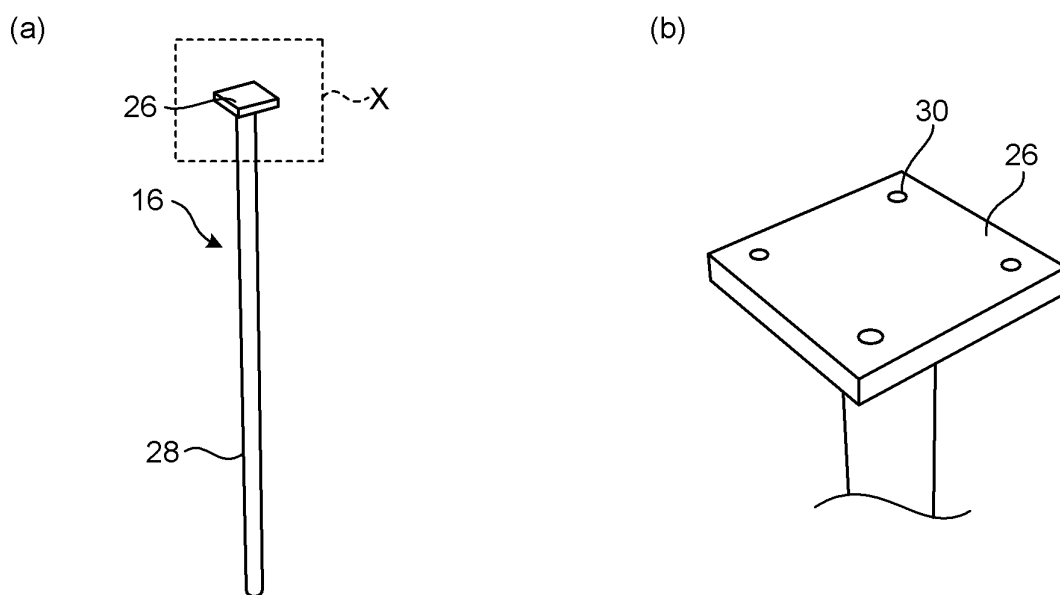


FIG.4

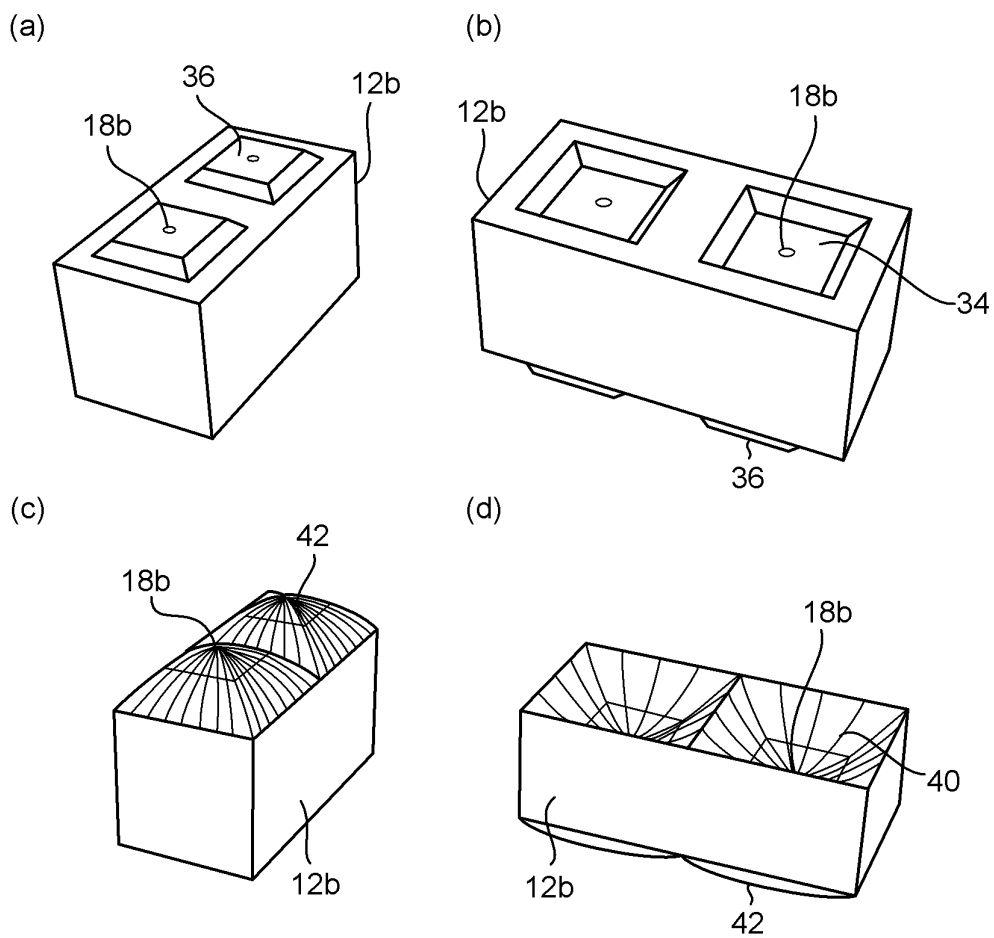


FIG.5

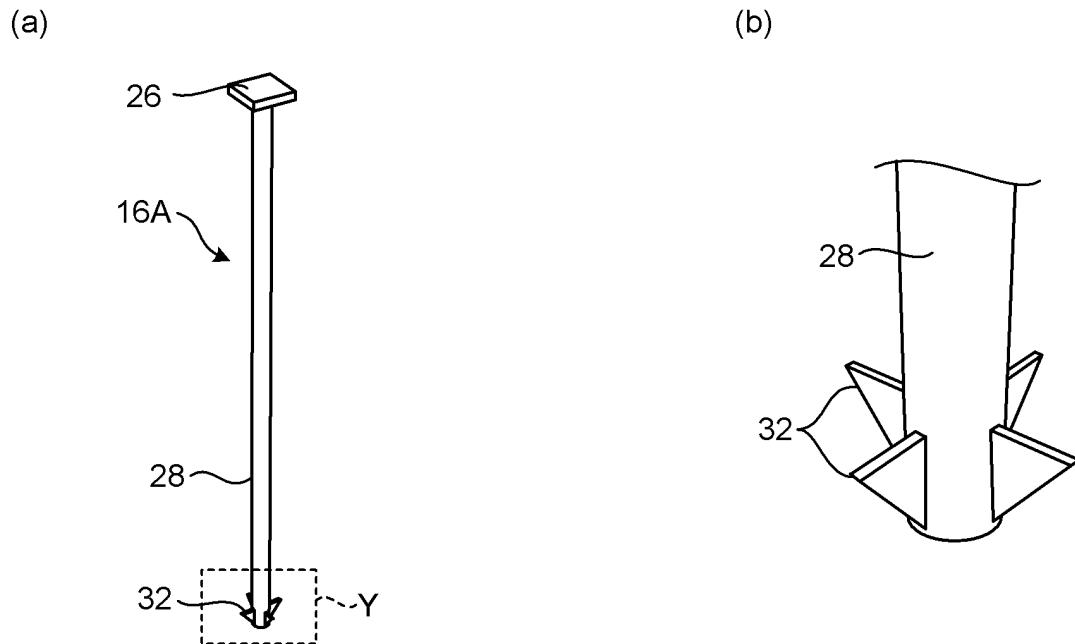


FIG.6

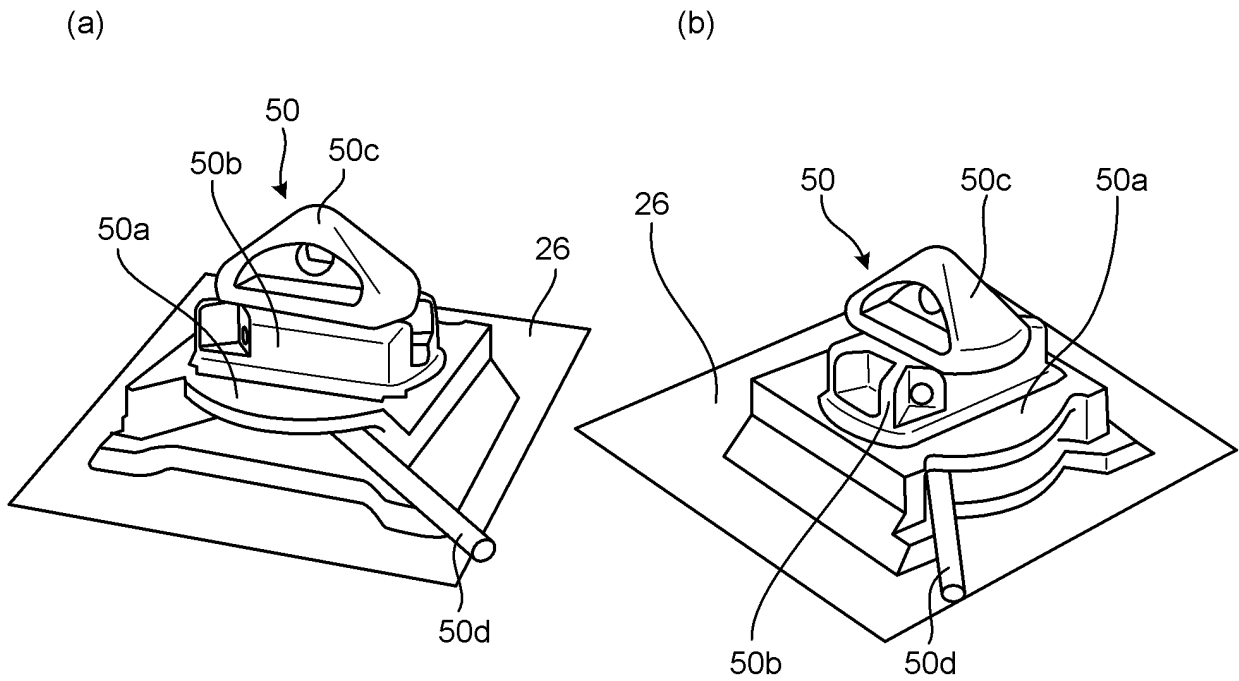
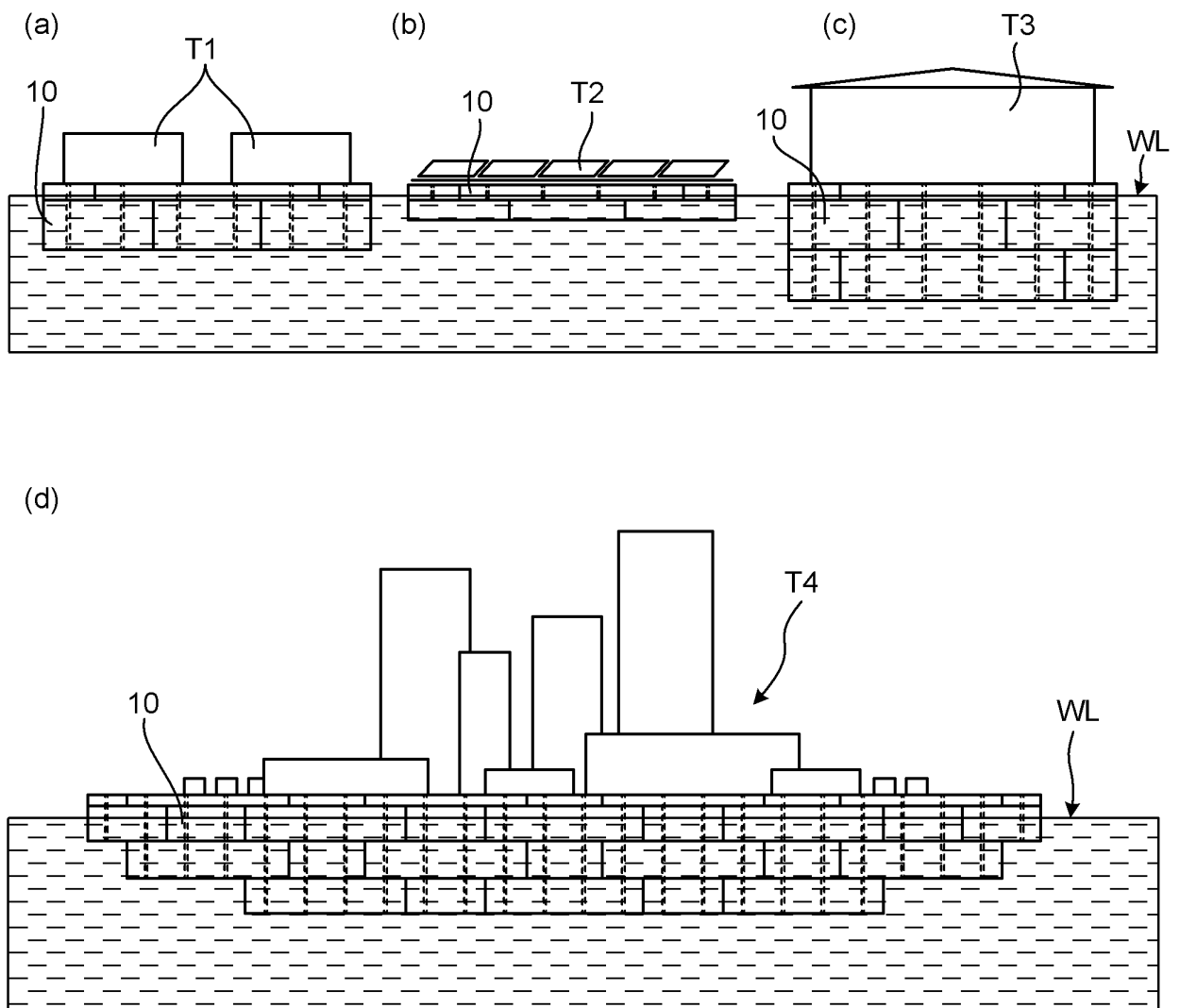


FIG.7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/044621

A. CLASSIFICATION OF SUBJECT MATTER B63B 35/38 (2006.01)i; B63B 35/44 (2006.01)i; E01D 15/14 (2006.01)i FI: B63B35/38 B; B63B35/44 M; E01D15/14 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) B63B35/38; B63B35/44; E01D15/14 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Published examined utility model applications of Japan 1922-1996 Published unexamined utility model applications of Japan 1971-2023 Registered utility model specifications of Japan 1996-2023 Published registered utility model applications of Japan 1994-2023 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)																					
C. DOCUMENTS CONSIDERED TO BE RELEVANT																					
<table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X A</td> <td>JP 2007-118925 A (KYOCERA CORP) 17 May 2007 (2007-05-17) paragraphs [0043]-[0048], [0104]-[0107], fig. 10-12</td> <td>1-5, 8-10 6-7, 11</td> </tr> <tr> <td>X Y A</td> <td>JP 10-67387 A (CHO, Masayuki) 10 March 1998 (1998-03-10) paragraphs [0018]-[0037], fig. 1-8</td> <td>1, 6, 10 7 2-5, 8-9, 11</td> </tr> <tr> <td>Y</td> <td>CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 76939/1993 (Laid-open No. 34028/1995) (CHO, Tsuyoshi) 23 June 1995 (1995-06-23), claims, fig. 1-4</td> <td>7</td> </tr> <tr> <td>A</td> <td>JP 2005-125979 A (AERO FACILITY KK) 19 May 2005 (2005-05-19)</td> <td>1-11</td> </tr> <tr> <td>A</td> <td>JP 2003-3419 A (HERABUNA SOGO KENKYUSHO KK) 08 January 2003 (2003-01-08)</td> <td>1-11</td> </tr> <tr> <td>A</td> <td>JP 5-4598 A (YAMAHA MOTOR CO LTD) 14 January 1993 (1993-01-14)</td> <td>1-11</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X A	JP 2007-118925 A (KYOCERA CORP) 17 May 2007 (2007-05-17) paragraphs [0043]-[0048], [0104]-[0107], fig. 10-12	1-5, 8-10 6-7, 11	X Y A	JP 10-67387 A (CHO, Masayuki) 10 March 1998 (1998-03-10) paragraphs [0018]-[0037], fig. 1-8	1, 6, 10 7 2-5, 8-9, 11	Y	CD-ROM of the specification and drawings annexed to the request of Japanese Utility Model Application No. 76939/1993 (Laid-open No. 34028/1995) (CHO, Tsuyoshi) 23 June 1995 (1995-06-23), claims, fig. 1-4	7	A	JP 2005-125979 A (AERO FACILITY KK) 19 May 2005 (2005-05-19)	1-11	A	JP 2003-3419 A (HERABUNA SOGO KENKYUSHO KK) 08 January 2003 (2003-01-08)	1-11	A	JP 5-4598 A (YAMAHA MOTOR CO LTD) 14 January 1993 (1993-01-14)	1-11
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Date of the actual completion of the international search 30 January 2023	Date of mailing of the international search report 14 February 2023																				
Name and mailing address of the ISA/JP Japan Patent Office (ISA/JP) 3-4-3 Kasumigaseki, Chiyoda-ku, Tokyo 100-8915 Japan	Authorized officer Telephone No.																				

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/044621

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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KR 10-1651819 B1	29 August 2016	(Family: none)	

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REFERENCES CITED IN THE DESCRIPTION

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