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(54) FLOATING MODULE AND FLOATING STRUCTURE

(57) A floating module (100) that comprises a reinforced concrete shell (101) having a rectangular top slab (102) and sidewalls (103) extending from the edges of the rectangular top slab (102) to define a cavity therein, a floating element arranged inside the cavity to provide buoyancy, a corner element (104) at each corner of the rectangular top slab, the corner element comprising at least two attachment points (106), and a side element (105) at each longer side of the rectangular top slab, the side element comprising at least two attachment points (106). A floating structure (200) that comprises a plurality of interconnected floating modules.

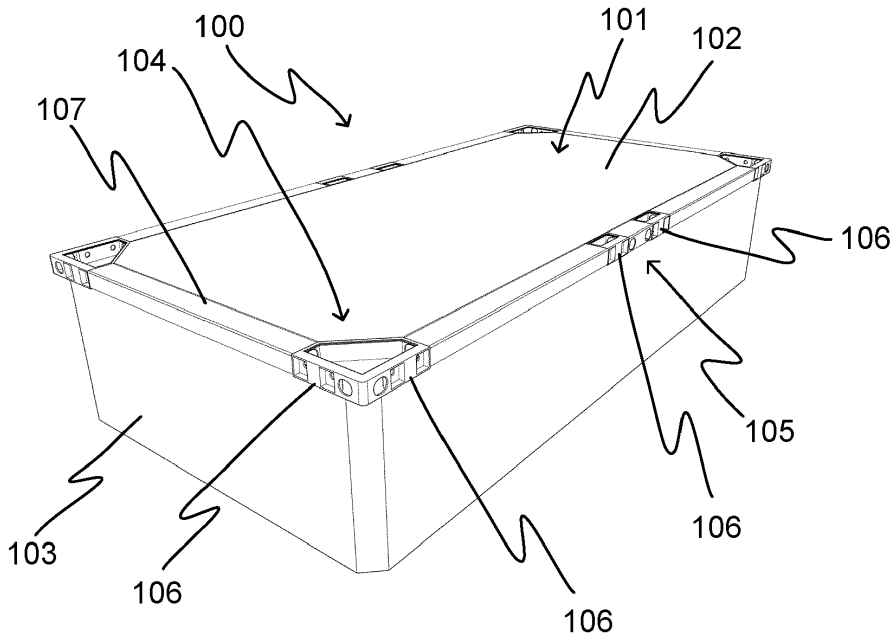

Fig. 1

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a floating module according to the preamble of the appended independent claim. The invention also relates to a floating structure that comprises a plurality of interconnected floating modules.

BACKGROUND OF THE INVENTION

[0002] Various floating structures, such as docks, platforms and bridges, are known in the prior art. Some of these floating structures are modular, consisting of interconnected floating modules. A problem associated with the known modular floating structures is that they are difficult and slow to assemble and disassemble. Another problem associated with the known modular floating structures is that the floating modules can be interconnected in only a particular way. Yet another problem associated with the known modular floating structures is that they are not strong enough to withstand harsh weather conditions and large loads.

OBJECTIVES OF THE INVENTION

[0003] It is the main objective of the present invention to reduce or even eliminate the prior art problems presented above.

[0004] It is an objective of the present invention to provide a floating module for a modular floating structure. In more detail, it is an objective of the invention to provide a floating module that enables the assembling and disassembling of a modular floating structure in an easy and quick manner. It is a further objective of the invention to provide a floating module that can be attached to other floating modules in various ways.

[0005] It is an objective of the present invention to provide a modular floating structure. In more detail, it is an objective of the invention to provide a modular floating structure that withstands harsh weather conditions and large loads. It is a further objective of the invention to provide a modular floating structure that can be placed in various places. It is yet a further objective of the invention to provide a modular floating structure that is suitable for temporary and permanent applications.

[0006] In order to realise the above-mentioned objectives, the floating module according to the invention is characterised by what is presented in the characterising portion of the appended independent claim. Advantageous embodiments of the invention are described in the dependent claims.

DESCRIPTION OF THE INVENTION

[0007] A floating module according to the invention comprises a reinforced concrete shell having a rectangular top slab and sidewalls extending from the edges of the rectangular top slab to define a cavity therein, and a floating element arranged inside the cavity to provide buoyancy. The floating module according to the invention further comprises a corner element at each corner of the rectangular top slab, the corner element comprising at least two attachment points, and a side element at each longer side of the rectangular top slab, the side element comprising at least two attachment points.

[0008] The floating module according to the invention is meant to be placed in water, such as a river, a lake or a sea, and it can be used for various purposes. The floating module can be used alone or attached to other floating modules. The interconnected floating modules form a modular floating structure. Depending on the arrangement, the orientation and the number of the interconnected floating modules, the floating structure can function, for example, as a dock, a platform or a bridge.

[0009] The floating module can have the shape of a rectangular block, the length and the width of which can be, for example, 8-12 m and 4-6 m, respectively. Preferably, the length of the floating module is twice the width of the floating module. The height of the floating module can be 1-3 m, and preferably 1.5-2.5 m. The floating module can have the length of 10 m, the width of 5 m and the height of 2 m. The ratio of width to length of the floating module can be, for example, 1:1, 1:2, 1:3 or 1:4.

[0010] The reinforced concrete shell comprises four sidewalls, which extend downwards from the edges of the rectangular top slab (deck). The sidewalls are connected to the edges of the rectangular top slab. Two of the sidewalls are connected to the longer sides of the rectangular top slab, and two of the sidewalls are connected to the shorter sides of the rectangular top slab. The ends of the sidewalls are connected to the ends of other sidewalls. Preferably, the sidewalls extend perpendicularly from the edges of the rectangular top slab, which means that the sidewalls are perpendicular to the rectangular top slab. In some cases, the sidewalls can be tilted towards each other. The sidewalls are preferably rectangular and planar.

[0011] The length of the rectangular top slab is preferably twice the width of the rectangular top slab. The length and the width of the rectangular top slab can be, for example, 8-12 m and 4-6 m, respectively. The rectangular top slab can have the length of 10 m and the width of 5 m. The thickness of the rectangular top slab can be, for example, 10-30 cm. The rectangular top slab is preferably planar. The ratio of width to length of the rectangular top slab can be, for example, 1:1, 1:2, 1:3 or 1:4.

[0012] The rectangular top slab together with the sidewalls define the cavity of the reinforced concrete shell. The bottom part of the reinforced concrete shell can be open, or it can be closed, for example, with a rectangular bottom slab. The rectangular bottom slab is connected at its edges to the sidewalls.

[0013] The floating element is arranged inside the cavity. The floating element provides buoyancy in water so

that the floating module can float. The floating element can be dimensioned in such a manner that when the (unloaded) floating module is in water, about half of the floating module is above the water surface. The floating element can be, for example, a pontoon, i.e. an airtight hollow structure, or an element made of a material having a density less than that of water. The floating element can have various shapes and sizes depending on the application. The floating element can have, for example, the shape of a cylinder or a rectangular block. The floating element may consist of one or more floating sections.

[0014] In the floating module according to the invention, one corner element is attached to each corner of the rectangular top slab. The corner element can, for example, be made of hot galvanized steel. Each corner element comprises at least two attachment points that can be used in attaching the floating module to other floating modules. The attachment point may comprise, for example, one or more holes for receiving an attachment bolt. The floating modules can be interconnected with attachment means that can attach to the attachment points of the corner elements. The attachment means may comprise, for example, attachment bolts. The corner element can consist of one or more parts. Preferably, the corner element consists of two parts, one of the parts being arranged at the longer side of the rectangular top slab and the other part being arranged at the shorter side of the rectangular top slab. The two parts can be attached to each other or arranged at a distance from each other. Each of the two parts comprises at least one attachment point.

[0015] In the floating module according to the invention, at least one side element is attached to each longer side of the rectangular top slab. The number of side elements can be chosen based on the ratio of width to length of the rectangular top slab. In a case where the length of the rectangular top slab is twice the width of the rectangular top slab, the floating module comprises one side element on each longer side of the rectangular top slab. In this case, the side element is placed in the middle of the longer side. Preferably, the side element is arranged close to the edge of the rectangular top slab. The side element can, for example, be made of hot galvanized steel. Each side element comprises at least two attachment points that can be used in attaching the floating module to other floating modules. The attachment point may comprise, for example, one or more holes for receiving an attachment bolt. The floating modules can be interconnected with attachment means that can attach to the attachment points of the side elements. The attachment means may comprise, for example, attachment bolts. The side element can consist of one or more parts. Preferably, the side element consists of two parts, each of which comprises at least one attachment point. The two parts are arranged consecutively, and they can be attached to each other or arranged at a distance from each other.

[0016] Preferably, each corner element and each side element comprise two attachment points. The distance between the attachment points in the adjacent corner and side elements can be the same as the distance between the attachment points in the adjacent corner elements. This allows the floating module to be attached to other floating modules in various ways. For example, two floating modules can be attached to each other so that their longer sides or shorter sides are side by side, or that the shorter side of one floating module is side by side with the longer side of the other floating module. In other words, two floating modules can be attached to each other so that their longitudinal directions are parallel or perpendicular.

[0017] The attachment point is preferably such that it enables the attachment to it in a releasable manner. The attachment point in the corner element or the side element may comprise, for example, one or more holes to which the attachments means, such as attachment bolts are attached, or one or more openings through which the attachment means, such as chains, can be passed. The attachment point in the corner element or the side element may comprise, for example, a counterpart for an attachment member of the attachment means.

[0018] An advantage of the floating module according to the invention is that it enables the assembling and disassembling of a modular floating structure in an easy and quick manner. Another advantage of the floating module according to the invention is that it can be connected to other floating modules in various ways.

[0019] According to an embodiment of the invention the reinforced concrete shell comprises a support beam that surrounds the edges of the rectangular top slab. The support beam is preferably connected to the corner elements and the side elements. In some cases, the side elements can be integrated to the support beam. Preferably, the support beam overhangs the sidewalls. The support beam improves the rigidity of the floating module and it can sustain impacts from other floating modules. The support beam enables the attachment of various components, such as ladders, bollards and lampposts, to the floating module. The support beam can, for example, be made of hot galvanized steel. The support beam can have, for example, a square, round, or rectangular cross section.

[0020] According to an embodiment of the invention the support beam is hollow. The hollow support beam enables to arrange various components, such as electric cables, and water pipes and hoses, inside the support beam. The corner element(s) and/or the side element(s) may comprise one or more openings through which, for example, an electric cable, or a water pipe or hose can pass into or out of the support beam.

[0021] According to an embodiment of the invention the reinforced concrete shell comprises tubes arranged to extend through the rectangular top slab in its longitudinal and transverse directions. Preferably, the reinforced concrete shell comprises at least two tubes in the longitudinal direction of the rectangular top slab and at

least four tubes in the transverse direction of the rectangular top slab. The tubes are preferably arranged to extend between the corner elements and the side elements. The tubes enable to pass various components, such as electric cables, and water pipes and hoses, through the tubes from one floating module to another. The corner element(s) and/or the side element(s) are preferably attached to the tube(s) and comprise one or more openings through which, for example, an electric cable, or a water pipe or hose can pass into or out of the tube.

[0022] According to an embodiment of the invention the floating element is made of polystyrene. The polystyrene is a material from which it is easy to manufacture floating elements in various shapes and sizes. The floating element can, for example, be a rectangular block having a length of 6-8 m, a width of 3-4 m, and a height of 1-1.5 m.

[0023] According to an embodiment of the invention the reinforced concrete shell is reinforced with a hot galvanized reinforcement mesh. The hot galvanized reinforcement mesh is highly corrosion and oxidation resistant and easy to use in the manufacturing of the floating module. The reinforced concrete shell can alternatively be reinforced with a stainless steel or composite reinforcement mesh.

[0024] According to an embodiment of the invention the reinforced concrete shell comprises a rectangular bottom slab, wherein the sidewalls extend to the edges of the rectangular bottom slab. In this case, the reinforced concrete shell is a closed structure, wherein the cavity is defined by the rectangular top and bottom slabs and the sidewalls. The surface area of the rectangular bottom slab is preferably the same or smaller than the surface area of the rectangular top slab. In a case where the surface area of the rectangular bottom slab is smaller than that of the rectangular top slab, the sidewalls are tilted towards each other.

[0025] According to an embodiment of the invention the sidewalls are tilted inwards. In other words, the opposite sidewalls of the reinforced concrete shell are tilted towards each other. An advantage of the tilted sidewalls is that it increases the structural strength of the floating module against ice loads.

[0026] According to an embodiment of the invention the floating module comprises at least one rubber element that is arranged in connection with the attachment point. In other words, at least one of the attachment points in the floating module is provided with a rubber element. The rubber element can be arranged to the attachment point of the corner element or the side element. Each or only some of the attachment points in the floating module can be provided with the rubber elements. The rubber element can be attached to the attachment point by using the attachment means. For example, the rubber element may comprise through-holes for attaching the rubber element to attachment bolts which are attached to the attachment point. The rubber element can have, for example, a shape of a rectangular block or a cylinder. The rubber element can, for example, be made of a natural or synthetic rubber.

[0027] The rubber elements are used between attachment points of interconnected floating modules. The rubber elements are elastic, which permits a slight relative movement of the floating modules in waves. The rubber elements also improve the load distribution between interconnected floating modules by reducing the shear forces acting on the floating modules.

[0028] According to an embodiment of the invention the floating module comprises at least one elastic element that is arranged in connection with the sidewall. Depending on the use of the floating module, one or more of the sidewalls can be provided with one or more elastic elements. In some applications, all sidewalls of the floating module are provided with one or more elastic elements. The elastic elements can be arranged at different heights of the sidewall. Preferably, the elastic element is arranged in connection with the lower portion of the sidewall. The elastic element can be attached to the sidewall. Alternatively, the elastic element can be attached to an end of a flexible connecting element, such as a chain, a cable or the like. The other end of the flexible connecting element can be attached to the corner element or the side element, or to the upper portion of the sidewall. Preferably, the other end of the flexible connecting element is attached in a releasable manner. The elastic element can be, for example, a rubber element or a spring element. The rubber element can have, for example, a shape of a rectangular block, a cylinder, or a ball. The rubber element can be made of a natural or synthetic rubber. The spring element can be made of a metal, synthetic or composite material.

[0029] The elastic elements prevent the sidewalls of interconnected floating modules from hitting each other. The elastic elements, especially the ones arranged in connection with the lower portion of the sidewall, improve the load distribution between the interconnected floating modules. Because of the elastic elements, the sagging, i.e. bending downward, of the interconnected floating modules is small. When an external downward pressing force acts on one or more floating modules, the elastic elements between the other interconnected floating modules are compressed against the sidewalls. As a result, the load produced by the external downward pressing force is more evenly distributed over the interconnected floating modules.

[0030] The present invention also relates to a floating structure. The floating structure according to the invention comprises a plurality of floating modules according to the invention attached to each other using attachment means, which are attached to the attachment points of the floating modules.

[0031] The floating structure according to the invention is a modular structure, which comprises interconnected floating modules. The floating modules are arranged side by side and in one or more layers. The floating structure according to the invention is meant to be placed in water,

such as a river, a lake or a sea, and it can be used for various purposes. Depending on the arrangement, the orientation and the number of the interconnected floating modules, the floating structure can function, for example, as a dock, a platform or a bridge. The number of the floating modules in the floating structure can be, for example, 2-10, 10-50, 50-200, or more than 200. The length of the floating structure can be, for example, less than 25 m, 25-50 m, 50-100 m, or more than 100 m. The width of the floating structure can be, for example, less than 10 m, 10-20 m, or more than 20 m.

[0032] The floating modules can be attached to each other in various ways. The adjacent floating modules can be arranged side by side so that their longitudinal directions are parallel or perpendicular with respect to each other. The floating modules can be arranged in more than one layer, i.e. arranged on top of each other, which considerably improves the rigidity of the floating structure.

[0033] The floating modules are attached to each other in a releasable manner so that one or more floating modules can be removed from the floating structure when needed. On the other hand, one or more floating modules can be added to the floating structure when needed. Because the floating modules are attached in a releasable manner, a damaged floating module can be easily replaced.

[0034] The attachment means may comprise, for example, a chain that is attached to the attachment points in the floating modules. The attachment point in the corner element or the side element may comprise, for example, an opening through which the chain is passed. The attachment means may comprise, for example, an attachment member that is attached to a counterpart in the attachment point.

[0035] An advantage of the floating structure according to the invention is that it can withstand harsh weather conditions and large loads. Another advantage of the floating structure according to the invention is that it can be easily assembled in various places. Still another advantage of the floating structure according to the invention is that it can be easily disassembled. Still another advantage of the floating structure according to the invention is that it is suitable for temporary and permanent applications.

[0036] According to an embodiment of the invention the floating modules are arranged in at least two layers. By arranging the floating modules in more than one layer, the rigidity of the floating structure can be improved and thus the floating structure can better withstand harsh weather conditions and large loads. Furthermore, the floating structure according to this embodiment has a larger freeboard, which facilitates the mooring of a vessel to the floating structure.

[0037] According to an embodiment of the invention the floating modules are arranged in a staggered manner. By arranging the floating modules in a staggered manner, the rigidity of the floating structure can be improved and thus the floating structure can better withstand harsh weather conditions and large loads.

[0038] According to an embodiment of the invention the floating structure comprises rubber elements between the sidewalls of the adjacent floating modules. The rubber elements prevent the sidewalls of the floating modules from hitting each other. The rubber elements also improve the load distribution.

[0039] According to an embodiment of the invention the floating structure is a dock, a platform or a bridge.

[0040] The exemplary embodiments of the invention presented in this text are not interpreted to pose limitations to the applicability of the appended claims. The verb "to comprise" is used in this text as an open limitation that does not exclude the existence of also unrecited features. The features recited in the dependent claims are mutually freely combinable unless otherwise explicitly stated.

[0041] The exemplary embodiments presented in this text and their advantages relate by applicable parts to the floating module as well as the floating structure according to the invention, even though this is not always separately mentioned.

BRIEF DESCRIPTION OF THE DRAWINGS

[0042]

Fig. 1 illustrates a floating module according to a first embodiment of the invention,

fig. 2 illustrates a floating structure according to an embodiment of the invention, and

fig. 3 illustrates a floating module according to a second embodiment of the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

[0043] The same reference signs are used of the same or like components in different embodiments.

[0044] Fig. 1 illustrates a floating module according to a first embodiment of the invention. The floating module 100 can be used alone, or it can be attached to other floating modules, which together form a floating structure, such as a dock, a platform or a bridge.

[0045] The floating module 100 comprises a reinforced concrete shell 101, which comprises a rectangular top slab 102 and sidewalls 103 that extend perpendicularly downwards from the edges of the rectangular top slab 102. The reinforced concrete shell 101 is reinforced with a hot galvanized reinforcement mesh (not shown in fig. 1).

[0046] The rectangular top slab 102 and the sidewalls 103 define a cavity (not shown in fig. 1), inside which is arranged a floating element (not shown in fig. 1). The floating element provides buoyancy so that the floating module 100 can float in water. The floating element has the shape of a rectangular block and it is made of polystyrene.

[0047] The floating module 100 comprises a corner element 104 at each corner of the rectangular top slab 102, and a side element 105 at each longer side of the rectangular top slab 102. Each corner element 104 and each side element 105 comprise two attachment points 106 that can be used in attaching the floating module 100 to other floating modules in various orientations. The floating module 100 can be attached to another floating module so that the longitudinal directions of the interconnected floating modules are parallel or perpendicular. The floating module 100 can be attached to other floating modules with attachment means (not shown in fig. 1) that can attach to the attachment points 106 in the floating module 100.

[0048] The reinforced concrete shell 101 comprises a support beam 107 that surrounds the edges of the rectangular top slab 102 and overhangs the sidewalls 103. The support beam 107 is attached to the corner elements 104 and the side elements 105. The support beam 107 is hollow, which enables the arrangement of electric cables (not shown in fig. 1) inside the support beam 107.

[0049] Fig. 2 illustrates a floating structure according to an embodiment of the invention. The floating structure 200 is a bridge that is placed in a river 201 between two riverbanks 202 and it provides a river crossing for people and vehicles. The ends of the floating structure 200 comprise widened sections 203, which are connected through ramps 204 to the riverbanks 202.

[0050] The floating structure 200 comprises a plurality of interconnected floating modules 100. The floating modules 100 are arranged in two layers and they are attached to each other with differing orientations that provides a rigid structure and thus enables the floating structure 200 to withstand harsh weather conditions and large loads. The floating modules 100 are attached to each other using attachment means 205, which attach to the attachment points 106 of the floating modules 100. Rubber elements (not shown in fig. 2) are arranged between the sidewalls 103 of the adjacent floating modules 100 in order to prevent the sidewalls 103 of the floating modules 100 from hitting each other.

[0051] Fig. 3 illustrates a floating module according to a second embodiment of the invention. The floating module 100 can be used alone, or it can be attached to other floating modules, which together form a floating structure.

[0052] The floating module 100 comprises a reinforced concrete shell 101, which comprises a rectangular top slab 102 and sidewalls 103 that extend perpendicularly downwards from the edges of the rectangular top slab 102. The rectangular top slab 102 and the sidewalls 103 define a cavity (not shown in fig. 3), inside which is arranged a floating element (not shown in fig. 3) that provides buoyancy.

[0053] The floating module 100 comprises a corner element 104 at each corner of the rectangular top slab 102, and a side element 105 at each longer side of the rectangular top slab 102. Each corner element 104 and each side element 105 comprise two attachment points 106 that can be used in attaching the floating module 100 to other floating modules in various orientations. The floating module 100 can be attached to other floating modules with attachment bolts 301 that are attached to the attachment points 106.

[0054] The reinforced concrete shell 101 comprises tubes 302 that are arranged to extend through the rectangular top slab 102 in its longitudinal and transverse directions. The tubes 302 enable to pass electric cables, and water pipes and hoses, through the tubes 302 from one floating module to another.

[0055] The floating module 100 comprises upper and lower rubber elements 303, 304. The upper rubber elements 303 are attached with the attachment bolts 301 to the attachment points 106. The lower rubber elements 304 are attached to the sidewall 103 with chains 305. The upper and lower rubber elements 303, 304 prevent the sidewalls 103 of the floating modules 100 from hitting each other.

[0056] Only advantageous exemplary embodiments of the invention are described in the figures. It is clear to a person skilled in the art that the invention is not restricted only to the examples presented above, but the invention may vary within the limits of the claims presented hereafter. Some possible embodiments of the invention are described in the dependent claims, and they are not to be considered to restrict the scope of protection of the invention as such.

Claims

1. A floating module, comprising:

   - a reinforced concrete shell having a rectangular top slab and sidewalls extending from the edges of the rectangular top slab to define a cavity therein, and
   - a floating element arranged inside the cavity to provide buoyancy,

   characterised in that the floating module comprises:

   - a corner element at each corner of the rectangular top slab, the corner element comprising at least two attachment points, and
   - a side element at each longer side of the rectangular top slab, the side element comprising at least two attachment points.

2. The floating module according to claim 1, **characterised in that** the reinforced concrete shell comprises a support beam that surrounds the edges of the rectangular top slab.

3. The floating module according to claim 2, **characterised in that** the support beam is hollow.

4. The floating module according to any of the preceding claims, **characterised in that** the reinforced concrete shell comprises tubes arranged to extend through the rectangular top slab in its longitudinal and transverse directions.

5. The floating module according to any of the preceding claims, **characterised in that** the floating element is made of polystyrene.

6. The floating module according to any of the preceding claims, **characterised in that** the reinforced concrete shell is reinforced with a hot galvanized reinforcement mesh.

7. The floating module according to any of the preceding claims, **characterised in that** the reinforced concrete shell comprises a rectangular bottom slab, wherein the sidewalls extend to the edges of the rectangular bottom slab.

8. The floating module according to any of the preceding claims, **characterised in that** the sidewalls are tilted inwards.

9. The floating module according to any of the preceding claims, **characterised in that** the floating module comprises at least one rubber element that is arranged in connection with the attachment point.

10. The floating module according to any of the preceding claims, **characterised in that** the floating module comprises at least one elastic element that is arranged in connection with the sidewall.

11. A floating structure, **characterised in that** the floating structure comprises a plurality of floating modules according to any of the preceding claims attached to each other using attachment means, which are attached to the attachment points of the floating modules.

12. The floating structure according to claim 11, **characterised in that** the floating modules are arranged in at least two layers.

13. The floating structure according to claim 11 or 12, **characterised in that** the floating modules are arranged in a staggered manner.

14. The floating structure according to any of claims 11 to 13, **characterised in that** the floating structure comprises rubber elements between the sidewalls of the adjacent floating modules.

15. The floating structure according to any of claims 11 to 14, **characterised in that** the floating structure is a dock, a platform or a bridge.

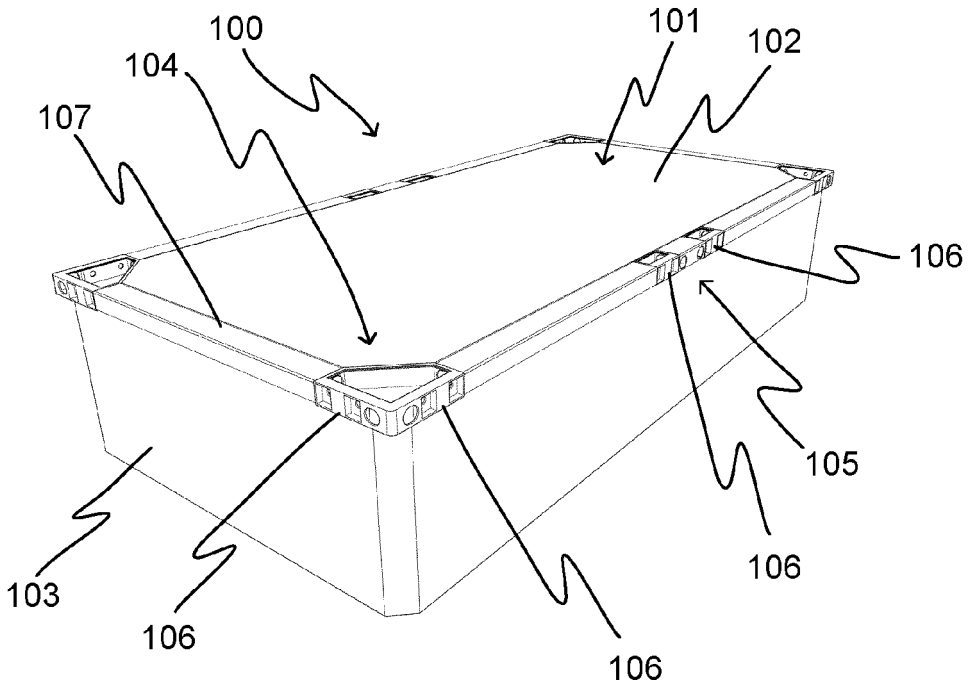
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Fig. 1

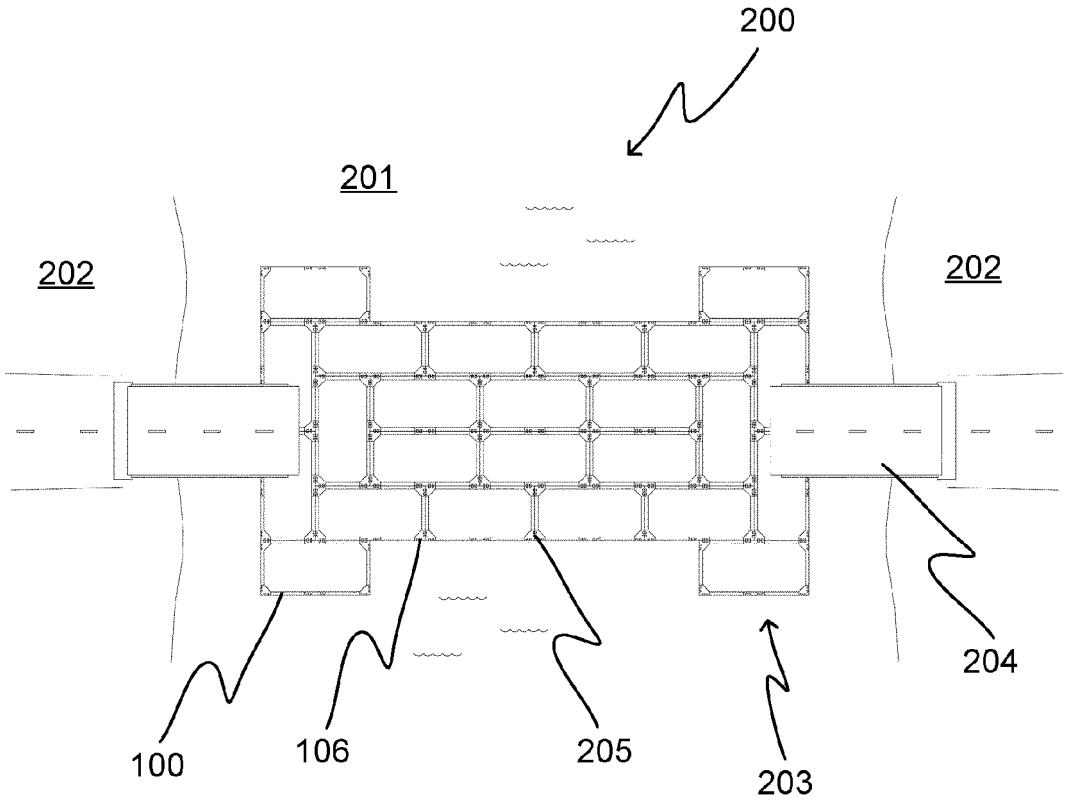
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Fig. 2

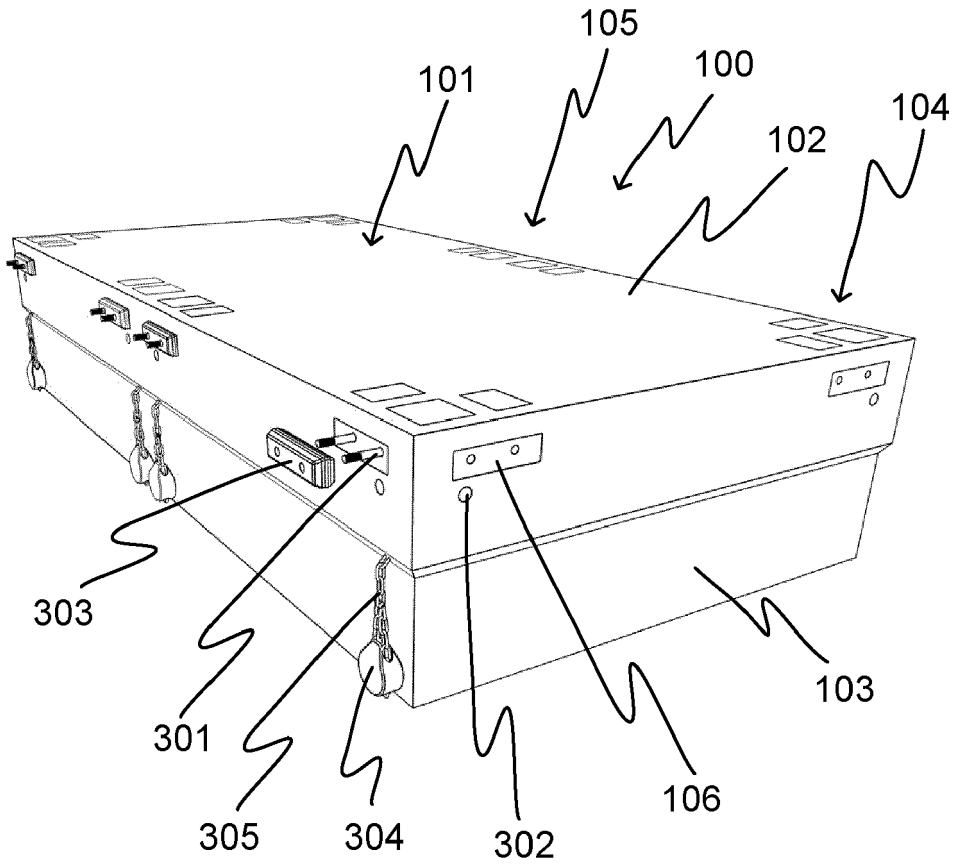

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 20 21 0314

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	KR 101 851 933 B1 (M MARINA [KR]) 25 April 2018 (2018-04-25) * figures 1-6 *	1-5,7-9, 11,12,15	
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			TECHNICAL FIELDS SEARCHED (IPC) B63B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 April 2021	Székely, Zsolt

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 21 0314

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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