

OFFSHORE FLOATING MARINA

Identification of parties concerned

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15 virtue of prior invention.

Background of the Invention

This invention relates to floating territories. In particular, this invention relates to a floating wave damper used to decrease the impact of the waves on marina floating territory, so that the floating territory,
20 here exemplified by a marina, can be installed offshore.

Floating marina or floating parts of marina can only be built in protected waters because they cannot withstand the effect of the waves as can happen offshore. Moreover, nearly all shores near populated areas are built up so that the further extension of existing onshore marinas is practically impossible.
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What is needed is a floating marina that can withstand the waves as can be found offshore and protect the boats moored into it.

30 Still further, what is needed is a system that can damp the effect of the waves so that floating infrastructures do not need to face the full strength of the offshore waves.

A further object of the invention is to provide a system that also allows the building of a floating island that can resist the waves and to harvest some of the energy provided by the waves.

Another object of the invention is to provide a system, that stores the energy harvested from the waves and delivers the energy on-demand to the user of any floating structure.

Still a further object of the invention is to provide a method for operating such systems.

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Summary of the Invention

A task of the invention is to provide a floating structure, which can be installed offshore. This task can be solved by a floating structure, preferably a floating marina, for floating in the open water, the floating structure optionally configured to serve as a boat docking, including:

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- a surrounding structure and an inner space, the surrounding structure surrounding the inner space for at least one boat to dock at a boat docking place of the floating structure, the surrounding structure including an opening for the boat to enter the inner space from the open water or leave it vice versa,

- a connecting point for connecting an anchoring line to anchor the floating structure to float at a set area within the open sea, the connection point being at a first side of the surrounding structure and the opening substantially being arranged at an opposite side of the surrounding structure, so the opening is arranged at a downstream end of the floating structure.

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The task can be solved by a wave energy harvesting system, preferably a wave attenuator having a plurality of floaters the floaters being able to move vertically independent from each other for each floater to follow the movement of sea waves when placed on the surface of the sea.

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The invention is based on the realization that the floating structure itself can act as a wave energy harvesting system for boats entering the inner space. Therefore, the possibly higher waves within the open water do not affect the moving of the boats within the inner space. Furthermore, by having arranged the connection point of the anchor at the first side of the surrounding structure and the opening for the boats to enter the inner space being arranged at the side of the surrounding structure being substantially the side opposite the first side, the controlling of the boat to be moored/parked in a parking slot or slip becomes easier.

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In a further development, the floating structure includes a wave energy harvesting system, preferably a wave attenuator fixed to the surrounding structure at the first side of the surrounding structure. Therefore, the inner space and the opening can be kept free of higher waves so that controlling the boat(s) for entering or leaving the inner space or steering the boat at the boat docking place is easier. Such wave energy

harvesting system may also be used to protect islands, coast lines, reefs, and the like from the strength of the waves.

5 In a further development of the floating structure or the wave energy harvesting system, the wave energy harvesting system includes a plurality of floaters, the floaters being able to move vertically independent from each other so that each floater can follow the movement of sea waves when placed on the surface of the sea. Therefore, the strength of the waves can be damped and energy for later usage can be stored. Furthermore, the weight of the floating structure would cause relative movement of the floaters.

10 In a further development, the wave energy harvesting system includes an energy converting system, the energy converting system adapted to generate electrical energy based on the relative movement of the floaters.

15 In a further development, the wave energy harvesting system includes a ballast system capable of adjusting the weight of the superstructure and thereby the immersion depth of the floaters. Therefore, the energy harvesting performance of the system can be adapted to the local meteorological conditions, such as waves height. The weight of the ballast system can exemplarily be adjusted by pumping water into a tank of the ballast system, whereby the tank is fixed to the superstructure.

20 In a further development, the energy converting system includes a pumping system for pumping a fluid into a reservoir based on the relative movement of the floaters to each other, the energy converting system further including an energy converter for converting energy, preferably potential energy, of the fluid in the reservoir into usable energy, preferably thermal energy or electrical energy. The pumping system provides the possibility of storing usable energy.

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In a further development the floating structure includes a superstructure.

Brief Description of the Drawings

30 The disclosed technologies are explained in more detail symbolically and by way of example on the basis of the figures. The same reference numerals signify the same components and reference numerals with different indices indicate functionally equivalent or similar components.

FIG. 1 is a schematic view of a floating structure being anchored;

FIG. 2 is a schematic view of the floating structure of FIG. 1 in detail;

35 FIG. 3 is a side view of a further floating structure in a side view;

FIG. 4 is a schematic view of a wave energy harvesting system according to a first embodiment;
FIG. 5 is a schematic view of a wave energy harvesting system according to a second embodiment; and
FIG. 6 is a schematic view of a floater.

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Detailed Description of the Preferred Embodiment

The following description is not intended to limit the scope of the invention in any way as it is exemplary in nature, serving to describe the best mode of the invention known to the inventors as of the filing date hereof. Consequently, changes may be made in the arrangement and/or function of any of the elements described in the exemplary embodiments disclosed herein without departing from the spirit and scope of the invention.

Referring now to FIG. 1, a floating structure 2, 2' is anchored at an anchoring point 4. The floating structure 2, 2' is connected to the anchoring point 4 by an anchor line 6. The anchor line 6, 6' may be an anchor chain or any other means suitable for anchoring the floating structure 2, 2' to the anchoring point 4, in particular downstream the anchoring point 4. Based on the direction of movement W, W' of the surrounding water, which may be similar to the direction of the blowing wind, the floating structure 2, 2' is arranged according to the position of the anchoring point 4, in particular downstream the anchoring point 4. More precisely the floating structure 2 is arranged in its according position shown in FIG. 1, when the floating water has a direction according to arrow W, and accordingly, the floating structure 2' is arranged at the position shown in FIG. 1, when the water is floating from the direction W'. Based on the length of the anchor line 6, the floating structure 2, 2' is positioned within a circular area, for instance having a radius of 500 m with the anchoring point 4 in the center of the circular area.

Referring now to FIG. 2, the floating structure 2, 2' of FIG. 1 is shown in detail. The floating structure 2, 2' is positioned according to the anchoring point 4, the length of the anchor line 6 and the direction W, W' of the floating water. The floating structure 2, 2' includes surrounding structure 10 and an inner space 20. Advantageously the floating structure 2, 2' further includes a wave energy harvesting system 14, a space 16 for placing buildings as restaurants, shops or service buildings or the like. The surrounding structure 10 includes an opening 12 for boats to enter the inner space 20, coming from the open water surrounding the floating structure 2, 2'. The inner space 20 may include at least one boat docking place 18, advantageously at least two boat docking places 18.

The anchor line 6 is connectable to the surrounding structure 10 at a connection point 24 at a first side of the surrounding structure 10. The opening 12 for the boats entering the inner space 20 is arranged at the

opposite side of the surrounding structure 10. Therefore, the connection point 24 is oriented towards the coming wind or towards the floating water respectively. Consequently, according to the opening 12 being arranged at the opposite side of the surrounding structure 10, the opening 12 is therefore oriented towards the downstream direction. Therefore, boats entering the inner space 20 drive against the streaming water giving a better possibility of controlling only small movement while steering into the boat docking place 18. Furthermore, the floating structure 2, 2', in particular, the surrounding structure 10 and optionally the wave energy harvesting system 14 protect the area of the opening 12 from being exposed to higher waves. Such higher waves, which using the invention can be avoided, would have the effect of complicating the entry of the boat into the inner space 20.

Referring now to FIG. 3, a floating structure 2, 2' includes a surrounding structure 10 and an inner space 20. The floating structure 2, 2' further includes a wave energy harvesting system 14 and optionally a space 16 for placing buildings. A restaurant 30 is optionally placed on the space 16. The surrounding structure 10 includes an opening 12 for boats to enter the inner space 20, coming from the open water surrounding the floating structure 2, 2'.

The anchoring point 4 for anchoring the floating structure 2,2' is exemplary situated at an anchoring pole 40. The anchor line 6 runs from the anchoring pole 40 to the connection point 24 completely under water. The connection point 24 is placed at the surrounding structure 10, which can reach deep below the water line. The surrounding structure 10 built to reach deep below the water line has the effect, that the floating structure 2, 2' is very stable independent of higher waves hitting the floating structure 2, 2'. The floating structure 2, 2' includes interconnected floating elements 32 connected to the surrounding structure 10. The floating elements 32 are each mounted at the surrounding structure 10, each floating element 32 being movable in a vertical direction relative to the surrounding structure 10 and also vertically movable relative to its immediate neighboring floating element(s) 32. Therefore, each of the floating elements vertically follows the water line.

In the current disclosure, the term "wave" is used to describe the water waves of the sea, lakes and/or oceans.

The system of the invention includes a floating island made of a rigid superstructure that is carried above the crests of the waves by a plurality of floaters, these floaters being free to move vertically and thereby to follow the upwards and downwards movements of the sea.

Referring now to FIG.4 and FIG.5, the system 100, 200 includes a rigid superstructure 1200, 2200 that

is carried above the surface of the waves 1302, 2302 by a flexible structure 1300, 2300 made of a large number, such as more than 10, preferably more than 100, even more preferably more than 1000 floaters 1310, 2310. The floaters 1310, 2310 are free to move substantially vertically and relative to one another, following the upward and downward movement of the waves 1302, 2302.

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All or a part of the floaters 1310, 2310 include an alignment feature 1314, 2314 that engages into a corresponding alignment feature 1324, 2324 on the superstructure 1200, 2200, to prevent creeping of the flexible structure 1300, 2300 relative to the superstructure 1200, 2200. Optionally all or a part of the floaters 1310, 2310 are maintained in an upright position by a ballast 1312, 2312 that may be installed below or within the floater 1310, 2310. Optionally, all or a part of the floaters 1310, 2310 maintain each other in their horizontal position relative to each other and/or to the superstructure 1200, 2200 by vertically sliding, optionally interlocking features (not represented in this figure). Optionally, all or some of the floaters maintain each other in an upright position by vertically sliding, optionally within interlocking features (not represented in this figure).

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The floaters 1310, 2310 carry the superstructure 1200, 2200 via a piston 1332 and cylinder 1334 constituting a pump, or via an inflatable cushion 2332. The inflatable cushion may have the shape of a tore or toroid or any other appropriate shape or configuration, such as e.g., multi-chambers configuration, as known in the industry. The cylinders 1334 or inflatable cushions 2332 are fluidically connected to a piping system 1412, 2412 that includes one-way valves or elements of similar function as known in the industry (not represented), so that the fluid pumped by the pistons 1332 and cylinders 1334 or by the inflatable cushions 2332 is collected into a reservoir 1414, 2414. The fluid used for pumping may be air, or water, or any other suitable fluid known in the industry. The reservoir 1414, 2414 is fluidically connected to an energy converter 1500, 2500 via another piping system 1418, 2418, such system including regulating means 1416, 2416 to adapt the quantity of fluid delivered to the energy converter 1500, 2500. The piping systems 1412, 1416, 1418, 2412, 2416, 2418 and the reservoir 1414, 2414 may include pressure converters or adapters, and monitoring equipment (not represented), as known in the industry. The energy converter 1500, 2500 may be an electricity generator, but could be also converting the fluid height or pressure (in case the fluid is a compressible fluid) into another form of energy, such as e.g., mechanical movement.

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The superstructure 1200, 2200 carries a ballast system 1202, 2202 to adapt its weight to the waves 1302, 2302 height and to the surrounding meteorological conditions, thereby ensuring optimal performance of the energy harvesting system 100, 200. The reservoir 1414, 2414 and/or the energy converter 1500, 2500 and/or other parts of equipment of the system 100, 200 may be installed on a separate floating installation to ensure maximum adaptability of the superstructure weight through the ballast 1202, 2202.

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When the waves 1302, 2302 are higher than the sum of the height of the floaters added to the immersion depth of the floaters 1310, 2310 due to their carrying the weight of the superstructure 1200, 2200 (such weight being adaptable through the use of the ballast 1202, 2202) and their own weight, the floaters 1310, 2310 are no longer permanently in contact with the superstructure 1200, 2200 and they follow the downward movement of the waves 1302, 2302. Since the floaters 1310, 2310 are free to move downwards, they don't weigh on the superstructure 1200, 2200. When a wave pushes the floaters 1310, 2310 upwards again, the floaters 1310, 2310 activate the piston 1332 or inflatable cushion 2332, pushing it upwards until the floaters 1310, 2310 carry the superstructure 1200, 2200, thereby pumping fluid through the collector piping system 1412, 2412 into the reservoir 1414, 2414. As a result, the reservoir 1414, 2414 constitutes a reserve of energy in the form of collected fluid, optionally fluid under pressure in case a compressible fluid is used.

When conversion of the stored energy into another form of energy, for example electricity, the user opens the regulator 1416, 2416 and produces the energy requested on-demand.

Referring now to FIG. 6, an example of floater 3300 of the invention is shown. The main body 3310 of the floater 3300 has the form of a vertically positioned triangular prism of a basic form of an equilateral triangle which is extruded at the same depth as the length of a side of the equilateral triangle along a perpendicular axis having alternating male and female dovetails or recesses, respectively, and includes interlocking male 3322 and female 3324 features, as well as an alignment feature 3314.

A floating structure of the invention may provide mooring for any number of boats of any size, as appropriate.

A floating structure of the invention may include any appropriate services, professional infrastructures and/or equipment, boat building or repair infrastructures and/or equipment, medical infrastructures and/or equipment, and/or leisure infrastructures.

As shown, the floating structure may be moored offshore and orients itself naturally downwind or downstream against the combined effect of the winds and the waves, in the same way as an anchored vessel. As a result, the entrance of the floating structure, when formed as a floating marina, the boats moored into it are best protected from the effect of the winds and waves. The floating structure may be equipped with motors or may be oriented actively or may be towed to any location as appropriate. The dimensions shown in this figure are given as an example and do not constitute any limitation of the size and/or proportion of the object of the invention.

The side of the surrounding structure which faces the combined effect of the winds and the waves may be protected by another floating infrastructure (wave attenuator) as being part of the floating structure, designed to amortize at least in part the force of the waves hitting the surrounding structure. The wave energy harvesting system and the surrounding structure are attached together, however such attachment is made so that the wave energy harvesting system and the residual parts of the floating structure can move vertically relative to each other.

Floating infrastructures or wave attenuators built as described in international patent applications PCT/IB2019/056405 MODULAR FLOATING STRUCTURE AND METHOD OF CONSTRUCTION and PCT/IB2020/056129 MODULAR FLOATING TERRITORY - the entirety of the content - are explicitly incorporated herein by reference and relied upon to define features for which protection may be sought hereby as it is believed that the entirety thereof contributes to solving the technical problem underlying the invention, some features that may be mentioned hereunder being of particular importance.

The floating wave energy harvesting system may include a rigid superstructure installed on floatable building components or buoys. The floatable building components follow the movement of the waves, but they are ballasted so that their movement consumes energy from the waves when moving up. The floatable building components are guided vertically relative to the superstructure by linear guiding systems and/or by interlocking features between themselves, so as to constitute a wall that is rigid in the direction of the waves but flexible vertically. The floatable building components have a height that is comparable to the height of the waves they are to dampen, ideally higher than the waves they are to dampen. As an example, to damp the energy of waves of 2 m height, floaters of 4 m height may be used, with a ballast ensuring them to float with approximately 75 per cent of their height immersed, so that they constitute a wall of 4 m height, of which 3 m are below the water. Several rows of floatable building components may be installed to obtain sufficient damping of the wave's energy.

In order for the floating structure to be rigid and stable, a part of its structure extends below the surface of the water, at a sufficient depth so that boats can circulate above without touching. This part of the structure that is underwater also provides the necessary attachments for the mooring of the at least one boat. The part of the structure that is underwater may be used to attach the floating structure to a mooring pillar.

An infrastructure similar to the waves energy harvesting system of the present invention may be used to protect any other floating infrastructure to be installed offshore.

An infrastructure similar to the waves energy harvesting system of the present invention may be used to reduce the effect of the waves on the shores or on corals.

5 In an advantage, a floating structure is provided that can withstand the waves as can be found offshore and protect the boats moored into it.

In a further advantage, a floating infrastructure is provided that can damp the effect of the waves to protect floating infrastructures or to reduce the effect of the waves on the shores or on corals.

10 It should be appreciated that the particular implementations shown and herein described are representative of the invention and its best mode and are not intended to limit the scope of the present invention in any way.

15 As will be appreciated by skilled artisans, the present invention may be embodied as a system, a device, or a method.

The present invention is described herein with reference to block diagrams, devices, components, and modules, according to various aspects of the invention. It will be understood that each functional block of the blocks diagrams, and combinations of functional blocks in the block diagrams, can be implemented by
20 computer program instructions which may be loaded onto a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions which execute on the computer or other programmable data processing apparatus create enable the functionality specified in the block diagrams.

25 Accordingly, the block diagram illustrations support combinations of means for performing the specified functions, combinations of steps for performing the specified functions, and program instruction means for performing the specified functions. Each functional block of the block diagrams and flowchart illustrations, and combinations of functional blocks in the block diagrams, may be implemented by either
30 suitable combinations thereof.

Moreover, the system contemplates the use, sale and/or distribution of any goods, services or information having similar functionality described herein.

35 The specification and figures should be considered in an illustrative manner, rather than a restrictive

one and all modifications described herein are intended to be included within the scope of the invention claimed. Accordingly, the scope of the invention should be determined by the appended claims (as they currently exist or as later amended or added, and their legal equivalents) rather than by merely the examples described above. Steps recited in any method or process claims, unless otherwise expressly stated, may be
5 executed in any order and are not limited to the specific order presented in any claim. Further, the elements and/or components recited in apparatus claims may be assembled or otherwise functionally configured in a variety of permutations to produce substantially the same result as the present invention. Consequently, the invention should not be interpreted as being limited to the specific configuration recited in the claims.

10 Benefits, other advantages and solutions mentioned herein are not to be construed as critical, required or essential features or components of any or all the claims.

As used herein, the terms "comprises", "comprising", or variations thereof, are intended to refer to a non-exclusive listing of elements, such that any apparatus, process, method, article, or composition of the
15 invention that comprises a list of elements, that does not include only those elements recited, but may also include other elements such as those described in the instant specification. Unless otherwise explicitly stated, the use of the term "consisting" or "consisting of" or "consisting essentially of" is not intended to limit the scope of the invention to the enumerated elements named thereafter, unless otherwise indicated. Other combinations and/or modifications of the above-described elements, materials or structures used in
20 the practice of the present invention may be varied or adapted by the skilled artisan to other designs without departing from the general principles of the invention.

The patents and articles mentioned above are hereby incorporated by reference herein, unless otherwise noted, to the extent that the same are not inconsistent with this disclosure.

25 Other characteristics and modes of execution of the invention are described in the appended claims.

Further, the invention should be considered as including all possible combinations of every feature described in the instant specification, appended claims, and/or drawing figures which may be considered new, inventive and industrially applicable.

30 Additional features and functionality of the invention are described in the claims appended hereto and/or in the abstract. Such claims and/or abstract are hereby incorporated in their entirety by reference thereto in this specification and should be considered as part of the application as filed.

35 Multiple variations and modifications are possible in the embodiments of the invention described here.

Although certain illustrative embodiments of the invention have been shown and described here, a wide range of changes, modifications, and substitutions is contemplated in the foregoing disclosure. While the above description contains many specific details, these should not be construed as limitations on the scope of the invention, but rather exemplify one or another preferred embodiment thereof. In some instances, 5 some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the foregoing description be construed broadly and understood as being illustrative only, the spirit and scope of the invention being limited only by the claims which ultimately issue in this application.

Claims

What is claimed Is:

- 5 1. A floating structure (2, 2'), preferably a floating marina, for floating in the open water, the floating structure (2, 2') configured to serve as a boat docking, comprising a surrounding structure (10) and an inner space (20), the surrounding structure (10) surrounding the inner space (20) for at least one boat to dock at a boat docking place (18) of the floating structure (2, 2'), the surrounding structure (10) comprising an opening (12) for the boat to enter the inner space (20) from the open water or leave it vice versa,
- 10 A connecting point (24) for connecting an anchoring line (6) to anchor the floating structure (2, 2') to float at a set area within the open sea, the connection point (24) being at a first side of the surrounding structure (10) and the opening (12) substantially being arranged at an opposite side of the surrounding structure (10), so the opening (12) is arranged at a downstream end of the floating structure (2, 2').
- 15 2. The floating structure (2, 2') of claim 1, comprising a wave energy harvesting system (14), fixed to the surrounding structure (10) at the first side of the surrounding structure (10).
3. The floating structure (2, 2') of claim 2, wherein the wave energy harvesting system (14) comprises a plurality of floaters, the floaters being able to move vertically independent from each other for each floater
- 20 to follow the movement of sea waves when placed on the surface of the sea.
4. The floating structure (2, 2') of claim 3, comprising an energy converting system, the energy converting system able to generate electrical energy based on the relative movement of the floaters.
- 25 5. The floating structure (2, 2') of claim 4, the energy converting system comprising a pumping system for pumping a fluid into a reservoir based on the relative movement, preferably vertical relative movement, of the floaters to each other, the energy converting system further comprising an energy converter for converting energy, preferably potential energy, of the fluid in the reservoir into usable energy, preferably thermal energy or electrical energy.
- 30 6. The floating structure (2, 2') of claim 5, comprising a superstructure carried by the floaters.
7. A wave energy harvesting system, preferably a wave attenuator, having a plurality of floaters the floaters being able to move vertically independent from each other for each floater to follow the movement of sea
- 35 waves when placed on the surface of the sea.

8. The wave energy harvesting system according to claim 7, comprising an energy converting system, the energy converting system able to generate electrical energy based on the relative movement of the floaters.
- 5 9. The wave energy harvesting system of claim 8, the energy converting system comprising a pumping system for pumping a fluid into a reservoir based on the relative movement of the floaters to each other, the energy converting system further comprising an energy converter for converting energy, preferably potential energy, of the fluid in the reservoir into usable energy, preferably thermal energy or electrical energy.
- 10 10. The wave energy harvesting system according to claim 8, comprising a ballast system (1202, 2202) capable of adjusting the weight of the superstructure (1200, 2200) and thereby the immersion depth of the floaters (1310, 2310).
- 15 11. The floating structure (2, 2') of claim 1, including the wave energy harvesting system of claim 7.