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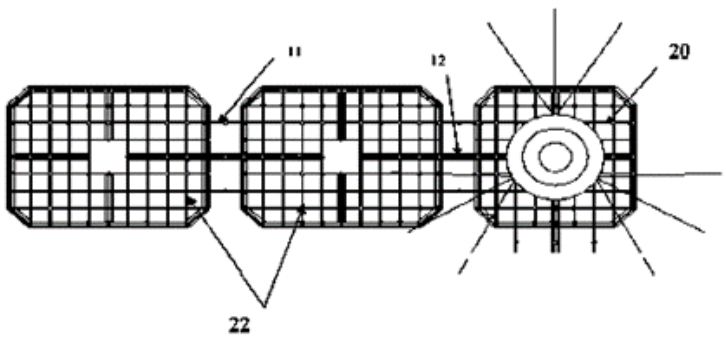
(54) Title: **A Module-based Offshore Fish Farm Platform**

(57) Abstract

The present disclosure provides a module-based marine fish farm platform that comprises a mooring module (20) and two or more fish-cage modules (22). The mooring module (20) comprises a turret (4) that is adapted to be moored to the seabed. The turret (4) is rotatable within the mooring module (20). Fish-cage modules (22) connected to a gridframe structure (1) of the mooring module 22, are rotatable around the turret (4). This provides pronounced water exchange inside as well as outside grid-frame cages, which brings fish within the fish farm platform a healthy environment.



A MODULE-BASED OFFSHORE FISH FARM PLATFORM

TECHNICAL FIELD

The present invention relates to a marine fish farm platform, and in particular, to a grid-frame module based offshore fish farm platform.

BACKGROUND

The annual output of aquaculture has increased by about 10% since 1980, which has played an important role in bridging the gap between the supply and demand of seafood. At present, most fisheries are located in shielded coastal sea areas, and there are increasingly fewer places suitable for fish farming in coastal areas. Excessive aquaculture has damaged the offshore marine environment. In order to meet the growing global demand for seafood and to expand the aquaculture industry, new fisheries are being forced into unshielded sea areas.

Open aquaculture cages with flexible floating rings represent a practical and common aquaculture technology, which technology has made significant progress in recent decades. An entire aquaculture system usually comprises floating rings, fishing nets, bottom ballasts, mooring systems, and so on. The floating rings are usually made of high-density polyethylene (HDPE). These are typically subjected to large vertical movements, hydrodynamic effects, and violent disturbances from wave structures, which can lead to fatigue and destruction of the floating rings. Large deformation of the fishing nets in water flows is another major problem faced by open cage systems. Various organisms that accumulate on fishing nets may further increase the deformation of the fishing nets, and the additional resistance brought by the bio-deposition also affects the load of the mooring system and may further lead to structural damage of the cages.

Installing a fishery in an unshielded area may have many benefits, including the access to large amounts of space to scale up, large seawater loading capacity, reduction of conflicts with numerous users, reduction of exposure to human sources of pollution and reduction of negative environmental impacts. However, problems and/or disadvantages found in previous studies indicate that conventional open cage technologies with flexible floating rings and fishing nets are not suitable for harsh environmental conditions in unshielded sea areas. Therefore, new and powerful marine fisheries are required to cope with these challenges.

In order to increase the production of seafood, several new fishery concepts with the potential to be used in the open sea have been proposed. Unlike the flexible floating rings

widely used in currently operating fisheries, these new concepts make use of rigid support structures to withstand harsh environmental loads.

SalMar ASA has built a rigid semi-submersible fishery, i.e., "Marine Fishery No. 1," which combines the technology in the field of aquaculture with the offshore oil and gas development technology. The design includes palisade supports, floating body units and a loose mooring system. The fishing nets are pulled tightly and fixed to the supports to avoid deformation in the water flow.

Norway Royal Salmon AS and Aker Solutions ASA have proposed another rigid semi-submersible fishery for unshielded sea areas, which contains two buoys that are connected by vertical and diagonal brackets. Cages of the fishery are fully submerged in the sea to avoid large wave loads near the water surface, and an underwater air bag is designed to provide air. It should be noted that this concept uses the conventional gravity cage, which relies on bottom ballasts to maintain the volume. Such cages encounter bigger deformation in the high-speed water flow in an unshielded area than in a shielded area. This could threaten the health of fish. In addition, there are also challenges with the use of the underwater air bag.

A boat-like fish farm has been proposed by Nordlaks AS, the boat-like fishery having a single point mooring system working as a weather vane. The fishery can rotate around a head structure in various environmental directions. Such a system can increase the spread of waste of fish resources and reduce the likelihood of infection. However, the proposed concept faces the following challenges. As the weather vane system allows the system to orient toward water flow and wave directions in most environmental conditions, in this boat-like fishery downstream cages are subjected to less water exchange than upstream cages for the reason that multiple cages are arranged in a row adjacent to each other, i.e. at small distances in boat-like fish farms. Therefore, levels of dissolved oxygen of the downstream cages will be lower, than in upstream cages, and the amount of waste increases, which may seriously affect the health of fish. In order to improve water exchange, dynamic positioning systems have been proposed to orient the fishery at an angle in relation to water flows, but this significantly increases energy consumption as well as operational and maintenance costs.

In addition to the technology of open cages, closed fisheries are also proposed. Marine Harvest Norway AS and Hauge Aqua AS have jointly proposed an "oval fishery". This design mainly considers that the living environment is easier to control in closed units. For instance, the possibility of sea lice infection is expected to be smaller than that in the open cages.

Escaping fish can also be avoided. However, because of the complexity of control system and cabin structures used, the cost of such an oval fishery is expected to be very high. In addition, due to its huge enclosed space and waterline area, the oval structure may suffer from huge environmental loads and internal impacts. As a result, oval structures are difficult to use in unshielded sea areas.

Thus, new configurations of marine fish farms, especially of fish farms in deep seas and high seas, are constantly emerging at present. However, each new fish farm system typically comes with its own problems and/or challenges, such as low sea use, high construction and maintenance costs, and being unfriendly to the environment, to mention a few.

Indeed, there is a demand of a new marine fishery platform that is arranged to withstand high sea conditions, to have a convenient layout and to be environmental friendly. In addition, it should be associated with low costs of construction and transportation.

SUMMARY

It is an object of the disclosure to address at least some of the issues outlined above, and this object and others are achieved by a modular marine fishery platform and a grid-frame modular marine fishery platform, according to independent claims and by embodiments according to the dependent claims.

According to an aspect, this disclosure provides a module-based marine fish farm platform. This platform comprises a mooring module and fish cage modules, wherein the mooring module has a grid-frame structure of hollow trusses and comprises a turret. The turret is adapted to be moored to a seabed. The grid-frame structure is rotatable around the turret. The fish cage modules are connectable to the grid-frame structure of the mooring module via a hinge device. Each fish cage module has a grid-frame cage of hollow trusses. The grid-frame cages are adapted to receive a fish net on its peripheral surfaces.

According to a further aspect, this disclosure provides a grid-frame module-based marine fish farm platform that comprises a single-point mooring module and several fish cage modules. The single-point mooring module is formed of a grid-frame structure that is composed of hollow ball tubes. A middle part of the grid-frame structure comprises a buoy, a first superstructure and a turret. A lower part of the grid-frame structure comprises anchor chains. A passage is laid on the upper part of the net-frame structure. The fish cage modules each comprises a cage composed of hollow ball tubes, a hollow cylindrical vertical column and a second superstructure. A fixed passage is arranged around an upper layer of the cage.

A slidable passage is arranged in the middle of each cage. The fish cage modules are connected to the single-point mooring module by using a hinge device.

The present disclosure comprises the following beneficial effects:

The module-based marine fish farm platform disclosed herein has the advantage that a grid-frame structure has excellent water permeability, has a pronounced structural strength and water wave resistance.

The grid-frame structure of the module-based marine fish farm platform may be regarded as a particle in water waves and may move in a circular motion with water waves. Also, optionally each ball node of the grid-frame structure may also be regarded as a particle. For this reason, the module-based marine fish farm platform reacts slowly to water waves, in usage. By adjusting the amount of ballasts, the center of gravity of the fish cage module may be lowered and render the module-based marine fish farm platform excellent stability and water wave resistance.

The module-based marine fish farm platform as disclosed herein also uses a mooring module, which is one example of a mooring system, around which the whole module-based marine fish farm platform may rotate freely. A single change in ocean wave, ocean current directions or wind direction will hence speed up the water exchange circulation of the seawater inside as well as outside each fish cage module, and is conducive to improving the aquaculture environment of the grid-frame cages.

Tubular shaped trusses of grid-frame structures/portions are typically spaced apart such that it facilitates arrangement of the fish nets and facilitates cleaning and maintaining the fish nets at the same time.

The beveled shape of the four corners of the grid-frame cages, i.e. it octagonal shape of the horizontal upper and lower layers an octagon, enables realizing of swimming habits of fish. For instance, the habit of swimming close to vertical surfaces, and changing swimming direction of less than 90 degrees, per change in direction.

Overall, the module-based or modular design of the marine fish farm platform reduces costs of platform construction, transportation and installation, and increases the flexibility of fish farm platform layout, but also facilitates daily maintenance and repair.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic top representation of a mooring module, according to the present disclosure;

FIG. 2 is a schematic side representation of a mooring module, being moored, according to the present disclosure;

FIG. 3 is a schematic top representation of a fish cage module, according to the present disclosure;

FIG. 4 is a schematic side representation of a fish cage module, according to the present disclosure; and

FIGS. 5 and 6 are schematic top representations of a module-based marine fish farm platform, according to the present disclosure.

DETAILED DESCRIPTION

In the following description, different embodiments of the disclosure will be described in more detail, with reference to accompanying drawings. For the purpose of explanation and not limitation, specific details are set forth, such as particular examples and techniques in order to provide a thorough understanding.

The module-based, or modular, marine fish farm platform as described in the present invention is further described in the following with reference to the accompanying drawings.

As visualized in FIGS. 1-6, a module-based, or modular, marine fish farm platform comprises a mooring module 20 and fish cage modules 22. The mooring module and the fish-cage modules 22 are formed of grid-frames. The mooring module 20 is adapted to be moored to the seabed by using anchor chains. The fish cage modules and the mooring module are adapted to be hinged to each other, forming a marine fish farm platform. The mooring module may a role when positioning the fish farm platform at a desired geographical location, but also while attaching/detaching fish-cages modules to/from the fish farm platform. The mooring module may rotate freely under the effect of waves, flows and/or currents to achieve an effect of accelerating water exchange and/or circulation in the fish cages and therefore improve the aquaculture environment. In addition, the entire fish farm platform may also move together, as well as perform relative hinging motion which will further increase water exchange inside and outside the fish cage modules.

The fish farm platform is positioned in the marine water such that a major part of the fish farm platform is below the water surface. Upon installation of the fish farm platform at a desired location, fish nets are arranged on the grid frame structure of the fish cages to form a

highly permeable aquaculture space.

Gangways as well as superstructures may be provided for the purpose of staff personnel to perform operation, installation, and maintenance of the fish farm platform as well as other related equipment therefore arranged above the water surface.

The grid-frame fish cages have good wave resistance and structural strength and marked resistance, against damages caused by environmental effects, which ensures safe operation in waves of 9 meters. The module-based marine fish farm platform is therefore well suited to be used as a module-based, or modular, offshore fish farm platform.

Moreover, the fish-cage modules may be linked freely by hinges, or hinge devices, and may be combined freely as required, thus facilitating processing, assembling, disassembling, transportation and maintenance. For this reason fish cage modules may be connected, at least temporarily, to the mooring module in two essentially perpendicular directions.

Fig. 1 illustrates a schematic top representation of a mooring module 20, being moored, according to the present disclosure.

The mooring module is configured to provide connections to which fish-cage modules 22 of the module-based fish farm platform, can be connected.

As such, the mooring module 20 is adapted to moor a modular marine fish farm platform to the seabed.

The mooring module 20 comprises a grid-frame structure 1 of hollow trusses and comprises a turret 4. The turret 4 is adapted to be moored to a seabed. The mooring module 20 is thus typically moored to the seabed, by mooring the turret to the seabed. The grid-frame structure 1 is moreover rotatable around the turret 4. Since the turret 4 is positioned in the center of the mooring module, rotation of the grid-frame structure around the turret is facilitated.

The mooring module 20 may further also comprise a buoy 2 to provide buoyancy of the mooring module, but also to provide reserve buoyancy to offset potential downward hydrodynamic forces, caused by incoming flows and waves, along anchor chains connected to the seabed.

Gangways 6 as well as a superstructure 3 placed onto the grid-frame structure 1 may be provided for the purpose of staff personnel to perform operation, installation, and maintenance of the fish farm platform as well as other related equipment therefore arranged above the water surface.

The mooring module 20 may be used to connect a mooring chain system and to

position the whole modular marine fish farm platform. The mooring module 20, and/or the superstructure 3 may also be used to store fish food and equipment, to place the control system for the fish farm platform, as well as to serve as living quarters for personnel on board. The structure type of the mooring module 20 is of grid-frame type, and may be connected to the buoy 2 or buoy-like arrangements such as pontoons, a small semi-submersible platform, a small spar platform or a barge shaped floater.

The mooring module 20 may also comprise a gangway 6 positioned on top of the grid-frame structure 1, along the circumferential edge thereof, for scheduled maintenance and operation. The grid-frame structure 1 of the mooring module may further comprise octagonal grid-frame portions vertically spaced in relation to one another. The grid-frame structure 1 may further comprise eight rectangular grid-frame portions to meet the two octagonal grid-frame portions, together forming the grid-frame structure.

Fig. 2 illustrates a schematic side representation of the mooring module 20 as illustrated in Fig. 1, according to the present disclosure. According to an embodiment of the present disclosure, the superstructure 3 is attached on top of the grid-frame structure 1. In this embodiment, the buoy 2 is positioned under the superstructure, but attached to the grid-frame structure 1 from below. The turret 4 is vertically elongated to span the entire height of the grid-frame structure 1 of the mooring module 20, in said embodiment, within which anchor chains are connected to the turret 4 to moor the mooring module to the seabed. In the context of mooring the mooring module to the seabed, the anchor chains are connected, in their upper ends, to the turret 4, and in this respect, the mooring module 20 may be regarded to be a single-point mooring module.

The mooring module 20 as illustrated in Figs. 1 and 2, adopts a grid-frame structure 1 of hollow trusses. These may comprise hollow ball tubes. The grid-frame structure 1 may thus comprise two octagonal grid frames vertically spaced, and eight rectangular grid-frames around. The trusses, and potentially the ball tubes, are hollow and may therefore provide buoyancy. A middle part of the mooring module 20 may comprise the buoy 2, a first superstructure 3 and the turret 4. The buoy 2 is configured to provide a reserve buoyancy to offset downward hydrodynamic force caused by incoming flows, waves and/or currents.

According to one embodiment, the size of the grid-frame structure 1 of the mooring module 20 is 48 m x 48 m x 36 m. Each one of the two octagonal grid-frame portions may comprise a squarish grid-frame of 9 x 9 ball nodes which are connected to 8 x 8 trusses, wherein the squarish grid-frames are beveled in each four corners, forming said octagonal shape. The grid-frame structure 1 may comprises 7 horizontal levels of trusses, spaced

vertically. The trusses and circular ball tubes may have a diameter of 0,5 meter, whereas ball nodes may have a diameter of about 1,5 m. Ball nodes may be spaced apart such that the distance between centers of two ball nodes is 6 m. Moreover, the turret 4 of the mooring module 20 may be a cylinder with a diameter of 15 m and a height of about 35 m. The trusses may be connected to the ball nodes forming cuboid shapes of within the grid-frame structure 1.

The buoy 2, as positioned around the periphery of the turret 4, may have a diameter of 30 m and a height of about 15 m.

The upper levels of the buoy 2 and the turret 4 may be attached to the net-frame structure 1. Superstructure 3 may be 5-6 m in height, and may be arranged on the buoy 2. The inner diameter of the superstructure 3 may be the same, or essentially the same, as the outer diameter of the turret 4, and the outer diameter of the superstructure may be 25 m. Moreover, anchor chains 5 may be installed below the turret 4, which are configured to serve the purpose of mooring the fish farm platform under the action of waves that are 9 m high and sea currents at the speed of 2 m/s. Gangways, or passages, optionally positioned on top of the grid-frame structure 1 may have a width of about 2 m, and may be arranged along the periphery of grid-frame structure 1, and optionally, across the grid-frame structure 1 and arranged on middle trusses and may be positioned to allow communication to/from the first superstructure 3, by personnel.

The grid-frame structure 1 and the buoy 2 may be connected by welding.

As the turret 4 is adapted to be moored to the seabed via the anchor chains 5, the grid-frame structure 1, the buoy 2, the superstructure 3 and the gangways/passages 6, may form an entire unit, which can rotate around the turret 4 in a range of 360°. Said entire unit may also rotate freely around the turret 4.

Figs. 3 and 4 illustrate a schematic top and side representation, respectively, of a fish cage module 22, according to the present disclosure. The fish cage modules 22 of the present disclosure each comprises a grid-frame cage 7 of hollow trusses. The grid-frame cages are adapted to receive a fish net on its peripheral surfaces.

Each fish-cage module 22 is adapted to be connected to either another fish-cage module 22 or to the grid-frame structure 1 of the mooring module 20, via a hinging connection, such a hinge device.

The fish-frame cage 7 of the fish-cage module 22 may comprise two octagonal grid frames vertically spaced, in relation to one another, and eight rectangular grid frames

arranged along a periphery of the octagonal grid frames, forming said fish-frame cage. The hollow trusses may provide buoyancy of the fish-frame cage 7 and may be hollow ball tubes. An aquaculture space may be provided by fish nets arranged on the peripheral surface of the fish-frame cage. The fish-frame cage may further comprise hollow cylindrical columns 8 vertically arranged and attached to ball nodes of an upper octagonal grid frame. These hollow cylindrical columns are typically used to support a resulting weight of the fish-cage module 22 and to improve the strength of the fish-frame cage 7.

By adjusting the amount of ballasts of the fish-cage module 22, the center of gravity of the fish-cage module 22 may be lowered, for which the reason the module-based marine fish cage platform can receive excellent stability properties and water wave resistance.

A pipeline, a camera probe and/or a sensor may be arranged inside the hollow cylindrical column 8, which may be used for feeding, monitoring dynamic states of fish and/or monitoring an environment internal to the fish-frame cage.

According to an example of fish-cage module 22, the size of the fish-frame cage 7 is 60 m x 48 m x 36 m, respectively representing the length, width and height thereof. The octagonal grid frames, i.e. an upper and lower layer of the fish-frame cage may be a square composed of 11 x 9 ball nodes connected to 10 x 8 hollow circular tubes, with four beveled corners, forming said octagonal shape. The fish-frame cage 7 may comprise 7 levels of trusses and ball nodes in the vertical direction.

The diameter of the ball nodes may be about 1,5 m, the diameter of the trusses or the circular tubes may be about 0,5 m. The distance between centers of two adjacent ball nodes may be 6 m.

Fish nets that are arranged around the periphery of the fish-frame cage may be pre-tensioned and further laid between the trusses circular tubes. Each fish-frame cage 7 may have a volume of approximately 100 000 m^3. Said upper and lower layers of the fish-frame cage 7 are supported by the hollow cylindrical columns 8 vertically arranged to provide and meet requirements of structural strength.

The installation position and size of the vertical column 8 are determined according to a calculation result of the structural strength. A fixed gangway or passage 9 may be arranged around the upper octagonal grid-frame portion or upper layer of the fish-frame cage 7. The width of the gangway or passage may be about 2 m.

A second superstructure 10 may be installed at an intersecting position of perpendicular gangways arranged across, and on top of, the fish-frame cage 7. This second superstructure 10 may a size of about 12 m x 12 m x 6 m and is movable as said gangways

are laterally slidable.

Fig. 5 schematically illustrates a top representation of a module-based marine fish farm platform, according to the present disclosure. The module-based marine fish farm platform of Fig. 5 comprises a mooring platform 20 and two fish-cage modules 22. The two fish-cage modules 22 are connected to each other by using a hinge device 11. Also, the two fish-cage modules 22 are connected to the mooring module 20 by using a hinge device 11.

According to one embodiment, the hinge device 11 is about 12 m long and may be comprised of circular tubes and hinged joints, and is designed to the strength requirements of the connections between any two modules connected under the action of waves that are 9 m high and sea currents at the speed of 2 m/s.

The fish-cage modules 22 may thus be connected onto the grid-frame structure 1 of the mooring module 20 by using a hinge device 11. The connected fish-cage modules may rotate around the turret 4 in a range of 360° together with the grid-frame structure 1, thus realizing rapid circulation of the sea water in the grid-frame cages 7 of the fish-cage modules 22 in an environment friendly manner.

The fish cage modules 22 may also be connected to other fish cages by using a hinge device 11 to form a multi-module marine fish farm platform.

It is noted that the hinge devices 11 essentially only transfers axial forces between two connected modules, but limits the transfer of any bending moment which is conducive to reducing the load between connected modules.

The fish cage modules 22 being connected to the mooring module 20 may thus rotate around the turret 4 together with the grid-frame structure 1, which is conducive to the circulation exchange between seawater inside and outside the grid-frame cages 7, thus improving the aquaculture environment in the fish farm and reducing the impact of water pollution on the fish being farmed. The fish cage modules 22 may be visited by staff personnel by using a detachable passage 12, which may be used for entering various modules.

In fact, hinge device 11 may facilitate loading and unloading, and may implement convenient and quick assembling and disassembling of modules, and may facilitate the usage of smaller tugboats or transport ships, which further reduce operating costs. Easy and convenient assembling and disassembling may be beneficial for maintenance of module-based marine fish farm platforms, of the present disclosure. Individual fish-cage modules 22 may be disconnected and brought ashore for maintenance without affecting the operation of

the entire module-based marine fish farm platform. Each connected module may be replaced with a new module. As far as fish welfare is concerned, rapid and flexible disconnection of the fish-cage modules 22 within a modular marine fish farm module may even prevent spreading of fish diseases among the grid-frame cages 7 of the fish-cage modules 22.

With reference to Fig. 5 an aspect of the present disclosure provides a module-based marine fish farm platform that comprises a mooring module 20 and fish cage modules 22, wherein the mooring module 20 has a grid-frame structure 1 of hollow trusses. The mooring module 20 further comprises a turret 4 that is adapted to be moored to a seabed. The grid-frame structure 1 is rotatable around the turret 4. The fish cage modules 22 are connectable to the grid-frame structure 1 of the mooring module 20 via a hinge device 11. Each fish cage module 22 has a grid-frame cage 7 of hollow trusses, and the grid-frame cages 7 are adapted to receive a fish net on its peripheral surfaces.

Anchor chains may be connectable from the bottom of the turret 4 to moor the mooring module 20 to the seabed.

Two or more of the fish cage modules 22 of the module-based marine fish farm platform, may be linearly connected to each other via a hinge device 11.

The grid-frame structure 1 of the mooring module 20 being rotatable around the turret 4, may also be lockable in relation to the turret 4.

The mooring module 20 may further comprise a buoy 2 and a first superstructure 3, both attached to the grid-frame structure 1.

The grid-frame structure 1 may comprise two octagonal grid-frame portions vertically spaced in relation to each other, and eight rectangular vertically oriented grid-frame portions forming a circumferential surface of the grid-frame structure 1.

Laterally slidable gangways may be arranged horizontally across each grid-frame cage 7 in directions perpendicular to one another, on top of each grid-frame cage 7 of the fish cage modules 22.

Each fish cage module 22 may comprise a further superstructure 10 being installed at an intersecting position of the laterally slidable gangways, and wherein the further superstructure 10 is movable along the laterally slidable gangways.

Each fish cage module 22 may comprise hollow cylindrical columns 8 vertically installed at an upper octagonal grid-frame portion of said each fish cage module 22.

The fish cage modules 22 may be connected to the grid-frame structure 1 of the mooring module 20 via said hinge device 11. The turret 4 may be moored to a seabed. The grid-frames cages 7 of the fish-cage modules 22, may comprise closed cages.

Referring to Fig. 5, a further aspect of the present disclosure provides a grid-frame modular marine fish farm platform that comprises a single-point mooring module 20 and several fish cage modules 22. The single-point mooring module 20 is formed of a grid-frame structure 1 composed of hollow ball tubes. A middle part of the grid-frame structure 1 comprises a buoy 2, a first superstructure 3 and a turret 4, wherein a lower part of the grid-frame structure 1 comprises anchor chains 5. A passage 6 is laid on the upper part of the grid-frame structure 1. The fish cage modules 22 each comprises a cage 7 composed of hollow ball tubes, a hollow cylindrical vertical column 8 and a second superstructure 10. A fixed passage 9 is arranged around an upper layer of each cage 7, and a slidable passage is arranged in a middle part of the cage 7. The fish cage modules 22 are connected to the single-point mooring module 20 by using a hinge device 11.

The grid-frame structure 1 may be composed of two octagonal grid frames arranged vertically and eight rectangular grid frames around. The ball tubes may be all hollow structures. The grid-frame structure 1 and the buoy 2 may be rigidly connected by welding. The first superstructure 3 may be arranged above the buoy 2.

The anchor chains 5 may be arranged at the bottom of the turret 4. The entire single-point mooring module 20 may be moored to the seabed by using nine anchor chains 5 installed at the bottom of the turret 4. The grid-frame structure 1, the buoy 2, the first superstructure 3 and the passage 6, may be rotatable relative to the turret 4.

The cage 7 of the fish cage modules 22 of the grid-frame module-based marine fish farm platform may be composed of two octagonal grid frames arranged horizontally and spaced vertically and eight rectangular grid frames around. The ball tubes of the cage 7 may all be hollow structures, and fish nets may be laid on peripheral surfaces of the cage 7.

The hollow cylindrical column 8 of the grid-frame module-based marine fish farm platform may be vertically installed in the interior of the cage 7, and may be welded at ball nodes in corresponding positions of the upper and lower layers of the cage 7. Within a hollow cylindrical column 8, a pipeline, a camera probe and a sensor may be arranged.

Within the grid-frame module-based marine fish farm platform, the second superstructure 10 may be installed above an intersecting position of middle passages. The second superstructure 10 may be movable along the middle passages.

The fish cage modules 22 of the grid-frame module-based marine fish farm platform may also be connected to other fish cages by using the hinge device 11 to form a multi-module marine fish farm platform. The fish cage modules 22 may be communicated with each module by using a detachable passage 12.

Fig. 6 schematically illustrates a top representation of a further configuration of the module-based marine fish farm platform, according to the present disclosure.

The module-based marine fish farm platform as presented herein is very similar to the one as presented in Fig. 5, the only exception of that Fig. 6 also illustrates that a further fish cage module 22, of two or more fish cage modules 22, may be assembled to the mooring module 20. Said further fish cage module 22 may be assembled to the mooring module 20 in a direction that is essentially perpendicular to the connected fish cage modules 22, of Fig. 5, i.e. perpendicular to the essentially linearly connected fish cage modules 22 of Fig. 5.

The module-based marine fish farm platform disclosed herein has the advantage that a grid-frame structure has excellent water permeability, has a pronounced structural strength and water wave resistance.

The grid-frame structure of the module-based marine fish farm platform may be regarded as a particle in water waves and may move in a circular motion with water waves. Also, optionally each ball node of the grid-frame structure may also be regarded as a particle. For this reason, the module-based marine fish farm platform reacts slowly to water waves, in usage. By adjusting the amount of ballasts, the center of gravity of the fish cage module may be lowered and render the module-based marine fish farm platform excellent stability and water wave resistance.

The module-based marine fish farm platform as disclosed herein also uses a mooring module, which is one example of a mooring system, around which the whole module-based marine fish farm platform may rotate freely. A single change in ocean wave, ocean current directions or wind direction will hence speed up the water exchange circulation of the seawater inside as well as outside each fish cage module, and is conducive to improving the aquaculture environment of the grid-frame cages. In addition, the grid-frame cages 7 and the grid-frame structure 1 of the design as described above, i.e. comprising tubular trusses and with ball nodes or spherical grid joints, together with the weather vane-like mooring arrangement, of the mooring module 20 that allows rotation of the entire platform dependent on water waves, currents and/or wind direction, enable pronounced water exchange and circulation inside as well as outside the grid-frame cages 7, without the need of using any power consuming engines or machines. This is environment adapted, or may even to be regarded as environment friendly, and is hence a marked advantage with module-based marine fish farm platforms of the present disclosure.

Tubular shaped trusses of grid-frame structures/portions are typically spaced apart such that it facilitates arrangement of the fish nets and facilitates cleaning and maintaining the fish nets at the same time.

The beveled shape of the four corners of the grid-frame cages, i.e. it octagonal shape of the horizontal upper and lower layers an octagon, enables realizing of swimming habits of fish. For instance, the habit of swimming along vertical surfaces and changing swimming direction of less than 90 degrees, per change in direction.

Overall, the module-based or modular design of the marine fish farm platform reduces costs of platform construction, transportation and installation, and increases the flexibility of fish farm platform layout, but also facilitates daily maintenance and repair.

The modular marine fish farm platform according to the present disclosure may thus achieve safe operation in the unshielded sea areas with waves 9 m high.

Embodiments of the modular marine fish farm platform may be featured with low costs, convenient maintenance, environmentally adapted or even friendly, an increased space utilization rate and convenient and flexible layout, and provide a new configuration solution for marine fish farms in deep seas and high seas.

Finally, it should be noted that the above examples and embodiments are only used to illustrate the technical solution of the present disclosure instead of limiting the technical solution. Notwithstanding the detailed description to the present disclosure with reference to the embodiments, those of ordinary skill in the art should understand that any modification or equivalent replacement to the technical solution of the present disclosure shall not depart from the spirit and scope of the technical solution of the present disclosure and shall be covered within the scope of the claims of the present disclosure.

CLAIMS

1. A module-based marine fish farm platform, comprising a mooring module (20) and fish cage modules (22), wherein the mooring module (20) has a grid-frame structure (1) of hollow trusses and comprises a turret (4), where the turret (4) is adapted to be moored to a seabed, wherein the grid-frame structure (1) is rotatable around the turret (4), wherein the fish cage modules (22) are connectable to the grid-frame structure (1) of the mooring module (20) via a hinge device (11), and where each fish cage module (22) has a grid-frame cage (7) of hollow trusses, and wherein the grid-frame cages are adapted to receive a fishing net on its peripheral surfaces.

2. The module-based marine fish farm platform according to claim 1, wherein anchor chains are connectable from the bottom of the turret (4) to moor the mooring module (20) to the seabed.

3. The module-based marine fish farm platform according to claim 1 or 2, wherein two or more of the fish cage modules (22) are linearly connected to each other via a hinge device (11).

4. The module-based marine fish farm platform according to claim 3, wherein a further fish cage module of said fish cage modules (22) is connected to the grid-frame structure (1) of the mooring module (20) in a direction essentially perpendicular to said linearly connected fish cage modules (22).

5. The module-based marine fish farm platform according to any one of claims 1 to 4, wherein the grid-frame structure (1) being rotatable around the turret (4), is also lockable in relation to the turret (4).

6. The module-based marine fish farm platform according to any one of the preceding claims, wherein the mooring module (20) further comprises a buoy (2) and a superstructure (3), both attached to the grid-frame structure (1).

7. The module-based marine fish farm platform according to any one of the preceding claims, wherein the grid-frame structure (1) comprises two octagonal grid-frame portions vertically spaced in relation to each other, and eight rectangular vertically oriented grid-frame portions forming a circumferential surface of the grid-frame

structure (1).

8. The module-based marine fish farm platform according to any one of the preceding claims, wherein laterally slidable gangways are arranged horizontally across each grid-frame cage (7) in directions perpendicular to one another, on top of each grid-frame cage (7) of the fish cage modules (22).

9. The module-based marine fish farm platform according to claim 8, wherein each fish cage module (22) comprises a further superstructure (10) installed at an intersecting position of the laterally slidable gangways, and wherein the superstructure (10) is movable along the slidable gangways.

10. The module-based marine fish farm platform according to any one of the preceding claims, wherein each fish cage module (22) comprises a hollow cylindrical column (8) vertically installed at an upper octagonal grid-frame portion of the fish cage module (22).

11. The module-based marine fish farm platform according to any one of the preceding claims, wherein the fish cage modules (22) are connected to the grid-frame structure (1) of the mooring module (20) via said hinge device (11).

12. The module-based marine fish farm platform according to any one of the preceding claims, wherein the turret (4) is moored to a seabed.

13. The module-based marine fish farm platform, wherein the cages of the fish-cage modules (22) comprise closed cages.

14. A grid-frame module-based marine fish farm platform, comprising a single-point mooring module (20) and several fish cage modules (22), wherein the single-point mooring module (20) is formed of a grid-frame structure (1) composed of hollow ball tubes, wherein a middle part of the net-frame structure (1) comprises a buoy (2), a first superstructure (3) and a turret (4), wherein a lower part of the grid-frame structure (1) comprises anchor chains (5), wherein a passage (6) is laid on the upper part of the grid-frame structure (1), wherein the fish cage modules (22) each comprises a cage (7) composed of hollow ball tubes, a hollow cylindrical vertical column (8) and a second superstructure (10); a fixed passage (9) is arranged around an upper layer of the cage

(7), and a slidable passage is arranged in the middle of the cage (7); and the fish cage modules (22) are connected to the single-point mooring module (20) by using a hinge device (11).

15. The grid-frame module-based marine fish farm platform according to claim 14, wherein the grid-frame structure (1) is composed of two octagonal grid frames arranged vertically and eight rectangular grid frames around, and the ball tubes are all hollow structures; the grid-frame structure (1) and the buoy (2) are rigidly connected by welding; and the first superstructure (3) is arranged above the buoy (2).

16. The grid-frame module-based marine fish farm fishery platform according to claim 14 or 15, wherein the anchor chains (5) are arranged at the bottom of the turret (4); the entire single-point mooring module (20) is moored to the seabed by using nine anchor chains (5) installed at the bottom of the turret (4); and the grid-frame structure (1), the buoy (2), the first superstructure (3) and the passage (6) are rotatable relative to the turret (4).

17. The grid-frame module-based marine fish farm platform according to any one of claims 14 to 16, wherein the cage (7) is composed of two octagonal grid frames arranged vertically and eight rectangular grid frames around, the ball tubes are all hollow structures, and fishing grids can be laid on peripheral surfaces of the cage (7).

18. The grid-frame module-based marine fish farm platform according to any one of claims 14 to 17, wherein the hollow cylindrical vertical column (8) is vertically installed in the middle of the cage (7), and welded with balls in corresponding positions of the upper and lower layers of the cage (7); and a pipeline, a camera probe and a sensor can be arranged inside the hollow cylindrical vertical column (8).

19. The grid-frame module-based marine fish farm platform according to any one of claims 14 to 18, wherein the second superstructure (10) is installed above an intersecting position of middle passages, and the second superstructure (10) is movable along the middle passages.

20. The grid-frame module-based marine fish farm platform according to any one of claims

14 to 19, wherein the fish cage modules (22) can also be connected to other fish cages by using the hinge device (11) to form a multi-module marine fish farm platform; and the fish cage modules are communicated with each module by using a detachable passage (12).

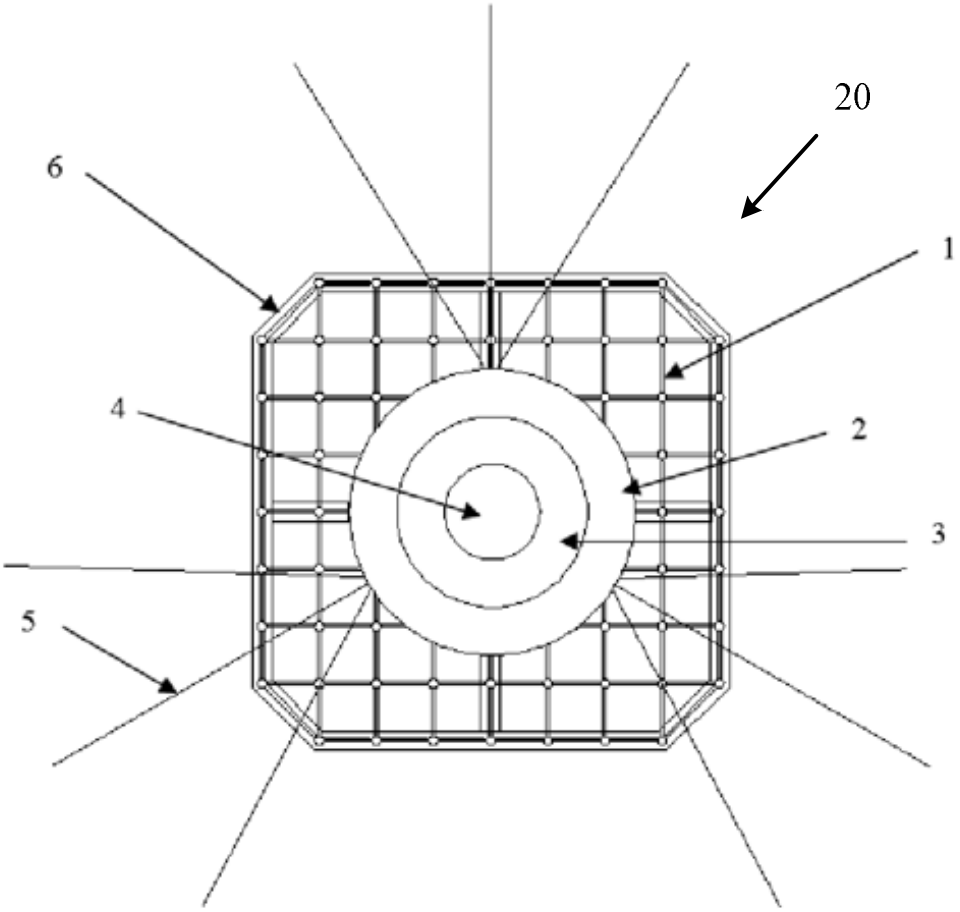


Fig. 1

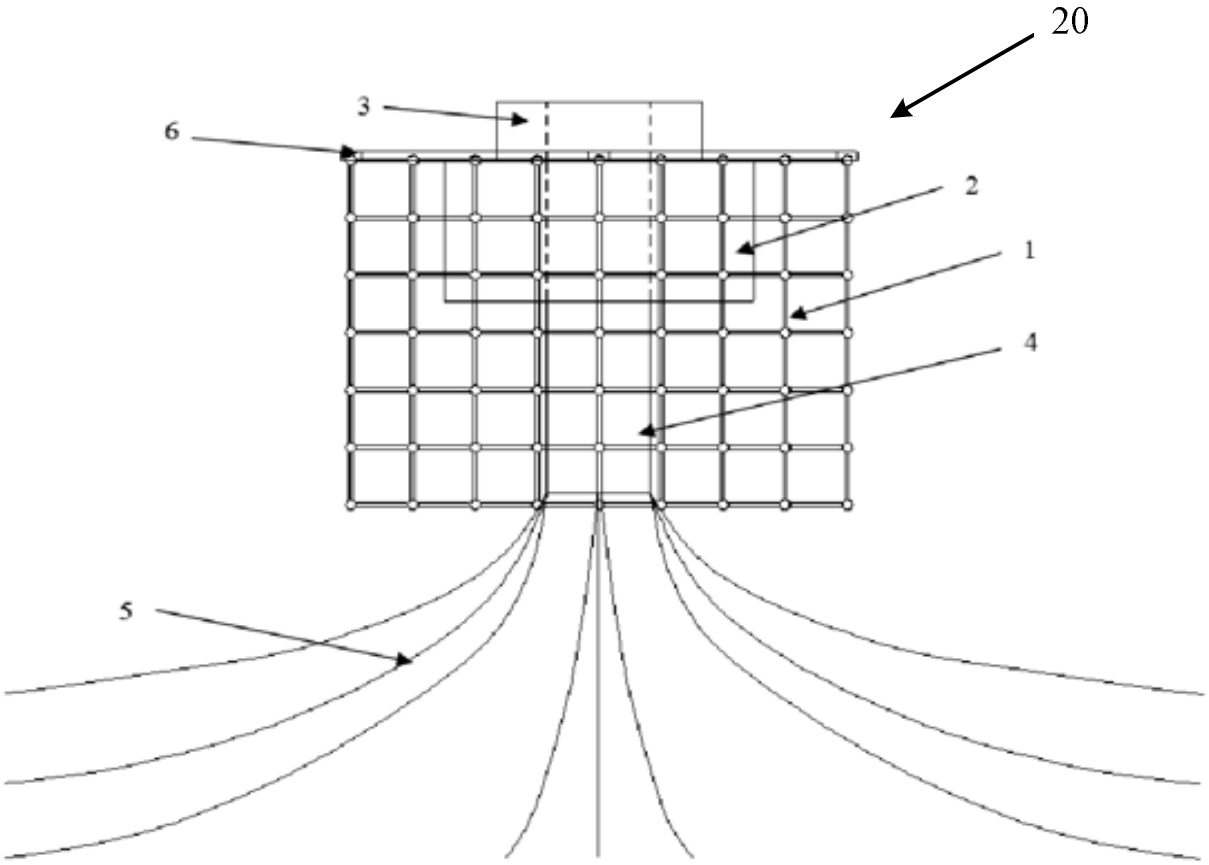


Fig. 2

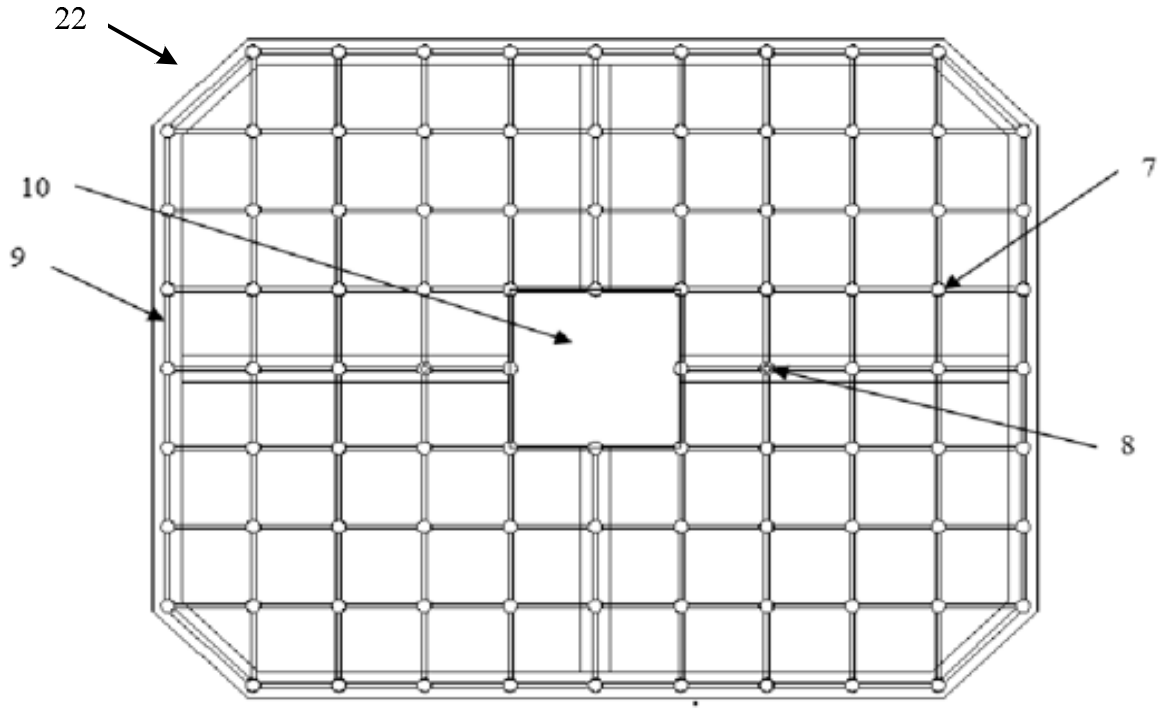


Fig. 3

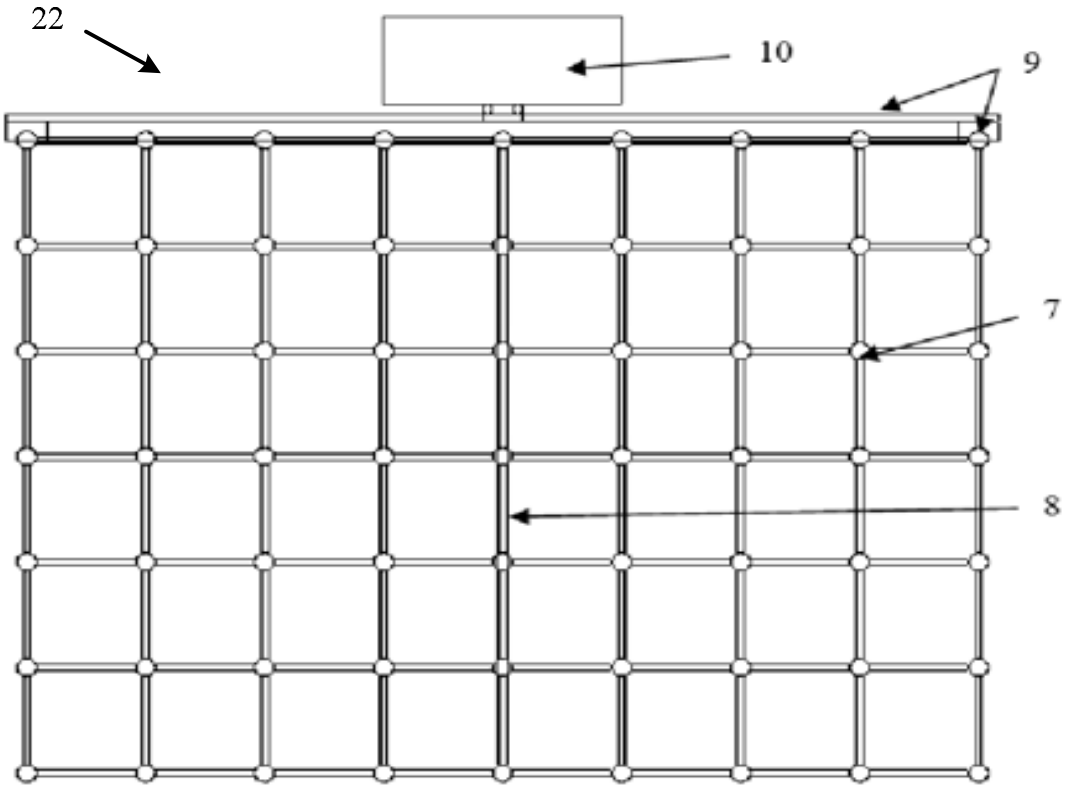


Fig. 4

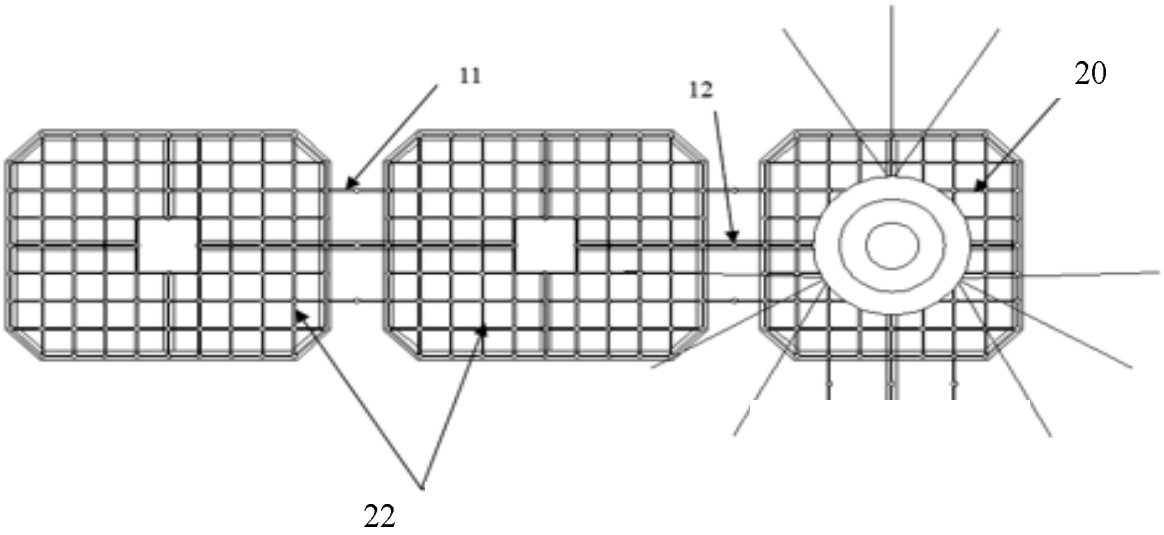


Fig. 5

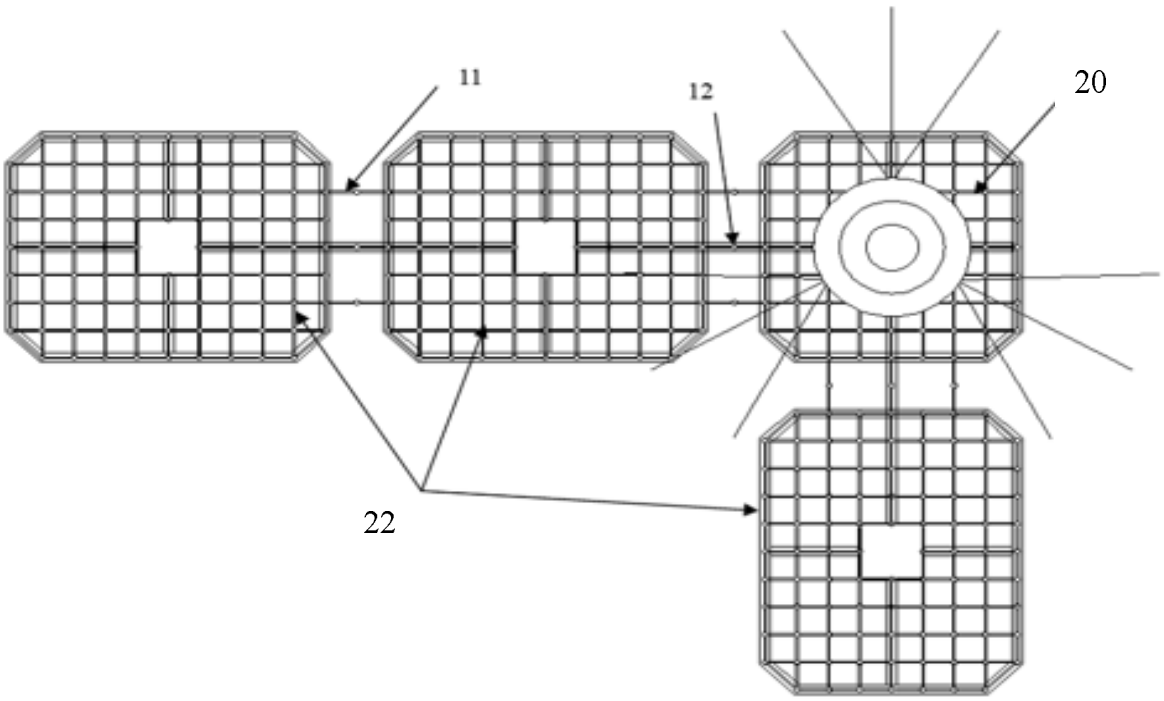


Fig. 6