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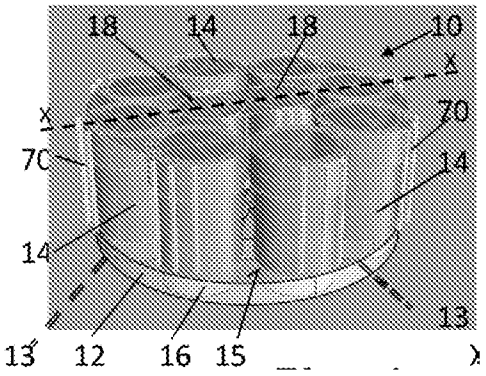
(54) Title **AquaOcean Semi Submersible Fish Farm**

(57) Abstract

A structure (10) for fish farming is disclosed, and it is characterised in that a polygonal or circular ring pontoon (2) is a lower part of the structure (10) forming a basis for a plurality of tanks (14) for containing fish, each tank (12) being arranged upwards in an annular pattern of the pontoon (12) top surface (15), and at least two adjacent tanks are interconnected by a closable lock structure. Each tank is a double wall structure. The tank bottom is a mesh net frame, which preferably is liftable by means of a hoist structure. Preferably there are two liftable mesh net frames (40,42) of individually different size meshes, inside the tank. A use is also described to separate fish of different sizes by individually lifting the to net frames (40,42) in the tank (12).



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STRUCTURE FOR FISH FARMING

Background

The present invention relates to a new designed structure for fish farming as given in the preamble of the following claim 1.

Fish-farming in Norway has traditionally been organized within protected fjords, to avoid impact of waves damaging the net cages containing the fish. The protection within fjords also facilitate more easy access to the cages for all kind of necessary service functions.
In addition, the open net cages permit a free flow of water through the cages, renewing the content of oxygen rich water to serve the breathing of the fish, as well as serving the purpose of removing the faeces and surplus of food by deploying it to the surroundings.
Further, the open net cages, see for example NO158201 and NO336739, enable establishment of fish farms at low investment cost.

However, the net cage farm solution put, due to the protected and sheltered environment required, some limitations to where location of farming may be possible, with negative effect on finding new suitable areas where establishment of fish farms may be permitted.
Also, as the open net solution is favourable with respect to exchange of water within the cage, the free flow of surface water unfortunately also give access to parasites, particularly the sea lice, which has given the fish farming industry big challenges. On this background fish farm designers have been looking for new solutions, which in addition to dealing with the matters commented above, also may introduce new alternatives of operation, improve the efficiency of the farming, the environment of the service personnel and the pollution impact on the surrounding area of the farm.

Semi-submersible structures are well known for offshore oil and gas related vessels in deep waters. They have one or more pontoons, which in operation is submerged below the action of surface waves, and a plurality of vertical columns both being buoyancy and stability bodies and structural elements for a part of the vessel being over the surface. Due to the counter action of the mass forces acting on the submerged pontoons and the pressure forces acting under the vertical columns, and the deep draft, a semi-submersible platform, is substantially less influenced by waves at the surface than a surface vessel, at least at the conditions, i.e. wavelength, and wave height, for which they are constructed. A skilled person is able to construct a semi-submersible for a specific location based on statistics on weather and wave

at the intended location. The structure may be elevated by reducing the volume of water introduced in the ring pontoon as ballast.

The object of developing the present tank farm, is to present solutions to a variety of new requirements related to an innovative way of farming fish. The inventor was previously one of the inventors of the invention as disclosed in Norwegian patent No. 343577 (application No. 2017 0955), which presented new solutions for suppressing the sea lice problem, protect the operating personnel as well as making operations in more exposed environments with heavy waves and strong currents possible.

According the mentioned patent a tank for fish farming is described, wherein the tank comprises: a polygonal or circular ring pontoon forming the lower part of the tank, sidewalls being substantially vertically arranged on the ring pontoon to form a substantially vertically arranged tubular member having a circular or polygonal cross section, and vertical columns being arranged perpendicular upwards on the ring pontoon and being connected to the sidewalls, and extends from the ring pontoon to the top of the sidewalls, where the ring pontoon and the vertical columns comprise closed buoyancy elements, and where the ring pontoon is adopted to be ballasted by means of water being pumped into the buoyancy element(s) therein.

Objects of the present invention.

An object is to further develop the known fish farming structure described in said Norwegian patent, and offer alternative solutions in the design of the hull, to deal with even more heavy wave and weather environment, improve the handling and wellbeing of the fish and further rationalize the efficiency of the farm. The structure of the present invention is based on a bottom or lower polygonal or circular ring pontoon structure accommodating plural number of columns containing concentric tanks for fish farming on top.

A primary object of the invention is to deal with the abovementioned disadvantages of the present fish fish farming structures.

The present invention.

The structure of the present invention is characterized in that a polygonal or circular ring pontoon is a lower part of the structure forming a basis for a plurality of tanks for containing fish, each tank being arranged upwards in an annular pattern of the pontoon top surface, and at least two adjacent tanks are interconnected by a closable lock structure. The invention is a semi-submersible floater structure, where a plurality of columns surrounding the tanks and configured in same ring on top of and integrated into said ring shaped pontoon structure.

The further preferable features of the semisubmersible structure, appear in the following independent claims 2-13.

According to a further aspect as given in claim 14, the structure is applied to separate fish of different sizes in leading the larger sized fish into the adjacent tank, by lifting the upper elevator of the smaller sized mesh net, the smaller fish may drop or swim downward into the tank compartment between elevators and while the bigger fish is carefully forced to escape through the lock and into the neighbouring tank.

The inventive structure combine the purpose of stabilizing the floater hydrostatically and hydrodynamically with the purpose of columns being containment system of the tanks for farming of the fish.

Due to tuning of column displacement and water plane area, in combination with ring pontoon shape and displacement, the motion characteristics of the present structure is expected to be very good and suitable for rougher sea and wheather environment than where fish farms are operated today.
Good motion characteristics of floater, and the location, proportions and motion surpressing system (anti sloshing perforated cofferdams) of the containment system in the columns, provide an excellent environment for farming of fish in the column tanks.

For circulation of water to the fish tanks in the columns, the intake of water circulation units is located below the draft where sea lic is expected to occur.

Drawing figures.
The invention will be disclosed more detailed by reference to the drawings, wherein;
Figure 1 and 2 are perspective views, seen obliquely from above and below respectively, of a semi-submersible fish farm structure of the invention, of a eight tanks which are anchored on top of a submersible ring pontoon structure.

Figure 3 plan perespective view, partly in section, of the fish farm unit of figures 1 og 2.

Figure 4 is a vertical cross sextion view of the fish farm structure along line X-X as indicated on figures 1 and 3, i.e. with the structure arranged floating in the sea in its upright correct position.

Figure 5A shows a vertical cross section ot two adjacent positioned tanks mounted on top of the bottom floater structure. The figure also shows the two internal hoistable elevator net frames inside each tank.

Figure 5B shows the sealing the gap between the liftable net mesh elevator and the inner wall of tankt.

Figures 6 and 7 show a coffer dam structure and the downward rotating water flow through the tank.

Specific embodiments of the invention.

The invention will be disclosed more in detail with reference to the drawing figures, in that the basic design is explained first.

The semi-submersible structure 10 shown in figures 1 -3 comprises a ring pontoon 12 onto which a plurality vertikal hollow tanks (or columns) 20 are arranged. The ring pontoon 12 and the vertical tanks 14 serve as structural support, buoyance and stabilizers for the fish farming unit. The ring pontoon 12 is a substantially circular ring shape but may be polygonal having four or more straight sections. The pontoon is arranged substantially horizontal or parallel to the sea surface 11 (figure 4) at the lowermost part of the unit. The circular inner wall of lower section of each tank, is designed to penetrate the pontoon 16, extedning from the top surface of the pontoon 12 to the bottom, see figure 2. Each tank is firmly secured to the pontoon, and may be replaced when needed.

The pontoon structure 12 is preferably be divided into two or more individual separated sub tank volumes all enabled to be induvidually ballasted.

According to the invention the volumes of the potoon 12, the gap 24 and hollow collar 28 are arranged to be ballasted by water/air to contribute to the position and balance of the fish farming structure in the sea. In this manner, by draining water off the pontoon/gap or in further arranged extra floats, hight level in the sea the structure may be regulated. While the fish containing tanks are open in bottom for free drainage of water through the bottom mesh-net elevator.

Each tank 14 is connected vertically upwards on the ring pontoon 12, and outer shell parts on to the pontoon 12 top surface 15,. The inner shell of each tank with a reduced diameter form a plug like socket 16, arranged to fit into a circular recess 18 extedning from the top surface of the pontoon 12 to the bottom, see figure 2. More precise as best shown in the enlarged

figure 5B, the outer ring shaped shell wall 22 and the entermiate section 24 are terminated a distance above the bottom 40 of the inner shell wall 24 thus a hook resting on top of the pontoon 12 edge.

The present fish farming structure is kept in position on location by a set of mooring lines 13 fixed to the unit's mooring system in one end and the seabed by anchors or piles in the other end as shown in figures 1 and 2.

I the preferred case, eight - 8 - tanks 20 are fixed to the pontoon 12 along the periphery around the circle.

Water is supplied into each tank at the top level, close to the the water surface 11. Said tank bottom 15 is arranged with a grid of a callibrated mesh, to prevent escape of fish from the tank inside and further to allow water including faeces and surplus of food particles to flow out of the tank bottom and into the surrounding water. This structure provides for a forced circulation of necessary water to supply the fish comfortably with oxygen.

In the open space internal of the circumferential arranged eight tanks 20 one or more (preferably two) further tanks 18 are erecting from the pontoon 12 bottom surface to the same level as the circumferential tanks. These tanks 18 are preferably of a single wall structure. The bottom of each of these tanks 18 is safely secured to the surrounding pontoon. The geometrical design of the tank set 14,18 appears of the figure plan view.

Tank design.

Each tank 14 is designed with a double hull, of concentric fashion, with an inner 20 and outer 22 shell wall (figure 4) being separated by a gap or space 24 having honeycomb structure to minimize the shell thicknesses and reduce weight, which is essential to secure the payload capacity and performance of the unit. The space 24 is preferably intended to be ballasted by supplying water and/or air to balance and give buyancy to the fish farming structure in the sea. The double hull volume between inner and outer shells of columns serve the purpose of stabilizing the structure hull, hydrostatically as well as hydrodynamically. The concentric solution is particularly configured to make possible minor tuning of the structure. The tanks are designed to include open top of inner tank making sufficient access to the tank for all kind of service purposes.-The inner sylinder of columns will border the fish tanks, and is a uniform cylinder from bottom to top, to allow installation of a hoistable floor with metal grating, to be elevated up and down with the intention to vary the permissible fish volume of the tanks above the floor. A bilge keel 80 (figure 4) may be provided to brake pitch/roll and add mass to the dynamic system.

Cofferdam.

At the upper part, at the surface level, a cofferdam collar 26 circumferntially encloses the outside of tank. The collar inner wall comprises radially inward perforations 29 extending through the tank wall also. On figures 6 and 7 said perforations are also shown partly continuing around the tank wall.

The purpose of the cofferdam is to dampen the effect of sloshing water inside the tank and in order to meet the environmental conditions on the intended location where the unit will be installed. Preferably each cofferdam extends 2-5 meter below and 3-8 meter above waterline. A second hollow collar 28 is circumferentially enclosing the cofferdam 26, and provides bouancy to the structure at surface level and is also arranged to be fully or partly ballasted as/if necessary.

Water supply and flow through tank.

The external outside of each tank 20 is arranged with one or more vertical pipes 70 (figure 7) to conduct or rise water from greater water depths for example 18-20 meters and to flow the water into the top level of the tank by a mainly horisontal pipe 71 extending into tank through the tank wall. Thus the intake of water circulation units is located below the draft where sea lic is expected to occur. To secure circulation of water in the tanks, each tank unit is equipped with several circulation units, that take water from +/- 18-20 meter depth and push the water at speed 1-3 meter pr second through pipes, to enter the tank at pre-set angles at the top.

Figure 7 indicates how the water is conducted at to flow from pipe **70** thorugh the tank wall and continues in a slow whirl **72** from top to bottom of the tank where it escapes through the elevator mesh 40 at the bottom, for example at depth +/-25m (depending on actual farm size) helped by the outside current. This figure 7 shows the elevator net mesh at the bottom outlet of the tank, while in figure 5A it is elevated 1/3 ut inside the tank volume. The capacity of the circulation system is at all times calibrated to feed the tank with the necessary amount of water to secure oxygen for the fish. Capacity of circulation units are computer controlled to ensure proper supply.

The structure will for each tank be equipped with a water circulation system feeding water by pumps in a dedicated piping system located on outside of the columns. To save energy the pumps to be low velocity in pipe flow type (propeller) with frequency control of the rotation speed to regulate the flow velocity.

The intake of the water circulation system (generally) to be just at or close to pontoon deck level, far enough away from sea surface to avoid sea lice entering the system, and above level of tank outlet under the columns from where the waste from the tanks are disposed.
In some instances, additional intakes may be located in deeper water to admit water of various temprature into the tanks and thereby have better seasonal control of the water temperature inside.

Flow connection of to adjacent tanks.

At an upper area of the water line 11, at least two adjacent tanks next to each other, and preferably all adjacents tanks, are interconnected by a closable lock structure 30. As shown in figures 3, 4 and 7, at an upper level, tank 14 is interconnected to a neighbouring tank via a channel section or lock 30 where the through flow opening 32 can be manipulated by inserted gate valves 34 with optional mesh openings. The interconnection channel shall serve the purpose of shifting fish from one tank to another tank when necessary to separate fish and/or treat fish individually. Preferably by means of the one or more liftable elevator floors which are disclosed further down in this specification.

The lock structure 30 between two tanks is situated in the area just below the cofferdam structure 26. The mesh size of a mesh net in lock passage, is regulated as to the size of fish one wishes to let through the lock port from one tank to the neighbouring tank.

Lifting elevator system.

Each tank bottom area, in the internal volume of the tank, comprises a net frame 40, allowing water to drain water off the tank bottom and for preventing fish escaping. See the right hand tank 14 on figure 5A.

In the preferable emvodiment, this net frame 40 is, as shown in the left side tank of figure 5A, is structured to operate as an liftable elevator net frame 40. In the further preferred embodiment of figure 5A left, there are two individually liftable net frames, named a lower first net elevator 40 and an upper second net frame elevator 42, i.e. the one positioned above the other. Each elevator is suspending down into the tank volume in sufficient lines 50 up to a hoist unit 50 on top of the tank structure. The sealing structure to prevent fish from escaping, appears on the enlarged detail of figure 5B.

Their purpose is to provide for separation of fish of different size, or to move fish from one tank 14 into another via the abovementioned port openings 30 as shown in figure 3. Preferably each elevator comprises a free flow metal net.

Elevating the floors (like a lift) up and down, enables a variation of the part volume of the tank above the elevator floor containing the farmed fish, several advantages are achieved. The fish may be carefully pushed towards the top of the tank enabling more convenient collection and transfer of the fish to transport ship, used to pick up the fish for processing.

For sorting fish in two sizes, use is made of the two net elevator floors 40, 40 of different mesh size elevator nets. The upper elevator floor 42 includes a net of smaller mesh size than the lower elevator net floor 40. The smaller net size accommodate the smaller size fish to be contained from the start of the fish farming or breeding. As the fish grow to bigger sizes, smaller and bigger sizes may be separated by elevating the upper floor upwards and let smaller size fish escape to the lower section of tank through a calibrated mesh escape section of the floor (mesh section to be opened occasionally) So when the upper tank volume containing fish of different sizes is reduced by lifting the upper floor 42, the smaller fish may drop or swim downward into the tank compartment below the floor 40 while the bigger fish is carefully forced upwards, to be collected for transfer to transport/treatment unit, or to escape through the port and into a neighbouring tank. Thus smaller fish is contained between the two net mesh elevators 40 and 42, while the larger fish is above the upper net mesh elevator 42.

Elevating of the floor may be used in cases where the fish need medical treatment to ease the catching for treatment by service vessel. The elevating floor in different tanks may be equipped with different mesh size for a particular tank to habit smaller size fish and another tank some bigger sizes.

As shown in figure 5B, each elevated floor 40/42 is guided on the cylinder wall 14 by rollers 47 to secure accurate and precise elevation and enable smallest possible slit between elevated floor 40 and the cylinder wall 14. The slit to may be closed with suitable brushes 43 and/or by expandable rubber seal 45 or similar. The elevator lifting line is indicated by reference numeral 49. In some cases lower floor may even be fixed to the sidewall of the tank.

Figures 5A and 7 show that the lower net elevator 40 forms the bottom of the tank, and water including impurities is allowed for free flowing through the bottom of the tank since the fish farming structure is intended for operation at open seas. The tank bottom structure may though include a system to collect and discharge faeces, food remains and dead fish to be transported to the surface through a hose for adequate treatment.

To clean tanks, keep the elevator grating free of waste and remove dead fish from the elevator deck, cleaning robot and dead fish collecting robot will be installed. From a temporary storage at elevator deck level, dead fish will be pumped to deck for ensiling.

The elevating floor in different tanks may be equipped with different mesh size for a particular tank to habit smaller size fish and another tank some bigger size

Facilities for service.

Above two pair of tanks the accommodation and the machinery section will cover the tank top area and provide roof and enclosed working environment for those areas, while other free-standing tanks will each have protecting sides and a protecting roof. Access between the working areas on top of tanks will be on protected gangways. Enclosure of the tanks from outside light enables control of light environment inside tanks by making a controlled inside light environment. The cleaning of tank-walls and floor as well as removing of dead fish will be performed by dedicated purpose-built robots. Most of the working areas will be indoor and/or environmentally protected to the extent possible to ensure safe and comfortable operation.

Typical size and capacity of structure.

A suitable size of the structure may have a ring pontoon diameter of about 70 meter, a draft of 25 meter and a height of the structure from keel to top of roof/shelter above tanks of about 36m. Volume of each fish tank may be about 5000m3 each, giving a total fish tank volume of about 50.000m3.

Further advantages.

As described in the aforementioned , the present utilizes a floater, and like all floaters when operating in environment with heavy waves and current, the waves and the environmental forces will tend to amplify the motions. To reduce the impact of the waves and suppress the motions, in the oil industry long time ago introduced the design of the semi-submersible hull, which since has been standard for oil drilling rigs. This principle as described above, is also utilized in this invention as was also the case for the solution appearing in NO343577.

But different from NO343577, in this invention utilizes a multicolumn hull configuration combining the function of the columns to have sufficient volume/waterplane to stabilize the floater hydrostatically and hydrodynamically, as well as containing the open tanks for fish inside, which are forming the centre part of the double hull columns.

By selecting this solution of the invention, it is possible to handle even more wave exposed environment than before achieved by other solutions, because a feasible diameter of the columns for stabilizing purposes can be combined with an inner tank having optimal diameter for suppressing of unacceptable sloshing, particularly if combined with the circumferent and partly open cofferdam at the surface level of the tank, where the size of the openings to the tank are tuned to critical surface wave of the tank.

At the same time, the open top makes access to the tank easy for all kind of service purposes, the semi open bottom with metal net prohibit escape of fish, and proportions makes it suitable for forced circulation of necessary water to supply the fish comfortably with oxygen.

In comparison with other concepts, where the open tank diameter is considerably larger, as for instance is the case for the structure of NO343577, the sloshing phenomena amplify more expressively with motions, and thereby limits the operational area more strictly for this kind of units than what is the case for the present new inventive structure named "AquaOcean".

To get the necessary volume of tank capacity for a large farm unit according to the present invention, a number tanks/columns are needed. In this case the selected number of tanks/columns are spaced in a circle around, and penetrating a ring pontoon. The tanks/columns are concentric double hull configuration, to secure necessary displacement and stability, as well as provide space for free surface open tanks inside. More precise the upper section of the ring pontoon is designed with a plurality recesses around the circumference, each recess accomodating and securing the bottom of its belonging upright positioned double hull/walled tank/column. The ring pontoon may have a circular, oval og square other suitable ring shapes.

Advantages of the new inventive structure

The solution with double hull columns penetrating the hull of the ring pontoon also secures another operational advance; the tank walls located in concentric facion inside the column, are like open wells, which can be made with same diameter and without obstructions all the way from bottom to top, enabling an elevated floor with a free flow metal net, to be provided. By elevating the floor (like a lift) up and down, and thereby enabling variation of the part volume of the tank above the floor containing the farmed fish, several advantages are achieved.

By elevating the floor, the fish may be carefully pushed towards the top of the tank enabling separation of different sizes of fish by letting the smaller sizes escape to the neighbouring tank through calibrated openings in the piping system connecting the tanks at the top. The fish may

be carefully pushed towards the top of the tank enabling more convenient collection and transfer of the fish to transport ship, used to pick up the fish for processing. Elevating of the floor may be used in cases where the fish need medical treatment to ease the catching for treatment by service vessel. The elevating the floor may also be lifted to the top for cleaning purposes and/or to equip the floor with some smaller mesh/restrictions to enable the tank to contain smaller size fish.

The elevating floor in different tanks may be equipped with different mesh size for a particular tank to habit smaller size fish and another tank some bigger sizes. So when the fish is grown to bigger size, the upper elevating floor is elevated to push the bigger fish to upper part of tank, while smaller fish escape through dedicated restrictions to lover part. Then escape restrictions are closed, and larger size fish are pushed through connecting pipe port/gate 30 to neighbouring tank with a more open mesh at the bottom, permitting more free circulation of water to satisfy oxygen requirement of bigger size fish, and ease deposit of faeces and food surplus.

The capability of the structure of the present invention, to stand environment with strong current, is favorable to enable operation in more severe environment and to secure transport of waste deposits away from the farm unit, for less pollution of local environment and better dispersion of the waste in area of installation.

Inside the tank, the water will flow in a slow whirl from top to bottom where it escapes through the mesh at the bottom at depth +/-25m (depending on actual farm size) helped by the outside current. The capacity of the system is at all times calibrated to feed the tank with the necessary amount of water to secure oxygen for the fish. Capacity of circulation units are computer controlled to ensure proper supply.

The placing of the intakes of the water circulation system deep down from the surface, are intended to avoid suction of sea lice puppets, mostly occurring at or close to sea surface, into the system, and thereby eliminate the problem of the sea lice parasite entering the tank. The size of the present inventive structure enables capacity of the unit to accommodate all necessary service functions to daily operate the unit independently, if necessary, also without supply of electric current from shore.

The structure will be equipped with accommodation for people to live and as necessary stay overnight. There will be service office, laboratory, and control room for people to operate all working functions of unit. An electric network to feed machinery and equipment utilizing shore current and/or installed current will be provided. There will also be storage and

machinery for food supply, equipment and space for treatment of dead fish, and necessary equipment to serve the farming operation etc.

The hull of the structure will be purpose designed for the actual environment where the unit will be installed. Of particular importance is the tuning of the hull configuration to secure proper hydrodynamic behaviour and protect the fish tank surface water from extensive sloshing. Depending on the chosen parameters, the capabilities of the fish farming structure to service a particular location can be optimized and meet requirements of many severe and demanding environments along the Norwegian coast.

To accommodate transport, installation and mooring of the structure, the draft of the unit can be varied by use of the installed ballast system, which is also used to keep the unit upright under all operating conditions. A variety of drafts are practically possible, by varying the water content of water in dedicated tanks, to elevate the unit from pontoon draft with the pontoon deck free above water, down to operating draft by ballasting.

The capability of varying the draft, is also of practical use during maintenance and cleaning of the unit, giving access above water to major part of the hull and its equipment.
As mentioned the fish farming structure will be kept in position on location by a set of mooring lines fixed to the unit's mooring system in one end and the seabed by anchors or piles in the other end. Depending on local conditions related to environment, seabed, water depths etc, utilisation of buoyancy elements along the mooring lines, may be required.

Summary of the invention
The objects described above have been met by the invention of the inventive fish farming structure in the following way:
It is a multicolumn semi-submersible with the columns, (6, 8 or more), located close to each other in a (ring shape) circular fashion to maximize the permissible square area of the columns within the border of a circumferent circle. A ring pontoon which is penetrated by the columns, is provided to carry the weight of the columns, and locate the columns at the lower end. At the upper end, a ring deck structure is provided to locate and support the columns horisontally. The penetration of the pontoon at the lower end is essential to give water open access to the fish tank of each column.

The elevated floor is guided on the cylinder wall by rollers to secure accurate and precise elevation and enable smallest possible slit between elevated floor and the cylinder wall. The slit to be closed with suitable brushes and/or by expandable rubber seal or similar. The elevated floor may in some cases be firmly located at the bottom of one or more tanks.

The elevated floor may be equipped with grating of various mesh to fit various size fish which will be accommodated in the tanks. An alternative is to make the two elevated floors, one on top of the other. The one on top may be equipped with a different size mesh to allow smaller size fish escape to the lower part of the tank when the upper floor is elevated. Bigger size fish will ultimately be pushed upwards to be catched for further treatment.

It is intended to make possible minor tuning of the structure hull to various load capacity/load conditions and environments at design stage, by adjusting the volume and waterplane of the honeycomb as required. The concept can this way be adjusted, without major change of principal layout and design of unit.

The tanks are located narrowly in a with narrow space between them to maximize number/size within a given outer circumference (important measure defining the capacity of the unit and the physical size with respect to handling of current and waves), as restrictions to column diameter due to sloshing limit the diameter of column and thereby the fish tank volume within each column. The distance between columns is chosen to allow practical access during building, maintenance, and operation.

The ring pontoon of the fish farming structure will have sufficient buoyancy to elevate the complete unit from maximum operating draft, to a draft where the pontoon deck is elevated above sea surface. The transverse rectangular shape (aspect ratio beam/height) and volume of the ring pontoon has been selected to meet needed volume of displacement, mass and added mass to carry loads and tune motion dynamics and particularly dampen the heave response of the fish farming structure structure in different waves environment.

The structure will be kept on location by a catenary mooring system, fixed in one end to unit by fairlead and chain stopper, and in the other end to seabed by anchors and/or piles. To soften the system and avoid dynamic response between unit motion and spring of mooring system, mooring lines may be equipped with floating elements (not shown).

PATENTKRAV.

1. A structure (10) for fish farming, characterised in that a polygonal or circular ring pontoon (2) is a lower part of the structure (10) forming a basis for a plurality of tanks(columns) (14) for containing fish, each tank (12) being arranged upwards in an annular pattern of the pontoon (12) top surface (15), and at least two adjacent tanks are interconnected by a closable lock structure.

2. A structure (10) according to claim 1, characterised in that each tank (14) is a double hull structure having an inner (20) and outer (22) shell wall being separated by a gap (24).

3. A structure (10) according to any of claims 1-2, characterised in that said gap (24) comprises a honeycomb structure to minimize shell (29,22) thicknesses.

4. A structure (10) according to any of claims 1-3, characterised in that the volumes of the potoon (12), the gap (24) and hollow collar (28) are arranged to be individually ballasted by water/air to contribute to the balance (stability) of the fish farming structure in the sea.

5. A structure (10) according to claim 1, characterised in that each tank bottom area of the internal volume of the tank, comprises a first bottom element of a net frame (40).

6. A structure (10) according to claim 5, characterised in that said bottom net frame (40) is structured to operate as an liftable bottom net frame elevator (40).

7. A structure (10) according to any of claims 5-6, characterised in that a second liftable net frame elevator (42) arranged above the first one bottom element of a net frame (40), in that both net frames (40,42) are individually liftable elevators inside the tank volume, and preferably the upper second net frame elevator (42) includes a different mesh size than the lower first net fram elevator (40).

8. A structure (10) according to any of the preceding claims, characterised in that each tank (14), at the surface water level (11) comprises an radially inwardly circumferental perforated cofferdam collar (26) to dampen the effect og sloshing water inside the tank (14).

9. A structure (10) according to any of the preceding claims, characterised in that the external side of each tank (20) is arranged with one or more vertical pipes (70 - figure 7) to soak up water from a greater depth.

10. A structure (10) according to any of the preceding claims, characterised in that each tank (column) (12) is attached to the pontoon by the outer tank shell (22) resting on the pontoon top, while the inner tank shell (20) section (16) with its reduced diameter to form a bottom plug socket (16) to fit into a circular shaped recess (18) extedning downward from the top surface (15) of the pontoon 12 to the bottom.

11. A structure (10) according to any of the preceding claims, characterised in that the closable lock structure (30) passage includes a gate valve of mesh net element of a size regulated as to the fish size one wishes to let through the lock port (30) from the one tank to the neighbouring tank.

12. A structure (10) according to any of the preceding claims, characterised in that radially inward of the annular tank arrangement, at least one auxiliary tank structure is arranged on the pontoon (10), said at least one tank comprise a single or similar double wall structure, and preferably.

13. A structure (10) according to claim 12, characterised in that two auxiliary tanks are arranged, and their structure is defined as in the preceding claims 2-12.

14. Use of the fish farming structure of claims 1-11 to separate fish of different sizes in leading the larger sized fish into the adjacent tank, by lifting the upper elevator (42) with a calibrated mesh net, the smaller fish may drop or swim downward tinto the tank compartment between elevators (42) and (42) while the bigger fish is carefully forced to escape through the port (30) and into the neighbouring tank.

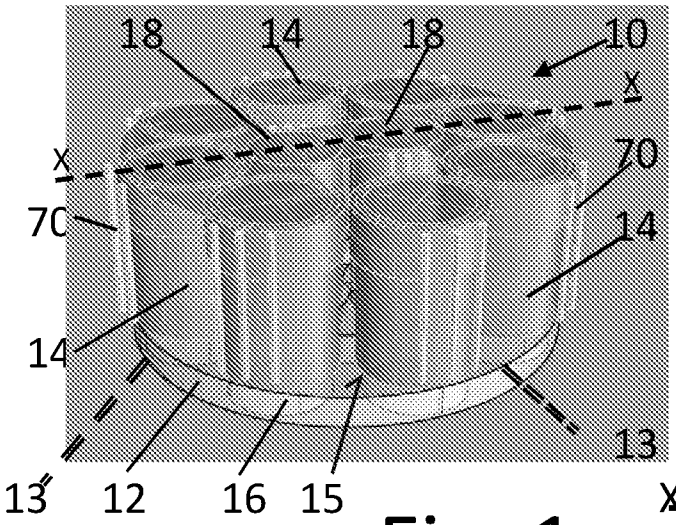

Fig. 1

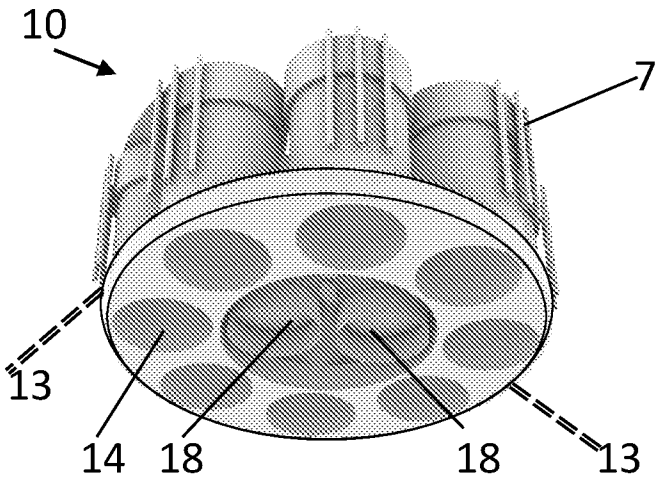

Fig. 2

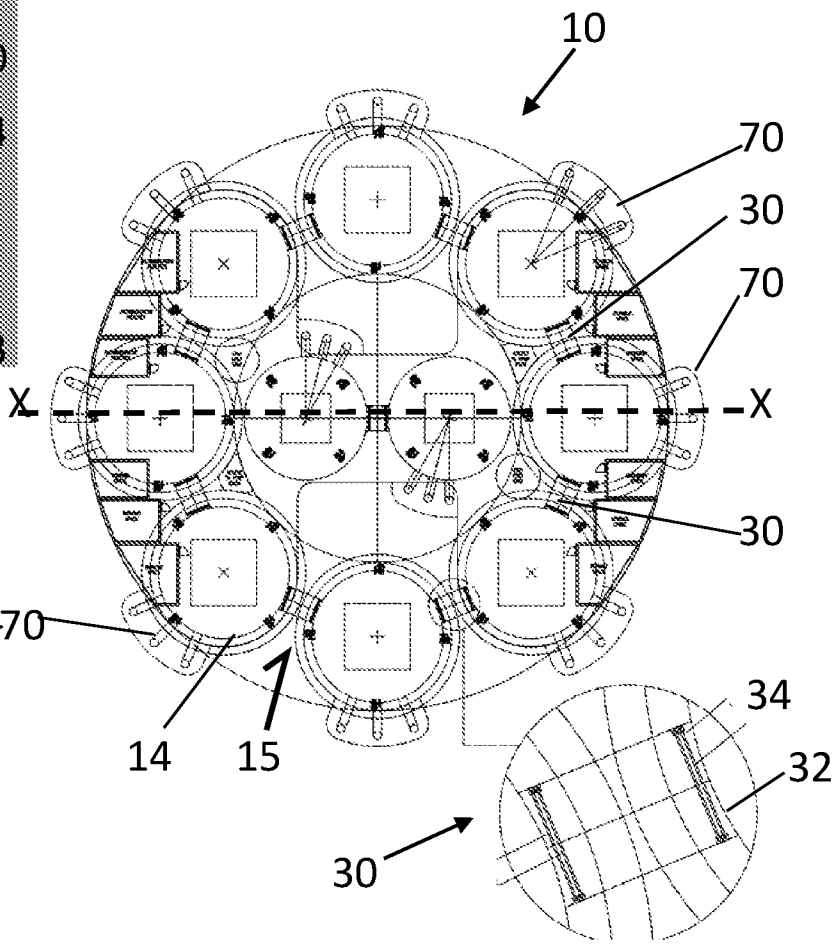

Fig. 3

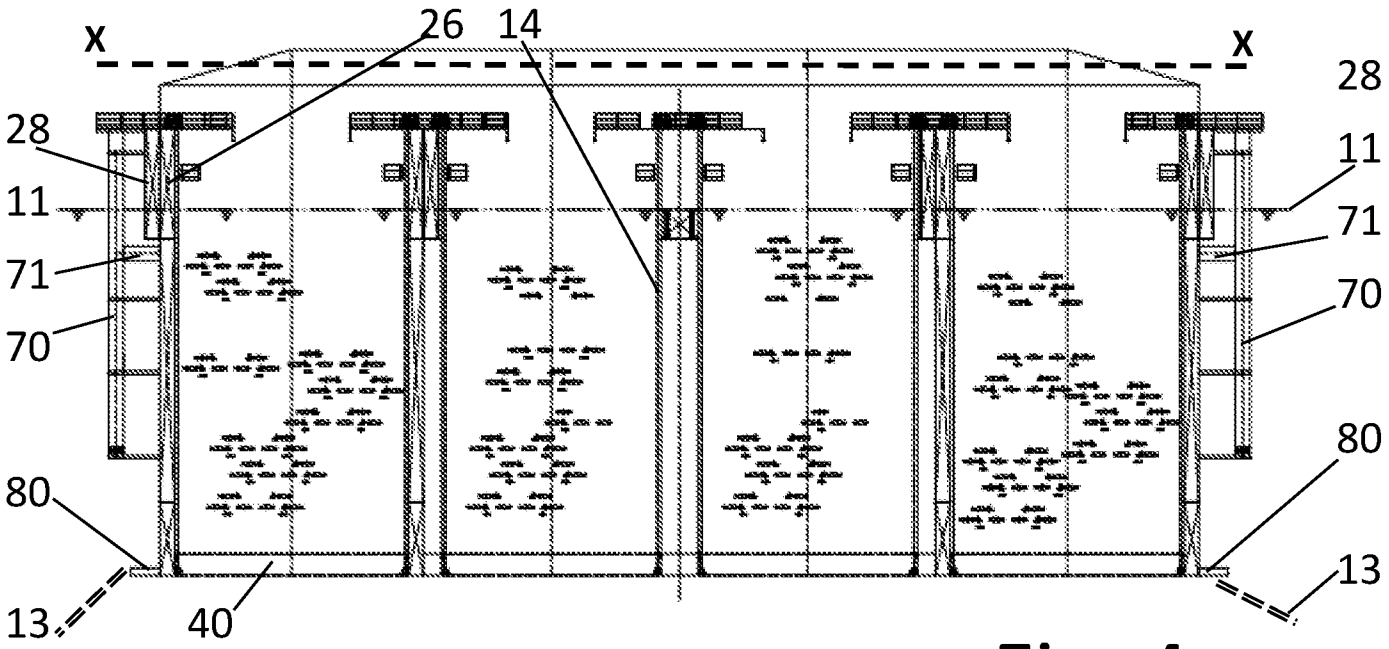

Fig. 4

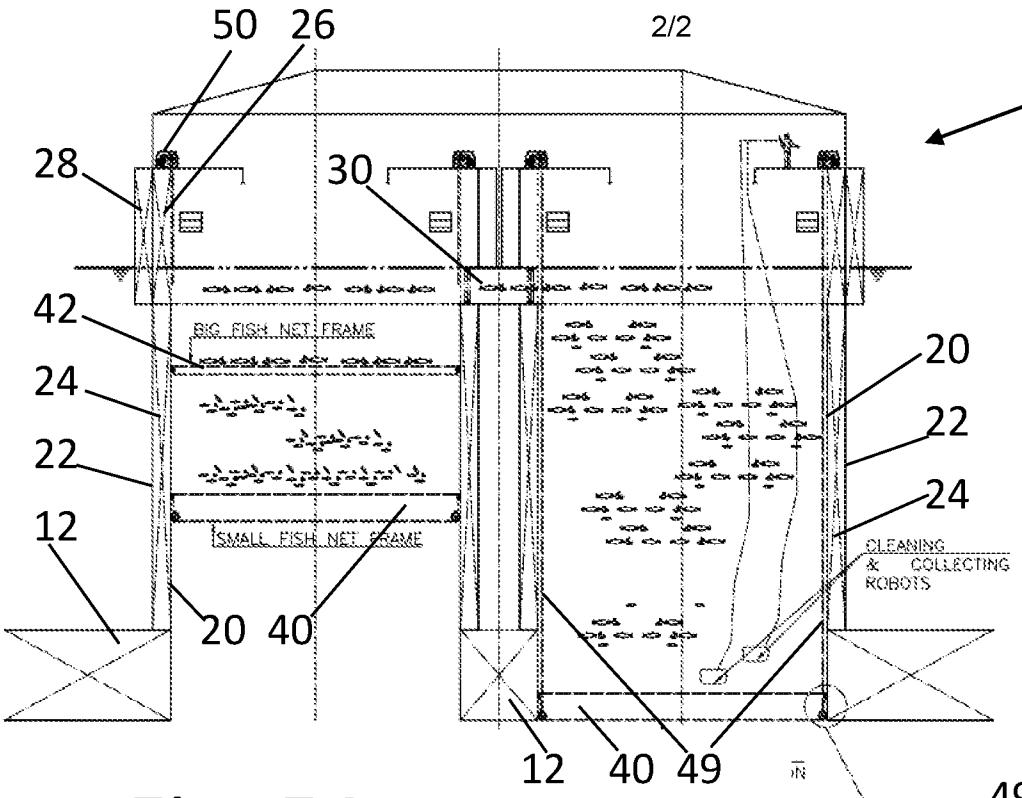

Fig. 5A

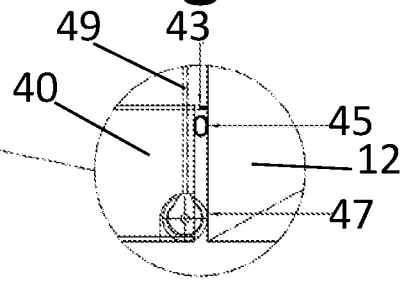

Fig. 5B

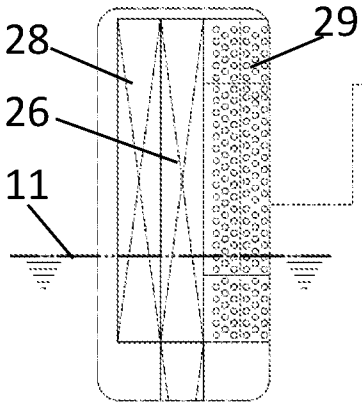

Fig. 6

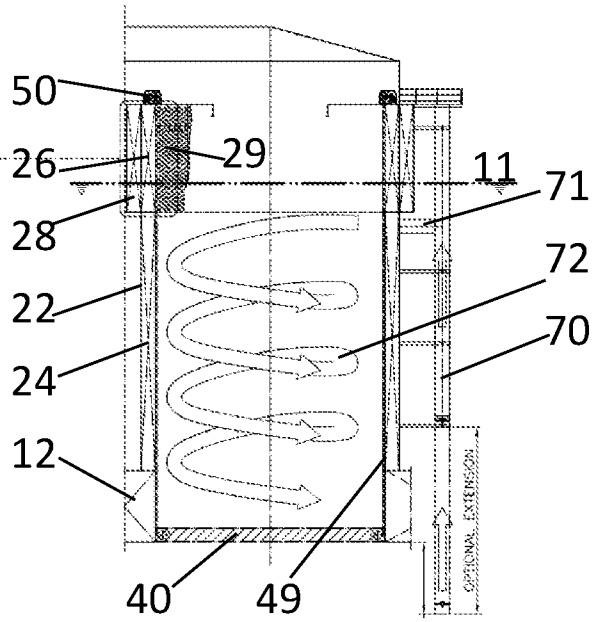

Fig. 7