

An Aquaculture System For Rearing Aquatic Species And A Method Thereof

Technical Field

[0001] The present invention relates to an aquaculture system for rearing aquatic species. Further, the present invention relates to a method for rearing aquaculture system.

Background

[0002] To increase food source, aquatic species, e.g. fish, prawn, are rear in industrial size tanks which can produce tonnes of aquatic species a year. Aquaculture systems and method to rear the aquatic species have improved over the years. However, it has always been a challenge to operate the aquaculture system of such scale in a cost effective and efficient way.

[0003] In order to keep the aquatic species healthy, it is important to control the rearing parameters in such aquaculture system to ensure that the conditions for rearing the aquatic species are optimal. If the conditions deteriorate in a rearing tank, as the density of the aquatic species in the rearing tanks are high, diseases may spread fast and the aquatic species may become sick and die within a short span of time.

[0004] Aquatic species naturally excretes ammonia as part of their metabolic processes. In a crowded rearing tank, the concentration of ammonia will increase sharply if it is not timely removed. High level of ammonia in the rearing tank can affect the health of the aquatic species.

[0005] It is commonly known that nitrification and denitrification processes are used to remove the ammonia. Nitrification units are used to carry out nitrification process by converting the ammonia to nitride and the nitride to nitrate. Thereafter, denitrification units are used to carry out denitrification processes to convert the nitrate to nitrogen, which may then be released into the environment.

[0006] While the processes are commonly known, the time and costs required to carry out the processes and maintain the units for large volume rearing tank are extremely high. Further, a

high level of expertise is also required to operating and maintaining such aquaculture system. In addition, the aquaculture systems require high number of manhours to manually clean, operate and maintain. Hence, the labour costs involve are substantially high.

Therefore, it is necessary to derive an aquaculture system that is relatively more cost effective and has a higher efficiency to operate and maintain.

Summary

[0007] According to various embodiments, an aquaculture system for rearing aquatic species is provided. The aquaculture system includes a rearing tank for rearing the aquatic species, the rearing tank adapted to contain water and the aquatic species therein, an intermediate tank in fluid communication with the rearing tank, the intermediate tank configured to extend from a proximal end to a distal end opposite the proximal end, such that the intermediate tank is adapted to receive the water at the proximal end and channel the water towards the distal end, a nitrification unit in fluid communication with the intermediate tank, such that the nitrification unit is configured to receive the water from the intermediate tank and return the water into the rearing tank, a denitrification unit in fluid communication with the intermediate tank, such that the denitrification unit is configured to receive the water from the intermediate tank and return the water into the rearing tank, a toxin removal unit in fluid communication with the intermediate tank, such that the toxin removal unit is configured to receive the water from the intermediate tank and return the water into the intermediate tank, such that the intermediate tank is configured to pump the water therein into the rearing tank.

[0008] According to various embodiments, the nitrification unit may be configured to receive the water from a first portion of the intermediate tank, such that the first portion may be between the proximal end and the distal end, such that the denitrification unit may be configured to receive the water from a second portion of the intermediate tank, such that the second portion may be between the proximal end and the distal end and downstream of the first portion, such that the toxin removal may be configured to receive the water from a last portion of the intermediate tank, and such that the last portion may be adjacent the distal end and downstream of the second portion.

[0009] According to various embodiments, the intermediate tank may include a booster disposed therein, such that the booster may be adapted to propel the water therein from the proximal end towards the distal end.

[0010] According to various embodiments, the booster may include a divider adapted to divide the intermediate tank into an upper stream portion and a lower stream portion, such that the divider may include a plurality of openings adapted to allow the water from the upper stream portion therethrough and projected into the lower stream portion.

[0011] According to various embodiments, the aquaculture system may further include a filtration tank adapted to receive and filter particles from the water and discharge the filtered water into the intermediate tank.

[0012] According to various embodiments, the filtration tank may include a settling tank having a top portion and a base portion below the top portion, such that the settling tank may be adapted to receive the water from the rearing tank at the top portion from one side of the settling tank, allow particles in the water to be settled to the base portion, and discharge the water out of the top portion at another side of the settling tank.

[0013] According to various embodiments, the settling tank may include a funnel and a drainage channel in communication with the funnel, such that the funnel may be adapted to receive and channel the particles into the drainage channel to be discharged.

[0014] According to various embodiments, the filtration tank may include a filtering tank including a filter extending from a proximal portion to a distal portion opposite the proximal portion, an inlet disposed above the filter and at the proximal portion for receiving the water into the filtering tank and an outlet disposed below the filter and at the distal portion for discharging the water from the filtering tank.

[0015] According to various embodiments, the toxin removal unit may include a frothing tank, a water inlet at a top portion for receiving the water into the frothing tank, a water outlet at a base portion opposite the top portion for discharging the water out of the frothing tank, an air

inlet for injecting air into the frothing tank to froth the water to create a foam, and an opening at the top portion adapted to allow the foam to exit the frothing tank therethrough.

[0016] According to various embodiments, the toxin removal unit may further include a holding tank disposed above the frothing tank and in fluid communication with the opening, such that the holding tank may be adapted to hold the foam exiting from the frothing tank.

[0017] According to various embodiments, the intermediate tank may include a fluid injection system adapted to pump the water from the intermediate tank into the rearing tank.

[0018] According to various embodiments, the rearing tank may be as long as the intermediate tank, such that the fluid injection system may be adapted to pump the water along and throughout the length of the intermediate tank into the rearing tank.

[0019] According to various embodiments, the fluid injection system may include a plurality of pumps disposed along the length of the intermediate tank from the proximal end to the distal end, such that the plurality of pumps are adapted to pump the water from the intermediate tank into the rearing tank.

[0020] According to various embodiments, a method of rearing aquatic species in a rearing tank adapted to contain water and the aquatic species therein may be provided. The method includes receiving the water into an intermediate tank at a proximal end of the intermediate tank and channelling the water towards a distal end of the intermediate tank, such that the intermediate tank is configured to extend from the proximal end to the distal end opposite the proximal end, receiving the water from the intermediate tank into a nitrification unit and returning the water into the rearing tank, receiving the water from the intermediate tank into a denitrification unit and returning the water into the rearing tank, receiving the water from the intermediate tank into a toxin removal unit and returning the water into the intermediate tank, pumping the water from the intermediate tank into the rearing tank.

[0021] According to various embodiments, the method may further include propelling the water therein from the proximal end towards the distal end.

[0022] According to various embodiments, propelling the water may include allowing the water from an upper stream portion of a divider to be projected through a plurality of openings of the divider into a lower stream portion of the divider.

[0023] According to various embodiments, the method may further include filtering the water from the rearing tank and discharging the filtered water into the intermediate tank.

[0024] According to various embodiments, the method may further include receiving the water from the intermediate tank at a top portion and from one side of the settling tank, allowing sediments in the water to be settled to a bottom portion of the settling tank, below the top portion, and discharging the water out of the top portion and at another side of the settling tank.

[0025] According to various embodiments, the method may further include receiving and channelling the particles into a drain to be discharged.

[0026] According to various embodiments, the method may further include receiving the water into a filtering tank via an inlet disposed above the filter and at a proximal portion of the filtering tank and discharging the water from the filtering tank via an outlet disposed below the filter at a distal portion of the filtering tank, such that the distal portion may be opposite the proximal portion.

[0027] According to various embodiments, the method may further include receiving the water into a frothing tank, injecting air into the frothing tank to froth the water to create a foam, and discharging the water out of the frothing tank, and allowing the foam to exit the frothing tank via an opening at a top portion of the toxin removal unit.

[0028] According to various embodiments, the method may further include holding the foam exiting from the frothing tank in a holding tank disposed above the frothing tank and in fluid communication with the opening.

[0029] According to various embodiments, the method may further include transferring the water along and throughout the length of the intermediate tank into the rearing tank, such that the rearing tank may be as long as the intermediate tank.

Brief Description of Drawings

[0030] Fig. 1 shows a top view of an exemplary embodiment of an aquaculture system for rearing aquatic species.

[0031] Fig. 2A shows a top view of an exemplary embodiment of the intermediate tank.

[0032] Fig. 2B shows a side view of the embodiment of the intermediate tank in Fig. 2A.

[0033] Fig. 2C shows an elevation view of the booster.

[0034] Fig. 3A shows a top view of an exemplary embodiment of the aquaculture system.

[0035] Fig. 3B shows a top view of an exemplary embodiment of the filtration tank.

[0036] Fig. 3C shows an elevation view of the filtration tank in Fig. 3B.

[0037] Fig. 4 shows an elevation view of an exemplary embodiment of the nitrification unit.

[0038] Fig. 5 shows an elevation view of an exemplary embodiment of the toxin removal unit.

[0039] Fig. 6 shows an exemplary method of rearing aquatic species in a rearing tank adapted to contain water and the aquatic species therein.

Detailed Description

[0040] In the following examples, reference will be made to the figures, in which identical features are designated with like numerals.

[0041] Fig. 1 shows a top view of an exemplary embodiment of an aquaculture system 100 for rearing aquatic species. Aquaculture system 100 includes a rearing tank 110 for rearing the aquatic species, such that the rearing tank 110 is adapted to contain water and the aquatic species therein. Aquaculture system 100 includes an intermediate tank 120 in fluid communication with the rearing tank 110. Intermediate tank 120 is configured to extend from a proximal end 120P to a distal end 120D opposite the proximal end 120P, such that the intermediate tank 120 is adapted to receive the water at the proximal end 120P and channel the water towards the distal end 120D. Aquaculture system 100 includes a nitrification unit 130 in fluid communication with the intermediate tank 120, such that the nitrification unit 130 is configured to receive the water from the intermediate tank 120 and return the water into the rearing tank 110. Aquaculture system 100 includes a denitrification unit 140 in fluid communication with the intermediate tank 120, such that the denitrification unit 140 is configured to receive the water from the intermediate tank 120 and return the water into the rearing tank 110. Aquaculture system 100 includes a toxin removal unit 150 in fluid communication with the intermediate tank 120, such that the toxin removal unit 150 is configured to receive the water from the intermediate tank 120 and return the water into the intermediate tank 120. Toxin removal unit 150 may be configured to return the water into the rearing tank 110. Intermediate tank 120 is configured to pump the water therein into the rearing tank 110. Aquaculture system 100 may include a plurality of nitrification units 130 depending on the volume of water required to be nitrified. Aquaculture system 100 may include a plurality of denitrification units 140 depending on the volume of water to be denitrified. Water may include seawater, fresh water, etc. By transferring the water from the rearing tank 110 into the intermediate tank 120, the intermediate tank 120 allows the water in the intermediate tank 120 more time to be treated by the nitrification unit 130, the denitrification unit 140 and the toxin removal unit 150. As the speed of the water flowing along the intermediate tank 120 is relatively lower than the speed of the water in the rearing tank 110, it is possible to carry out the denitrification and nitrification processes more thoroughly in the intermediate tank 120. Intermediate tank 120 is adapted to separate the cleansing of the water from the rearing tank 110.

[0042] Referring to Fig. 1, the rearing tank 110 may include a perimeter wall 112 extending from a base 114. Rearing tank 110 may include an incoming side 112N along the perimeter wall 112 where the water enters the rearing tank 110 and an outgoing side 112T along the

perimeter wall 112 where the water exits the rearing tank 110. Rearing tank 110 may include a draining channel 110D for receiving and draining waste from the rearing tank 110. Rearing tank 110 may include a base 114 which may be sloped towards the draining channel 110D to direct the waste towards it. Intermediate tank 120 may be disposed along the incoming side 112N of the rearing tank 110 such that water may be pumped into the rearing tank 110 from the intermediate tank 120 along the incoming side 112N of the rearing tank 110. While the incoming side 112N is adjacent the outgoing side 112T, the incoming side 112N may be opposite the outgoing side 112T. Water in the rearing tank 110 may flow from the incoming side 112N towards the outgoing side 112T of the rearing tank 110. Rearing tank 110 may have a capacity of 250-500 tonnes of water and/or aquatic species.

[0043] As shown in Fig. 1, the intermediate tank 120 may include a proximal end 120P and a distal end 120D opposite the proximal end 120P. Water may enter the intermediate tank 120 at the proximal end 120P and flows towards the distal end 120D. Aquaculture system 100 may be configured such that the nitrification unit 130 may be configured to receive the water from a first portion 120F of the intermediate tank 120, such that the first portion 120F may be between the proximal end 120P and the distal end 120D, the denitrification unit 140 may be configured to receive the water from a second portion 120S of the intermediate tank 120, such that the second portion 120S may be between the proximal end 120P and the distal end 120D and downstream of the first portion 120F, the toxin removal may be configured to receive the water from a last portion 120L of the intermediate tank 120, such that the last portion 120L may be adjacent the distal end 120D and downstream of the second portion 120S. Intermediate tank 120 may be configured to be elongated such that the length of the intermediate tank 120 is substantially longer than the width of the intermediate tank 120. The ratio of the length to the width may be more than 5:1 or more than 10:1. In addition, by having an elongated intermediate tank 120, extending from the proximal end 120P to the distal end 120D, and the nitrification unit 130, denitrification unit 140 and toxin removal unit 150 lined up along the length of the intermediate tank 120, the water may be received by the nitrification unit 130 and denitrification unit 140 to convert the ammonia therein into nitrogen as it flows from the proximal end 120P to the distal end 120D of the intermediate tank 120. As the water reaches the distal end 120D of the intermediate tank 120, the water may be received by the toxin removal unit 150 to remove the toxin and protein therein. Intermediate tank 120 is adapted to

consolidate the toxin and protein at about the distal end so that there is sufficient time for the toxin removal unit 150 to remove the toxin and protein from the water.

[0044] Fig. 2A shows a top view of an exemplary embodiment of the intermediate tank 120. Intermediate tank 120 may include a booster 122 disposed therein. Booster 122 may be adapted to propel the water therein from the proximal end 120P towards the distal end 120D. Booster 122 may extend across the width of the intermediate tank 120. Although the booster 122 is able to push the water in the intermediate tank 120, the speed of water in the intermediate tank 120 is substantially lower than the speed of water in the rearing tank 110. Intermediate tank 120 may include a plurality of air injectors 120A for injecting air into the intermediate tank 120. Plurality of air injectors 120A may be disposed along the length of the intermediate tank 120 and spaced apart from each other. Intermediate tank 120 may include a plurality of drains 120R adapted to collect waste from the water and be discharged out of the intermediate tank 120. For example, when the intermediate tank 120 is emptied for washing, the waste from the washing may be collected by the plurality of drains 120R and be discharged therefrom.

[0045] Fig. 2B shows a side view of the embodiment of the intermediate tank 120 in Fig. 2A. Booster 122 may include a divider 122D adapted to divide the intermediate tank 120 into an upper stream portion and a lower stream portion, such that the divider 122D may include a plurality of openings 122N adapted to allow the water from the upper stream portion therethrough and projected into the lower stream portion. When the water enters the intermediate tank 120 at the proximal end 120P, the water flows towards and through the plurality of openings 122N. Due to the reduction in flow area of the plurality of openings 122N, the velocity of the water increases, whereby the water is being projected downstream of the divider 122D. Booster 122 may include a plurality of dividers 122D arranged one after another and spaced apart from each other so that the water is being projected intermittently towards the distal end 120D. As shown in Fig. 2B, the plurality of air injectors 120A may be configured to inject air at the bottom portion of the intermediate tank 120. Intermediate tank 120 may include a fluid injection system 124 adapted to pump the water from the intermediate tank 120 into the rearing tank 110. Referring to Fig. 1, the rearing tank 110 may be as long as the intermediate tank 120, such that the fluid injection system 124 may be adapted to pump the water along and throughout the length of the intermediate tank 120 into the rearing tank 110. Fluid injection

system 124 may include a plurality of pumps disposed along the length of the intermediate tank 120 from the proximal end 120P to the distal end 120D, such that the plurality of pumps are adapted to pump the water from the intermediate tank 120 into the rearing tank 110. When the intermediate tank 120 is disposed adjacent the rearing tank 110, the water from the intermediate tank 120 may be discharged into the rearing tank 110 from above the water level in the rearing tank 110. Pumps may include mechanical pump and/or air lifting pump, etc. Air lifting pump allows air to be pumped into the pumps to propel the water therein out of the pump. As the water is being pumped from the intermediate tank 120 into the rearing tank 110 along the incoming side 112N of the rearing tank 110, the pumped water pushes the water towards the outgoing side 112T of the rearing tank 110. In this way, the flow of the water creates a current in the rearing tank 110. By pumping the water along the length of the incoming side 112N of the rearing tank 110, as the water flows towards the outgoing side 112T, the water is made to flow laminarly and turbulent flow is minimized. Incoming side 112N may be adjacent the outgoing side 112T. Incoming side 112N may be opposite the outgoing side 112T. The skilled person can appreciate that the aquaculture system 100 requires minimal power to be operated. As the water is being pumped from the intermediate tank 120 into the rearing tank 110, the water is being circulated back to the intermediate tank 120 without another pump. The water in the intermediate tank 120 is being driven along the length of the intermediate tank 120 using the booster 122 which does not require electricity. Aquaculture system 100 may be able to operate a high capacity rearing tank, e.g. 500 tonnes, with minimal power consumption.

[0046] Fig. 2C shows an elevation view of the booster 122. Booster 122 may include a divider 122D having a plurality of openings 122N. Plurality of openings 122N may be spaced apart from each other and disposed one on top of another. Each of the plurality of openings 122N may include a slot extending laterally across the divider 122D. Each of the plurality of openings 122N may include circular holes or holes of any shape as long as the flow area for the desired water velocity downstream of the divider 122D is achieved.

[0047] Fig. 3A shows a top view of an exemplary embodiment of the aquaculture system 300. Aquaculture system 300 may include a filtration tank 360 adapted to receive and filter particles from the water and discharge the filtered water into the intermediate tank 320. Water in the intermediate tank 320 may be received by the nitrification unit 330, the denitrification unit 340 and the toxin removal unit 350. Water from the rearing tank 310 may overflow into the filtration

tank 360. Water in the nitrification unit 330, the denitrification unit 340 and the toxin removal unit 350 may be discharged into the rearing tank 110.

[0048] Fig. 3B shows a top view of an exemplary embodiment of the filtration tank 360. Filtration tank 360 may include a settling tank 362 having a top portion 362T and a base portion (not shown in Fig. 3B) below the top portion 362T, such that the settling tank 362 may be adapted to receive the water from the rearing tank 310 at the top portion 362T from one side 362E of the settling tank 362, allow particles in the water to be settled to the base portion 362B, and discharge the water out of the top portion 362T at another side 362A of the settling tank 362. While the another side 362A of the settling tank 362 may be adjacent the one side 362E, the another side 362A may be opposite the one side 362E of the settling tank 362. Filtration tank 360 may include a plurality of settling tanks 362. As shown in Fig. 3B, the present embodiment may include two settling tanks 362. Depending on the filtration requirement, the filtration tank 360 may include more or lesser number of settling tanks 362. Plurality of settling tanks 362 may be arranged side by side to form a row of settling tanks 362. Water from one settling tank 362 may flow into another settling tank 362.

[0049] Fig. 3C shows an elevation view of the filtration tank 360 in Fig. 3B. Settling tank 362 may include the top portion 362T and the base portion 362B. Filtration tank 360 may include a plurality of inflow vents 362V adapted to receive water into the settling tank 362. Inflow vents 362V may be disposed at the top portion 362T and on the one side 362E of the settling tank 362. Settling tank 362 may include a wall 362W along the another side 362A that extends up to and below the plurality of inflow vents 362V, such that the water in the settling tank 362 may overflow the wall 362W to exit the settling tank 362. Settling tank 362 may include a funnel 362F and a drainage channel 362D in communication with the funnel 362F, such that the funnel 362F may be adapted to receive and channel the particles into the drainage channel 362D to be discharged. Funnel 362F may include a pair of slanted walls extending from the top portion 362T of the settling tank 362 and below the inflow vents 362V to the base portion 362B of the settling tank 362 towards the drainage channel 362D. Water from one settling tank 362 may flow over the wall 362W on the another side 362A into an adjacent settling tank 362.

[0050] Filtration tank 360 may include a filtering tank 364 with a filter 364L extending from a proximal portion 364P to a distal portion 364D opposite the proximal portion 364P, an inlet 364N disposed above the filter 364L and at the proximal portion 364P for receiving the water into the filtering tank 364 and an outlet 364U disposed below the filter 364L and at the distal portion 364D for discharging the water from the filtering tank 364. Water that overflows from the settling tank 362 may flow into the filtering tank 364 via the inlet 364N. Inflowing water may flow through the filter 364L where particles from the water. Filtered water may be discharged from filtering tank 364 via the outlet 364U and enter the intermediate tank 320 (not shown in Fig. 3C). Intermediate tank 320 may include a water entry point (not shown in Fig. 3C) where the water enters the intermediate tank 320. Water entry point may be up to or below the outlet 364U so that water from the filtration tank 360 may overflow into the water entry point at the proximal end 320P of the intermediate tank 320. Divider 122D may have a height above the water entry point of the intermediate tank 320 so that the water does not flow over the divider 122D. Filter 364L may include two or more layers whereby the upper layer may be configured to filter larger particles than the lower layers. For example, the upper layer may be configured to filter particles of 2000 microns and the lower layer may be configured to filter particles of 1000 microns. As shown in Fig. 3B, the filter 364L may be composed of a plurality of sections, such that the sections may be replaced separately. In this way, it is not necessary to change the whole filter 364L when only a section needs to be cleaned or replaced when damaged. Filtering tank 364 may include a drain 364R for draining any waste in the filtering tank 364 and a funnel 364F for funneling the waste into the drain 364R. As shown in Fig. 3C, the filtration tank 360 may include a plurality of settling tanks 362 and a filtering tank 364 arranged in a row such that the settling tanks 362 may be disposed nearer to one end 360N and the filtering tank 364 may be disposed at the another end 360A opposite the one end 360N. Water may enter the settling tanks 362 at the one end 360N and flow towards the filtration tank 360 at the another end 360A. As the larger particles in the water have settled in the settling tank 362, the water may flow into the filtering tank 364 and through the filter 364L to be filtered. It can be appreciated that the sections of the filter 364L nearer to the settling tank 362s may be occupied with more particles and larger particles than the sections of the filter 364L further away from the settling tanks 362. The sections of the filter 364L may be swapped or replaced to allow the filter 364L to be effective. Referring to Fig. 3C, after the water is being filtered, the water exits the outlet 364U below the filter 364L and enters the intermediate tank 320.

[0051] Fig. 4 shows an elevation view of an exemplary embodiment of the nitrification unit 130. Nitrification unit 130 may include a chamber 130C having a top part 130T and a bottom part 130B, an inflow channel 130N at the bottom part 130B for receiving water into the chamber 130C and an outflow channel 130U at the top part 130T for discharging the water from the chamber 130C. Nitrification unit 130 may include a plurality of cultivating mats 132 disposed in the chamber 130C. Plurality of cultivating mats 132 may include porous cellulose material for cultivating bacteria. Water entering the chamber 130C via the inflow channel 130N may flow upwardly through the cultivating mats 132 and discharged via the outflow channel 130U. Inflow channel 130N may be in fluid communication with the intermediate tank 120 and outflow channel 130U may be in fluid communication with the rearing tank 110. Nitrification unit 130 and denitrification unit 140 may be structurally identical. The function of the units 130,140 may be differentiated by the bacteria cultured in the units. Nitrification unit 130 may culture nitrifying bacteria to nitrify the ammonia to nitride to nitrate and the denitrification unit 140 may culture denitrifying bacteria to denitrify the nitrate to nitrogen gas. Nitrification unit 130 may include a first pump (not shown in Fig. 4) for pumping the water from the rearing tank 110. First pump may have a pumping capacity of 36 tonne/hour. Additional first pumps may be added if necessary. Denitrification unit 140 may include a second pump (not shown in Fig. 4) for pumping the water from the rearing tank. Second pump may have a pumping capacity of 18 tonne/hour.

[0052] Fig. 5 shows an elevation view of an exemplary embodiment of the toxin removal unit 150. Toxin removal unit 150 may be adapted to remove toxic organic matter of about 0.1-25 microns. Toxin removal unit 150 may include a frothing tank 152, a water inlet 152N at a top portion 152T for receiving the water into the frothing tank 152, a water outlet 152U at a base portion 152B opposite the top portion 152T for discharging the water out of the frothing tank 152, an air inlet 154 for injecting air into the frothing tank 152 to froth the water to create a foam, and an opening 152P at the top portion 152T adapted to allow the foam to exit the frothing tank 152 therethrough. Air inlet 154 may be disposed below the water inlet 152N. Air inlet 154 may be configured to direct the air into a vertical centre portion of the frothing tank 152. Air inlet 154 may extend into the vertical centre portion of the holding tank and adapted to inject the air downwardly towards the base portion 152B of the frothing tank 152. There may more than one air inlets 154. In this way, the frothing effect can be maximized. As the

water enters the frothing tank 152 via the water inlet 152N, the water is being injected with the air from the air inlet 154 as it flows downwardly towards the water outlet 152U at the base portion 152B of the frothing tank 152. Water outlet 152U may include a channel extending from the base portion 152B towards the top portion 152T such that the water is discharged at the top portion 152T of the frothing tank 152. Water outlet 152U may be in fluid communication with the rearing tank 110 and may discharged the water from the toxin removal unit 150 to the rearing tank 110. Toxin removal unit 150 may include a holding tank 156 disposed above the frothing tank 152 and in fluid communication with the opening 152P, such that the holding tank 156 is adapted to hold the foam exiting from the frothing tank 152. Holding tank 156 may include a top wall 362W and a base wall 362W opposite the top wall 362W. Frothing tank 152 may include a neck 152K extending into the holding tank 156 through the base wall 362W with the opening 152P at the end of the neck 152K, such that the opening 152P is disposed within the holding tank 156, above the base wall 362W and spaced from the top wall 362W of the holding tank 156. When the foam reaches and flows through the opening 152P, the foam overflows over the neck 152K and onto the base wall 362W of the holding tank 156, such that the neck 152K prevents the foam from backflowing into the frothing tank 152. Holding tank 156 may be transparent to allow the user to monitor the foam volume therein. Hence, the toxin removal unit 150 is adapted to separate the foam from the water. As the foam contains microorganisms and organic matter, separating the foam from the water and removing it from the holding tank 156 removes them from the aquaculture system 100. Holding tank 156 may include a drain hole 156D for draining the holding tank 156. Toxin removal unit 150 may include a waste channel 158 adapted to channel waste in the frothing tank 152 out. Waste channel 158 may be disposed at the base portion of the base portion 152B of the frothing tank 152. Toxin removal unit 150 may function as an oxygenator by introducing air into the water therein via the air inlet 154. As the toxin removal unit 150 is disposed at the distal end 120D of the intermediate tank 120, the toxin and protein in the water may be consolidated at the distal end 120D of the intermediate tank 120. In this way, the toxin and protein can be removed at a desirable rate as the water at the distal end 120D is consolidated and does not flow. Hence, it is possible to provide a toxin removal unit 150 of a smaller capacity or provide one or a minimal number of toxin removal units 150 to remove the toxin and protein quickly. Therefore, the costs for installing the toxin removal unit 150 can be reduced. Preferably, the ratio of air to water may be about 36 cubic feet of air t 36 ton of water.

[0053] Fig. 6 shows an exemplary method 1000 of rearing aquatic species in a rearing tank adapted to contain water and the aquatic species therein. Method 1000 includes receiving the water into an intermediate tank at a proximal end of the intermediate tank and channelling the water towards a distal end of the intermediate tank in step 1100, such that the intermediate tank is configured to extend from the proximal end to the distal end opposite the proximal end, receiving the water from the intermediate tank into a nitrification unit and returning the water into the rearing tank in step 1200, receiving the water from the intermediate tank into a denitrification unit and returning the water into the rearing tank in step 1300, receiving the water from the intermediate tank into a toxin removal unit and returning the water into the intermediate tank in step 1400, and pumping the water from the intermediate tank into the rearing tank in step 1500.

[0054] A skilled person would appreciate that the features described in one example may not be restricted to that example and may be combined with any one of the other examples.

[0055] The present invention relates to an aquaculture system and a method of rearing aquatic species generally as herein described, with reference to and/or illustrated in the accompanying drawings.

Claim

1. An aquaculture system for rearing aquatic species, the aquaculture system comprising,
 - a rearing tank for rearing the aquatic species, the rearing tank adapted to contain water and the aquatic species therein,
 - an intermediate tank configured to extend from a proximal end to a distal end opposite the proximal end, wherein the intermediate tank is adapted to receive the water at the proximal end and channel the water towards the distal end,
 - a plurality of air injectors configured to inject air at the bottom portion of the intermediate tank,
 - a filtration tank adapted to receive and filter particles from the water from the rearing tank and discharge the filtered water into the intermediate tank,
 - a nitrification unit in fluid communication with the intermediate tank, wherein the nitrification unit is configured to receive the water from the intermediate tank and return the water into the rearing tank,
 - a denitrification unit in fluid communication with the intermediate tank, wherein the denitrification unit is configured to receive the water from the intermediate tank and return the water into the rearing tank,
 - a toxin removal unit in fluid communication with the intermediate tank, wherein the toxin removal unit is configured to receive the water from the intermediate tank and return the water into the intermediate tank, wherein the toxin removal unit is configured to receive the water from a last portion of the intermediate tank, wherein the last portion is adjacent the distal end,
 - wherein the intermediate tank is adapted to consolidate the toxin at the distal end for the toxin removal unit to remove the toxin from the water, and
 - a fluid injection system adapted to pump the water along and throughout the length of the intermediate tank from the proximal end to the distal end into the rearing tank.
2. The aquaculture system according to claim 1, wherein the nitrification unit is configured to receive the water from a first portion of the intermediate tank, wherein the first portion is between the proximal end and the distal end, wherein the denitrification unit is configured to receive the water from a second portion of the intermediate tank, wherein the

second portion is between the proximal end and the distal end and downstream of the first portion.

3. The aquaculture system according to claim 1 or 2, wherein the intermediate tank comprises a booster disposed therein, wherein the booster is adapted to propel the water therein from the proximal end towards the distal end.

4. The aquaculture system according to any one of claims 1 to 3, wherein the booster comprises a divider adapted to divide the intermediate tank into an upper stream portion and a lower stream portion, wherein the divider comprises a plurality of openings adapted to allow the water from the upper stream portion therethrough and projected into the lower stream portion.

5. The aquaculture system according to claim 1, wherein the filtration tank comprises a settling tank having a top portion and a base portion below the top portion, wherein the settling tank is adapted to receive the water from the rearing tank at the top portion from one side of the settling tank, allow particles in the water to be settled to the base portion, and discharge the water out of the top portion at another side of the settling tank.

6. The aquaculture system according to claim 5, wherein the settling tank comprises a funnel and a drainage channel in communication with the funnel, wherein the funnel is adapted to receive and channel the particles into the drainage channel to be discharged.

7. The aquaculture system according to any one of claims 1 to 6, wherein the filtration tank comprises a filtering tank comprising a filter extending from a proximal portion to a distal portion opposite the proximal portion, an inlet disposed above the filter and at the proximal portion for receiving the water into the filtering tank and an outlet disposed below the filter and at the distal portion for discharging the water from the filtering tank.

8. The aquaculture system according to any one of claims 1 to 7, wherein the toxin removal unit comprises a frothing tank, a water inlet at a top portion for receiving the water into the frothing tank, a water outlet at a base portion opposite the top portion for discharging the water out of the frothing tank, an air inlet for injecting air into the frothing tank to froth the

water to create a foam, and an opening at the top portion adapted to allow the foam to exit the frothing tank therethrough.

9. The aquaculture system according to claim 8, wherein the toxin removal unit further comprises a holding tank disposed above the frothing tank and in fluid communication with the opening, wherein the holding tank is adapted to hold the foam exiting from the frothing tank.

10. The aquaculture system according to claim 1, wherein the fluid injection system comprises a plurality of pumps disposed along the length of the intermediate tank from the proximal end to the distal end, wherein the plurality of pumps are adapted to pump the water from the intermediate tank into the rearing tank.

11. The method of rearing aquatic species in a rearing tank adapted to contain water and the aquatic species therein, the method comprising,

receiving and filtering particles from the water from the rearing tank and discharging the filtered water into an intermediate tank,

receiving the water into the intermediate tank at a proximal end of the intermediate tank and channelling the water towards a distal end of the intermediate tank, wherein the intermediate tank is configured to extend from the proximal end to the distal end opposite the proximal end,

injecting air at a bottom portion of the intermediate tank,

receiving the water from the intermediate tank into a nitrification unit and returning the water into the rearing tank,

receiving the water from the intermediate tank into a denitrification unit and returning the water into the rearing tank,

receiving the water from a last portion of the intermediate tank into a toxin removal unit and returning the water into the intermediate tank, wherein the last portion is adjacent the distal end, wherein the intermediate tank is adapted to consolidate the toxin at the distal end for the toxin to be removed from the water, and

transferring the water along and throughout the length of the intermediate tank from the proximal end to the distal end into the rearing tank.

12. The method according to claim 11, further comprising propelling the water therein from the proximal end towards the distal end.

13. The method according to claim 12, wherein propelling the water comprises allowing the water from an upper stream portion of a divider to be projected through a plurality of openings of the divider into a lower stream portion of the divider.

14. The method according to any one of claims 11 to 13, further comprising receiving the water from the intermediate tank at a top portion and from one side of a settling tank, allowing sediments in the water to be settled to a bottom portion of the settling tank, below the top portion, and discharging the water out of the top portion and at another side of the settling tank.

15. The method according to claim 14, further comprising receiving and channeling the particles into a drain to be discharged.

16. The method according to any one of claims 11 to 15, further comprising receiving the water into a filtering tank via an inlet disposed above the filter and at a proximal portion of the filtering tank and discharging the water from the filtering tank via an outlet disposed below the filter at a distal portion of the filtering tank, wherein the distal portion is opposite the proximal portion.

17. The method according to claim 16, further comprising receiving the water into a frothing tank, injecting air into the frothing tank to froth the water to create a foam, and discharging the water out of the frothing tank, and allowing the foam to exit the frothing tank via an opening at a top portion of the toxin removal unit.

18. The method according to claim 17, further comprising holding the foam exiting from the frothing tank in a holding tank disposed above the frothing tank and in fluid communication with the opening.

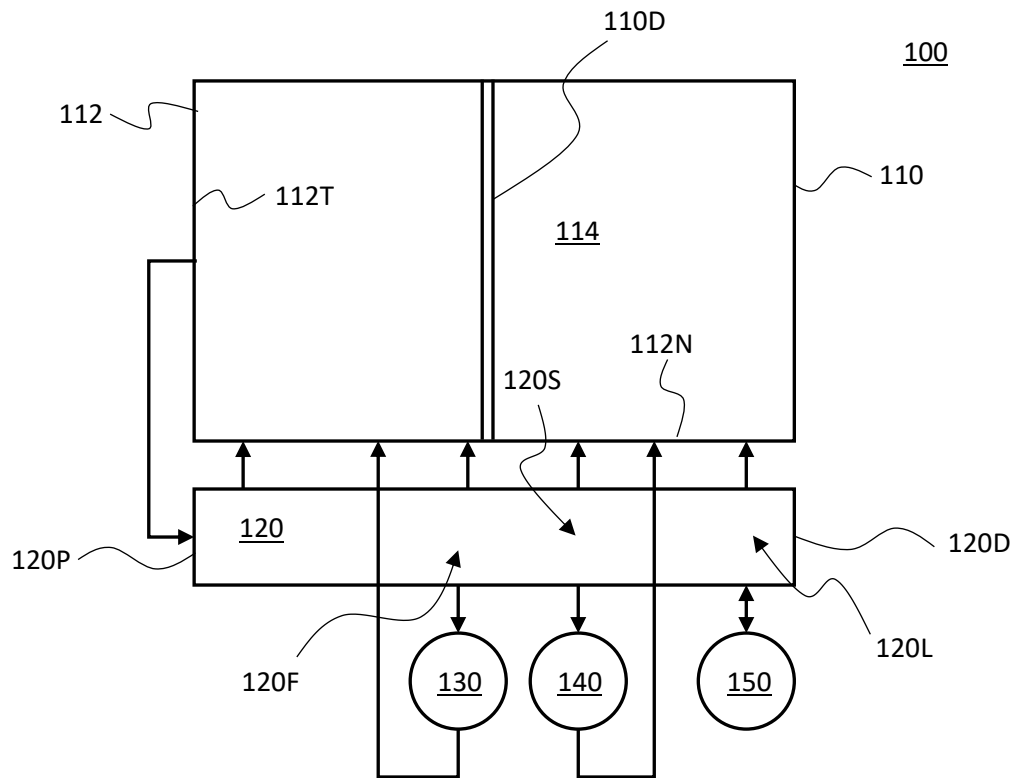


Fig. 1

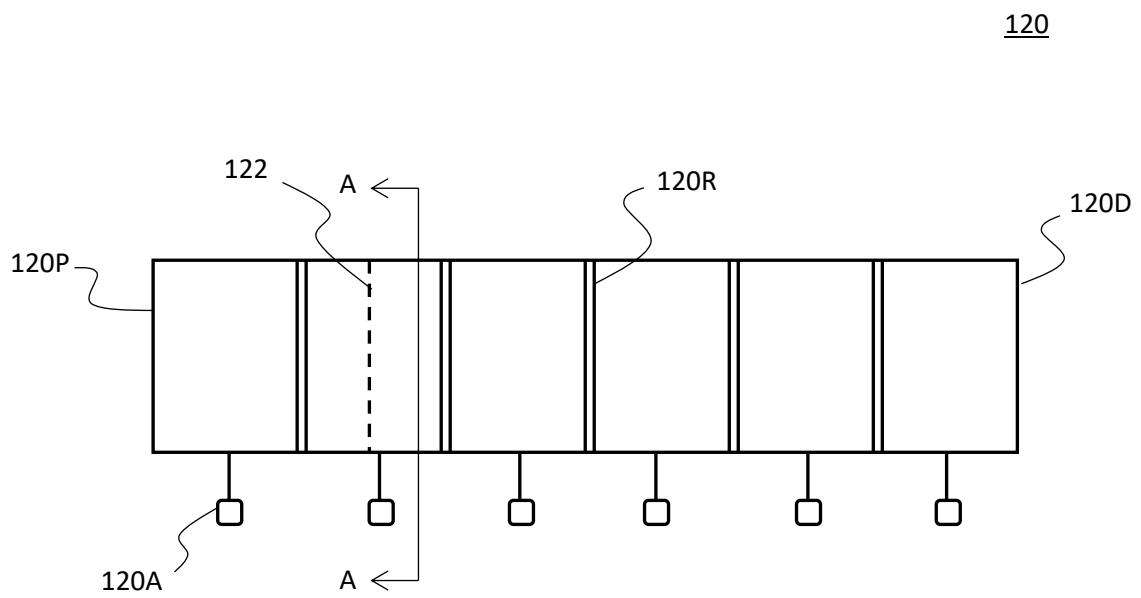


Fig. 2A

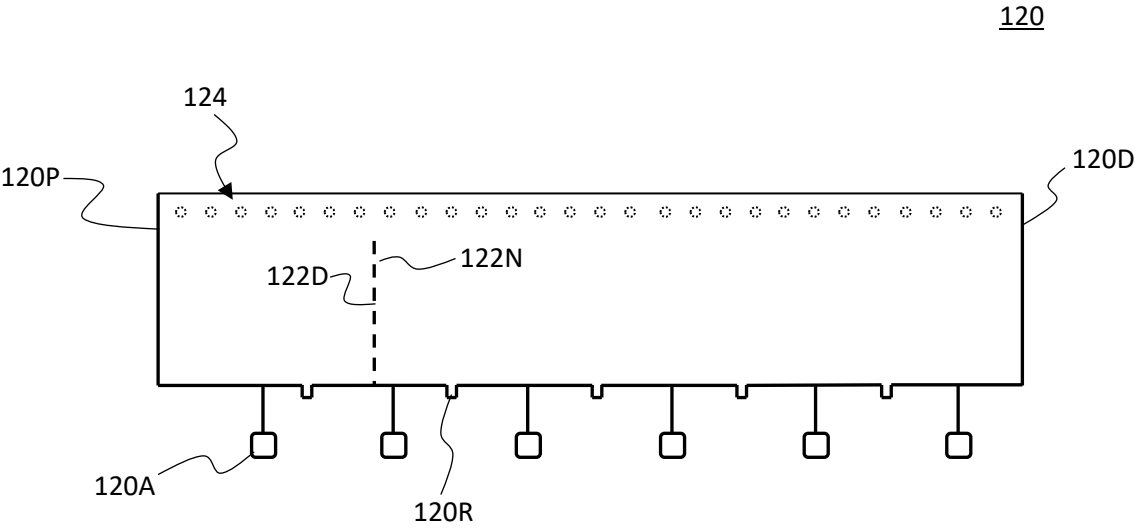


Fig. 2B

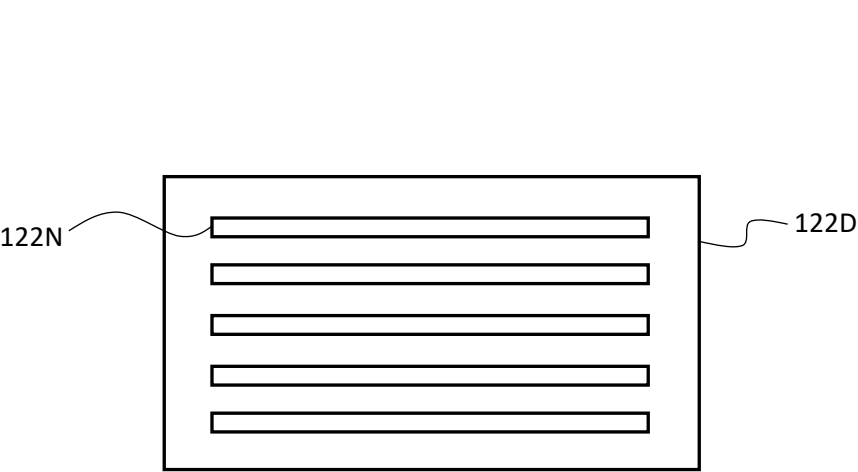


Fig. 2C

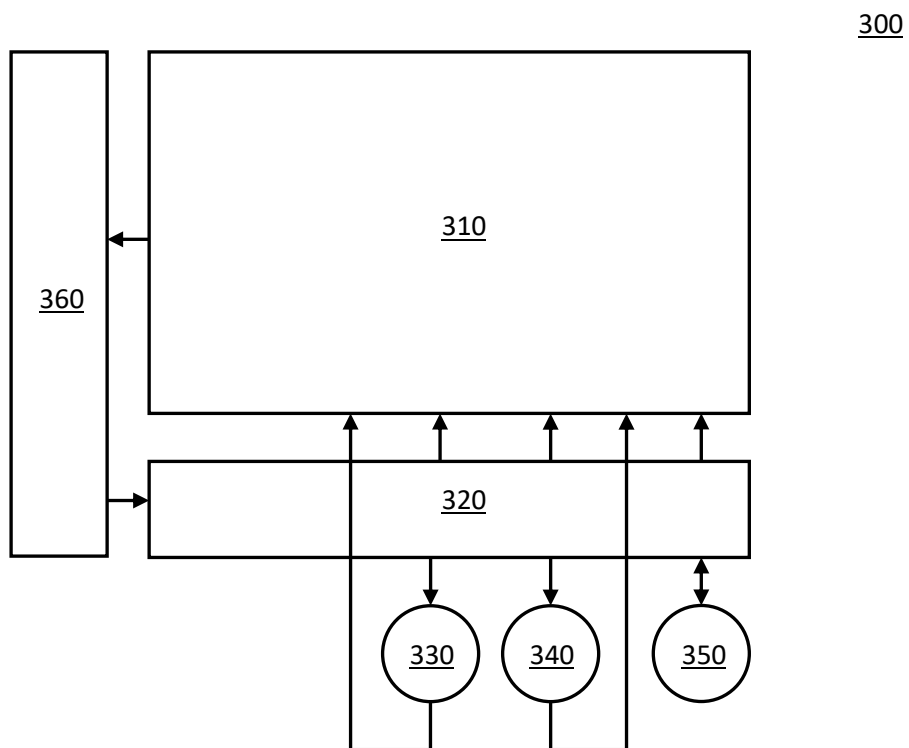


Fig. 3A

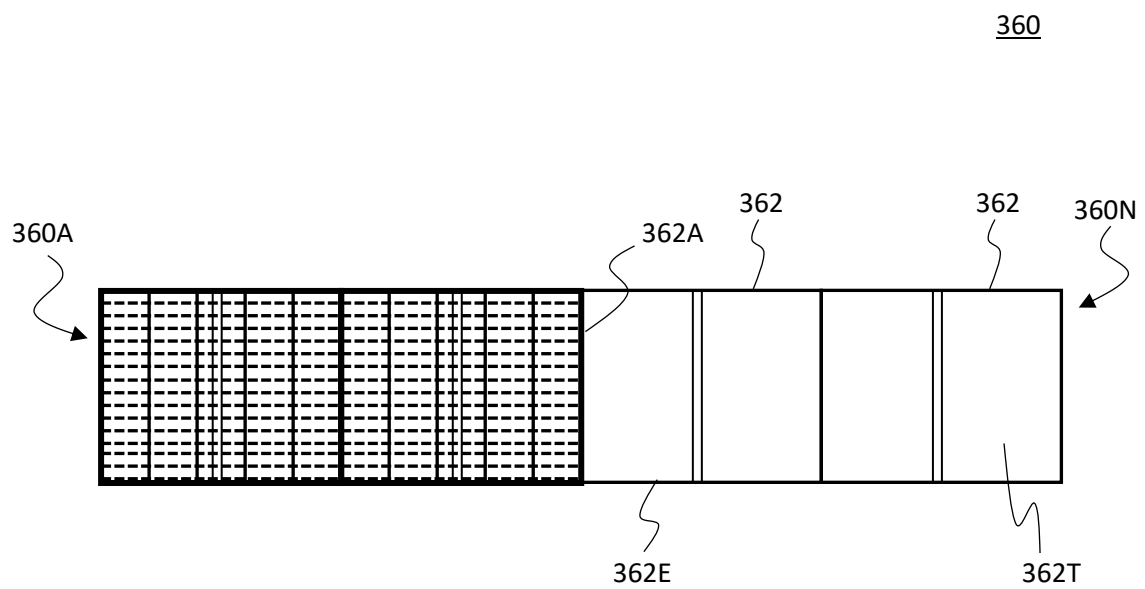
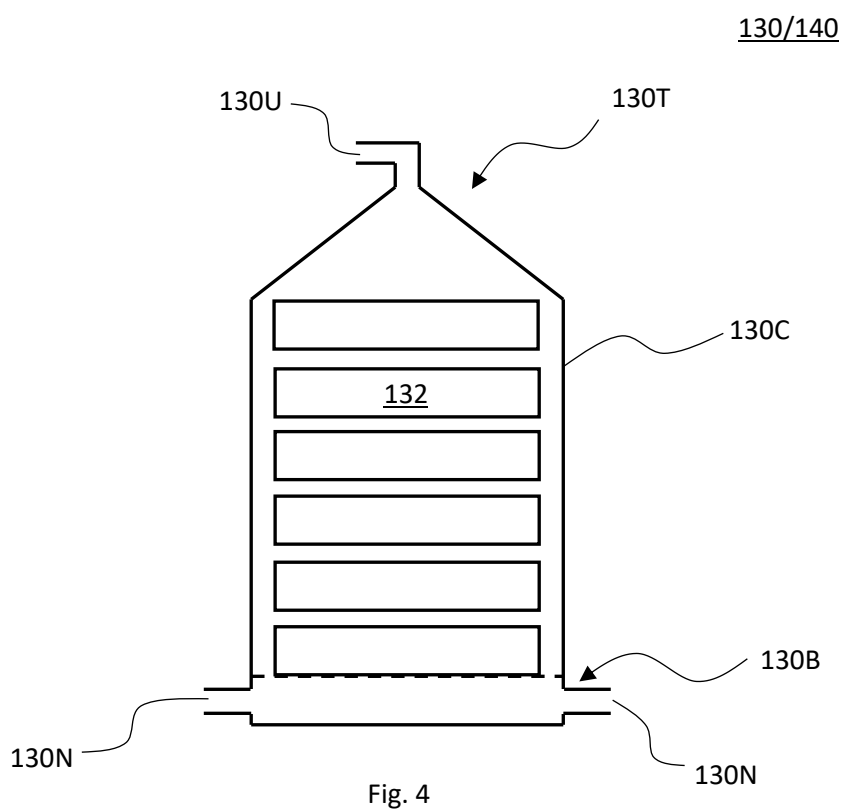
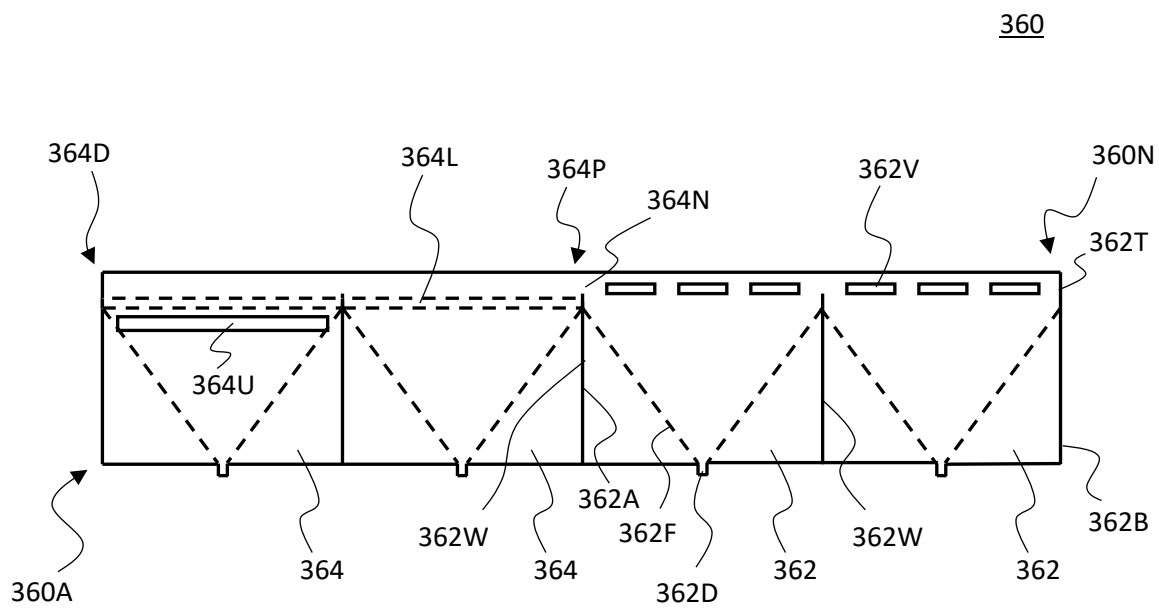
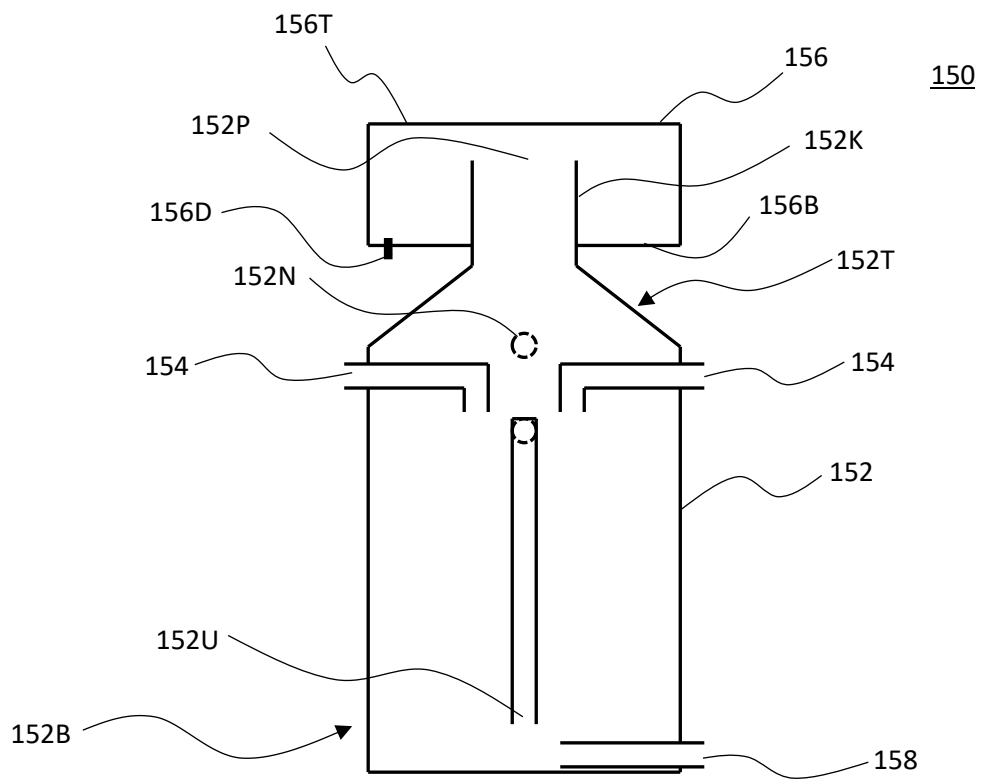


Fig. 3B





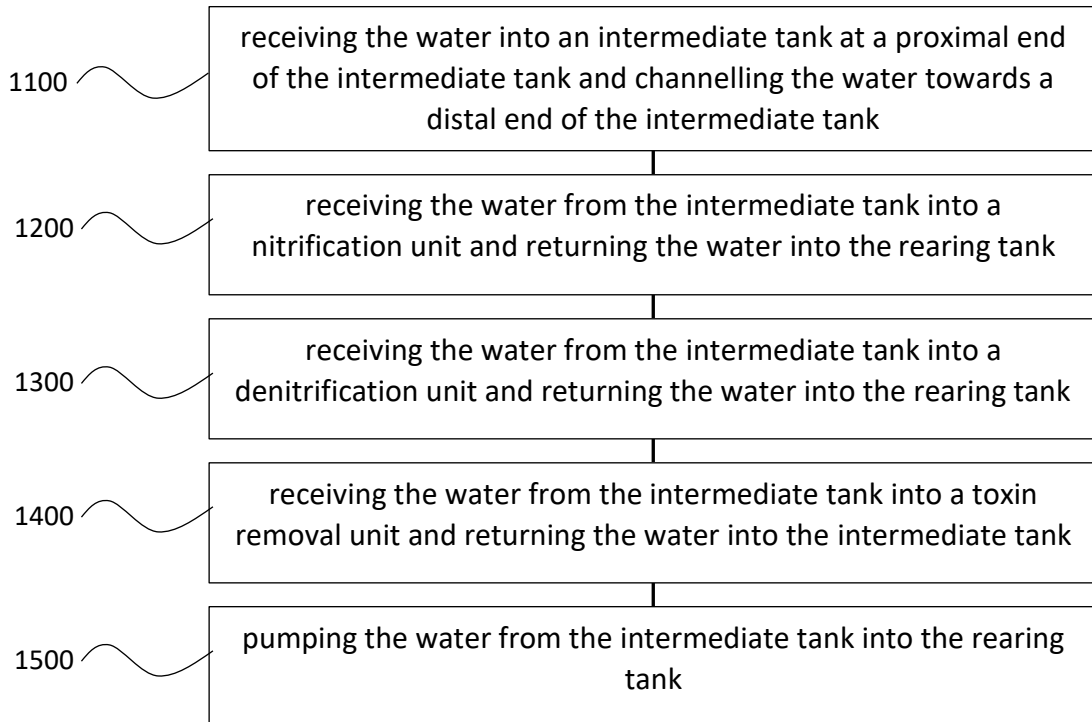
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Fig. 6