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**Title: Means for removing gases and particles from a liquid, and/or for transfer of a liquid.**

**5 Field of the invention**

The present invention relates to a device for removal of gases and particles from a liquid and/or for transport of a liquid.

**Background of the invention**

10 In many systems there is a need to remove gasses from a liquid. This relates to, for example, fish farming installations where fish in the installation produce CO<sub>2</sub>. If the liquid shall be recirculated back to the installation, such as in so called RAS installations, the CO<sub>2</sub> must be removed and preferably replaced by O<sub>2</sub>.

15 Water treatment is necessary in many other instances, such as treatment of effluent, for example.

**Objects of the present invention.**

20 Thus, it is an object of the present invention to provide a solution where one removes gases from a liquid. Preferably, it is an aim to provide a solution to remove CO<sub>2</sub>, but it is intended that the solution can be used to remove any gas which is dissolved in a liquid.

25 It is also an object of the present invention to provide a solution where smaller particles and foam are removed from a liquid.

The solution that is provided is partly based on the syphon principle and the establishing of a negative pressure in a section of a pipeline and in this way one can also transport a liquid from one container to another.

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Thus, it is also an object of the present invention to provide a solution that can move a volume of liquid from one container to another.

We have experienced in connection with moving a liquid in a farming installation, that it is possible to move a liquid and fish which are in the liquid and at the same time subject the liquid to degassing and removal of particles/foam.

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### Summary of the invention

The present invention relates to a device for removal of gases from a liquid and/or for removal of foam and particles from a liquid and/or for transport of a liquid, characterised in that the device is comprised of pipelines to transport the liquid from a first liquid volume A to a second liquid volume B, where the pipeline is comprised of a first upstream pipe section for intake of liquid, and a pipe section in the main horizontal, a downstream pipe section to lead the liquid out of the pipeline and a venting pipe section to lead the gases and part of the liquid out of the pipeline and that arranged in a downstream pipe section or in the transition to the downstream pipe section and venting pipe section is a venting section and that in the upstream pipe section and/or the horizontal pipe section means are arranged for the supply of micro bubbles to the pipeline and that in the pipeline there are means to establish a negative pressure in parts of the pipeline.

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In one embodiment there are injection means in the pipeline for the supply of gases to the pipeline.

In one embodiment the injector means are arranged in a horizontal pipe section.

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In one embodiment the injector means are arranged in an upstream pipe section.

In one embodiment 0-25%, more preferred 0.01-10% of the liquid that is led through the pipeline is led out via the venting pipe section.

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In one embodiment the diameters of the downstream pipe section and the venting pipe section are set up as well as the degree of negative pressure in the pipeline so

that one can decide on the percentage of the liquid that is led out via the venting pipe section.

5 In one embodiment a pumping device to pump liquid in via an upstream pipe section or a horizontal pipe section is also arranged.

In one embodiment said venting section is in the form of an extended, horizontal pipe section.

10 In one embodiment the upstream pipe section and/or the horizontal pipe section is comprised of a ring with openings set up for passive sucking in of air to the liquid stream that is led through the horizontal pipe section.

15 In one embodiment the upstream pipe section and/or the pumping means of the horizontal pipe section are set up for injection of liquid to said pipe sections.

In one embodiment the device is comprised of one or more pipe sections for the supply of liquid to one or more venting sections and venting pipe sections.

20 In one embodiment where more than one horizontal pipe section has been incorporated, these are set up at different vertical positions in the upstream pipe section.

25 In one embodiment gases and liquid are led via several venting sections to the same pipe section.

In one embodiment the different horizontal pipe sections have different lengths, such that the liquid that is led out via the downstream pipe sections is moved to different liquid volumes or to different positions in the liquid volume.

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In one embodiment the downstream pipe section is angled so that flow is established in the liquid volume.

In one embodiment gases and liquid are led via the venting section to different venting pipe sections.

5 In one embodiment gases and liquid that are led out via the venting pipe section are taken to one or more further device(s) comprised of a horizontal pipe section, venting section, venting pipe section and downstream pipe section.

10 In one embodiment the first liquid volume A is a net cage and the second liquid volume B is a different net cage.

In one embodiment the first liquid volume A is one segment of a net cage and the second liquid volume B is a different segment of the net cage.

15 In one embodiment said first and second water volumes are the same water volume.

In one embodiment said pumping device is a propeller pump or an ejector pump.

20 In one embodiment said means for establishing a negative pressure is a vacuum pump or a fan.

In one embodiment the venting section has a given volume that ensures a large liquid:gas interfacial area and that the liquid circulates slowly via the pipeline so that a reduced amount of gas follows the liquid via the downstream pipe section to the second liquid volume B.

25 In one embodiment a cyclone that separates gases from a liquid is attached to the venting section via the pipe section and means to establish a negative pressure in the cyclone and the venting section are arranged to the upper part of the cyclone.

30 In one embodiment the device is arranged in an installation for farming of marine organisms.

In one embodiment the device is arranged in a net cage and that the net cage is comprised of a float collar that holds the unit afloat in a net cage installation.

5 In one embodiment the liquid flow through the device is completely or partially caused by a supply of air from an injector so that the liquid column in the upstream pipe section is made to be lighter than in the downstream pipe section.

10 In one embodiment the device is arranged in an installation for treatment of waste water.

In one embodiment means are arranged for supplying oxygen in the pipeline so that the oxygen is supplied to the liquid before the outlet via the downstream pipe section.

15 In one embodiment the negative pressure in the pipeline and the cyclone is sufficient to lead foam and smaller particles with the gas/liquid flow out of the pipeline.

20 In one embodiment the liquid level A and the liquid level B are different that the throughflow of water in the pipeline is completely or partially driven by the difference in the levels.

In one embodiment larger units, such as fish, are transported with the liquid flow out of the downstream pipe section.

## 25 **Description of the figures**

Preferred embodiments of the invention shall now be described in the following in more detail with reference to the enclosed figures, where:

30 Figure 1 shows schematically an embodiment of a device for removal of gases that are transported via a pipeline.

Figure 2 shows schematically an embodiment of a device with an expanded venting section for the removal of gases from a liquid. The liquid is recirculated back to the container it was brought from.

- 5 Figure 3 shows schematically the same embodiment as in figure 2, but where the liquid is transported to a different container than the one from which it was collected.

Figure 4 shows an embodiment where several horizontal pipe sections are coupled to an upstream pipe section.

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Figure 5 shows an embodiment where several devices are coupled after each other.

- Figure 1 shows a first embodiment of the invention. In a first liquid volume A, one or more pipelines 16 are incorporated to circulate water from a first liquid volume A to a second liquid volume B. Of course, there can be several such pipelines 16 to circulate water from a first to a second liquid volume. The pipelines 16 have an upstream pipe section 16a that extends from the first liquid volume A and, in the main, vertically upwards to above the surface level of the first liquid volume A and this upstream pipe section 16a is used for the intake of liquid to the pipeline 16.

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- In a section above the liquid level in the liquid volume A, the upstream pipe section 16a is in fluid communication with a horizontal pipe section 16b. It is preferred that this pipe section 16b is made to be tilting or, in the main, horizontal. Downstream of the horizontal pipe section 16 the liquid is transported further through a downstream pipe section 16c. This downstream pipe section 16c is, in the main, arranged vertically and carries the liquid out of the pipeline 16. The horizontal pipe section 16b can, in some preferred embodiments, be of a substantial length so that the liquid is transported a considerable distance.

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- 30 Arranged in a part of the upstream pipe section 16a or the horizontal pipe section 16b is an injector 17. The injector 17 supplies micro bubbles of gas, preferably air, to the pipeline 16. The micro bubbles that are transported through the pipeline 16

- together with the liquid from the liquid volume A will lead to the gases and smaller particles that are dissolved in the liquid volume A to seek the micro bubbles. For example, if CO<sub>2</sub> is dissolved in the first liquid volume A this will be pulled towards the micro bubbles and be able to be vented out of the liquid. With the term “injector” is meant any supply of a gas into a liquid stream so that micro bubbles are formed from the gas or air in the liquid. Thus, the term covers also an “ejector” which is based on the gas being sucked passively into the stream of liquid (venturi) and an “injector” which is based on something being injected (forced) into the liquid/gas stream.
- 10 A negative pressure is established in the pipeline 16 in that means 19 to generate a negative pressure is in communication with the pipeline 16. The fluid flow that runs through the horizontal pipe section 16b is diverted in that the pipe section 16b goes over to a downstream pipe section 16c where the main part of the liquid flows through to a venting section 16e where gases are pulled out of the pipeline 16 due to
- 15 the established negative pressure. By adjusting the negative pressure in the pipeline 16 and adapting the dimension (diameter) of the downstream pipe section 16c and the venting section 16e, it is also possible to transfer a part of the liquid that flows through the horizontal pipe section 16b via the venting section 16e.
- 20 Tests have shown that it is possible to transfer up to 25% of the liquid via the venting section 16e. However, it is preferred that between 0.01 and 10% of the liquid is led out via the venting section 16e and the remaining liquid is led through the downstream pipe section 16c.
- 25 The supply of gases, preferably air, will ensure that the liquid is rising in the pipeline (in the upstream pipe section 16a or horizontal pipe section 16b) as it has become lighter and that it is also lighter than the liquid which is led out of the pipeline via the pipe section 16c, as the gases/air are removed from the liquid in the venting section 16d. That the liquid in the front section 16a is lighter than in the pipe section 16b sets
- 30 up the flow and transport of the fluid through the pipeline 16. Tests have shown that with sufficient supply of air via the injector 17 and the setting up of sufficient negative pressure via the means 19 to generate a negative pressure, the liquid is transported

with sufficient speed through the device 10 without one having to use pumps to pump the liquid.

5 It will also be the lighter part of the liquid (that has a large amount of dissolved gas bubbles) that is led out via the venting pipe section 16e.

10 In some embodiments of the device 10 in a section of the pipeline 16, i.e. either in the upstream pipe section 16a, the horizontal pipe section 16b or the downstream pipe section 16c, there is preferably arranged a pumping device 18 to pump the water up from the first liquid volume. It is preferred that this is a propeller pump 18 which is well suited for the pumping of large amounts of water at a low pressure. In one embodiment the pump, as shown in figure 1, is arranged in the upstream pipe section 16a so that the liquid is pulled from the first liquid volume via the upstream pipe section 16a.

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In the embodiment which is shown in figure 1 the pipe section 16b has a considerable length and it is gently tilting downwards so that liquid which is pumped to the top of the pipe section 16b will flow through the pipe section 16b. A large liquid surface area is generated, and this will ensure effective removal of any gases that are in the first liquid volume. Thus, the liquid contains smaller amounts of dissolved gases after it has passed the pipe section 16b and the venting section 16d.

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25 If the device 10 is used in a farming installation, the first liquid volume A is normally the water reservoir in which the marine organisms such as fish can be found, and this will, after some time, contain large amounts of dissolved CO<sub>2</sub>. Therefore, it is an aim of the present invention to remove this CO<sub>2</sub> or to simultaneously exchange it with oxygen or air. There is a relatively high level of CO<sub>2</sub> and low O<sub>2</sub> in the first liquid. Furthermore, there will be a mixture of water and small air bubbles in the pipeline sections 16a and 16b and CO<sub>2</sub> goes from being dissolved in water and into the air bubbles because of the equilibrium principle. In embodiments of the invention which are not shown in the figures in the downstream pipe section 16c there will be means

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for the supply of oxygen to the liquid that flows out of the pipeline 16 via the downstream pipe section 16c.

In one embodiment arranged in a section, preferably in the transition between the horizontal pipe section 16b and the downstream pipe section 16c, there is a device 5 19 to set up a negative pressure in the pipe section 16b. This is shown by a fan 19 in figure 1. At such negative pressure the air bubbles that are in the liquid are, in effect, pulled out of the liquid that flows through the horizontal pipe section 16b and further via the venting section 16d to the downstream pipe section 16c. Because of the 10 negative pressure and large surface area between the air bubbles and water this method will effectively remove CO<sub>2</sub> and other gases from the liquid.

As shown in figure 1 the liquid in the first liquid volume is depleted of gases as it is led through the device 10, i.e. through the different pipe sections 16a, 16b and 16c. 15 At the same time as this depletion of gases occurs, the device 10 can be used to move liquids. As shown in figure 1 the liquid is transported from the first liquid volume A via the pipeline 16 to another liquid volume B. This can be from one net cage to another net cage, or it can be from one segment of a net cage to another segment of the net cage. In some embodiments the liquid that is transported through 20 the pipeline 16 is led back to the same liquid volume it comes from, i.e. that the first and second liquid volumes are the same net cage volume or net cage segment.

Figure 2 shows an alternative embodiment where a cyclone is used in addition to separate gases and liquid. It can be seen in figure 2 that the device is comprised of a 25 mainly vertical upstream pipe section 16a that goes over into a mainly horizontal pipe section 16b. In the pipe section 16a there are means 17 arranged to supply air, preferably micro bubbles of air. It is not necessary but, in some embodiments, means 18 (not shown in the figure 2) are also used in the upstream pipe section 16a to pull water up from the first liquid volume A and through the pipeline 16. In the 30 transition between the horizontal pipe section 16b and the downstream pipe section 16c, a venting section 16d is set up so that gases, during transport of liquid and air in via the upstream pipe section 16a and the horizontal pipe section 16b, in the venting

section 16d are removed from the liquid and are led out of the pipeline 16 via the venting pipe section 16e. Out from the venting section 16d foam and gases are removed via the pipe section 16e, as in the pipe section 16e or in connection to the pipe section 16e means 19 are arranged to establish a negative pressure in the  
5 venting section 16d. The means 19 to establish the negative pressure can be directly connected to the pipe section 16e and not necessarily via the cyclone 20 as shown in the figure 2.

By establishing a sufficient negative pressure and appropriate dimensioning of the  
10 circumference of the pipe for the pipe section 16e and pipe section 16c, a part of the liquid will also be led out of the pipeline 16 via the venting pipe section 16e. This is the lightest part of the liquid, i.e. the part that has a high level of gas bubbles that will be led out of the venting pipe section 16e. The heaviest part of the liquid will be led out through the downstream pipe section 16c.

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It is an advantage that the venting section 16d is of a given volume and in particular that the liquid surface is of a given size. Then, one gets a large liquid:gas interfacial area that together with the negative pressure that is set up will give efficient  
20 extraction of the gases dissolved in the liquid. Air bubbles that are supplied to the liquid from the injector 17 via the upstream pipe section 16a or the horizontal pipe section 16b will lead to smaller particles being extracted from the liquid and over into the gas phase and out via the venting pipe section 16e. Foam will also be generated in this section that is pulled over into the pipe section 16e. The conditions that are set up in the venting section 16d, i.e. negative pressure, large surface area and a  
25 liquid with air bubbles will efficiently separate gases from the liquid. The gases are removed via the pipe section 16e and the largest part of the liquid are led out via the downstream pipe section 16c.

Furthermore, arranged in the device 10 that is shown in figure 2 is a ring 21 with  
30 openings 21a for passive sucking in of air. This ring 21 can be arranged in the upstream pipe section 16a above the liquid surface in the liquid volume A, or it can

be arranged in the horizontal pipe section 16b. The openings 21a can be adjustable so that one can regulate the amount of air that is supplied.

Furthermore, there is an injection device 2 in the device that is shown in figure 2 that can supply (inject) liquid to the flow of liquid in the pipeline 16. The injection device 22 is preferably arranged in the upstream pipe section 16a but can also be arranged in the horizontal pipe section 16b.

Furthermore, a cyclone 20 is located in the device 10 that is shown in figure 2 to separate liquid and gases that flow through the cyclone from the venting pipeline 16e. The means 19 to set up the negative pressure can then be in communication, via the cyclone venting pipeline 16f, with the cyclone 20.

Figure 2 shows that the first and second liquid volumes are the same, i.e. the liquid is transported through the device 10 to extract gases and remove foam and particles in the liquid, while the main body of the liquid is led via the downstream pipeline 16c back to the same liquid volume (given as the liquid volume A in the figure).

Figure 3 shows the same solution as in figure 2, but where the liquid is transported from a first liquid volume A via the upstream pipe section 16a, horizontal pipe section 16b and the downstream pipe section 16c to a second liquid volume B.

Figure 4 shows an embodiment where one has connected several horizontal pipe sections 16a to an upstream pipe section 16b. Figure 4, which shows the device 10 seen from above, shows the connections of four horizontal pipe sections 16b with associated four venting sections 16d. Any number of pipe sections 16b can be connected to one pipe section 16a.

Furthermore, as shown in figure 4, the horizontal pipe sections 16b can be connected at different vertical positions in an upstream pipe section 16a. One can also adjust vertically where the venting section 16d shall be with respect to the intake of liquid via the horizontal pipe section 16b and venting pipe section 16e.

Figure 5 shows an embodiment where several devices 10 are connected after each other. This means gases and, to a smaller extent, liquid, being led via the venting pipe section 16e via a horizontal pipe section 16b' in a second device 10'. The device 10' is comprised of (which corresponds to the device 10) a venting section 16d' and a venting pipe section 16e'. This means that the liquid is cleaned of gases, particles and foam in several subsequent cleaning steps. The figure also shows that the rings 21 with openings can be placed in an upstream pipe section 16a and in the horizontal pipe sections 16b', 16b''. The figure also shows that the injection device 22 for injection of liquid can be placed in the upstream pipe section 16a and in the horizontal pipe sections 16b', 16b''.

The principles of the invention have been verified through testing in full scale where the device 10 was fitted so that it lifted water up 2m from the centre of a tank and took it out and down into an outer segment of the tank. A vacuum pump 19 with a negative pressure of 300 mbar lifted the water up 3m in the pipes. The horizontal pipe 16b was at a height of 2m, while the connection to the vacuum pump 19 was at 3.5m height. Ejectors 17 fitted 1m below the surface of the water at the bottom of the riser 16a, driven by water (30 l/min) at a pressure of 2.5 bar, sucked in air and generated micro bubbles that were supplied to the pipe section 16a. These air bubbles made the weight of the water in the riser 16a lighter than in the down pipe 16c and thereby generated circulation in the pipeline 16. This functions as a syphon. The flow of water out of the tube 16c down in the outermost ring volume was measured to 330 l/min. The pipe dimension was a diameter of 110 mm.

At the same time the air was sucked up in the exhaust together with the foam that was formed by the micro bubbles and particles that were in the water. The foam was separated and drained out as water in the cyclone 20. The test was carried out with clean seawater. After a five minute operation one litre of water was drained from the cyclone. Samples were sent for analysis as this was badly discoloured. It had a turbidity of FNU 20-30, where the majority of the particles had a size of 2-10  $\mu\text{m}$ .

At the same time gas measurements were taken at the inlet and in the downpipe. These showed a drop in gas pressure from 100% to 95%. This verifies that the method is effective for the removal of gases (in particular CO<sub>2</sub> as this is very soluble in water) and the smallest particles in the same process which one uses to move  
5 water from one location to another. Therefore, this is a very energy efficient method.

Claims

1. Device (10) for removal of gases in a liquid and/or for removing foam and particles from a liquid and/or for transport of a liquid, characterised in that the device (10) comprises pipelines (16) to transport the liquid from a first liquid volume A to a second liquid volume B where the pipeline (16) comprises a first upstream pipe section (16a) for intake of liquid in an, in the main, horizontal pipe section (16b), a downstream pipe section (16c) to lead the liquid out of the pipeline (16) and a venting pipe section (16e) to lead the gases and a part of the liquid out of the pipeline (16), and that a venting section (16d) is arranged in the downstream pipe section (16b) or in the transition to the downstream pipe section (16c) and the venting pipe section (16e), and that means (17) for the supply of micro bubbles to the pipeline (16) are arranged in the upstream pipe section (16a) and/or the horizontal pipe section (16b), and that means (19) to set up a negative pressure in parts of the pipeline (16) are in the pipeline (16).
2. Device according to claim 1, characterised in that injector means (17) are located in the pipeline (16) for the supply of gases to the pipeline (16).
3. Device according to claim 1, characterised in that the means (17) are arranged in the horizontal pipe section (16b).
4. Device according to claim 1, characterised in that the means (17) are arranged in the upstream pipe section (16a).
5. Device according to claim 1, characterised in that 0-25%, more preferred 0.01-10% of the liquid that is led through the pipeline (16) is led to the venting pipe section (16e).
6. Device according to claim 5, characterised in that the diameters of the downstream pipe section (16c) and the venting pipe section (16e), and also the extent of the negative pressure in the pipeline (16) are set up so that one can decide on the percent of the liquid that is led out via the venting pipe section (16e).
7. Device according to claim 1, characterised in that a pumping device (18) is also arranged to pump in the liquid via the upstream pipe section (16a) or the horizontal pipe section (16b).

8. Device according to claim 1, characterised in that said venting section (16d) is in the form of an extended horizontal pipe section (16b).
9. Device according to claim 1, characterised in that the upstream pipe section (16a) and/or horizontal pipe section (16b) comprises a ring (21) with openings (21a) set up to passively suck in air to the liquid flow that runs through the horizontal pipe section (16b).
10. Device according to claim 1, characterised in that the upstream pipe section (16a) and/or the horizontal pipe section (16b) is comprised of pumping means (22) set up for injection of liquid to said pipe sections (16a, 16b).
11. Device according to any of the preceding claims, characterised in that the device comprises one or more pipe sections (16b) for the supply of liquid to one or several venting sections (16d) and venting pipe sections (16e).
12. Device according to claim 11, characterised in that as there are arranged more than one horizontal pipe sections (16b), these are arranged at different vertical positions in the upstream pipe section (16a).
13. Device according to claim 11 or 12, characterised in that the gases and liquid are transported via several venting sections (16d) to the same pipe section (16e).
14. Device (10) according to claim 11, characterised in that the different horizontal pipe sections (16b) have different lengths so that the liquid that is led out via the downstream pipe sections (16c) is moved to different liquid volumes or to different positions in the liquid volume.
15. Device according to claim 1, characterised in that the downstream pipe section (16) is at an angle such that a flow is set up in the liquid volume.
16. Device according to claim 11, characterised in that the gases and liquid are led via the venting pipe section (16d) to different venting pipe sections (16e).
17. Device according to claim 1, characterised in that the gases and liquid that are led out via the venting pipe section (16e) are led to one or more further device(s) (10') which are comprised of a horizontal pipe section (16b'), venting section (16d'), venting pipe section (16e) and downstream pipe section (16c').
18. Device according to any of the claims 1-17, characterised in that the first liquid volume A is a net cage (12) and the second liquid volume B is another net cage (12).

19. Device according to any of the claims 1-17, characterised in that the first liquid volume A is a segment of a net cage (12) and the second liquid volume B is a different segment of the net cage (12).
20. Device according to any of the claims 1-17, characterised in that said first and  
5 second water volumes are the same water volume.
21. Device according to any of the claims 1-20, characterised in that said pumping device (18) is a propeller pump or an ejector pump.
22. Device according to any of the claims 1-21, characterised in that said means (19) to set up a negative pressure is a vacuum pump (19) or a fan (19).
- 10 23. Device according to any of the claims 1-22, characterised in that the venting section (16d) has a given volume which ensures a large liquid:gas interfacial area and that the liquid is circulating slowly via the pipeline (16) so that one reduces the amount of gas which goes with the liquid via the downstream pipe section (16b) to the second liquid volume B.
- 15 24. Device according to any of the preceding claims, characterised in that a cyclone (20) is arranged to the venting section (16d) via the pipe section (16e) that separates gases from the liquid, and that means (19) are arranged to an upper section of the cyclone (20) to set up a negative pressure in the cyclone (20) and the venting section (16d).
- 20 25. Device (10) according to any of the preceding claims, characterised in that the device (10) is arranged in an installation for farming of marine organisms.
26. Device (10) according to claim 23, characterised in that the device (10) is arranged in a net cage (12) and that the net cage (12) is comprised of a float collar that keeps the unit afloat in a net cage installation.
- 25 27. Device (10) according to any of the preceding claims, characterised in that the liquid flow through the device (10) is achieved completely or partially by the supply of air from an injector (17) such that the liquid column in the upstream pipe section (16a) is made lighter than in the downstream pipe section (16b).
28. Device (10) according to claim 1, characterised in that the device (10) is arranged  
30 in an installation for treatment of waste water.

29. Device (10) according to any of the preceding claims, characterised in that means for supplying oxygen are placed in the pipeline such that the oxygen is supplied to the liquid before the exit via the downstream pipe section (16c).
- 5 30. Device (10) according to any of the claims 24-29, characterised in that the negative pressure in the pipeline (16) and the cyclone (20) is sufficient to lead foam and smaller particles with the gas-liquid flow out of the pipeline (16).
- 10 31. Device (10) according to any of the preceding claims, characterised in that the liquid level in the liquid volume A and the liquid volume B are different such that the throughflow of water in the pipeline (16) is completely or partially driven by the level differences.
32. Device (10) according to any of the claims 1-31, characterised in that larger units, such as fish, are transported with the liquid flow out of the downstream pipe section (16c).

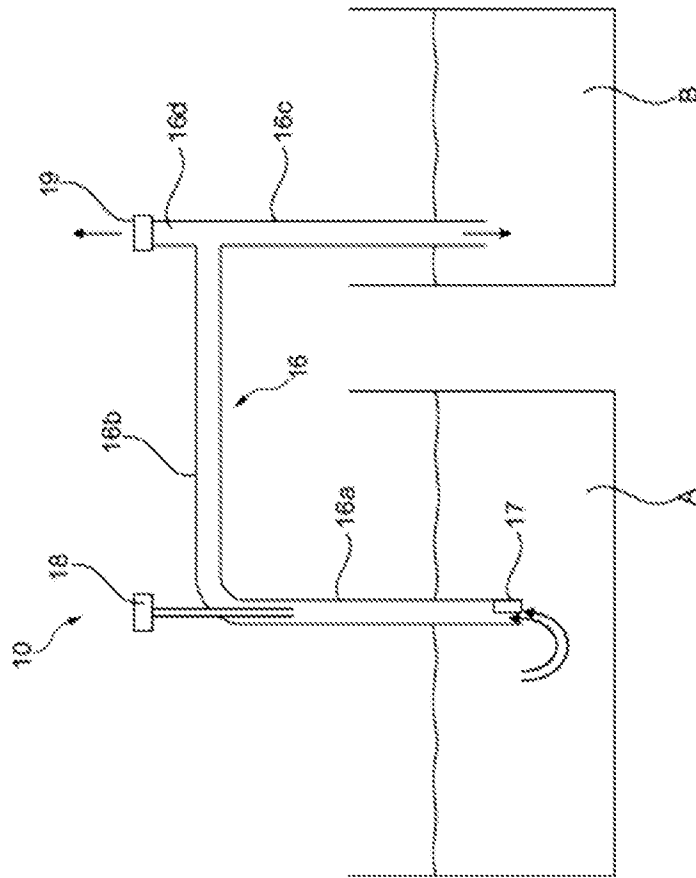


Fig. 1

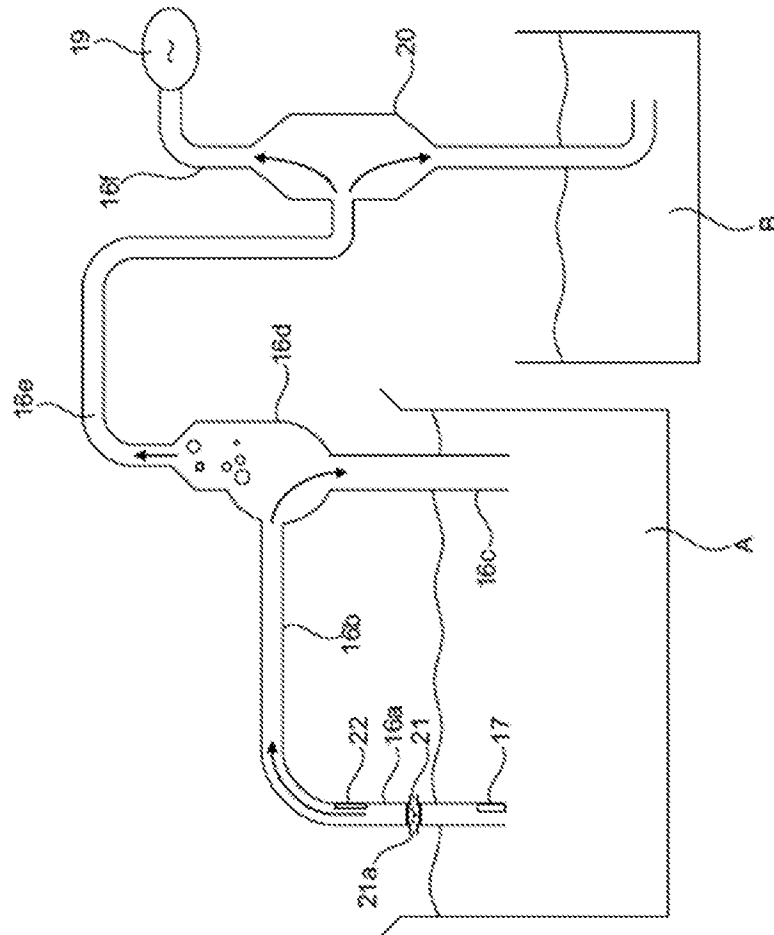


Fig. 2

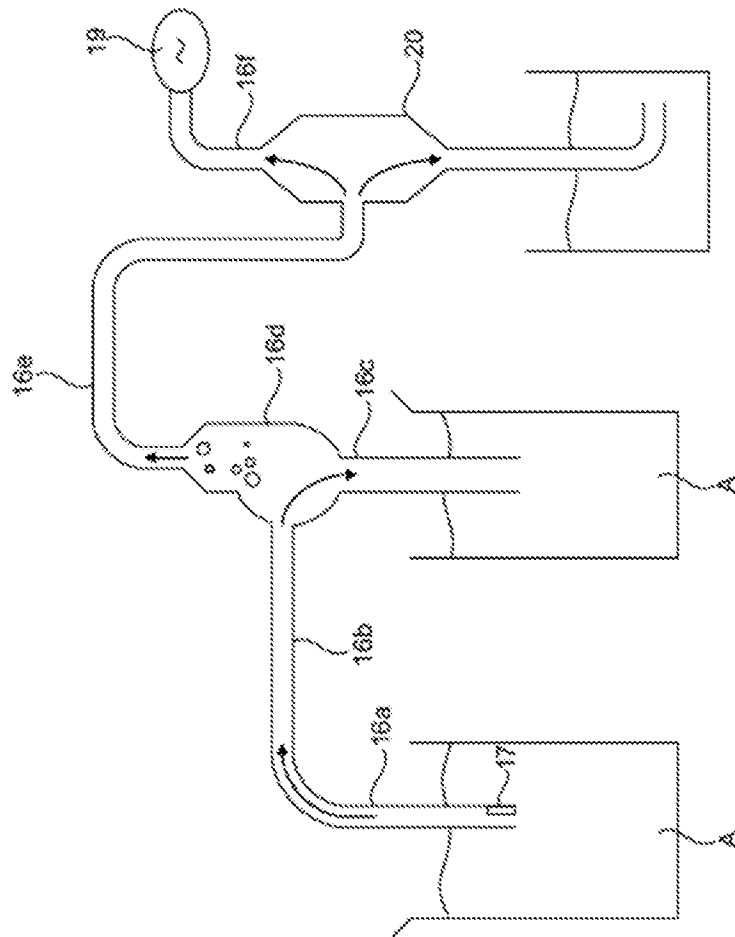


Fig. 3

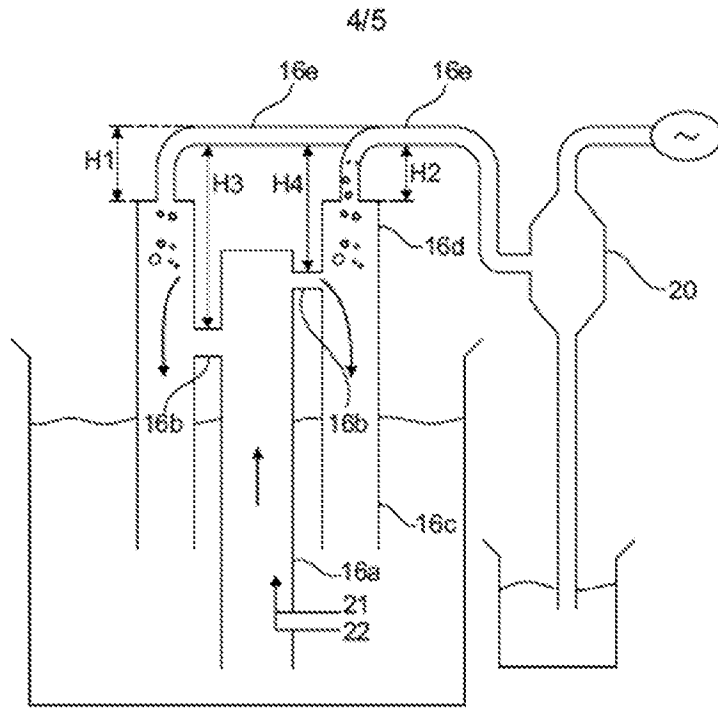


Fig. 4a

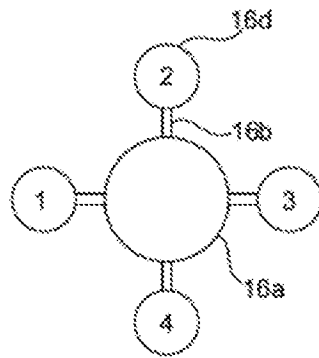


Fig. 4b



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/NO2019/050051

A. CLASSIFICATION OF SUBJECT MATTER		
IPC: see extra sheet		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC: A01K, B01D, C02F		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE, DK, FI, NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
EPO-Internal, PAJ, WPI data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0645168 A1 (PRAXAIR TECHNOLOGY INC), 29 March 1995 (1995-03-29); page 2, line 5; page 3, line 50 - line 52; page 4, line 1 - line 2; page 4, line 3; page 4, line 6; figure 1 --	1-5, 7, 9-17, 21-24, 31
A	US 20080011679 A1 (CHAMPAGNE JEAN-YVES ET AL), 17 January 2008 (2008-01-17); paragraphs [0065]-[0086]; figure 2 -- -----	1-32
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
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**Continuation of:** second sheet

**International Patent Classification (IPC)**

***B01D 19/00*** (2006.01)

***A01K 61/10*** (2017.01)

***C02F 1/20*** (2006.01)