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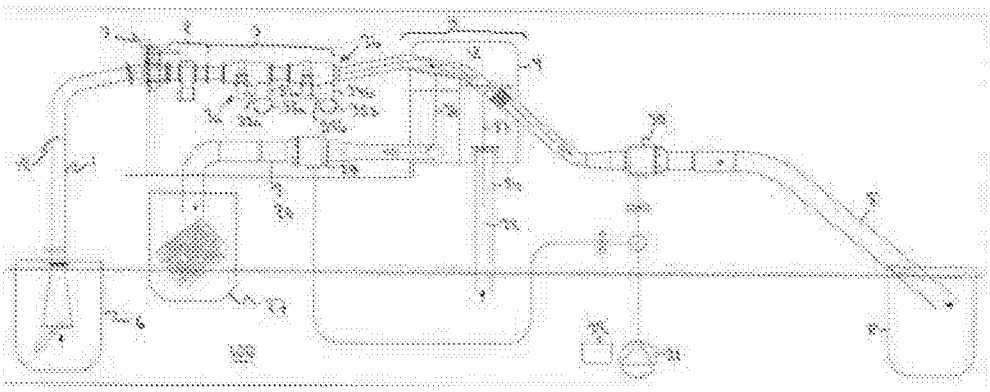
(54) Title **Fish separation apparatus**

(57) Abstract

The present invention relates to a fish separation apparatus for separating fish in a flow of water from organic or non-organic objects in the flow of water. The fish separation apparatus comprises a chamber sealed to the surrounding atmosphere comprising: a first inlet for introducing the flow of water carrying the fish and the organic or non-organic objects into an air pocket in the chamber; a separation device arranged in the air pocket downstream of the first inlet for separating the fish from the flow of water and the organic or non-organic objects; a first compartment arranged downstream of the separation device for receiving the flow of water and the organic or non-organic objects; a second compartment arranged downstream of the separation device for receiving the fish; a second inlet arranged in fluid communication with the second compartment for introducing replacement water free of the organic or non-organic objects into the second compartment; a first outlet arranged in fluid communication with the first compartment for evacuating the flow of water and the organic or non-organic objects from the first compartment; a second outlet arranged in fluid communication with the second compartment for evacuating the fish from the second compartment; wherein the first outlet is a suction outlet arranged to pressurise the air pocket to an absolute pressure which is lower than atmospheric pressure.



Field of the invention

The present invention relates to a fish separation apparatus for separating fish in a flow of water from organic or non-organic objects in the flow of water.

In particular, the invention relates to a fish separation apparatus which is capable of separating fish in a flow of water from dislodged ectoparasites in the flow of water and/or separating a first subset of fish from a second subset of fish in the flow of water, e.g. separating a first subset of fish having a first size from a second subset of fish having a second size.

The present invention also relates to fish treatment systems comprising such a fish separation apparatus.

The present invention also relates to a method for separating fish in a flow of water from organic or non-organic objects in the flow of water, e.g. separating fish in a flow of water from dislodged ectoparasites in the flow of water and/or separating a first subset of fish from a second subset of fish in a flow of water, e.g. subsets of fish having different sizes.

Background

Damages caused by ectoparasites, e.g. sea lice from the genera *Lepeophtheirus* and *Caligus*, cost fish farmers huge sums of money each year. There are major challenges associated with the control of sea lice and other ectoparasites on fish, and it has long been known to use different chemical agents to combat ectoparasites. The use of chemical agents, such as vaccination or feed additives, has a number of adverse side effects, and in the aquaculture industry there has been a need to provide alternative methods for combating ectoparasites in general and sea lice in particular. As an alternative to chemical agents, attempts have been made to use wrasse that feed on the parasites. This is a satisfactory solution for cleaning the individual fish, but cannot be implemented with satisfactory capacity on a large scale in a commercial farm.

WO 98/24304A1 discloses a system for removing ectoparasites from fish without using chemicals. The system comprises a conduit guiding a flow of water containing fish to be treated through a parasite removing station. The removing station is provided with nozzles which are directed into the flow of water such that water jets emerging from the nozzles can impact the body of the fish passing through the parasite removing station. The nozzles are connected to a water pump which creates sufficient pressure to allow efficient yet gentle cleaning of the body of the fish by means of the water jets creating a force acting on the body surface of the fish which is greater than the force with which the ectoparasites attach to the fish. The water jets thus remove the ectoparasites from the fish mechanically. Once removed, the flow of water containing the treated fish and the dislodged ectoparasites is lead to separation station where the ectoparasites are collected in a filter bag while the treated fish is diverted from the main flow of water and the dislodged ectoparasites carried by the main flow of water.

WO 2014/184766A1 discloses another system for removing ectoparasites, e.g. sea lice, from fish. The apparatus comprises a conduit guiding a flow of water containing fish to be treated through a parasite removing station. As with the parasite removing station of WO 98/24304A1, the removing station of WO 2014/184766A1 comprises nozzles which direct water jets towards the passing fish. However, in the WO 2014/184766A1 parasite removing station, gas bubbles are mixed into the water jets to improve the parasite removing capability of the water jets. After the parasite removing station, the flow of water is directed to a separation station where the treated fish is diverted from the main flow of water and the dislodged ectoparasites. The separation station comprises an outlet chamber where the treated fish are passed through a side opening of the chamber, but where the main flow of water and the ectoparasites carried therein is released in a filter bag filtering out the ectoparasites.

A problem with the prior art separation stations, however, is that the dislodged ectoparasites may follow the diverted fish instead of following the main flow into the filter bag.

The present invention is directed towards providing an efficient system for diverting fish carried by a flow of water from the flow of water, thus allowing any objects carried by the flow of water, e.g. dislodged ectoparasites, to be separated from the fish.

Summary of the invention

The fish separation apparatus according to the invention is characterised in that it comprises:

- a chamber sealed to the surrounding atmosphere comprising:
  - a first inlet for introducing the flow of water carrying the fish and the organic or non-organic objects into an air pocket in the chamber;
  - a separation device arranged in the air pocket downstream of the first inlet for separating the fish from the flow of water and the organic or non-organic objects;
  - a first compartment arranged downstream of the separation device for receiving the flow of water and the organic or non-organic objects;
  - a second compartment arranged downstream of the separation device for receiving the fish;
  - a second inlet arranged in fluid communication with the second compartment for introducing replacement water free of the organic or non-organic objects into the second compartment;
  - a first outlet arranged in fluid communication with the first compartment for evacuating the flow of water and the organic or non-organic objects from the first compartment;
  - a second outlet arranged in fluid communication with the second compartment for evacuating the fish from the second compartment;

wherein the first outlet is a suction outlet arranged to pressurise the air pocket to an absolute pressure which is lower than atmospheric pressure.

The method according to the invention is characterised by the steps of:

- pressurising an air pocket in a chamber sealed to the surrounding atmosphere to an absolute pressure which is lower than atmospheric pressure;
- introducing the flow of water carrying the fish and the organic or non-organic objects into the air pocket via a first inlet of the chamber, which introduction of the flow of water carrying the fish and the organic or non-organic objects is assisted by the pressure in the air pocket;
- separating the fish from the flow of water and the organic or non-organic objects utilising a separation device arranged in the air pocket downstream of the first inlet;
- routing the flow of water and the organic or non-organic objects into a first compartment arranged downstream of the separation device;
- routing the fish into a second compartment arranged downstream of the separation device;
- introducing replacement water free of the organic or non-organic objects into the second compartment via a second inlet arranged in fluid communication with the second compartment;
- evacuating the flow of water and the organic or non-organic objects from the first compartment via a first suction outlet arranged in fluid communication with the first compartment; and
- evacuating the fish from the second compartment via a second suction outlet arranged in fluid communication with the second compartment.

Said organic or non-organic objects may for example be ectoparasites dislodged from the fish or a subset of fish.

In the fish separation apparatus, it may be advantageous if the pressure in the air pocket is kept below ambient atmospheric pressure such that the pressure in the air pocket can be utilised to draw the flow of water containing the fish and the organic or non-organic objects into the chamber.

During operation of the fish separating apparatus, the pressure in the air pocket may advantageously be kept within the range of 30 to 40 kPa below ambient atmospheric pressure.

The separation device may advantageously comprise a screen displaying openings being sufficiently large to allow the organic or non-organic objects to pass through the openings together with the flow of water, and being sufficiently small to prevent the fish from passing through the openings.

The fish separation apparatus may be employed in a fish treatment system for separating treated fish from ectoparasites dislodged from the fish, wherein said organic or non-

organic objects are said ectoparasites, and wherein said separation device is arranged to accept the ectoparasites but not the fish. Such a fish treatment system, may advantageously comprise a parasite removal apparatus arranged upstream of the fish separating apparatus for dislodging the ectoparasites from the fish.

The fish separation apparatus may also be employed in a fish treatment system for separating a first subset of fish from a second subset of fish in a flow of water, wherein said organic or non-organic objects are fish belonging to said second subset, and wherein said separation device is arranged to accept fish belonging to the second subset of fish but not fish belonging to the first subset of fish.

The fish separation apparatus may also be employed in a fish treatment system for removing ectoparasites from fish in a flow of water, and for separating a first subset of fish from a second subset of fish in the flow of water, wherein said separation device comprises a first screen section is arranged to accept the ectoparasites but not the fish, and also a second screen section arranged to accept fish belonging to the second subset of fish but not fish belonging to the first subset of fish.

In the following, specific embodiments of the invention will be discussed in more detail with reference to the appended drawings. It is to be noted, however, that the drawings illustrate only various embodiments of the invention and are therefore not to be considered limiting the invention's scope as it may include other effective embodiments as well.

In the drawings, like reference numerals indicate like features having like functions unless otherwise stated.

Description of the drawings

Fig. 1 discloses a fish treatment system comprising a separation apparatus according to the invention.

Fig. 2 discloses the separation apparatus of Fig. 1.

Fig. 3 discloses a second embodiment of a separation apparatus according to the invention.

Fig. 4 discloses a second embodiment of a fish treatment system.

Fig. 5 discloses the separation apparatus disclosed in Fig. 4.

Detailed description of the invention

Fig. 1 discloses a treatment system for removing ectoparasites, in particular sea lice, from sea-farmed salmonids, e.g. salmon or sea trout.

The treatment system comprises an in-take conduit 1, a metering apparatus 2, a parasite removal apparatus 3, a separation apparatus 4, and an outlet conduit 5.

The in-take conduit 1 is arranged to accept a flow of water containing fish to be treated from a first fish container 6, e.g. a fish cage, a fish pin, a fish tank or similar. In the present embodiment fish container 6 is a first fish cage positioned in a body of water 100, e.g. the sea.

The metering apparatus 2 is connected to the in-take conduit 1 via a suitable coupling 7 and is arranged to meter the number and also the size of the fish introduced into the treatment system via the in-take conduit 1. The metering apparatus 2 can be any type of prior art metering device, e.g. the FLS metering device marketed by Flatsetsund Engineering AS.

The parasite removal apparatus 3, which in the present embodiment is positioned immediately downstream of the metering apparatus 2 and is connected to the same, is arranged for removing or dislodging ectoparasites from the body of individual fish when they pass through the parasite removal apparatus 3. In the disclosed embodiment the parasite removal apparatus 3 is a flushing device comprising two flushing stations 3a and 3b, each comprising nozzles (not disclosed) arranged to direct water jets towards the passing fish such that the ectoparasites are dislodged from the body of the fish. The flushing stations 3a and 3b may advantageously comprise the flushing apparatus disclosed in any one of documents WO 98/24304A1 and WO 2014/184766A1, which are hereby incorporated by reference in their entirety. However, the parasite removal apparatus 3 may alternatively comprise any other type of apparatus capable of removing or dislodging ectoparasites from the body of the fish.

The separation apparatus 4, which in the present embodiment is positioned immediately downstream of the parasite removal apparatus 3 and is connected to the same, is arranged for separating fish from the ectoparasites dislodged by the parasite removal apparatus 3.

The outlet conduit 5, which in the present embodiment is positioned immediately downstream of the separation apparatus 4 and is connected to the same, is arranged for ejecting treated fish into a second fish container 8, which in the present embodiment is a second fish cage positioned in the body of water 100.

The separation apparatus 4 will now be discussed in more detail with reference to Fig. 2.

The separation apparatus comprises a chamber 9 holding an air pocket 10. The chamber 9 comprises a first inlet 11 which is connected to the parasite removal apparatus 3 for introducing the flow of water 12 carrying fish 13 and suspended ectoparasites 14 dislodged by the parasite removal apparatus 3 into the air pocket 10 of the chamber 9.

The chamber 9 further comprises a separation device 15 arranged in the air pocket 10 downstream of the first inlet 11 for separating the fish 13 from the flow of water 12 and the dislodged ectoparasites 14 carried therein. In other words, the separation device 15 is arranged to divert the fish 13 from the flow of water carrying the dislodged ectoparasites 14. The chamber 9 also comprises a first compartment 16 and a second compartment 17

positioned downstream of the separation device 15, which first compartment 16 is arranged for receiving the flow of water 12 carrying the dislodged ectoparasites 14, and which second compartment 17 is arranged for receiving the diverted fish 13. In the present embodiment the first and second compartments 16 and 17 are separated by a dividing wall 18 which extends vertically from the bottom of the chamber 9 to approximately two thirds of the height of the chamber 9 and divides the lower part of the chamber 9 into two compartments forming said first and second compartments 16 and 17.

In the present embodiment, the separation device 15 comprises a screen 19 which is positioned adjacent the first inlet 11 such that the flow of water 12 carrying the fish 13 and the dislodged ectoparasites 14 is released onto the screen 19. The screen 19 displays through-going openings which are sufficiently large to allow the dislodged ectoparasites 14 to pass through the openings together with the flow of water, but which are sufficiently small to prevent fish 13 from passing through the openings. The screen 19 is positioned above the first compartment 16 allowing the flow of water 12 and the dislodged ectoparasites 14 that pass through the screen 19 to be collected in the fist compartment 16. The screen 19 has an inclined orientation towards the second compartment 17 in order to facilitate the transport of the diverted fish 13 to the second compartment 17.

The screen 19 may advantageously comprise parallel tubes or bars which are arranges such that a spacing within the range of 8 to 12 mm is formed between neighbouring tubes or bars. Advantageously, the tubes or bars are arranged parallel with the flow of water.

In order to prevent dislodged ectoparasites from following the fish 13 into the second compartment 17, it may be advantageous to position a spray nozzle 20 above the screen 19 and arrange the spray nozzle 20 to spray water onto the fish 13 as they slide over the screen 19 so that dislodged ectoparasites not yet separated from the fish 13 can be flushed into the first compartment 16.

The chamber 9 further comprises a second inlet 21 arranged in fluid communication with the second compartment 17 for introducing replacement water 22 free of ectoparasites into the second compartment 17. A valve 23 is arranged in the second compartment 17 for keeping the replacement water in the second compartment 17 at a predetermined, constant level. The valve 23 may advantageously be a float valve comprising a float which, when the water level drops, levers the valve 23 to open such that the predetermined level is restored. Such float valves are well known within the art and will not be discussed further here. In the present embodiment the replacement water is 22 is supplied from the body of water 100 via a replacement water conduit 24 (see Fig. 1).

The chamber 9 further comprises a first outlet 25 arranged in fluid communication with the first compartment 16 at the bottom thereof for evacuating water and dislodged ectoparasites 14 from the first compartment 16. The first outlet 25 is in fluid communication with an evacuation conduit 26 which opens into a filter bag 27 positioned in the body of water 100 (see Fig. 1). The evacuation conduit 26 is provided with a suction

pump 28 which draws water and the ectoparasites 14 suspended therein from the first compartment 16.

The chamber 9 also comprises a second outlet 29 arranged in fluid communication with the second compartment 17 for evacuating fish 13 from the second compartment 17 to the second fish container 8 via the outlet conduit 5. The second outlet 29 is positioned at the upper part of the second compartment 17 but below the predetermined replacement water level. The outlet conduit 5 is provided with a suction pump 30 (see Fig. 1) which draws replacement water 22 and fish 13 from the second compartment 17 while the above-discussed valve 23 maintains the water level in the second compartment 17 at the predetermined level.

At the second outlet 29, the outlet conduit 5 is arranged such that diverted fish 13 can be received directly in the outlet conduit 5. At the second outlet 29, the outlet conduit 5 is provided with through-going openings 101, e.g. slits, which allow replacement water 22 to enter the outlet conduit 5at a flow rate corresponding to the pumping capacity of the suction pump 30. Consequently, in the second compartment 17 the open end of the outlet conduit 5 forms a receptacle in which diverted fish 13 is received directly from the separation device 15, which receptacle is always filled with replacement water 22 by virtue of the through-going openings 101.

The suction pumps 28 and 30 may advantageously be ejection pumps. In the disclosed embodiment, the pumps 28 and 30 are injection pumps of the type disclosed in NO301440B1, which is hereby incorporated by reference in its entirety. Injection water for the pumps 28 and 30 is provided by a frequency regulated ejection water pump 31 which is regulated by a frequency converter drive 32. Water to the injection water pump 31 is advantageously drawn from body of water 100.

The chamber 6 is sealed to the surrounding atmosphere. Therefore, during operation, suction pump 28 will maintain the pressure in the air pocket 10 at a level which is lower than ambient atmospheric pressure. Consequently, the first outlet 25 will act as a suction outlet arranged to pressurise the air pocket 10 to an absolute pressure which is lower than ambient atmospheric pressure. This will cause water and fish to be drawn from the first fish cage 6 to the chamber 9 via the in-take conduit 1. This will also cause replacement water 22 to be drawn from the body of water 100 to the second compartment 17 via replacement water conduit 24 when the valve 23 so allows, i.e. when the valve 23 is open.

The required pressure in the air pocket 10 will depend on the particulars of the system, e.g. the length and diameters of the conduits, the vertical distance between the surface of the body of water 100 and the water level in the compartments 16 and 17 and the desired through-put of the system. However, by way of example, in a system where the vertical distance between the surface of the body of water 100 and the water level in the compartments 16 and 17 is approximately 3 m, which is a typical height-difference when the system is mounted on a floating vessel, it has been found advantageous if the pressure

in the air pocket 10 is kept within the range of 30 to 40 kPa below ambient atmospheric pressure.

In each flushing station 3a and 3b, water for the nozzles (not disclosed) is provided via a flushing water in-take 33a, 33b. This water is advantageously drawn from the body of water 100 and is advantageously pressurised by a dedicated flushing pump (not disclosed) in a manner which is, as such, known on the art. The flushing water will add to the flow of water in the in-take conduit 1 and, if left unchecked, may increase the velocity of the flow of water after the nozzles. Fish in general, and salmon (*Salmon salar*) in particular, is sensitive to changes in water flow condition. Therefore, the parasite removal apparatus 3 may advantageously comprise a suction outlet 34a, 34b driven by a suction pump 35a, 35b positioned immediately downstream of the nozzles of each flushing station 3a, 3b and arranged to remove a volume of water from the water flow which corresponds to the volume introduced by the nozzles. The suction pumps 35a and 35b can also be used to assist in raising water in the in-take conduit 1 during start-up of the system.

The fish treatment system, when in operation, comprises a first fluid circulation loop 36 originating and ending in the body of water 100 running from the first fish cage 6 to the first compartment 16 in the chamber 9 and further to the filter bag 27, and also a second fluid circulation loop 37 running from the in-take of the replacement water conduit 24 to the second compartment 17 of the chamber 9 and further to the second fish cage 8. Both circulation loops 36 and 37 are closed, i.e. are not exposed to ambient atmosphere, which provides a controlled and protected environment for the fish. This enables the system to be run in a manner which does not stress the fish. This, in turn, allows the quality of the fish to be maintained during treatment and also contributes to a low mortality in the fish.

Above, the treatment system has been discussed from the objective of separating treated fish from dislodged ectoparasites. It is to be understood, however, that the system, and in particular the separation apparatus 4 can be used to sort fish based on size. In such a scenario one can envision a system similar to the one disclosed in Fig. 1 but without the parasite removal apparatus 3 and with the filter bag 27 substituted for a third fish container or fish cage. In this application, the first fish cage 6 will contain a first subset of fish having a first, lager size, and a second subset of fish having a second, smaller size. Both subsets of fish are drawn into the in-take conduit 1 and into the chamber 6. If the size of the openings of the screen 19 is chosen such that the second subset of smaller fish is allowed through the screen 19 but not the first subset of larger fish, the second subset of smaller fish will be passed to the first compartment 16 together with the water in the in-take conduit 1, while the first subset of larger fish will be diverted to the second compartment 22, as is disclosed in Fig. 3. The first subset of larger fish can then be brought to the second fish cage 8 by means of suction pump 30, and the second subset of smaller fish can be brought to the third fish cage (which is not disclosed but arranged in the position of the filter bag 27 in Fig. 1) by means of suction pump 28.

Within the scope of the invention, it is also possible to envision a system in which removal of ectoparasites is combined with sorting of fish based on size. Such a system is disclosed in Figs. 4 and 5.

In this embodiment, the chamber 9 also comprises two compartments – a first compartment 16 for receiving dislodged ectoparasites and the water of the in-take conduit 1, and a second compartment 17 for receiving fish diverted from the ectoparasite infested water 12. However, in this embodiment the treatment system comprises a second outlet conduit 5b in addition to the previously discussed first outlet conduit 5a, each outlet conduit 5a, 5b comprising a suction pump 30a, 30b and associated support equipment – ejection water pump 31a, 31b and frequency converter drive 32a, 32b. The outlet conduits 5a, 5b are in fluid communication with the second compartment 17 via second and third outlets 29a, 29b. The outlet conduits 5a, 5b terminate or opens into separate fish containers 8a, 8b, e.g. fish cages positioned in the body of water 100.

Each outlet conduit 5a, 5b is arranged such that diverted fish 13a, 13b can be received directly in the outlet conduit 5a, 5b in the same way as has been previously discussed in relation to outlet conduit 5. Consequently, in the second compartment 17, the open end of each outlet conduit 5a, 5b forms a receptacle in which diverted fish 13a, 13b is received directly from the separation device 15, which receptacle is always filled with replacement water 22 by virtue of through-going openings 101a, 101b.

In this embodiment, the separation device 15 comprises a screen 19 having a first screen section 19a and a second screen section 19b which is arranged downstream of the first screen section 19a and forms a continuation thereof. The first screen section 19a is positioned adjacent the first inlet 11 such that the flow of water 12 carrying the fish 13a, 13b and the dislodged ectoparasites 14 is released onto the first screen section 19a. The first screen section 19a displays through-going openings which are sufficiently large to allow the dislodged ectoparasites 14 to pass through the openings together with the flow of water, but which are sufficiently small to prevent fish 13a, 13b from passing through the openings. The first screen section 19a is positioned above the first compartment 16 allowing the flow of water 12 and the dislodged ectoparasites 14 that pass through the first screen 19a to be collected in the fist compartment 16 while diverting the fish 13a, 13b to the second screen section 19b.

The second screen section 19b has through-going openings which are sufficiently small to prevent a first subset of larger fish 13a from passing there-trough, but which are sufficiently large to accept a second subset of smaller fish 13b. The outlet 29a of outlet conduit 5a is positioned at the downstream end of the second screen section 19b such that the first subset of larger fish 13a can be received in outlet conduit 5a and brought to fish cage 8a by virtue of suction pump 30a. Advantageously, the second screen section 19b has an inclined orientation towards the outlet 29a in order to facilitate transport of the diverted first subset of larger fish 13a to the outlet 29a.

The outlet 29b of outlet conduit 5b is positioned at the downstream end of a chute 102 positioned below the second screen section 19b such that the second subset of smaller fish 13b can be received in outlet conduit 5b and brought to fish cage 8b by virtue of suction pump 30b. Advantageously, the chute 102 has an inclined orientation towards the outlet 29b in order to facilitate transport of the second subset of smaller fish 13b to the outlet 29b.

The ectoparasites and water in the first compartment 16 are transported to a filter bag 27 in the same way as is disclosed in Fig. 1, and replacement water 22 circulation loops 37a, 37b are employed to transport the first and second subsets of fish 13a, 13b to the individual fish cages 8a, 8b in the same way as the replacement water circulation loop 37 disclosed in Fig. 1.

In the preceding description, various aspects of the apparatus according to the invention have been described with reference to the illustrative embodiment. For purposes of explanation, specific numbers, systems and configurations were set forth in order to provide a thorough understanding of the apparatus and its workings. However, this description is not intended to be construed in a limiting sense. Various modifications and variations of the illustrative embodiment, as well as other embodiments of the apparatus, which are apparent to persons skilled in the art to which the disclosed subject matter pertains, are deemed to lie within the scope of the present invention.

For example, if the separation device comprises a screen, it is understood that the size of the openings of the screen should be adapted to the size of the objects which are to allowed through the screen. For example, if the screen is to divert fish from a main flow of water comprising sea lice in the fully mature adult phase, the screen may advantageously comprise parallel tubes or bars which are arranges such that a spacing within the range of 8 to 12 mm is formed between neighbouring tubes or bars. However, in a fish sorting application, the distance between neighbouring tubes or bars should of course be adapted to size of fish to be sorted.

The treatment systems disclosed above may be mounted on a vessel, e.g. on a support vessel deployed to serve sea-based aquaculture fish farming facilities. However, it is to be understood that the separation apparatus according to the invention can also be used in land-based and/or fresh water fish farming facilities.

Claims

1. A fish separation apparatus (4) for separating fish (13) in a flow of water (12) from organic or non-organic objects (14) in the flow of water (12),
characterised in that the separation apparatus (4) comprises:
   - a chamber (9) sealed to the surrounding atmosphere comprising:
     - a first inlet (11) for introducing the flow of water (12) carrying the fish (13) and the organic or non-organic objects (14) into an air pocket (10) in the chamber (9);
     - a separation device (15) arranged in the air pocket (10) downstream of the first inlet (11) for separating the fish (13) from the flow of water (12) and the organic or non-organic objects (14);
     - a first compartment (16) arranged downstream of the separation device (15) for receiving the flow of water (12) and the organic or non-organic objects (14);
     - a second compartment (17) arranged downstream of the separation device (15) for receiving the fish (13);
     - a second inlet (21) arranged in fluid communication with the second compartment (17) for introducing replacement water (22) free of the organic or non-organic objects (14) into the second compartment (17);
     - a first outlet (25) arranged in fluid communication with the first compartment (16) for evacuating the flow of water (12) and the organic or non-organic objects (14) from the first compartment (16);
     - a second outlet (29) arranged in fluid communication with the second compartment (17) for evacuating the fish (13) from the second compartment (17);

   wherein the first outlet (25) is a suction outlet arranged to pressurise the air pocket (10) to an absolute pressure which is lower than atmospheric pressure.

2. The fish separation apparatus (4) according to claim 1, **characterised in that** the pressure in the air pocket (10) is utilised to draw the flow of water (12) containing the fish (13) and the organic or non-organic objects (14) into the chamber (9).

3. The fish separation apparatus (4) according to any one of the preceding claims, **characterised in that** the pressure in the air pocket (10), during operation of the fish separating apparatus (4), is kept within the range of 30 to 40 kPa below ambient atmospheric pressure.

4. The fish separation apparatus (4) according to any one of the preceding claims, **characterised in that** the separation device (15) comprises a screen (19) displaying openings being sufficiently large to allow the organic or non-organic objects (14) to pass through the openings together with the flow of water (12), and being sufficiently small to prevent the fish (13) from passing through the openings.

5. A fish treatment system for removing ectoparasites (14) from fish (13) in a flow of water, **characterised in that** it comprises a fish separating apparatus (4) according to any one of claims 1 to 4 for separating treated fish from ectoparasites dislodged from the fish, wherein said organic or non-organic objects (14) are said ectoparasites, and wherein said separation device (15) is arranged to accept the ectoparasites (14) but not the fish (13, 13a, 13b).

6. The fish treatment system according to claim 5, **characterised in that** it comprises a parasite removal apparatus (3) arranged upstream of the fish separating apparatus (4) for dislodging the ectoparasites from the fish (13, 13a, 13b).

7. A fish treatment system for separating a first subset of fish from a second subset of fish in a flow of water, **characterised in that** it comprises a fish separation apparatus (4) according to any one of claims 1 to 4 for separating the first subset of fish from the second subset of fish, wherein said organic or non-organic objects (14) are fish (13b) belonging to said second subset, and wherein said separation device (15) is arranged to accept fish (13b) belonging to the second subset of fish but not fish (13a) belonging to the first subset of fish.

8. A fish treatment system for removing ectoparasites (14) from fish (13a, 13b) in a flow of water, and for separating a first subset of fish (13a) from a second subset of fish (13b) in the flow of water, **characterised in that** it comprises a fish separating apparatus (4) according to any one of claims 1 to 4, wherein said separation device (15) comprises a first screen section (19a) is arranged to accept the ectoparasites (14) but not the fish (13a, 13b), and also a second screen section (19a) arranged to accept fish (13b) belonging to the second subset of fish but not fish (13a) belonging to the first subset of fish.

9. A method of separating fish (13) in a flow of water (12) from organic or non-organic objects (14) in the flow of water (12), comprising the steps of:
   - pressurising an air pocket (10) in a chamber (9) sealed to the surrounding atmosphere to an absolute pressure which is lower than atmospheric pressure;
   - introducing the flow of water (12) carrying the fish (13) and the organic or non-organic objects (14) into the air pocket (10) via a first inlet (11) of the chamber (9), which introduction of the flow of water (12) carrying the fish (13) and the organic or non-organic objects (14) is assisted by the pressure in the air pocket (10);
   - separating the fish (13) from the flow of water (12) and the organic or non-organic objects (14) utilising a separation device (15) arranged in the air pocket (10) downstream of the first inlet (11);
   - routing the flow of water (12) and the organic or non-organic objects (14) into a first compartment (16) arranged downstream of the separation device (15);
   - routing the fish (13) into a second compartment (17) arranged downstream of the separation device (15);

- introducing replacement water (22) free of the organic or non-organic objects (14) into the second compartment (17) via a second inlet (21) arranged in fluid communication with the second compartment (17);
- evacuating the flow of water (12) and the organic or non-organic objects (14) from the first compartment (16) via a first suction outlet (25) arranged in fluid communication with the first compartment (16); and
- evacuating the fish (13) from the second compartment (17) via a second suction outlet (29) arranged in fluid communication with the second compartment (17).

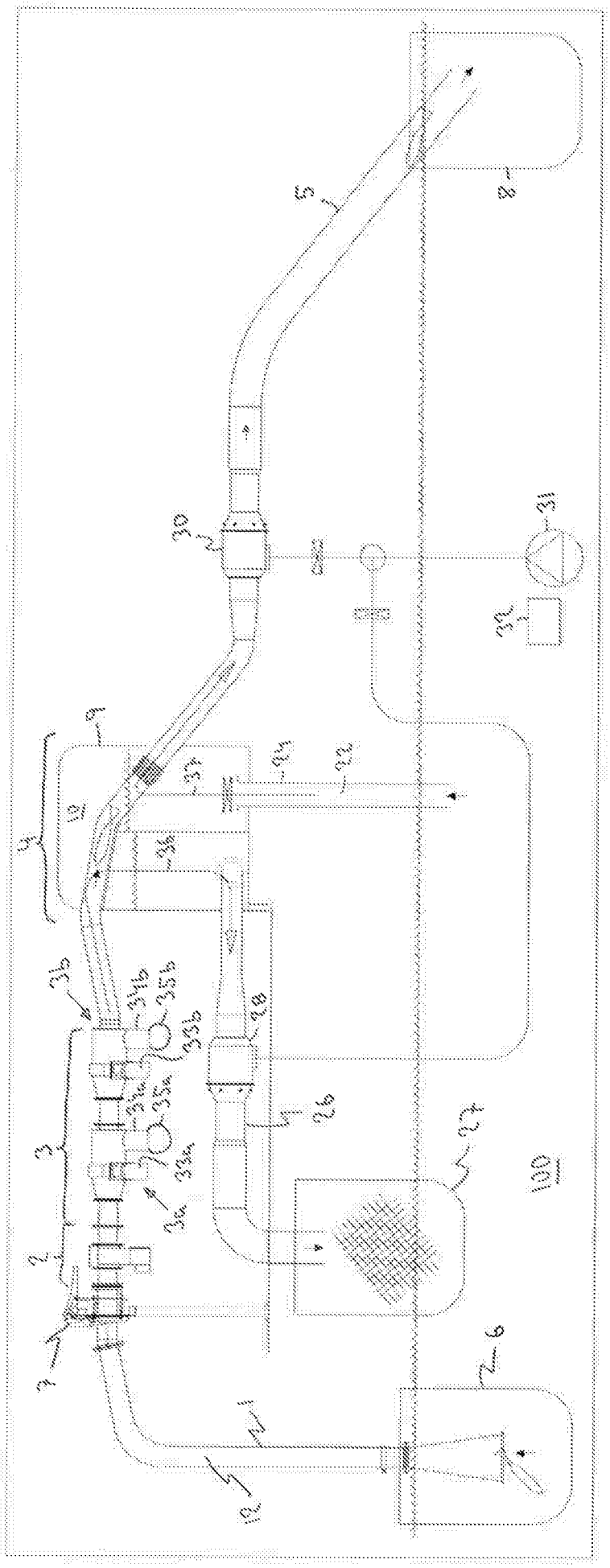

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Fig. 1

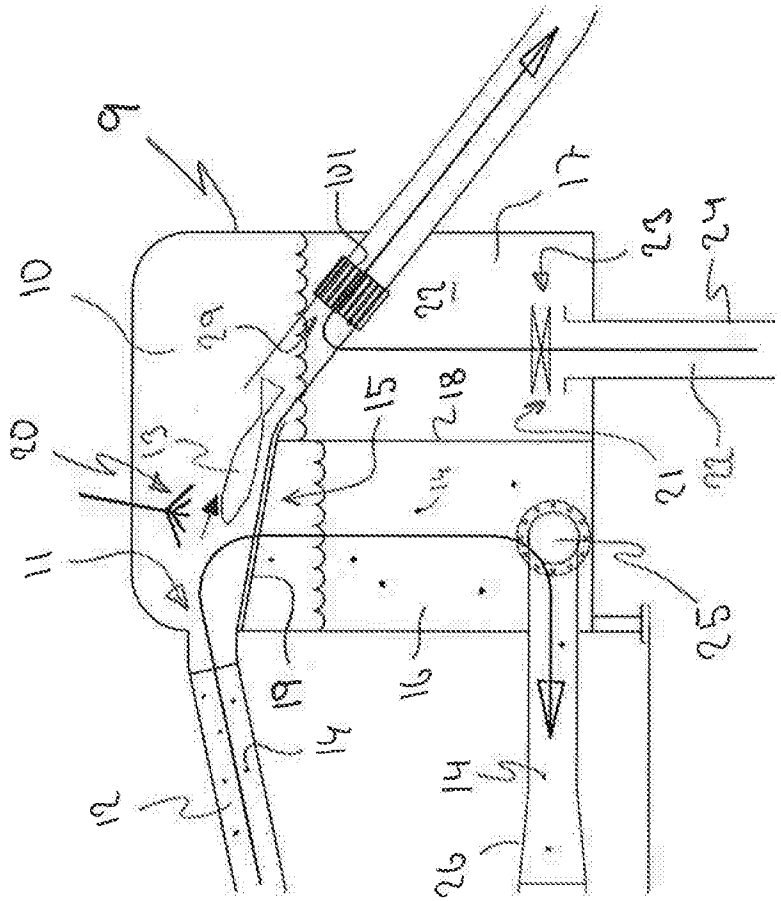

Fig. 2

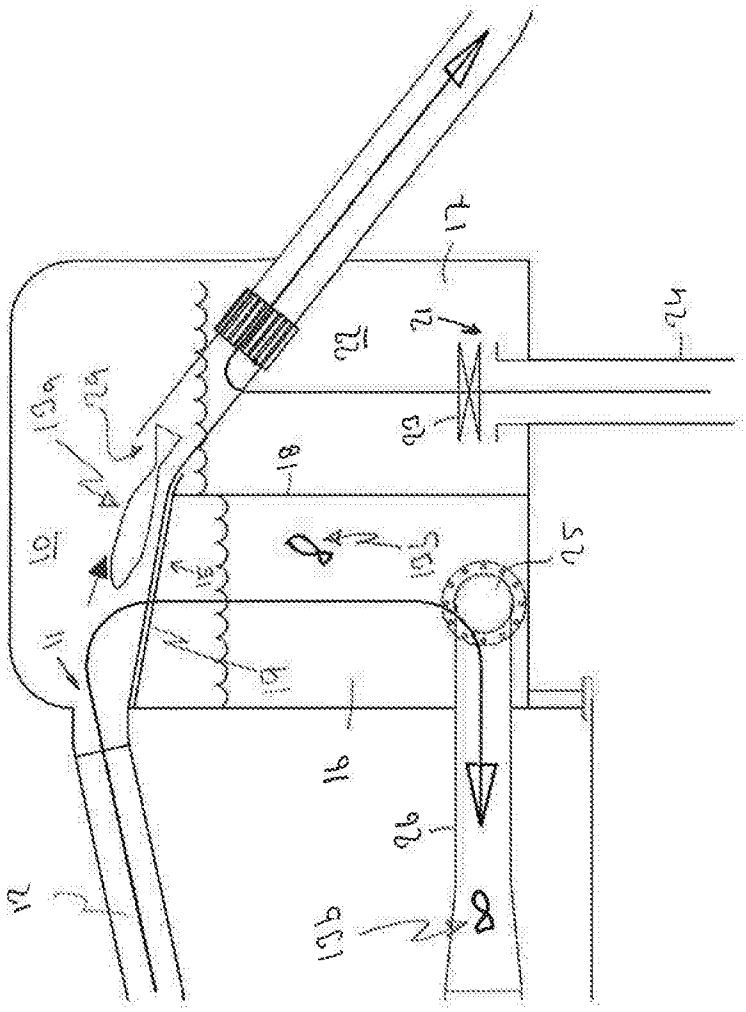

Fig. 2

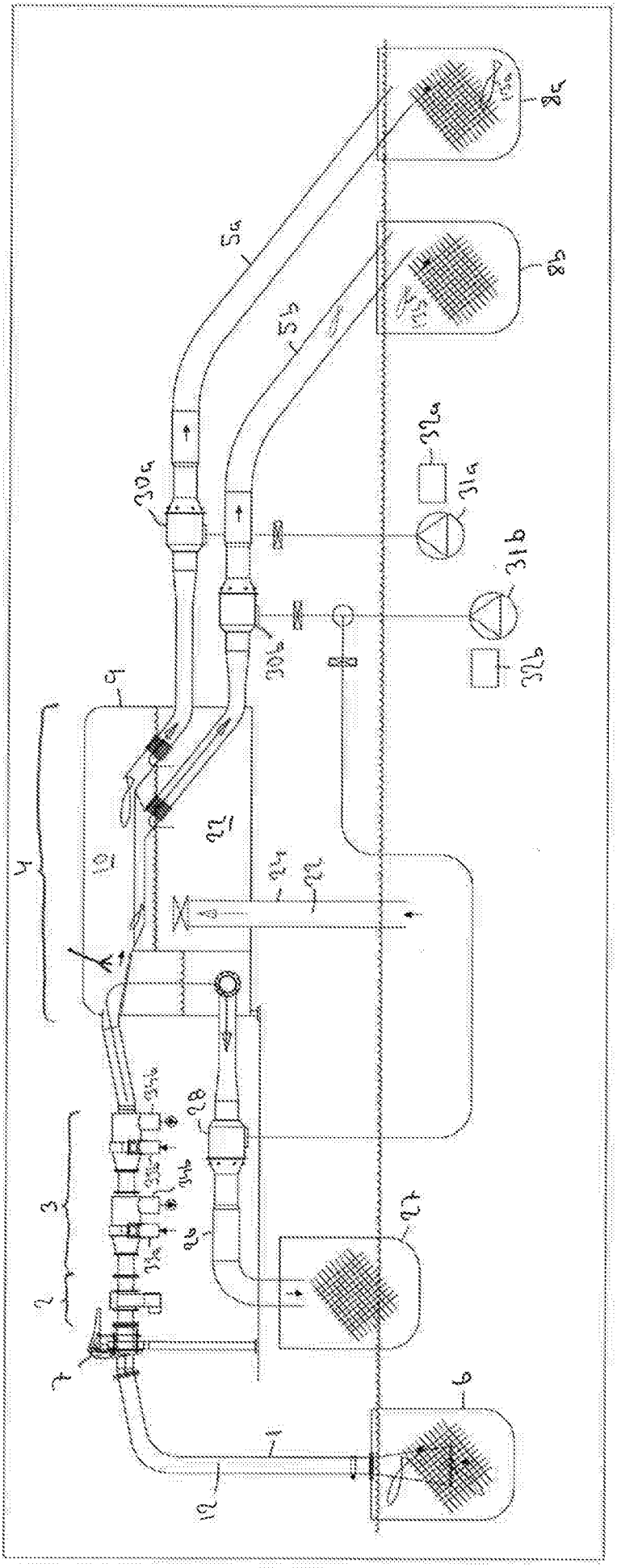

Fig. 4

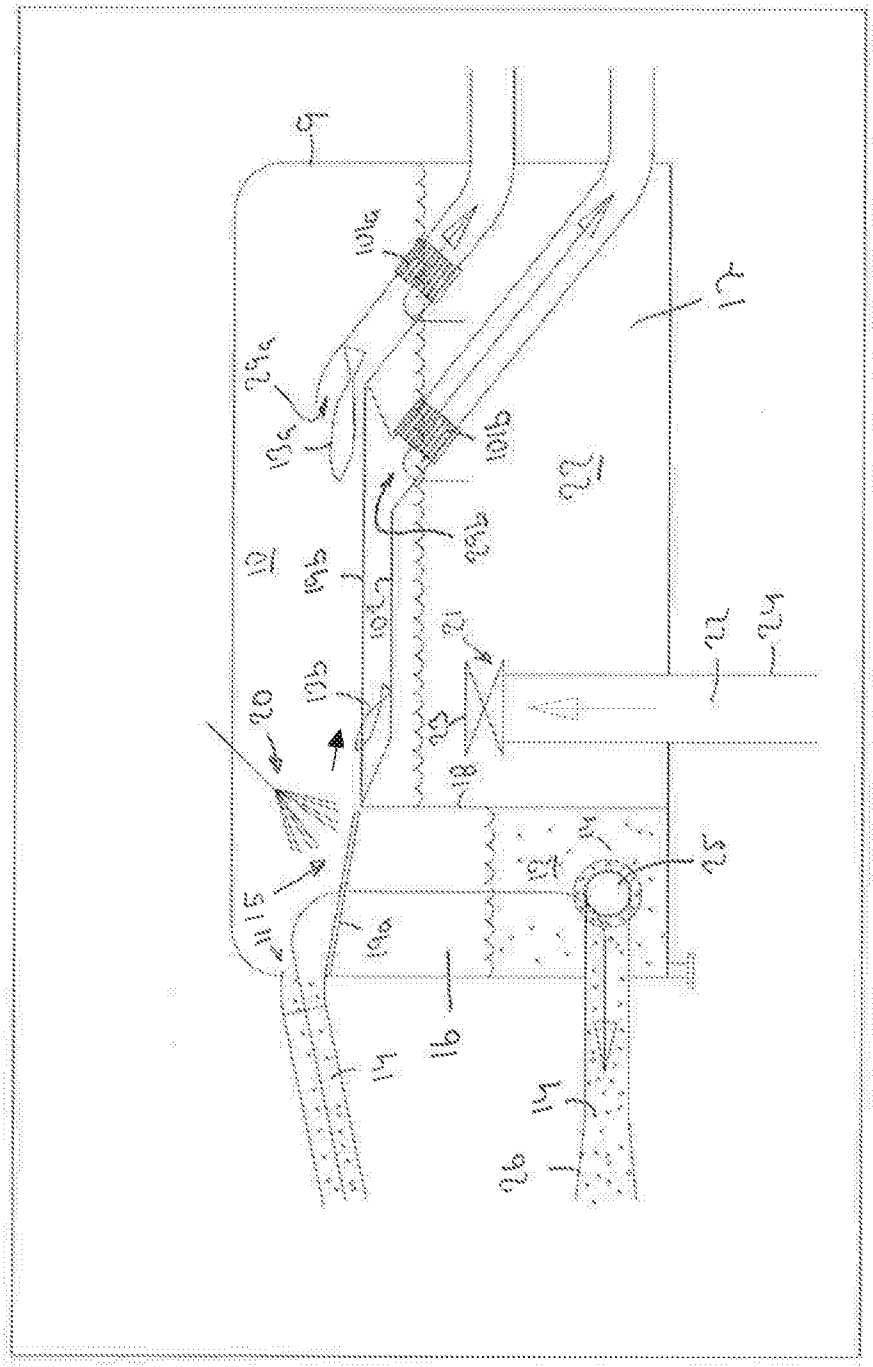

Fig. 5