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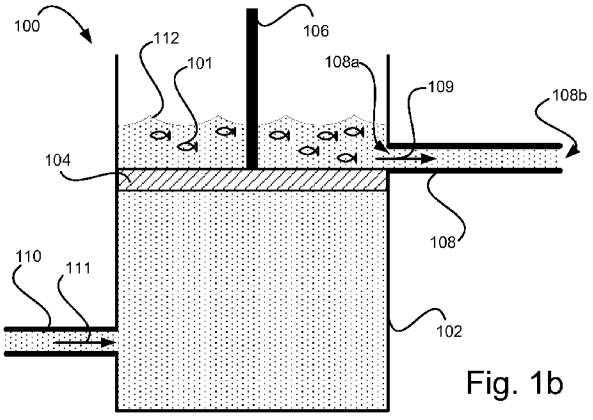

Fig. 1b

(57) Abstract: A device and method are presented for guiding fish from a reservoir to a desired destination. The device comprises a water reservoir for containing fish and having an inlet and an outlet; first and second conduits connected to respectively the outlet and inlet of the reservoir; and a space reducing assembly within the reservoir. The first conduit serves for guiding a fish flow to a desired location, and comprises an inlet which is joined to the outlet of the reservoir, and has a size and shape configured for receiving only one fish at a given time from the reservoir. The second conduit is configured for introducing water into the reservoir via the inlet of the reservoir, so as to create a water current within the reservoir directed toward the outlet of the reservoir joined to the inlet of the first conduit. The space reducing assembly is operable to gradually reduce a volume of water containing the fish in the vicinity of the inlet of the first conduit thereby forcing the fish toward the inlet of the first conduit. The water current in the reservoir directed toward the input of the first conduit and the gradual reduction of water volume in the vicinity of the inlet of the first conduit prevent crowding the fish at the inlet of the first conduit and allow the fish to successively enter the first conduit one fish at a time.

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DEVICE FOR USE IN MONITORING FISH CONDITION

FIELD OF THE INVENTION

This invention is generally in the field of fish farming, and relates to monitoring of fish condition. More particularly, the invention relates to a device for guiding fish flow from a reservoir to a desired destination so as to enable automatic inspection of the fish.

BACKGROUND

In fish farming, fish are raised commercially in tanks or enclosures. Fish so raised may be used as food, or may be released into the wild for recreational fishing or for supplementing a species' natural numbers.

In fish farms, it is often necessary to perform routine fish handling operations on a large number of live fish, such as counting fish, sorting fish by size, tagging fish, and performing vaccinations. Some of these operations typically require that fish be separated from each other, so that each fish can be handled individually. In the art, many techniques are known for automatically separating fish.

US Patent Publication 2006/0096547 discloses a system and method for controlling the flow of fish. The system includes a vessel containing water and having an exit aperture. The system also includes a sensor configured to sense a first fish moving through the exit aperture. In addition, the system includes a jet device in communication with the sensor. The jet device is positioned adjacent to the exit aperture and is configured to spray a jet to prevent a second fish from moving through the exit aperture. In one embodiment, the system also includes a gate positioned at the exit aperture, the gate being normally closed and configured to be pushed open by a fish moving through the exit aperture. The system may be employed for providing spacing between fish or may be employed to provide a single fish on demand.

US Patent No. 3,716,025 discloses a self-contained system for rearing and harvesting fish commercially, e. g. catfish or the like. This system includes a vertically disposed cylindrical tank having a roof positioned over the open upper end thereof. A cone-shaped bottom member of the tank collects toxic matter and decomposed food and

provides sump which is communicated with a closable dump valve. Also included are primary and secondary aeration units which jointly provide multilevel aeration from a source of air. An automatic portion feeder is included which is connected with an outside water source and has discharge structure communicated with the interior of the tank for conveying and discharging optimum portions of feed into the tank. The temperature of the water within the tank is thermostatically controlled within an optimum temperature range by structure provided and adapted for this purpose. A remote control panel is included which is electrically connected to certain disclosed structure to conveniently operate the totally self-contained system. Also included is a circular grid which is adapted to be raised to a discharge outlet that communicates with a loading chute. Raising the grid is effective to urge the fish through the discharge outlet hence the loading chute for loading the harvested fish onto a suitable conveyance.

US Patent 3,040,980 discloses a device for counting fish and the like mobile aquatic creatures comprising separate adjacent holding and receiving tanks, said holding and receiving tanks being constructed so as to provide space for said creatures to freely swim, a connection between the lower parts of said tanks for conducting a flow of water from the holding tank to the receiving tank, a water delivery supply positioned to deliver a flow of water to the holding tank, said flow continuing through said connection to the receiving tank, said receiving tank being provided with an overflow outlet above said connection for maintaining a prescribed depth of water therein, said connection being shaped so as to converge from a larger cross-sectional area adjacent the receiving tank to a counting passage of minimum cross-sectional area adjacent the holding tank, said counting passage being constructed so as to provide a path transversely thereof along which a beam of light can be projected, a light source positioned externally in respect to said counting passage for projecting a light beam along said path and photo responsive means positioned externally in respect to said counting passage and located so that said light beam can impinge thereon so as to be activated thereby.

US Patent 4,743,742 discloses a counting device for fish, especially smolt, comprising a pipe that is open at both ends and is adapted for being secured at one end to a vessel containing a quantity of fish to be counted. To the pipe devices are connected for generating a water flow in the pipe, the water flow having a higher velocity at the outer portion of the pipe in a direction towards the outlet of the pipe that at the portion

closed to the vessel. At the outlet of the pipe a device known per se for detecting each individual fish is provided.

US Patent Publication 2011/0114029 discloses an aquatic-animal counting system. The system includes a channel, a linear photographing device, and an operation processing device. A channel is used for a plurality of aquatic animals to pass through. The linear photographing device is used for photographing the aquatic animals passing through the channel to generate at least one image. The operation processing device is electrically connected to the linear photographing device and the operation processing device includes an image processing module. The image processing module utilizes at least one operation rule to analyze the at least one image, so as to calculate a number of the aquatic animals in the at least one image. An aquatic-animal counting method and a recording medium are also provided.

GENERAL DESCRIPTION

There is a need in the art to provide a system enabling monitoring /automatic inspection of the condition of fish. This requires the fish flow, one-by-one, along a conduit, from a reservoir to a desired location.

It is known that fish typically swim against the water current. Some known techniques utilize this phenomenon to induce the fish flow from a reservoir. More specifically, according to these techniques, the fish is drawn from the reservoir to enter a conduit by creating a water flow in the reservoir directed away from the inlet of the conduit. Thus, once current away from the conduit is generated, the fish swim against the current on their own accord. However, this impedes the control of the flow of fish into the conduit, and moreover, such natural (uncontrolled) movement of the fish toward the conduit against the current from the conduit causes a crowding of fish in the vicinity of the conduit's inlet (as explained, for example, in Karplus et al., *"Guidance of groups of guppies (Poecilia reticulata) to allow sorting by computer vision"*, Aquacultural Engineering, 32 (2005), pp. 509–520). This crowding may cause injury to the fish, and may cause the fish to enter the conduit too close to each other (e.g. in groups), thereby making the automatic inspection practically impossible.

In the present invention, there is provided a novel technique for guiding fish from a reservoir to a desired destination via a conduit, such that spacing between the fish is created and the fish successively arrive at the destination being separated from

one another. According to the invention, a water flow/current is created in a fish-containing reservoir in a direction towards an outlet of the reservoir connected to an inlet of a conduit; and concurrently and independently the fish in the reservoir is brought/pushed toward a region in the reservoir in the vicinity of the conduit's inlet (e.g. by a piston head moving within the reservoir) thereby gradually restricting the volume of water in which the fish swim.

Therefore, because of the water current in the reservoir in a direction toward the input of the conduit and because of the decrease of volume of water in the reservoir accessible to the fish, the fish are carried against their will into the conduit by the water flowing into the conduit's inlet. In this manner, overcrowding near the conduit's inlet is decreased, and consequently a certain separation between fish entering the conduit is created. Also, as the fish is caused to swim against a water current which is higher than a current that can be withstood by the fish, the fish are rotated and carried tail first by the current toward the conduit's inlet and into the conduit. This effect even more decreases the overcrowding near the conduit's inlet, and consequently contributes into the separation between fish entering the conduit. The inlet of the conduit has a shape and size designed to enable passage of one fish at a time. In this manner, the fish enter the conduit one after the other, and flow towards their destination separately.

Thus, the device of the present invention for guiding fish from a reservoir to a desired destination includes first and second conduits connected to the fish reservoir. The first conduit is a fish flow conduit which is by its inlet connected to the outlet of the reservoir and extends to the desired location, and the second conduit introduces water into the reservoir thus creating the water current in the reservoir directed towards the inlet of the first conduit. The inlet of the fish flowing conduit and the respective outlet of the reservoir has a shape and size designed to enable passage of only one fish. Also provided is a space reducing assembly operable to vary the volume of water in which the fish swim in the reservoir. As indicated above, such space reducing assembly may include a piston head. In some embodiments the piston head has an inclined surface, for further restricting the volume available to the fish. Optionally, the inclined surface tapers in the vicinity of the conduit's inlet, in order to ease the entry of the fish into the conduit's inlet.

Thus, according to one broad aspect of the present invention, there is provided a device for guiding fish from a reservoir to a desired destination, the device comprising:

a water reservoir for containing fish, the reservoir having an inlet and an outlet;

a first conduit comprising an inlet joined to the outlet of the reservoir, the first conduit having a size and shape configured for receiving only one fish at a given time from the reservoir, and for guiding a fish flow to a desired location;

a second conduit configured for introducing water into the reservoir via the inlet of the reservoir, to create a water current within the reservoir directed toward the outlet of the reservoir joined to the inlet of the first conduit; and

a space reducing assembly within the reservoir configured and operable to gradually reduce a volume of water containing the fish in the vicinity of the inlet of the first conduit thereby forcing the fish toward the inlet of the first conduit;

the water current in the reservoir directed toward the input of the first conduit and the gradual reduction of water volume in the vicinity of the inlet of the first conduit preventing crowding the fish at the inlet of the first conduit and allowing the fish to successively enter the first conduit by one fish at a time.

In a variant, the first conduit is titled downward such that a vertical position of the inlet is higher than a vertical position of the outlet.

In another variant, the first conduit's inlet is elevated with respect to a base of the reservoir, and the space reducing assembly (e.g. piston head) is configured to raise the fish toward the first conduit's inlet.

In a further variant, the piston head is configured to move from a first side of the reservoir to a second side of the reservoir, in order to push the fish toward the first conduit's inlet.

In yet another variant, the first conduit's inlet is substantially level with a base of the reservoir.

In yet a further variant, the piston head is impassable to water.

Optionally, the piston head is tilted with respect to a waterline, such that when the piston head is brought to the level of the first conduit's inlet, a lowermost section of the piston head is aligned with the lower part of the inlet of the first conduit.

According to some embodiments of the present invention, the side of the piston head facing the fish includes elevated walls arranged to define a channel between the walls.

In a variant, a width of the channel decreases as the channel's distance from the first conduit's inlet decreases.

In another variant, a width of the channel in proximity of the inlet of the first conduit is substantially equal to a width of the inlet of the conduit.

In a further variant, the side of the piston head facing the fish includes a slide tapering toward the first conduit's inlet.

In yet another variant, the first conduit comprises a pipe.

In yet a further variant, the first conduit comprises a duct having a top portion open to air.

Optionally, the first conduit comprises at least one section in form of a pipe and at least one section in form of a duct having a top portion open to air.

According to a second aspect of the present invention, there is provided a system for use in inspection of fish. The system includes a device for guiding fish from a reservoir to a desired destination container; a conveyor for moving an array of containers to said desired destination, such that that the containers sequentially arrive to said destination, wherein each of the containers is configured for receiving a single fish from a fish guiding device, and being transparent to certain radiation used in an inspection system such that an image of the container captured by the inspection system comprises the image of the fish while in the container.

In a variant, the device for guiding fish is configured according to any one of embodiments mentioned above.

According to a third aspect of the present invention, there is provided a container for use in a fish inspection system. The container is configured for receiving a single fish from liquid medium in a fish guiding device into liquid medium in the container, and being transparent to certain radiation used in the inspection system such that an image of the container captured by the inspection system comprises the image of the fish while in the container.

Optionally, the container is transparent to optical radiation.

According to a fourth aspect of the present invention, there is provided a method for guiding fish from a reservoir to a desired destination via a conduit having an inlet joined to an outlet of the reservoir and having a size and shape configured for receiving one fish at a time, the method comprising:

creating a water current within the reservoir, the water current being directed toward the inlet of the conduit joined to reservoir;

gradually decreasing a volume of water accessible to the fish within the reservoir at the inlet of the conduit, while moving the fish toward the inlet of the conduit, thereby ensuring that the fish are in the vicinity of the conduit's inlet;

the water current in the reservoir directed toward the input of the conduit and the gradual reduction of water volume in the vicinity of the inlet of the conduit forcing the fish to enter the conduit via said inlet while preventing crowding of the fish at the inlet of the conduit, thereby allowing the fish to successively enter the conduit by one fish at a time.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Figs. 1a-1b are schematic drawings illustrating a device of the present invention for delivering fish from a reservoir to a desired location, wherein a piston is raised to bring the fish near the inlet of a conduit and decrease the volume of water accessible to the fish;

Figs. 2a-2b are schematic drawings illustrating an example in which a conduit for guiding the fish is tilted downward;

Figs. 3a-3b are schematic drawings illustrating an example of the present invention, in which the piston's head is tilted with respect to the water line;

Figs. 4a-4b are schematic drawings illustrating an example of the present invention in which the reservoir is tilted with respect to the water line;

Figs. 5a-5c are schematic drawings exemplifying an embodiment of the present invention, in which the piston head is impassable to water;

Fig. 6 is a perspective drawing illustrating an embodiment of the present invention, in which the top portion of the piston's head includes elevated walls arranged to define a channel between the walls;

Figs. 7a-7b are schematic drawings illustrating a side view and a front view of the piston's head, which includes a slide tapering toward the first conduit's inlet;

Figs. 8a-8b are schematic drawings illustrating a device of the present invention for delivering fish from a reservoir to a desired location, wherein the piston is moved

from a first side of the reservoir to second side of the reservoir, to bring the fish near the inlet of a conduit and decrease the volume of water accessible to the fish;

Fig. 9a-9b are schematic drawings exemplifying an embodiment of the device of **Figs. 8a-8b** in which the piston head is tilted with respect to the waterline;

Fig. 10 is a schematic drawing of a system for sorting fish, according to some embodiments of the present invention;

Fig. 11 is a flowchart illustrating a method of the present invention for delivering fish from a reservoir to a desired location; and

Fig. 12 is a flowchart illustrating a method of the present invention for sorting fish according to one or more predetermined parameters.

DETAILED DESCRIPTION OF EMBODIMENTS

Referring now to **Figs. 1a-1b**, schematic drawings illustrate an example of a device of the present invention for guiding fish, generally **101**, from a water reservoir **102** to a desired location. It should be noted that the present invention is particularly useful for guiding live fish from a reservoir to the desired location, and is therefore described below with respect to this specific application. The device **100** includes a first conduit **108** and a second conduit **110** connected to a fish containing reservoir **102**, and a space reducing assembly (e.g. a piston head) **104** in the reservoir **102**. The first conduit **108** has an inlet **108a** joined to the reservoir **102** for receiving a fish flow from the reservoir, and an outlet **108b** located in proximity of a desired location, such that fish **101** leaving the first conduit **108** are delivered to the desired location. The second conduit **110** serves for flowing water into the reservoir **102**. Thus, water flows into the reservoir **102** via the second conduit **110** (flow **111**), and out of the reservoir **102** via the first conduit **108** (flow **109**). In this manner, the water current within the reservoir **102** is created in the direction of the first conduit **108**.

The desired location may be that where the fish are separately collected in dedicated containers (which option will be exemplified further below) e.g. for inspection, sorting, tagging, and performing vaccinations and other applications. If the fish are inspected, the inspection results may be stored to be further used as sorting decision related data. Generally, the case may be such that the fish are being inspected during their propagation along the first conduit **108**, in which case the destination location may be associated with a physical sorting station.

As indicated above, the space reducing assembly **104** is used for gradually decreasing the volume of water accessible to the fish in the vicinity of the first conduit's inlet **108a**. In the present specific but not limiting example, the space reducing apparatus **104** includes a piston head permeable to water. In **Fig. 1a**, the piston head **104** is near the bottom of the reservoir. **Fig. 1b** shows a successive stage of the device operation, where the piston head **104** is raised to be located near the conduit's inlet thus decreasing the volume of water accessible to the fish.

The piston head **104** is located within the reservoir **102** to fit within the inner surface of the reservoir **104**, and is operable to be moved within the reservoir **102**, for example, via the shaft **106**. The piston head **104** is impassable to the fish **101**, while being penetrable by water. When the piston head **104** is moved (e.g. raised) toward the inlet of the first conduit **108**, the volume of water accessible to the fish **101** is diminished (as can be seen in **Fig. 1b**), so that the fish **101** are trapped in the limited water volume between the piston head **104** and the water line **112**.

In **Fig. 1b**, the fish are located in the limited volume of water proximal to the inlet **108a** of the first conduit **108** and are subjected to a water flow which pulls the fish **101** toward the inlet **108a**. In this manner, the fish are carried by the water current into the inlet **108a** of the first conduit **108**.

It should be understood that because of the water current in the reservoir towards the inlet **108a** of the first conduit **108** (keeping in mind that fish tend to swim against the flow), and because of the decrease of water volume accessible by fish in the vicinity of the inlet **108a**, the effect of fish crowding at the inlet **108a** is avoided or at least significantly reduced, and also the fish **101** are typically carried into the first conduit **108** tail first. The significant reduction of crowding and the appropriate shape and size of the conduit's inlet **108a** provide together that the fish flow into the conduit in fish-by-fish manner with proper separation between the fish.

The water flow **111** into the reservoir **102** may be set to match the flow **109** of water leaving the reservoir **102** through the first conduit **108**, in order to maintain the water line **112** above the inlet **108a** of the first conduit **108**. The flow **109** of water leaving the reservoir may be increased in order to ensure that the water current within the reservoir **112** is higher than the water current that can be withstood by the fish. In this manner, it is ensured that the fish **101** are carried by the water current towards the

inlet **108a**. The water flow **109** may be increased, for example, by a pump and/or by tilting the conduit **108** downward, as described below in **Figs. 2a-2b**.

The shape and size of the inlet **108a** of first conduit **108** are set, so as to allow only one fish to enter the first conduit **108** at a time. This causes some spacing to be created between the fish travelling in the first conduit **108**. This may provide for separate collection of the fish into dedicated containers at the outlet of the first conduit **108**.

Preferably, the size of the inlet **108a** is slightly larger than that of the fish, in order to decrease the chances of injury to the fish **101** during the fish's entry into the first conduit **108**. In a variant of the present invention, the cross sectional size of the first conduit **108** is substantially constant throughout the length of the first conduit **108**, to ensure that at each position along the first conduit **108** the spacing between fish is maintained.

In a variant the first conduit **108** may be a closed pipe enclosing the fish from both the sides and from the top and bottom. In another variant the first conduit **108** is a duct that encloses the fish from sides and the bottom, but has a top portion open to air. The opening on the duct's top section enables the exhaust of air bubbles or cavitations (pockets of vapor or vacuum) that may be formed in the first conduit **108**. If not exhausted, air bubbles and cavitations may slow or impede the movement of fish within the first conduit **108**, and may even prevent the fish from entering the first conduit's inlet. Optionally, the first conduit **108** is composed by one or more first sections in the form of closed pipes, and by one or more second sections in the form of ducts having an open top portion.

The spacing between the fish inside the first conduit **108** and at the first conduit's outlet **108b** may be controlled by controlling the water flow **109** via the first conduit **108**. For example, a higher water flow **109** may cause the fish **101** to enter the first conduit **108** at a higher rate, and therefore may bring about a decreased spacing between the fish. Similarly, a lower water flow **109** may cause the fish **101** to enter the first conduit **108** at a lower rate, and therefore may bring about an increased spacing between the fish.

Because the fish **101** enter the first conduit **108** separately, the fish **101** may be easily counted while travelling within the first conduit **108**. The counting may be performed by a user, or automatically (e.g., via an appropriate sensing technique, e.g.

optical technique or acoustic pressure sensing). Optionally, the shape and size of the outlet **108b** of the first conduit **108** are also set in order to allow passage of only one fish at a time. In this manner, the fish **101** leave the conduit **108** separately (one by one), and a certain time interval passes between the delivery of any two fish into the desired location. This may be advantageous in the inspection and/or sorting system illustrated in **Fig. 10**, in which fish are delivered to moving containers, such that only one fish is delivered to one of the containers.

The piston head **104** may be made of a porous material traversable by water, or may be a net-structure composed by crossing members. The apertures in the net are set to be smaller than the fish, so as to prevent the fish to cross the piston head **104**. The crossing members may be rigid (e.g. metal rods, plastic rods, etc.) or flexible (e.g. ropes).

In a variant, the piston head **104** is configured to tightly fit the inner surface of the reservoir **102**, such that at all times, the piston head's circumference is in contact with the reservoir's inner surface. In another variant, the piston head **104** is configured to loosely fit inner surface of the reservoir **102**, such that a gap between the piston head's circumference and the inner surface of the reservoir **102** can be present. Optionally, the gap is smaller than the size of the fish, in order to prevent passage of fish via the gap, and ensure that all the fish in the reservoir are moved with the movement of the piston head **104**.

The outlet of the second conduit **110** may be below the water line **112** (as shown in the figures) or above the water line **112**. If the second conduit's outlet is below t he water line **112**, the outlet of the second conduit **110** into the reservoir may be covered by a filter, in order to ensure that fish do not enter the second conduit **110**. In some embodiments, the strength of the water flow **111** into the reservoir **102** may be enough to prevent the fish from entering the second conduit **110**. Optionally, the outlet of the second conduit **110** is located at the base of the reservoir **102**.

Referring now to **Figs. 2a-2b**, schematic drawings illustrate an example in which a conduit for guiding the fish is tilted downward. In **Fig. 2a**, the piston head is near the bottom of the reservoir. In **Fig. 2b**, the piston head is raised to be located near the conduit's inlet. To facilitate understanding, the same reference numbers are used for identifying components that are common in all the examples of the invention.

In **Figs. 2a-2b**, the device **100** includes the first conduit **108**, the second conduit **110**, and the piston head **104**, as described above. However, in **Figs. 2a-2b**, the first conduit **108** is tilted downward, such that the inlet **108a** is higher than the outlet **108b**. In this manner, the speed of the water flowing through the conduit **108** is increased. This causes an increase in the water flow at the inlet **108a**, and an ensuing increase in the current generated within the reservoir **102**. The tilted configuration of the first conduit **108**, therefore, increases the water current leading the fish **101** into the first conduit **108**.

Referring now to **Figs. 3a-3b**, schematic drawings illustrate an example of the present invention, in which the piston's head is tilted with respect to the water line. In **Fig. 3a**, the piston head is near the bottom of the reservoir. In **Fig. 3b**, the piston head is raised to be located near the conduit's inlet.

In the device **100** of **Figs. 3a-3b**, the piston head **104** is tilted with respect to the water line **112**. The tilting is such that when the piston head **104** is raised to be at the level of the first conduit's inlet **108a**, the lowermost section of the piston head is aligned with the lowermost part of inlet **108a** of the first conduit **108**. In this manner a slope is produced, leading the fish toward the first conduits' inlet **108a**. It should be noted that, compared to the case in which the piston head is substantially parallel to the water line, the provision of a tilted piston head **104** further decreases the volume of water available to the fish and ensures that the fish are brought even closer to the inlet **108a**. This can be seen by comparing, for example, **Fig. 3b** (tilted piston head) with **Fig. 1b** or **Fig. 2b** (piston head parallel to the water line).

Referring now to **Figs. 4a-4b**, schematic drawings illustrate an example of the present invention in which the reservoir is tilted with respect to the water line. In **Fig. 4a**, the piston head is near the bottom of the reservoir. In **Fig. 4b**, the piston head is raised to be located near the conduit's inlet.

The effect provided by the tilted piston head **104** of **Figs. 3a-3b** can be achieved by providing a reservoir **102** which is tilted with respect to the water line, as illustrated in **Figs. 4a-4b**. The piston head **104** is parallel to the base of the reservoir **102**. Since the base of the reservoir **102** is titled with respect to the water line **112**, the piston head **104** is also tilted with respect to the water line **112**. In this manner, when the piston head **104** is brought to the vicinity of the first conduit's inlet **108a**, a slope is produced, as explained above, with reference to **Figs. 3a-3b**. It should thus be understood that

generally the tilted configuration may be achieved by tilting the piston in a vertical reservoir or by tilting the reservoir with respect to the water line. Optionally, the conduit **108** is also titled, as explained above in **Figs. 2a-2b**.

Referring now to **Figs. 5a-5c**, there is exemplified an embodiment of the present invention, in which the piston head is impassable to water. In **Fig. 5a**, the piston head is near the bottom of the reservoir. In **Fig. 5b**, the piston head is raised to be located near the conduit's inlet, raising the level of the water line. In **Fig. 5c**, the water line descends as water drains from the reservoir into the conduit.

The device **200** includes a piston head **204**, and a conduit **108** associated with the reservoir **102**. The conduit **108** is configured for receiving fish from the reservoir and leading the fish to a desired location, as described above. The piston head **204** is moves within the reservoir **102** to carry the fish **101** near the inlet **108a** of the conduit **108**, as described above. The reservoir **102** may or may not be part of the device **200**. In the device **200**, the piston head **204** is impassable to both water and fish **101**. Therefore the piston head **204** is configured to tightly fit the reservoir's inner surface, such that all the water and the fish **101** are carried with the piston head **204** toward the conduit **108**, as the piston head **204** moves.

When raised toward the inlet **108a** of the conduit **108**, the piston head **204** raises the water as well as the fish. In **Fig. 5a**, the water line **112** is initially below the level of the conduit's inlet **108a**. In **Fig. 5b**, the piston head **204** is raised to be aligned with the conduit's inlet **108a**, thereby raising the water and the fish **101**. At this point the water line **112** is above the level of the conduit's inlet **108a**. In this manner, a flow **109** from the reservoir **102** into the conduit **108** is created, as the water drains from the reservoir into the conduit **108**. The flow carries the fish toward (and into) the conduit **108**. In **Fig. 5c**, the water line **112** has descended because of the water draining into the conduit **108**. The drainage of the water into the conduit **108** decreases the volume of water of accessible to the fish **101**, and therefore brings the fish **101** which are still in the reservoir closer to the conduit's inlet **108a**. The water flow into the conduit **108** and the decrease of accessible water in the reservoir **102** force the fish **101** to enter the conduit **108**.

As explained above, the conduit **108** is configured to allow entry thereto of one fish at a time. Preferably, the conduit **108** also releases the fish therefrom one at a time.

The device **200** may further include a second conduit (not pictured), configured for bringing water into the reservoir **102** after the piston head **204** has been raised to be aligned with the inlet **108a** of the conduit **108**. This enables the water line **112** to be maintained at a desired height, and thereby to maintain the water current carrying the fish from the reservoir **102** into the conduit **108**. For this purpose, the second conduit's outlet is located either at the level of the inlet **108a** of the conduit **108** or above the level of the inlet **108a**.

The piston head **204** may be tilted with respect to the water line toward the conduit **108**, as described above. Because the piston head **204** is impassable to water, the tilt of the piston head **204** increases the flow rate of the water from the reservoir **102** into the conduit **108**.

Referring now to **Fig. 6**, an embodiment of the present invention is illustrated, in which the top portion of the piston's head (i.e. the portion of the piston head facing the fish) includes opposite elevated walls arranged to define a channel between the walls.

The piston head **104** may be titled (as shown in **Fig. 6**) or parallel to the water level. The piston head **104** includes a first elevated wall **300a** and a second elevated wall **300b**, impassable to fish. The walls **300a** and **300b** are located on the upper surface of the piston head **104**, and define a channel between them, to further restrict the volume of water accessible to the fish. Each wall extends from the channel's border to the circumference of the piston head **104**. In this manner, fish carried by the water current toward the conduit **108** are forced to pass through the channel.

Optionally, the channel is set such that the channel's size (width) in proximity of the inlet of the conduit **108** substantially matches that of the inlet of the conduit **108**. In this manner, the channel leads the fish towards the inlet of the conduit **108** and eases the entry of the fish into the conduit **108**. It should be noted that the piston head **104** of any of **Figs.1a-1b**, **2a-2b**, **3a-3b**, **4a-4b** (penetrable by water) as well as the piston head **204** of **Figs. 5a-5c** (impassable to both fish and water) may be formed with such elevated walls **300a** and **300b**. Moreover, the walls **300a** and **300b** and the channel may or may not be impassable to water.

According to some embodiments of the present invention, the channel tapers toward the conduit **108**. In other words, the width of the channel decreases as the channel's distance from the conduit's inlet decreases. The channel's section located at the inlet of the conduit **108** has a width that is substantially that of the conduit's inlet.

The tapering prevents an overcrowding of fish in the zone near the conduit's inlet. Such overcrowding may lead to a blockage of the inlet conduit **108** and to the possible injury of the fish. In fact, the tapering of the channel ensures that only one fish can be located near the inlet of the conduit **108**.

In a variant, the height of the walls **300a** and **300b** is chosen, such that the topmost section of the walls is near the water line. In this manner, all the fish are located in the channel, and the volume of water accessible to the fish is further reduced. This further eases the entry of the fish into the conduit **108**.

Referring now to **Figs. 7a-7b**, there are schematic drawings illustrating a side view (**Fig. 7a**) and a front view (**Fig. 7b**) of the piston's head including a slide tapering toward the first conduit's inlet.

Instead of the walls described in **Fig. 6**, the piston head **104** of Figs. **7a-7b** includes a slide **400** tapering toward the inlet of the conduit **108**. The slide **400** is located in the upper surface of the piston head **104** (i.e. on the side of the piston head facing the fish), and is enclosed on the sides by two barriers **402** and **404**. Optionally, a portion of the slide **104** is elevated over the upper surface of the piston head **104**.

The slide **400** has the same function as the channel of **Fig. 6**, namely, to ease the entry of the fish into the conduit **108**. The tapering of the slide **400** is similar to the tapering of the above-described channel, and prevents an overcrowding of fish in the zone near the conduit's inlet. Optionally, the slide **400** is designed such that the bottom section thereof and the barriers **402** and **404** are curved to fit the shape of the fish, and further ease the passage of the fish from the reservoir **102** to the conduit **108**.

Referring now to **Figs. 8a-8b** and **Fig. 9a-9b**, a device of the present invention is illustrated for delivering fish from a reservoir to a desired location, wherein the piston is moved from a first side of the reservoir to second side of the reservoir, to bring the fish near the inlet of a conduit and decrease the volume of water accessible to the fish. In **Figs. 8a** and **9a**, the piston head is far from the conduit's inlet. In **Figs. 8b** and **9b**, the piston head is moved towards the conduit's inlet. In **Figs. 8a-8b**, the piston head is substantially perpendicular to the water line. In **Fig. 9a-9b**, the piston head is tilted wither respect to the water line.

The device **100** of the **Figs. 8a-8b** and **Fig. 9a-9b** is generally similar to the device **100** described in Figs. **1a-1b**, **2a-2b**, **3a-3b**, **4a-4b**. The difference between such devices lies in the fact that in **Figs. 8a-8b** and **Fig. 9a-9b**, the piston head **104** moves

substantially horizontally within the reservoir **102** (i.e. in the fish flow direction), rather than vertically (transverse to the fish flow direction). The inlet **108a** of the conduit **108** is joined to either the lower section of a side of the reservoir **102**, or to the bottom of the reservoir **102** proximal to the side of the reservoir **102**. The piston head **104** is impassable to the fish **101**, but permeable to water. The piston **104** is moved from a first side of the reservoir **102** to a second side of reservoir, toward the conduit **108**. In this manner, the volume of water accessible to the fish is reduced. At the same time, water flows from the second conduit **110** to the first conduit **108**, creating a water current within the reservoir, to drive the fish **101** toward the first conduit **108**. As explained above, the decrease of water volume accessible to the fish combined with the water current created in the reservoir causes the fish **101** to be carried to the inlet **108a** and into the first conduit **108**.

The piston head **104** may be substantially perpendicular to the water line **112** (**Figs. 8a-8b**) or tilted with respect to the water line **112**. The piston head **104** may be tilted such that the distance between the piston head **104** and the side of the reservoir proximal to the first conduit **108** increases with height (**Figs. 9a-9b**). Alternatively, the piston head **104** may be tilted such that the distance between the piston **104** head and the side of the reservoir proximal to the first conduit **108** decreases with height (not pictured). Optionally, the side of the piston head facing the fish is joined to two walls defining a channel (see **Fig. 6**), or to a slide (see **Figs. 7a-7b**). If present, the channel/slide is configured to ease the entry of the fish **101** into the first conduit **108**, as explained above. Optionally, the channel/slide tapers toward the inlet **108a** of the conduit **108**.

Referring now to **Fig. 10**, a system **500** for use in sorting fish according to some embodiments of the present invention is illustrated. The system **500** may be used to sort live fish and/or dead fish.

The system **500** includes a guiding device **502** for delivering fish, a plurality of containers **504** (e.g. filled with water) for receiving the fish, and a conveyor **506** for moving the containers **504** along a predetermined path. Also preferably provided in the system **500** is an inspection system. In the present example, the inspection system includes a sensing system comprising one or more cameras **508** for capturing one or more images of the fish while in the containers. Also, preferably, each container is marked by a unique identification code which may be optically read and recorded while

imaging the fish in the same container. Optionally, a counter is provided to count the containers, such that each container is assigned a number upon being counted. Such a counter may be used as alternative to the use of identification codes, or as an addition thereto. The system **500** further includes a control unit **512**, which is typically a computer system including *inter alia* a processor configured for analyzing the images of the fish, and generating sorting data to be used for sorting the fish accordingly at a sorting station. Also, one or more manipulators (e.g. **509**, **510**, **511**) may be provided for handling the containers and delivering their contents into selected tanks (e.g., **513**, **514**, **515**). The manipulating units (**509**, **510**, **511**) may be controlled by the control unit **512** to deliver selected fish to selected tanks.

The guiding device **502** is configured for flowing the fish one by one through the guiding device and for outputting one fish at a given time. For example, the guiding device **502** is configured as any of the devices exemplified above. The device **502** may be used for the delivery of live fish or dead fish, alike. Fish are delivered from the device **502** into the containers **504** via a delivery conduit **108** (described above with reference to the preceding figures). The containers **504** are moved by a conveyor **506** with respect to the guiding device **502** to successively pass the outlet of the delivery conduit **108**. The rate at which the fish are delivered and/or the speed at which the containers **504** are moved by the conveyor **506** are set, so as to ensure that each of containers **504** receives no more than one fish. The delivery rate of fish can be also controlled by controlling the water current within the reservoir, as explained above. The speed of the conveyor **506** may be controlled manually or automatically. In a variant, the conveyor **506** moves the containers **504** along a path shaped as a closed loop, enabling each container to repeatedly receive the fish from the device **502** and deliver the fish to the tanks (e.g., **513**, **514**, **515**). The speed of conveyor, and/or the current within the reservoir may be controlled by the control unit **512**, by a different automated unit, or manually by a user.

The containers **504** may be filled with water prior to receiving the fish or may be filled with water during reception of the fish from the delivery conduit **108**. In some embodiments, at least some water received by the containers **504** from the delivery conduit **108** is drained, in order to limit the movement of the fish during inspection. This may be achieved by providing one or more drainage holes on the containers **504**. In a variant, at least some of the water is drained while in the conduit **108**, before

reaching the containers **504**. This may be achieved, for example, by providing one or more drainage holes in the conduit **108**.

The camera **508** captures images of the fish in the containers. The images may be stills or video images. The camera may be an optical camera configured for detecting light returned from the fish (e.g. reflected by the fish), or may be part of an imaging unit, such as an acoustic imaging unit (which transmits and receives acoustic waves to and from the containers), or a radiological unit (which emits and detects radiation – such as x-rays). In a variant, the camera **508** receives waves/radiation coming directly from the fish. In another variant, the system includes radiation directing arrangement (e.g. optical) for receiving radiation coming from the fish and directing it (e.g. by deflection, diffraction, etc.) towards the camera **508**. Optionally, such radiation directing arrangement includes a mirror located on the side of the fish which does not face the camera, so as to enable the camera **508** to receive light coming from both the side of the fish facing the camera and the side of the fish which is outside the field of view of the camera. In this manner the inspection of the fish is enhanced.

The images captured by the camera **508** are sent to the control unit **512**, which includes an image processing utility configured to determine one or more properties or parameters of the fish. Non-limiting examples of the properties may include: size, color, sex, body pattern, absence of tails or fins, health, vitality. Data indicative of the fish properties/parameter(s) is generated by the image processing utility of the control unit **512** and processed by sorting utility (e.g. a look-up table or an algorithm) of the control unit **512**, where each fish is identified according to the ID or number of the dedicated container, and categorized and assigned to one of a plurality of predetermined groups (which are to be separated) according to the transmitted data.

In the present example, a plurality of tanks (e.g., tanks **513**, **514**, **515**) is provided near the conveyor **506** for receiving fish. Each tank corresponds to one of the predetermined groups. The manipulators (e.g. manipulators **509**, **510**, **511**) are configured for delivering each categorized fish into its corresponding tank, when the container that houses the fish passes by the tank corresponding to the group to which the fish is assigned. Optionally, each manipulator corresponds to a single tank. For example, the manipulator **509** corresponds to the tank **513**, and is configured for delivering to the tank **513** fish belonging to the group associated with the tank **513**. Similarly, the manipulator **510** corresponds to the tank **514**, and the manipulator **511**

corresponds to the tank **515**. Alternatively, two or more manipulators are assigned to each tank. In this manner, two or more containers **504** may be manipulated at once to deliver the fish to their assigned tanks. In an embodiment of the present invention, the manipulators are stationary or have a limited movement range, and are located in the vicinity of their corresponding tanks. In this embodiment, the manipulators handle the appropriate containers **504** when such containers are moved by the conveyor **506** to the vicinity of the manipulators.

In a variant, the manipulators are configured to grab the containers **504**, empty the content of the containers **504** into the appropriate tanks, and return the empty containers to the conveyor **506**. In another variant, the manipulators push the containers **504** along with their contents into the corresponding tanks. In yet another variant, each container **504** is joined to the conveyor **506**, via a respective hinge **514**. In such an embodiment, the manipulators are operable to cause the containers **504** to rotate about their hinges **514**, tilting the containers **504** to spill their contents in the tanks **511**. In a variant, the hinges **514** are spring loaded. In this manner, after being tilted, the containers return to their upright position and can be used again to receive fish from the device **502**. Optionally, each container **504** includes a flap, which is horizontal when the container is in its upright position. When the flap is lifted by the manipulator, the container **504** is tilted.

In a variant, the manipulators are controlled directly by the control unit **512**. In such a case, the control unit **512** is informed at all times about the positions of the categorized fish, in order to operate the appropriate manipulator at the appropriate time, and deliver each categorized fish into its corresponding tank. Optionally, the information is relayed to the control unit **512** by one or more external sensors tracking the positions of the categorized fish. According to some embodiments of the present invention, each container is counted when the image thereof is captured by the camera **508**, and is assigned a number. The control unit **512** is provided with a timing utility, which is provided with or measures the speed at which the containers **504** are moved by the conveyor **506**. The timing utility is also provided with a distance between each manipulator and the location at which the counting is performed. Therefore, the timing utility of the control unit **512** is configured for determining the time at which each counted container **504** passes near each manipulator, and can control suitable manipulators to deliver the contents of suitable containers into the appropriate tanks.

As indicated above, each of the containers **504** may be marked by a unique identification indicator. The identification indicators are recognizable by an appropriate sensor **508a** associated with the camera **508** and possibly also by a second sensor associated with or included in each of the manipulators **510**. The identification indicator may be a barcode or any other optical mark (a color or a pattern), which may be recognized, respectively, by a barcode scanner or an optical detector, or may be imaged together with the container contents to be recognized in the image itself. Alternatively or additionally, the identification indicator may be in the form of a signal (electromagnetic, acoustic, RF, etc.) emitted by an emitter at each container and appropriately modulated to distinguish between the containers, in which case the control unit has an appropriate receiver. When the image of a particular fish is captured by the camera **508**, the sensor **508a** detects the identification code of the container in which the particular fish is located. The image of the fish is associated with the detected identification code.

In a variant, after the fish is categorized, data relating to the identification code associated with the particular fish's container is sent by the control unit **512** to one or more manipulators located near a tank associated with the group to which the particular fish belongs. The second sensors of these manipulators scan each container that travels near the manipulators, and compare the IDs of the passing containers to the ID supplied by the control unit **512**. When a match is found between the ID of a passing container and the ID supplied by the control unit **512**, the manipulator(s) corresponding to the second sensor that has found a match is activated to deliver the particular fish to the appropriate tank. In this manner, the fish associated with each group are delivered to their intended tank. Optionally, the manipulator is activated a certain time interval after the second sensor's detection of the matching identification indicator. In this manner, the manipulator is activated when the container is in the vicinity of the manipulator.

In another variant, the manipulators are all connected to and controlled by the control unit **512**. The second sensors transmit to the control unit **512** data relating to the scan of the passing containers' identification indicators. The control unit includes a comparison utility configured to compare the IDs of the containers passing near the manipulators with the ID of the container holding the particular fish. When a match is found, the control unit **512** determines whether the container containing the particular fish is located near the tank associated with the fish's group. This may be done, for

example, by checking which manipulator's second sensor sensed the matching ID. If it is determined that matching ID was sensed by a second sensor associated with a manipulator located near the tank associated with the particular's fish's group, such manipulator is activated to deliver the fish into the tank. Otherwise, no manipulator is activated.

According to some embodiments of the present invention, the containers **504** are transparent to the waves (e.g., optical, radiation, acoustic) detected by the camera **508**. This feature enables images of the fish to be taken from one of a plurality of angles. In this manner, the camera **508** may be located anywhere in the system **500**, and the location of the camera **508** is not restricted by the geometry of the containers **504**. Furthermore, a plurality of cameras may be used to capture different images from different angles, in order to better determine the properties/parameters of the fish. If the camera **508** is an optical camera capturing light coming from the fish, the containers **504** may be made, for example, of transparent plastic, or glass.

Referring now to **Fig. 11**, a flowchart **600** illustrates an example of a method of the present invention for guiding fish from a reservoir to a desired location.

At **602**, a water current in created in a reservoir toward an inlet of a delivery conduit (conduit **108** of any one of the above examples). This may be done by maintaining the water level in the reservoir to be above the delivery conduit's entry (as described above). The water current may be controlled by a pump or by the inclination of the delivery conduit. The water current is set such that fish are carried by the current towards the conduit's inlet, even when the fish swim against the current.

At **604**, the volume of water accessible to the fish is decreased, as the fish are brought to the vicinity of the delivery conduit's inlet. This is done by moving the fish toward the conduit's inlet via a piston head which is impassable to the fish (e.g. the piston head **104** of **Figs. 1a-1b**, **2a-2b**, **3a-3b**, **4a-4b, 5a-5c**, or the piston head **204** of **Figs. 5a-5c**). The piston head is moved along the reservoir, for example horizontally or vertically. Optionally, the piston head is tilted with respect to the water line, in order to further decrease the volume of water accessible to the fish (as described above with reference to **Figs. 3a-3b**, **4a-4b**).

At **606**, owing to the current in the reservoir and the decrease of the water volume accessible to the fish, the fish are carried toward the delivery conduit and received by the delivery conduit. The delivery conduit sports a shape and a size which

allows entry of only one fish at a time. Preferably, the shape and size of the delivery conduit are set such that only one fish at a time can exit the delivery conduit.

Optionally, in order to ease the entry of the fish into the delivery conduit, the top surface of the piston head includes either a channel defined by two walls or a slide (as described above, with reference to **Figs. 6, 7a-7b**, respectively).

Referring now to **Fig. 12**, a flowchart **700** illustrates a method of the present invention for sorting fish according to one or more predetermined parameters.

Steps **702**, **704**, and **706** are analogous to the steps **602**, **604**, and **606** of **Fig. 11**, respectively.

At **708**, the fish is delivered by the delivery conduit into a container, such that a single fish is contained in the container (for example, a container **504** of **Fig. 10**). At **710**, the container is moved by a conveyor (for example, the conveyor **506** of **Fig. 10**). At **712**, an image of the fish in the container is captured by a camera (for example, the camera **508** of **Fig. 10**). At **714**, the image is analyzed by an image processing utility, in order to determine properties of the fish (fish parameters). Such properties may be, for example, a fish's size, color, or sex. At **716**, the determined fished parameters are used by a sorting utility to create and record sorting data which categorizes the fish and assigns the fish to one of a plurality of predetermined groups. Then, the fish may be delivered to a tank in accordance with the sorting data (optional step **718**). The delivery of the fish is performed as described above, in the description of **Fig. 10**.

CLAIMS:

1. A device for guiding fish from a reservoir to a desired destination, the device comprising:

a water reservoir for containing fish, the reservoir having an inlet and an outlet;

a first conduit comprising an inlet joined to the outlet of the reservoir, the first conduit having a size and shape configured for receiving only one fish at a given time from the reservoir, and for guiding a fish flow to a desired location;

a second conduit configured for introducing water into the reservoir via the inlet of the reservoir, to create a water current within the reservoir directed toward the outlet of the reservoir joined to the inlet of the first conduit; and

a space reducing assembly within the reservoir configured and operable to gradually reduce a volume of water containing the fish in the vicinity of the inlet of the first conduit thereby forcing the fish toward the inlet of the first conduit;

the water current in the reservoir directed toward the input of the first conduit and the gradual reduction of water volume in the vicinity of the inlet of the first conduit preventing crowding the fish at the inlet of the first conduit and allowing the fish to successively enter the first conduit one fish at a time.

2. The device of claim 1, wherein the inlet of the first conduit is elevated with respect to a base of the reservoir; and the space reducing assembly is configured to raise the fish toward the first conduit's inlet.

3. The device of claim 1 or 2, wherein the space reducing assembly comprises a piston head.

4. The device of claim 3, wherein the piston head is configured to move from a first side of the reservoir to a second side of the reservoir, in order to push the fish toward the first conduit's inlet.

5. The device of claim 3, wherein the piston head is configured to move from a first side of the reservoir to a second side of the reservoir, in order to push the fish toward the first conduit's inlet, the first conduit's inlet being located substantially at a level of a base of the reservoir.

6. The device of claim 3, wherein the piston head is impassable to water.

7. The device of any one of claims 3 to 6, wherein the piston head is tilted with respect to a waterline, such that when the piston head is brought to the level of the first

conduit's inlet, a lowermost section of the piston head is aligned with the lower part of the inlet of the first conduit.

8. The device of any one of claims 3 to 7, wherein the side of the piston head facing the fish includes elevated walls arranged to define a channel between the walls.

9. The device of claim 8, wherein a width of the channel decreases as the channel's distance from the first conduit's inlet decreases.

10. The device of claim 8 or 9, wherein a width of the channel in proximity of the inlet of the first conduit is substantially equal to a width of the inlet of the conduit.

11. The device of any one of claims 3 to 7, wherein the side of the piston head facing the fish includes a slide tapering toward the first conduit's inlet.

12. The device of any one of the preceding claims, wherein the first conduit comprises a pipe.

13. The device of any one of claims 1-11, wherein the first conduit comprises a duct having a top portion open to air.

14. The device of any one of claims 1-11, wherein the first conduit comprises at least one section in form of a pipe and at least one section in form of a duct having a top portion open to air.

15. A system for use in inspection of fish, the system comprising: the device of any one of claims 1-14 for guiding fish from a reservoir to a desired destination container; and a conveyor for moving an array of containers to said desired destination, such that the containers sequentially arrive to said destination, wherein each of the containers is configured for receiving a single fish from the fish guiding device, and being transparent to certain radiation used in an inspection system such that an image of the container captured by the inspection system comprises the image of the fish while in the container.

16. A system for use in inspection of fish, the system comprising:

a device for guiding fish from a reservoir to a desired destination container;

a conveyor for moving an array of containers to said desired destination, such that the containers sequentially arrive to said destination, wherein each of the containers is configured for receiving a single fish from a fish guiding device, and being transparent to certain radiation used in an inspection system such that an image of the container captured by the inspection system comprises the image of the fish while in the container.

17. A container for use in a fish inspection system, the container being configured for receiving a single fish from liquid medium in a fish guiding device into liquid medium in the container, and being transparent to certain radiation used in the inspection system such that an image of the container captured by the inspection system comprises the image of the fish while in the container.

18. The container of claim 17, wherein the container is transparent to optical radiation.

19. A method for guiding fish from a reservoir to a desired destination via a conduit having an inlet joined to an outlet of the reservoir and having a size and shape configured for receiving one fish at a time, the method comprising:

creating a water current within the reservoir, the water current being directed toward the inlet of the conduit joined to reservoir;

gradually decreasing a volume of water accessible to the fish within the reservoir at the inlet of the conduit, while moving the fish toward the inlet of the conduit, thereby ensuring that the fish are in the vicinity of the conduit's inlet;

the water current in the reservoir directed toward the input of the conduit and the gradual reduction of water volume in the vicinity of the inlet of the conduit forcing the fish to enter the conduit via said inlet while preventing crowding of the fish at the inlet of the conduit, thereby allowing the fish to successively enter the conduit by one fish at a time.

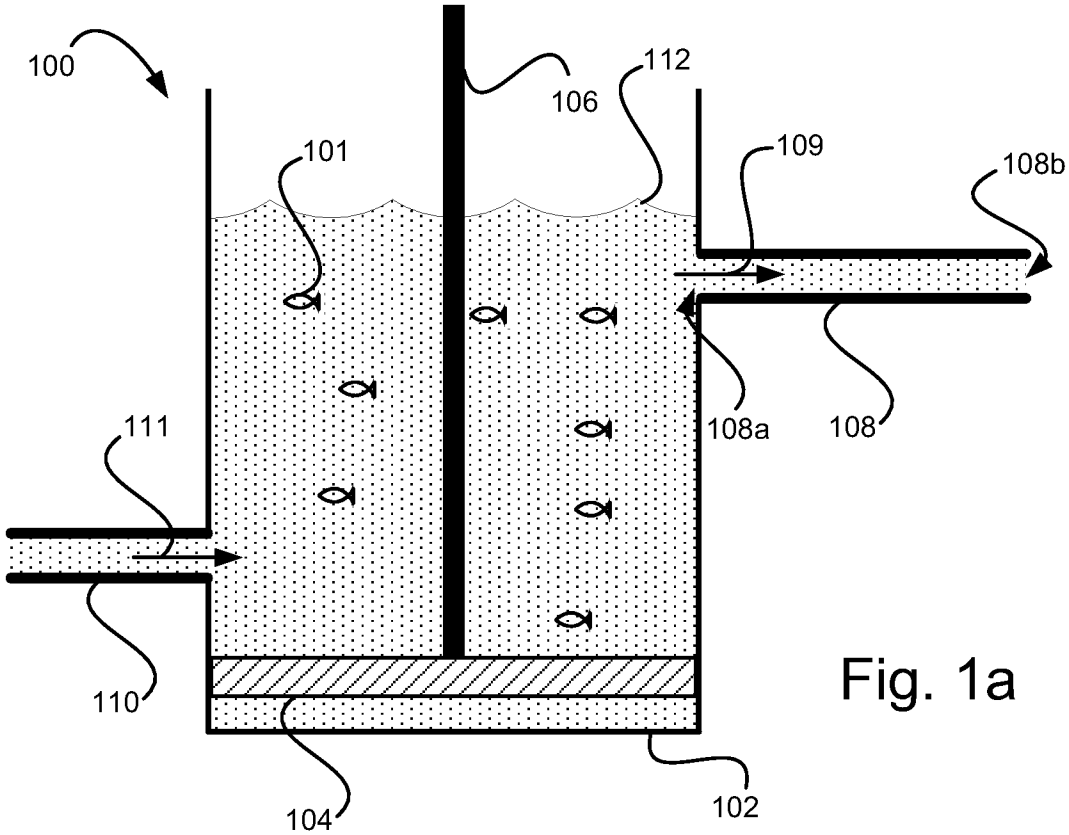
100
106
112
101
109
108b
108a
108
111
110
104
102

Fig. 1a

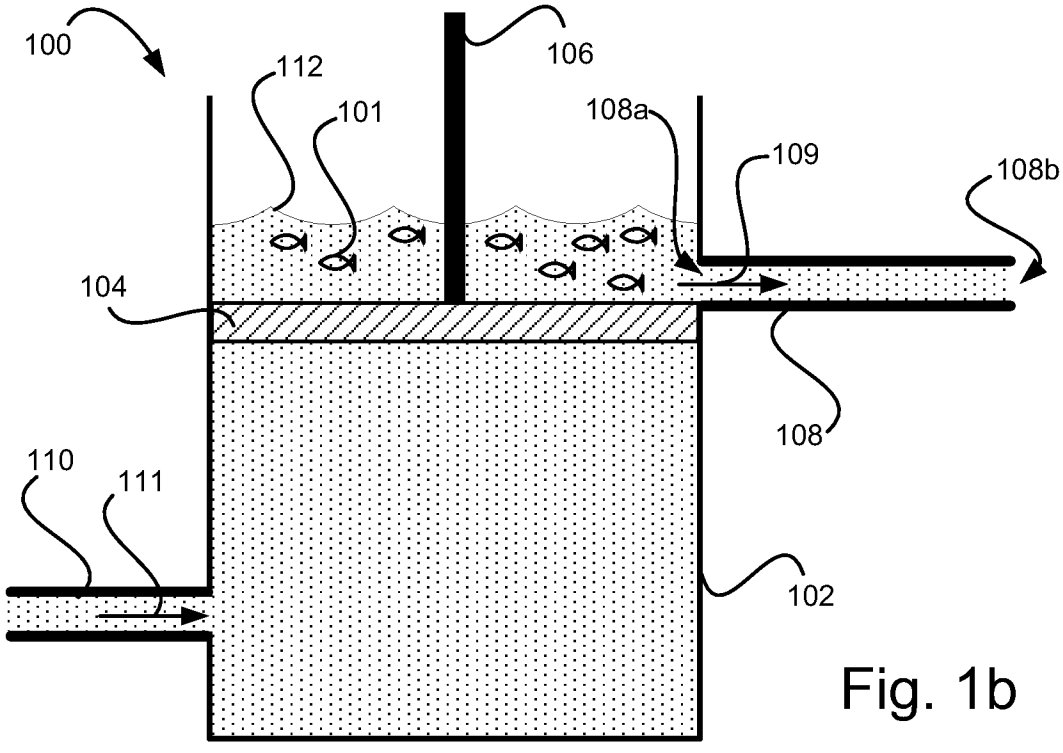
100
106
112
101
108a
109
108b
104
108
110
111
102

Fig. 1b

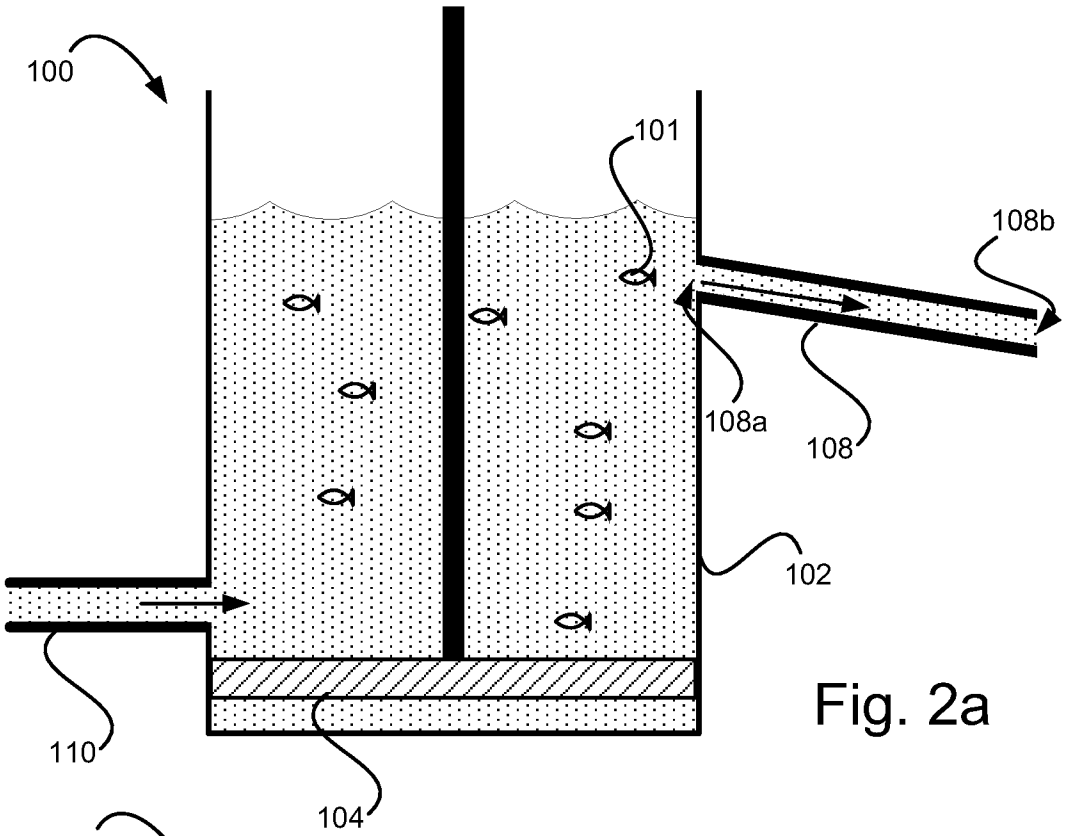
100
101
108b
108a
108
102
110
104

Fig. 2a

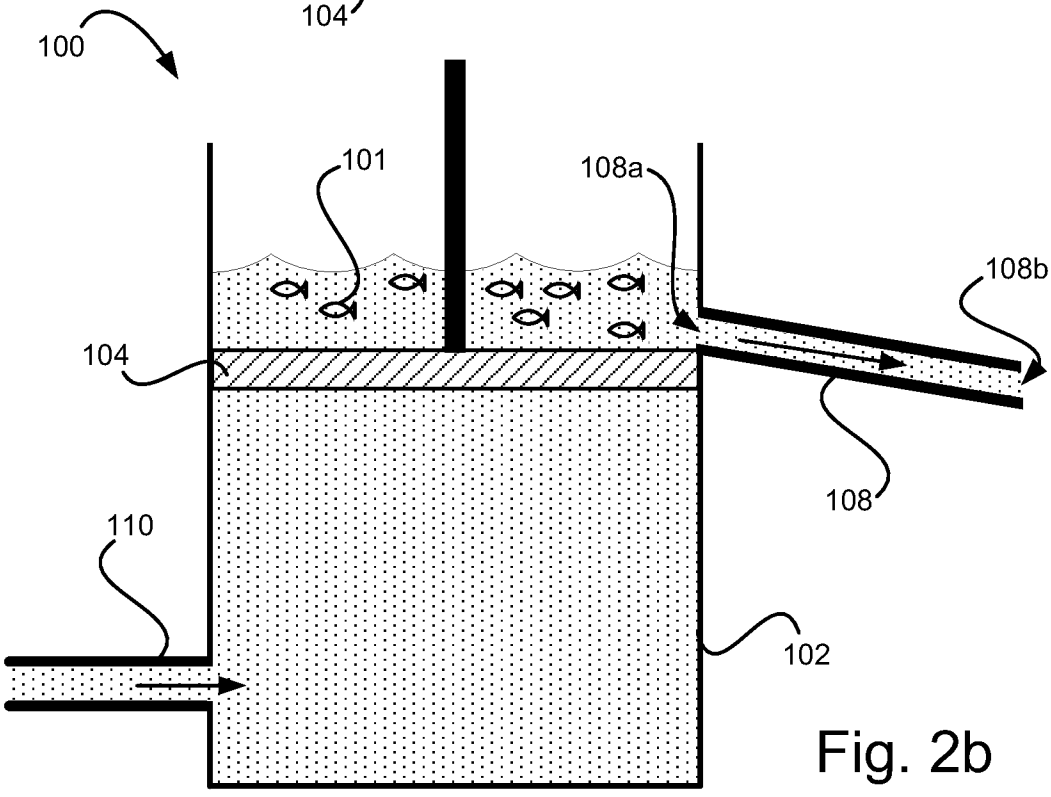
100
101
108a
108b
104
108
110
102

Fig. 2b

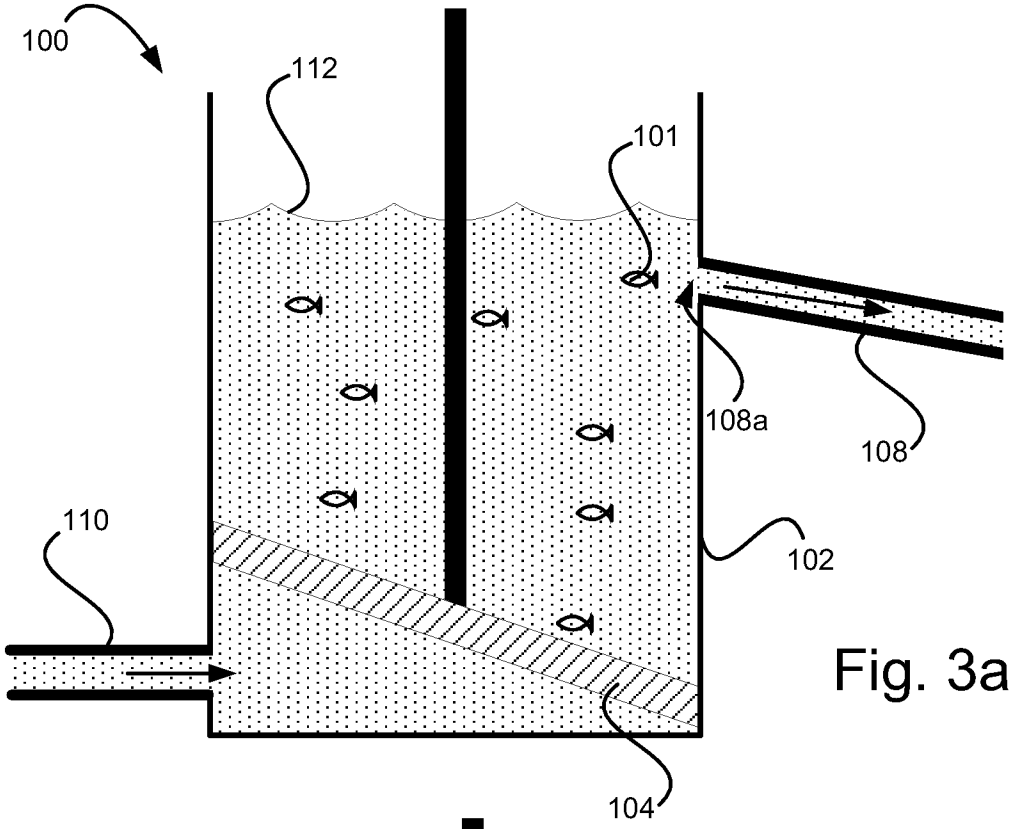
100
112
101
108a
108
110
102
104

Fig. 3a

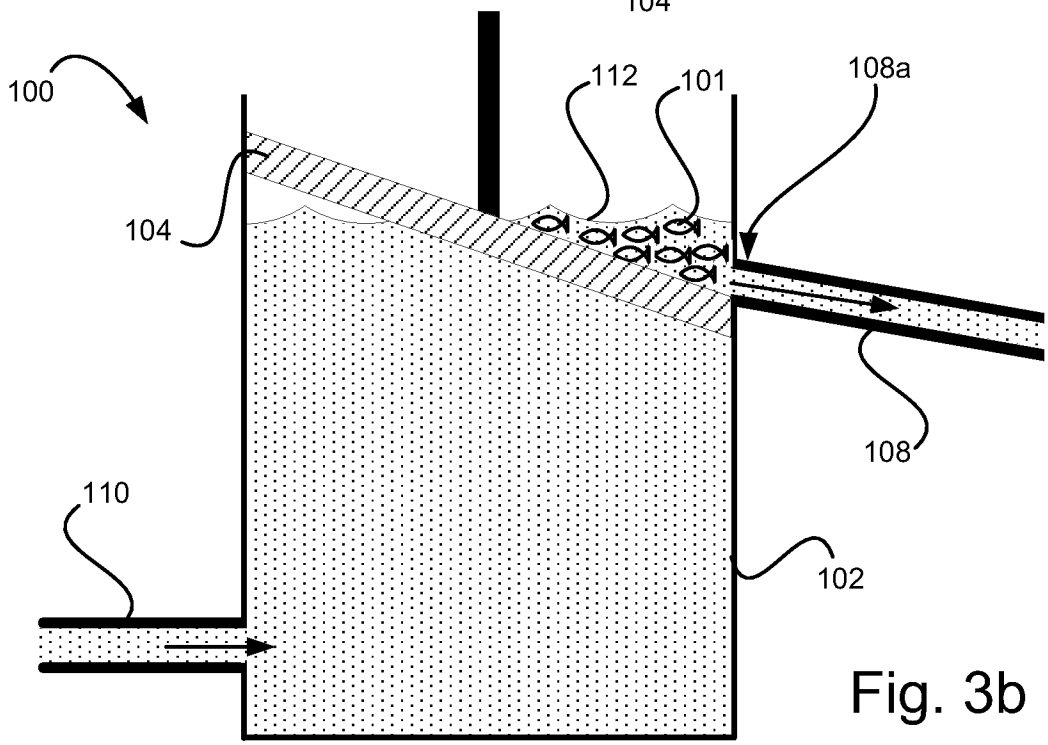
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Fig. 3b

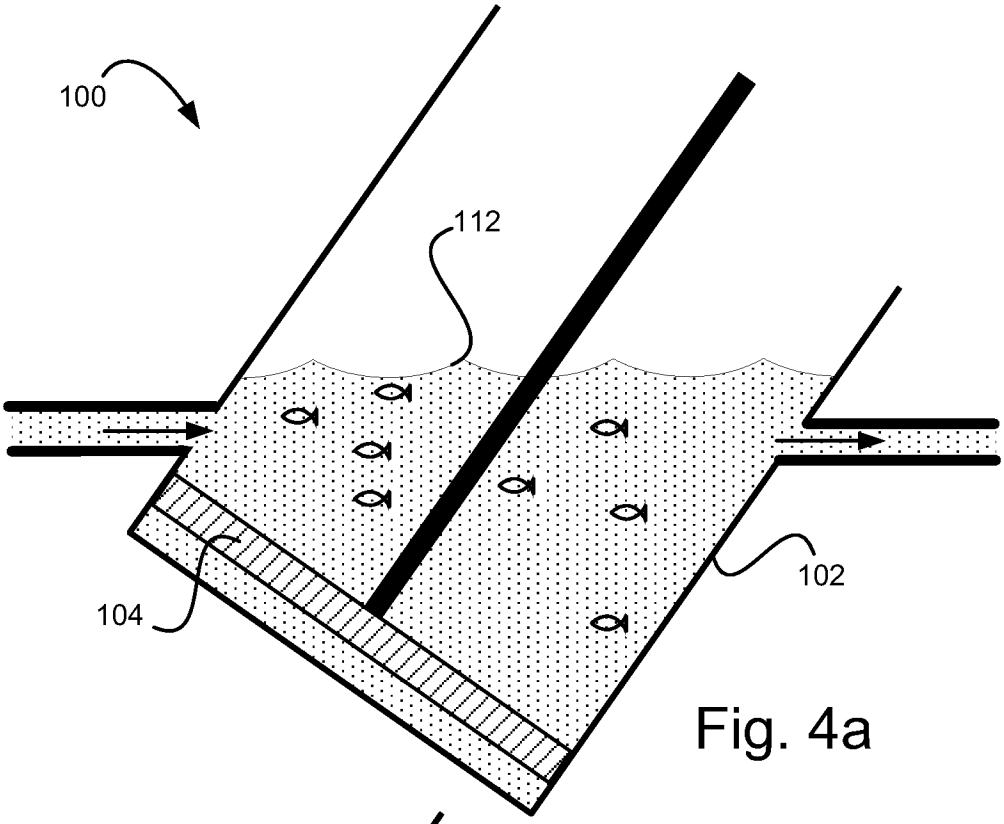

Fig. 4a

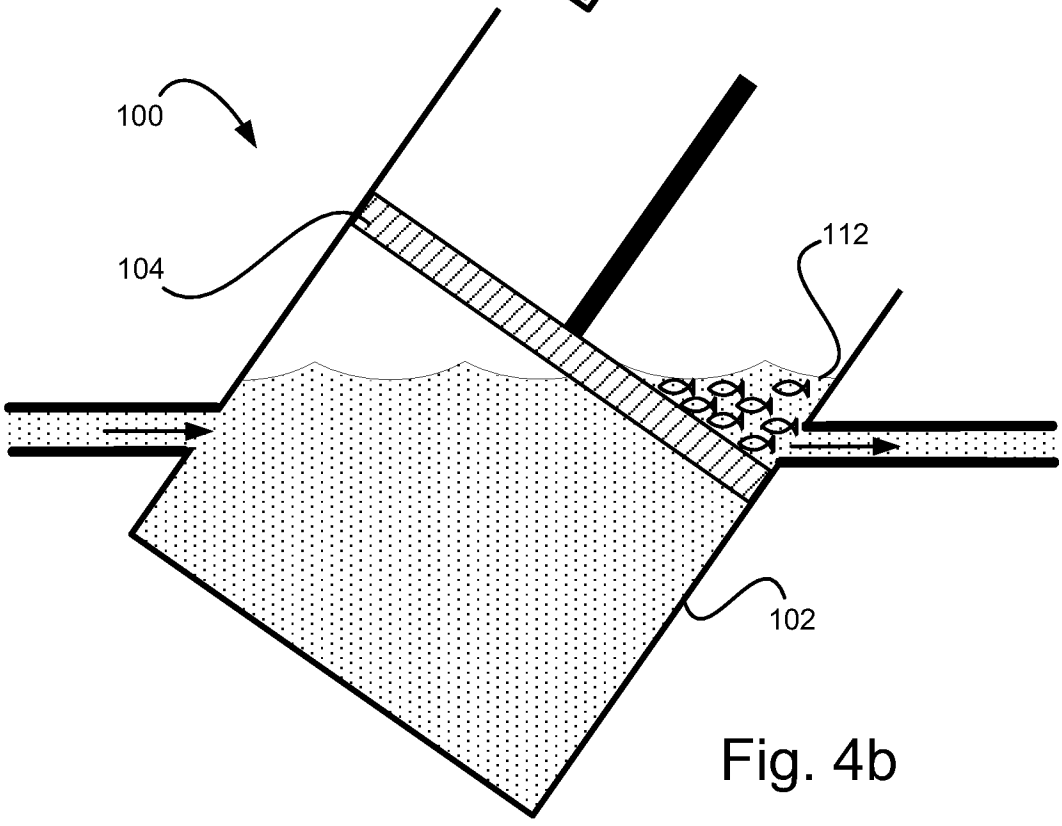

Fig. 4b

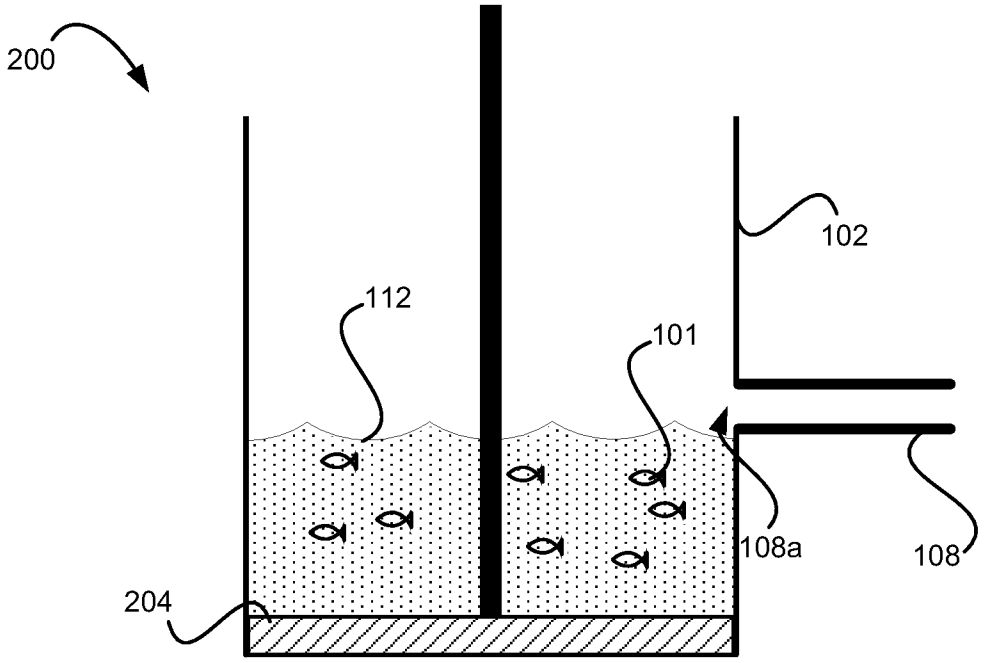

Fig. 5a

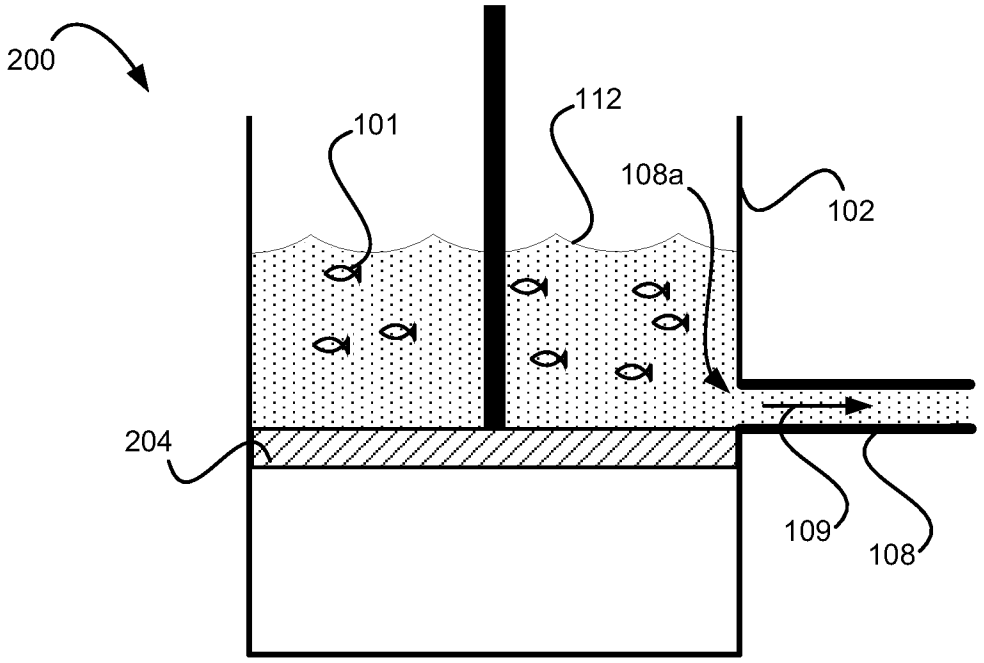

Fig. 5b

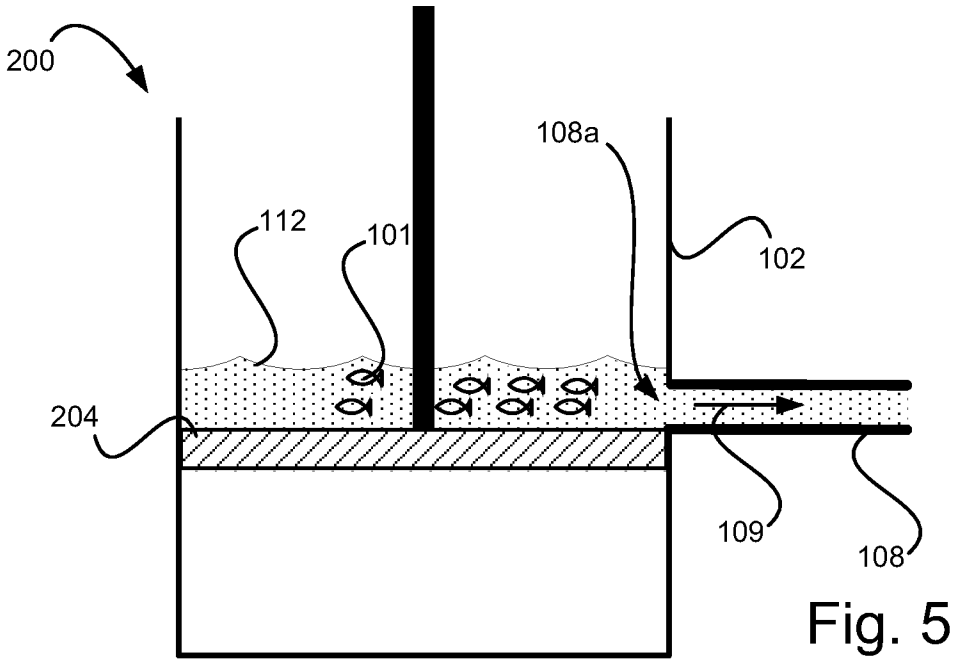

Fig. 5c

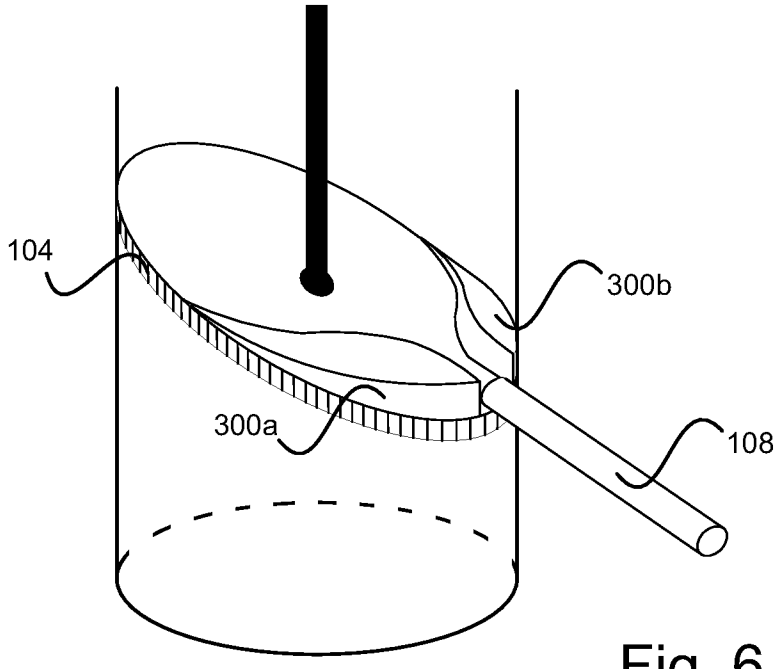

Fig. 6

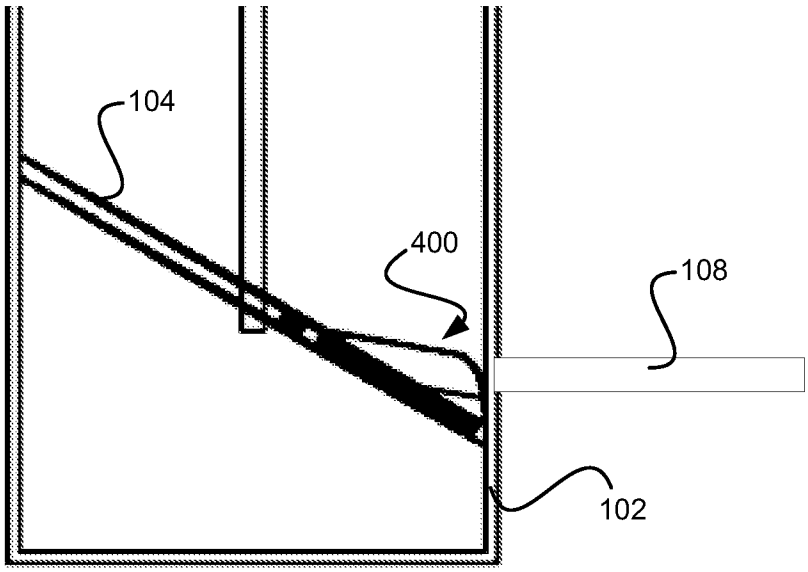

Fig. 7a

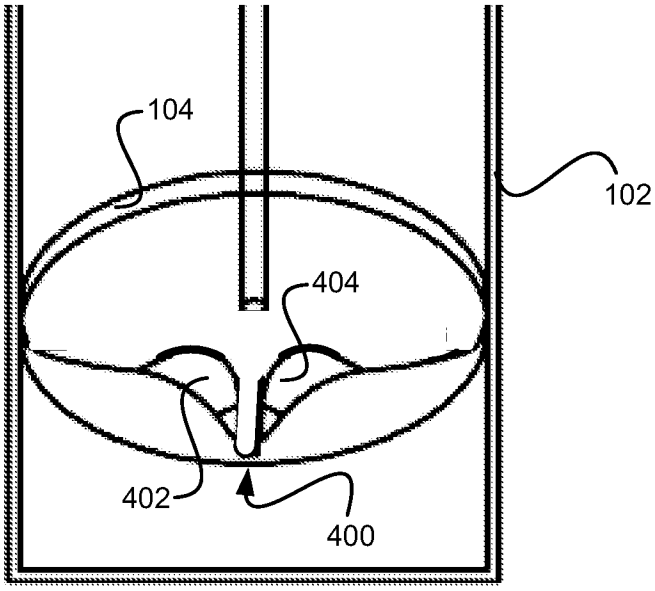

Fig. 7b

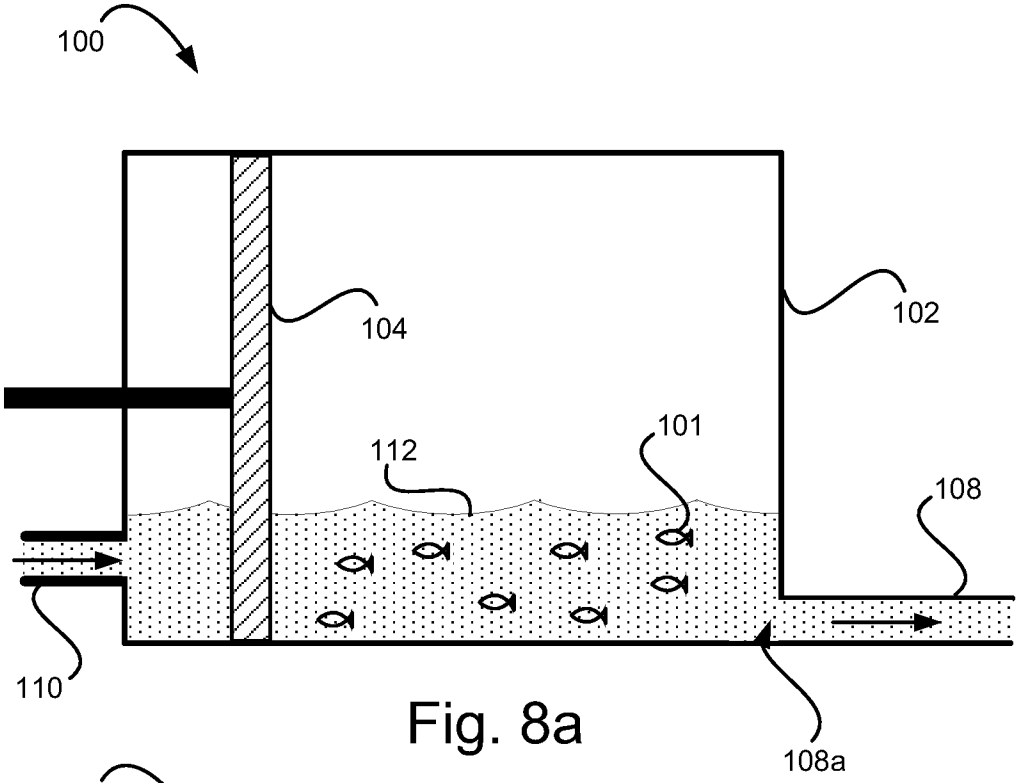
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Fig. 8a

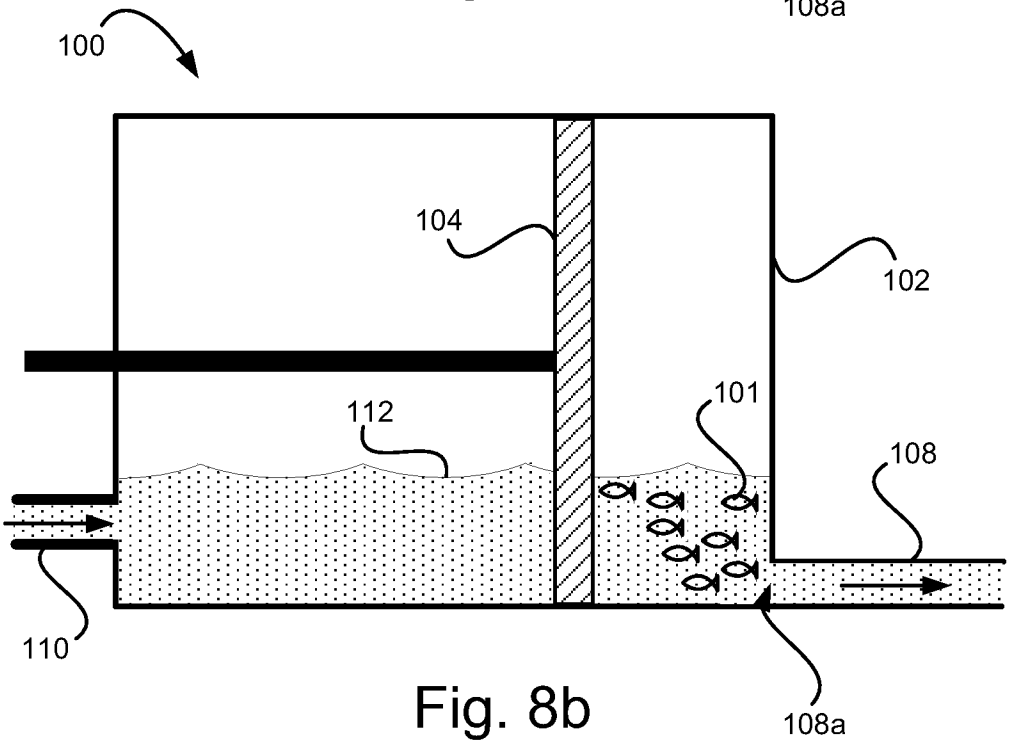
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Fig. 8b

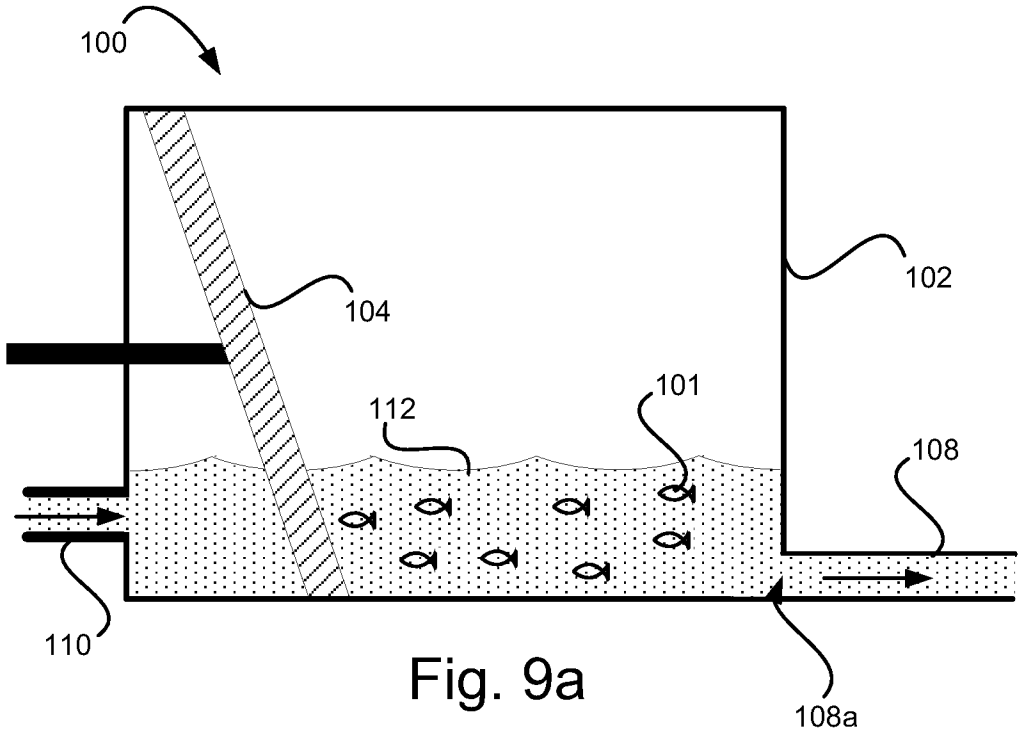
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Fig. 9a

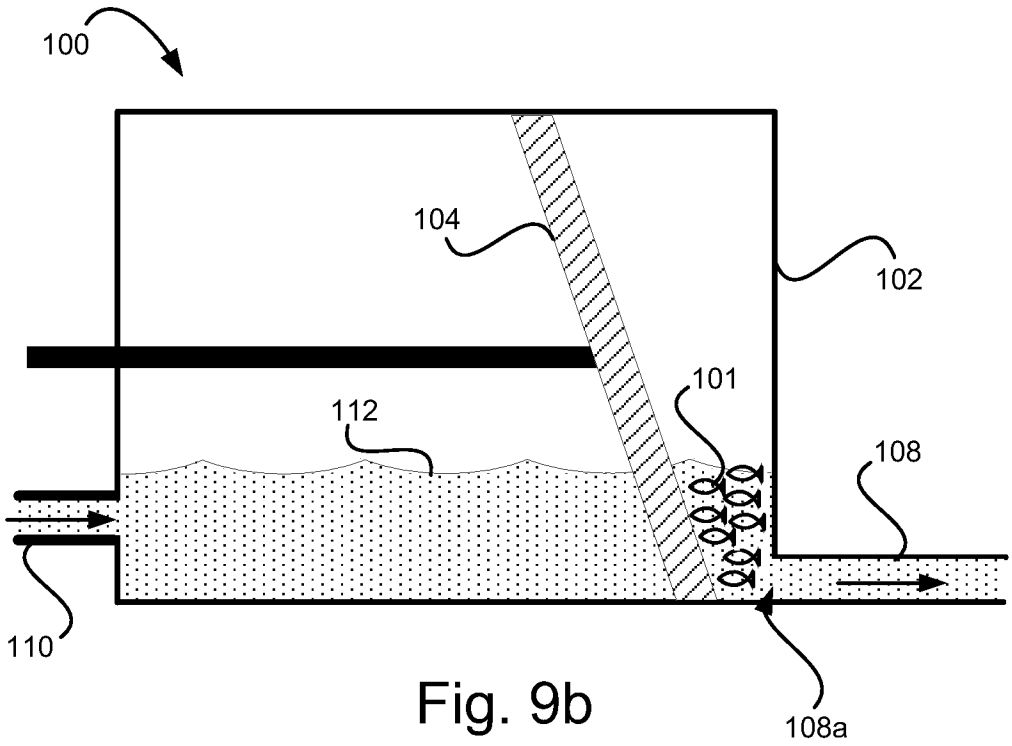
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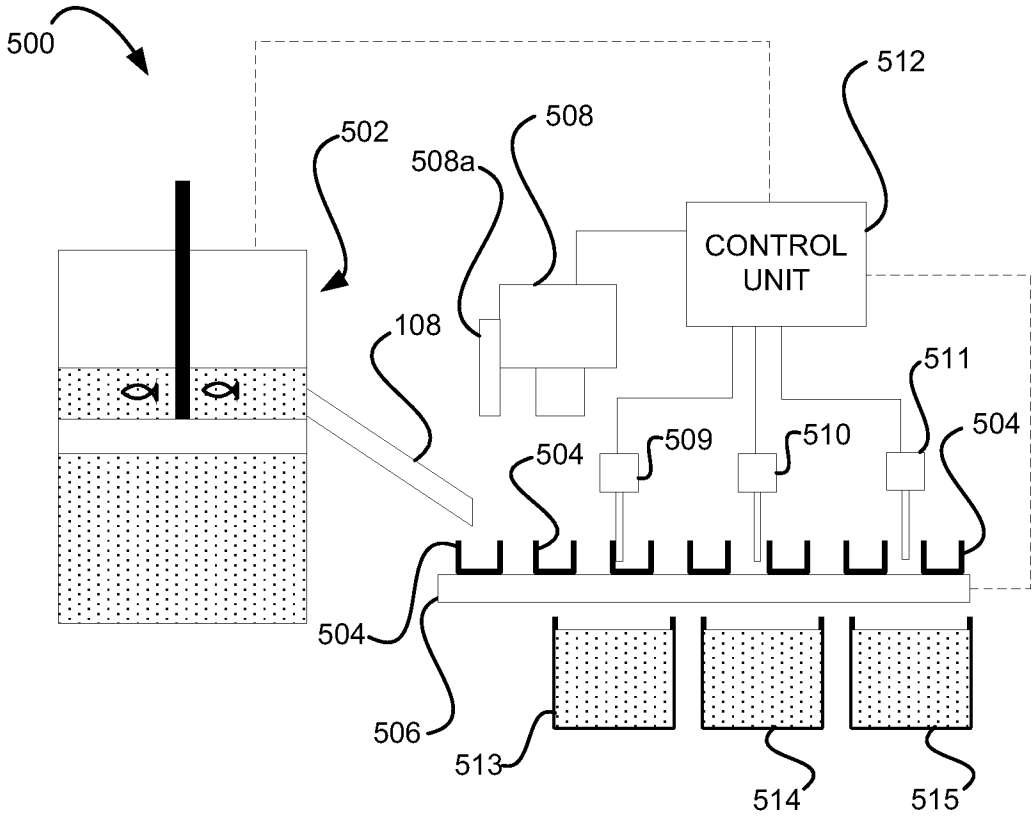
Fig. 9b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512
CONTROL UNIT
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Fig. 10

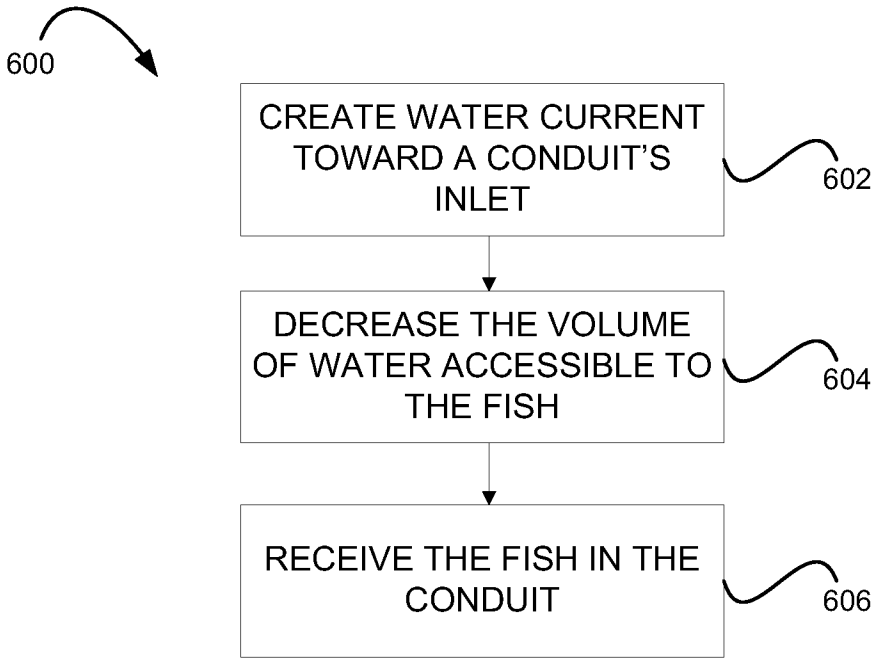
600
CREATE WATER CURRENT TOWARD A CONDUIT'S INLET
602
DECREASE THE VOLUME OF WATER ACCESSIBLE TO THE FISH
604
RECEIVE THE FISH IN THE CONDUIT
606

Fig. 11

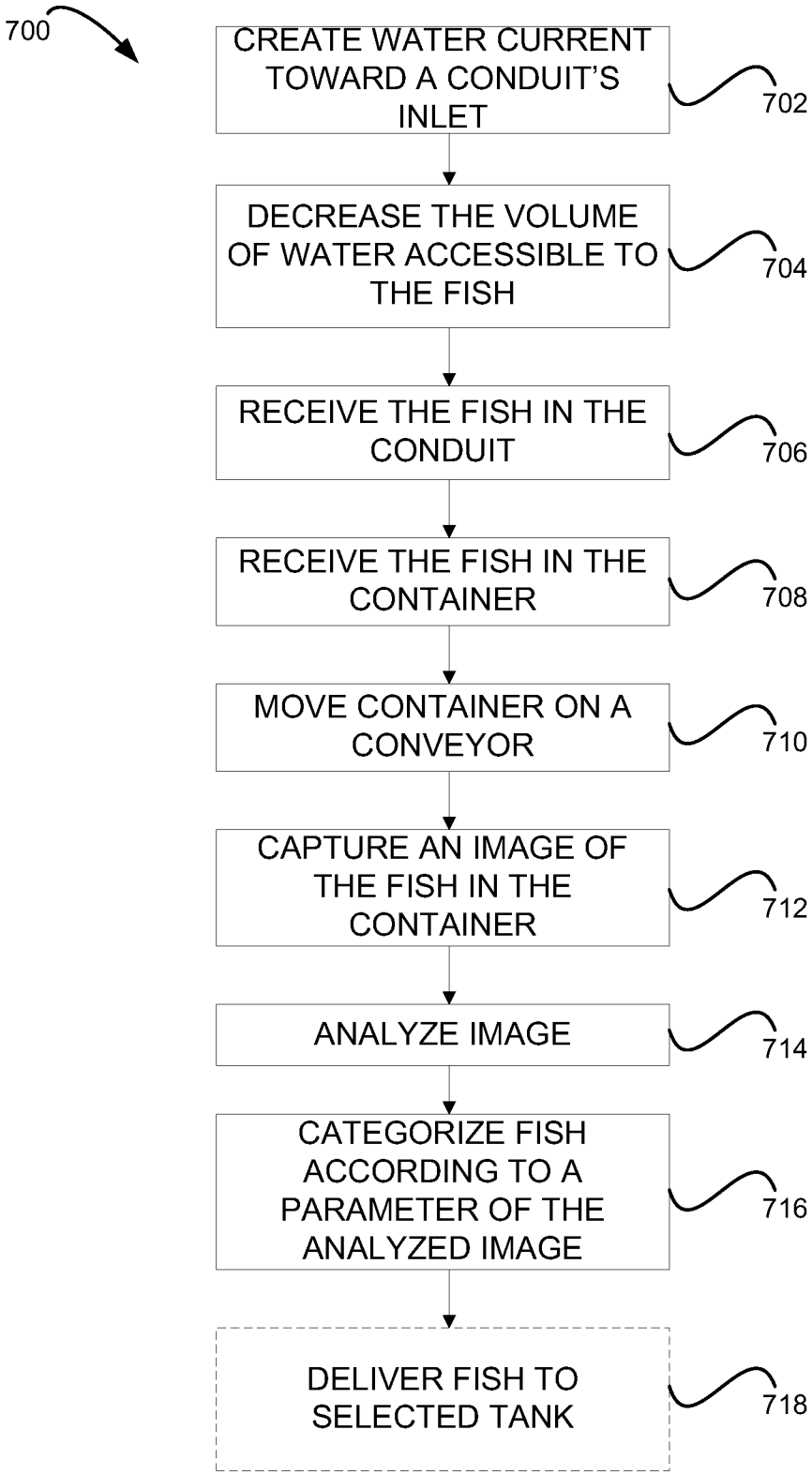
700
CREATE WATER CURRENT TOWARD A CONDUIT'S INLET
702
DECREASE THE VOLUME OF WATER ACCESSIBLE TO THE FISH
704
RECEIVE THE FISH IN THE CONDUIT
706
RECEIVE THE FISH IN THE CONTAINER
708
MOVE CONTAINER ON A CONVEYOR
710
CAPTURE AN IMAGE OF THE FISH IN THE CONTAINER
712
ANALYZE IMAGE
714
CATEGORIZE FISH ACCORDING TO A PARAMETER OF THE ANALYZED IMAGE
716
DELIVER FISH TO SELECTED TANK
718

Fig. 12