

FRESHWATER COLLECTOR

The present application relates to a freshwater collector. The application also relates to a cluster of freshwater collectors. This application further relates to methods for making, assembling, disassembling, installing, configuring, modifying, repairing, maintaining, upgrading, downgrading and using the freshwater collector or the cluster of freshwater collectors.

About one fifth of the world's population (about 1.4 billion people) currently live in regions affected by physical water scarcity, where there is no sufficient freshwater (i.e. fresh water) resource to meet a country's or regional demand. For example, Singapore has to adopt water reclamation (known as NEWater) and seawater desalination techniques to provide freshwater at about 750,000m³ (cubic meter) per day for supplementing the imported freshwater of 1,100,000m³ per day currently. High and continuously rising cost of labour, materials, fuels and environmental impact for reclaiming waste water and desalinating seawater have put pressure onto Singaporeans for obtaining adequate and steady supply of freshwater at reasonable cost. Worldwide, governments, institutions and individuals have been tirelessly searching for viable solutions to solve the problem of physical water scarcity.

The present invention aims to provide new and useful devices and methods for solving, or at least alleviating the above-mentioned problems. For example, the present application aims to provide a new and industrially useful freshwater collector or a cluster of freshwater collectors. The present invention also aims to provide new and useful methods of making, assembling, disassembling, installing, configuring, modifying, repairing, maintaining, upgrading, downgrading and using the freshwater collector or the cluster of freshwater collectors. Essential features of the invention(s) are provided by one or more independent claims, whilst advantageous features of the invention(s) are given by their dependent claims. The freshwater collector may alternatively be known as water collector, water catchment, water harvester, ambient water harvester, freshwater harvester, clean water collector, ambient water harvester, natural water harvester, clean water accumulator, freshwater gatherer or other similar terms.

The present application claims the priority date of Singapore patent application 2014013932 that was filed on 13 February 2014. All content or subject matter of this earlier Singapore patent application is hereby incorporated by reference.

5 According to a first aspect of the invention, the application provides a freshwater collector for collecting freshwater from the environment or ambient, such as rainwater, condensate water, dew water, snow water, ice water, lake water or river water. In contrast to seawater, these types of water do not contain, or has little dissolved salts or other chemical contaminates. Freshwater naturally occurs on the Earth's surface in
10 ice sheets, ice caps, glaciers, icebergs, bogs, ponds, lakes, rivers and streams, and underground as groundwater in aquifers and underground streams. Freshwater is generally known to have low concentrations of dissolved salts and other total dissolved solids. Accordingly, the freshwater may be alternatively termed as drinkable water.

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The freshwater collector comprises a pail for collecting the freshwater from ambient environment of the freshwater collector. The ambient environment includes sea, river, swimming pool, lake, mountain, sky, wind, moist, shop floor, and other neighbouring places that keep the freshwater collector. The freshwater collector further comprises
20 one or more floats or buoys connected to the pail directly or indirectly for supporting the pail partially or fully on or above a water body, such as sea, river, swimming pool or lake by buoyancy (force). The float or floats may alternatively be known as buoy or group(s) of buoys, which may be floating devices for providing buoyancy force. The pail may have an extended surface area for increasing its contact or collection area
25 with the environment. For example, the pail includes a plane that covers a large ground area.

The freshwater collector further comprises a tank for storing the freshwater. The tank may be separated or integrated with the pail such that the freshwater may be
30 collected from the ambient environment and further stored in the freshwater collector. The tank may comprise a hard or soft shell/ skin for adapting to different storing purposes. For example, the tank has a telescopic skin that is extendable to suit the amount freshwater stored inside. The tank may also be constructed by one or more materials of large ($>1\text{g/cm}^3$) or small ($>1\text{g/cm}^3$) mass density. When built with the

material of large mass density, the tank can sink into water, which makes the freshwater collector stable. If manufactured with small mass density, the water tank can possibly float on water when empty, making it easy for access by boat. When filled with freshwater, the tank may be fully or partially immersed in the water body
5 such that weight of the tank (including freshwater as collected) is supported by buoyancy or buoyance force, without overloading the floats.

The tank comprises a joint for joining, linking or connected the tank to the pail for draining the freshwater from the pail into the tank 34. Since the freshwater collector is intended for continuous or repeated use, emptying the pail facilitates subsequent
10 freshwater collection or continuous operation. If the joint is installed at a low or lowest position of the pail, the collected freshwater can flow to the joint under gravity, avoid deploying active driving means, such as blower, pump or other devices. In other words, the freshwater collector can collect the freshwater passively, without
15 consuming much electricity or fuel, or causing pollution.

Although rainwater harvesting is known for thousands of years, most known rainwater catchments are made for deployment on land. Accordingly, land conditions greatly affect the rainwater harvesting. Therefore, the known rainwater catchments are
20 typically used by single households individually in practice because they normally provide small amount of water for supplementing freshwater supply to individual households or farms. For example, a rainwater tank (rain barrel, water butt) is used to collect and store rainwater runoff from a rooftop of a house via rain gutters. In contrast, the present freshwater collector can be deployed on seas/oceans, rivers or lakes
25 whose surfaces are generally large, stable, flat and free from obstruction. Since these natural water surfaces are typically unoccupied by buildings or hills, the freshwater collector can collect freshwater from its ambient environment continuously without interruption. The otherwise unused or "wasted" (not utilised or non-productive) water surfaces provide large freshwater or rainwater collection areas for hosting the
30 freshwater collector.

When in use, the freshwater collector floats on seawater surface and the pail extends over the seawater surface. When raining, the pail provides a large area such that rainwater droplets are gathered by the pail and flow down to the tank via the joint.

The pail can comprise one or more slopes for guiding flow of the freshwater on the pail. Instead of being flat, the pail can provide slanted areas such that rainwater droplets can flow down the slopes under gravity gathering at the joint. The slopes may
5 be orientated in different directions or angles for water collection at different parts of the pail. By adopting the slopes, the freshwater collector does not have to involve active driving means (e.g. pumps, fans) for avoiding energy consumption or pollution.

The pail may comprise one or more rods at one or more edges of the pail. The one or
10 more rods uphold shape of the pail so that the pail can be extended in desired configuration/patterns or angles, similar to the holding of a kite's profile. The rod may be provided by light and inexpensive materials such that the freshwater collector can be constructed sturdily at low cost.

15 The one or more rods can be curved for enhancing stiffness of the one or more rods. A straight rod tends to sag under its own weight, which prevents the rod from holding a desired profile. In contrast, the same rod can uphold a rigid profile when curved. Curved rods not provide weight and cost savings, but also keep the desired profile over a prolonged period, reducing maintenance effort.

20 The pail may comprise one or more regular shapes (e.g. equilateral polygons). The regular shapes contain polygonal shapes, equilateral shapes and equiangular shapes, which may be tessellated. Known regular shapes include equilateral triangle, rectangle, equilateral rectangle, quadrilateral, pentagon, hexagon, octagon, and other
25 polygons with more edges (e.g. icosagon). The regular shapes are easy to construct at low cost. Of course, the pail with a circular or other curved profile also provides regular shapes. Edges of the circular or curved pail may be further supported by one or more rods, which are curved further (.e.g. having curls locally).

30 The pail can comprise one or more sheet materials for providing the one or more extended area. The sheet material is light and can be wrapped around a rod. When made with corrosion registrant and light-weight material, such as by Polyethylene, the one or more sheet materials can serve to collect the rainwater droplets over several years with reasonable reliability.

The pail may further comprise a filter for connecting to the water tank. The filter is usually provided at the lowest position of the pail such that collected rainwater droplets may flow through the filter, whilst foreign objects are prevented from
5 contaminating collected freshwater in the tank.

The filter can comprise a mesh for blocking debris. The mesh is a semi-permeable barrier made of connected strands of metal, fibre, or other flexible/ductile materials. The mesh is similar to a web or a net in that it has many attached or woven strands.
10 When made with stainless steel or polystyrene, the mesh can withstand corrosion from moisture or seawater such that the filter can reliably serve the freshwater collector for years without replacement.

The pail may further comprise one or more rim areas for forming an enclosure or
15 pocket. The rim areas are similar to skirt or apron which surrounds one or more edges of the pail. Since the pail is typically horizontally orientated and generally parallel to water surface below, the rim areas can be vertically positioned and connected to the edges of the pail, forming the enclosure below the pail. If extending the rim areas to be close to the water surface below, the pail and the rim areas generally form a cap
20 on the water surface. Alternatively speaking, the freshwater collector thus resembles a bowl being upside down.

The enclosure on seawater surface can have a different temperature as compared to surroundings of the freshwater collector. When the pail and the rim areas are made
25 with transparent material(s), sunlight tends to heat up air trapped inside the enclosure such that seawater under the freshwater collector evaporates. Evaporated seawater becomes freshwater vapour (free from saline) and condenses at an underside of the pail because the pail is constantly being cooled down by passing wind. Together with the rainwater, the condensed water (i.e. condensate liquid) is further collected by the
30 water tank. Similarly, dew droplets that are collected on the pail in the mornings or evenings are again gathered by the pail for storage in the tank.

The freshwater collector may further comprise one or more connectors for connecting the pail to other pails or freshwater collectors, which may or may not be similar to the

disclosed freshwater collector. The one or more connectors provide anchor(s) for locking position of the freshwater collector. Accordingly, in storm or windy seasons, the freshwater collector will be secured at designated location, and its connection (e.g. water piping) or structure will not be detracted.

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The one or more floats can be connected to one or more edges of the pail. In other words, the floats are removed from a centre of the freshwater collector such that the water tank below has more room for expansion, being able to store more freshwater.

- 10 The one or more floats may comprise one or more poles detachably joined to one or more floaters (buoyancy objects). The one or more poles may be convenient welded or screw-tighten to the freshwater collector such that the freshwater collector is held on sea or river surface. The one or more floaters or floats may be varied or adjustable in size/buoyancy force for supporting freshwater collectors of diverse sizes.

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The tank can comprise one or more expandable balloons that are formed by thin skins respectively for storing the freshwater inside. Since the thin skin can be flexible and extendable, the tank can expand according to the amount of freshwater stored. The tank or balloon(s) may be partially or fully immersed inside its surrounding water body (e.g. seawater or river) such that buoyancy force from the water body holds the flexible water tank steadily and further keeps water tank/balloon cool (avoiding unnecessary evaporation). In other words, collected freshwater is stored in the surrounding sea/river/lake water such that the pail is not affected by the amount of freshwater stored.

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The balloon may comprise a core cylinder connected to opposite ends of the balloon for supporting the balloon. The core cylinder may have a diameter of about 30mm (millimetre) and a length of about 165mm, which determines a length of the balloon. The core cylinder may have screw threads at its opposite ends such the tank or
30 balloon can be detachably joined to external water hoses, such as to the joint.

The core cylinder can comprise a perforated exterior area/surface for permitting fluid communication inside balloon via an internal passage of the core cylinder. Since the balloon can be made of thin film, the thin film can collapse and crumbled together

under suction force (e.g. pumping freshwater away from the tank). The perforated core cylinder allows almost all freshwater of the tank to be depleted without interference from collapsed think film for blocking suction passage.

- 5 The core cylinder may comprise a net, mesh or gauze in forming the perforated area or surface. For example, a cylindrical wall of the core cylinder is formed by a stainless steel screen mesh such that the core cylinder is both robust and corrosion resistant. The core cylinder of net, mesh or screen mesh can be made at low cost.
- 10 The tank can further comprise a funnel whose end connects the tank to the pail. The funnel can further have a mouth of conical or other profiled shapes that matches a lower end of the pail. The funnel can divert freshwater from a large area (e.g. pail) to a narrow orifice at the tank. The tank can be further detachably connected to the pail, other parts of the tank or both such that the funnel can be easily maintained.

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The tank may further comprise a stem that is connected to a top side of the pail for guiding the freshwater from the top side into the tank. The stem may looks like a tube for acting as a conduit and discharging freshwater from the pail. The stem further provides a strong structure for rigidly connecting the tank to the pail, making the

20 freshwater collector a sturdy assembly.

The tank can comprise a tube that is connected to an underside of the pail for guiding the freshwater from the underside into the tank. The underside is one or more surface areas that face the water body (sea, lake or river) below the pail. In contrast, an upper

25 side denotes one or more surface areas facing the sky when positioning the freshwater collector on a lake for rainwater droplets collection. The tube provides an entrance for water collected at the underside for entering the tank.

The stem and the tube may enclose each other either partially or wholly and have a

30 gap in-between them. The gap provides the entrance of freshwater from the underside of the pail for entering the tank. Accordingly, the freshwater collected from both the upper and under side are channelled to the same water tank. The upper or top side the pail can collect rainwater or dew water, whilst the underside of the pail can collect condensate or dew water.

The funnel can comprise an extended mouth connected to the pail, whilst the funnel comprises the stem, the tube or both. The funnel thus provides the joint between the pail and other components of the water tank. Since the funnel can be produced with
5 good mechanical strength or corrosion resistance at low cost (e.g. by stainless sheet material), the freshwater collector has robust structure for long-term operation with reliability.

The freshwater collector may further comprise a pot that further comprises the pail,
10 the one or more floats and the tank. The joint is connected to the pot for draining the freshwater (e.g. condensate, dew-water or rainwater) from the pot. The joint can be open or shut off when necessary. Alternatively speaking, the pail, the floats and the tank may be integrated as a single piece, whilst the pot has an orifice discharging water from the tank, preferably at the lowest place of the pot. For example, the pot
15 has a water hose connector (hose connector) at bottom such that collected rainwater is drained from the pot continuously for keeping the pot afloat.

The freshwater collector can further comprise a cap connected to a rim of the pot for covering the pot. The cap can alternatively be termed as a covering sheet, which may
20 be transparent or reflective. Hence, the freshwater collector has a canopy that prevents evaporation of collected water in the pot. When made reflective, the cap rejects sunlight for reducing evaporation of the collected water.

The freshwater collector may further comprise a filter for preventing debris from
25 entering the pot. The filter mainly stops debris from mixing with the collected freshwater. The filter may alternatively remove particles when rainwater passing through the filter.

The filter can be connected to a low position of the cap, at the joint, or both. Preferably,
30 the cap is made of thin film that sags at its centre. The filter can be fixed to the centre such that solid foreign objects are blocked outside the pot.

The freshwater collector may further comprise a water hose joint for connecting the freshwater collector directly or indirectly to a pump. The water hoses joint (hose

connector) is preferably located at the lowest position of the tank such that collected freshwater flows to the water hose joint under gravity, without using much external force.

- 5 The water hose joint can be connected to the core cylinder for draining. Since the core cylinder provides a rigid passage for water flow, collapsing of the balloon cannot block water flow inside the core cylinder. Accordingly, collected freshwater can be completely drained through the water hose joint.
- 10 The water hose joint may comprise a multiway joint (e.g. 4-way hose connector) so that the freshwater collector may be connected to multiple freshwater collectors or pumps. The multiway joint facilitates fluid communication with multiple water tanks, either from a single freshwater collector or several freshwater collectors.
- 15 Two or more components of the freshwater collector can have screw threads for detachably constructing the freshwater collector. As compared to other fasteners, the freshwater collector can be assembled without using any tools if the screw threads are used for joining the components. The freshwater collector thus can be assembled by hands onsite, making its convenient for installation.
- 20 The freshwater collector may further comprise a non-return valve connected to the pail for draining excess freshwater away from the pail. The non-return may take diverse forms, and also known as check valve, clack valve or one-way valve. For example, the non-return valve may be in the form of a channel that is connected to
- 25 the pail at a predetermined height such that excess freshwater above the channel will be drained away or removed from the pail by gravity.

The present application also provides a cluster of freshwater collectors that comprises two or more of the freshwater collectors. The two or more of the freshwater collectors

30 are connected to each other by one or more of the connectors for covering a water surface larger than that of a single freshwater collector. The freshwater collectors can be joined together at their pails and tanks such that a substantially large water body may be covered by the freshwater collector for collecting rainwater, dew water and condensate water. Since Singapore has an annual rainfall of about 2,500mm, the

cluster can cover an area of 4km^2 that collects rainwater of about $10,000,000\text{m}^3$ per year, which is about 3.65% of the total annual water supply in Singapore in year 2013. In other words, a cluster that covers 110km^2 (i.e. $10.5\text{km} \times 10.5\text{km}$) can possibly supply all freshwater currently required by Singapore. The freshwater may be increased by adding dew water and condensate water.

One of more of the water hose joints of the cluster may be connected to a pump for draining the freshwater. Accordingly, freshwater gathered by multiple freshwater collectors may be collectively drained by the by the pump for transporting to a water treatment nearby. The cluster thus provides an unlimited supply of fresh water.

According to another aspect of the invention, the present application provides a method for collecting freshwater. The method comprises a first step of providing a pail, a second step of supporting the pail on a water body by buoyancy, and a third step of collecting the freshwater into a tank, whilst the tank is connected to the pail. The method may further comprise a step of immersing the tank fully or partially in the water body for supporting. The method can additionally comprise a step of discharging the freshwater from the pail, the tank or both.

The accompanying figures (Figs.) illustrate embodiments of the inventions and serve to explain principles of these embodiments. It is to be understood, however, that these figures are presented for purposes of illustration only, and not for defining limits of relevant inventions.

- Fig. 1 illustrates a perspective view of a first freshwater collector;
- Fig. 2 illustrates a connector of the first freshwater collector;
- Fig. 3 illustrates a non-return valve of the first freshwater collector;
- Fig. 4 illustrates a first cluster of freshwater collectors;
- Fig. 5 illustrates a second cluster of freshwater collectors;
- Fig. 6 illustrates a front view of a third freshwater collector;
- Fig. 7 illustrates a third cluster of freshwater collectors; and
- Fig. 8 illustrates a front view of a fourth freshwater collector.

Exemplary, non-limiting embodiments of the present application will now be described with references to the above-mentioned figures.

Figs. 1 to 3 relate to a first embodiment of the invention. In particular, Fig. 1 illustrates a perspective view of a first freshwater collector 30. The first freshwater collector 30 comprises a pail 32, a tank 34, four floats 36-42 and four pail connectors 44-50. The pail 32 has a substantially square profile whose four corners are supported by the four floats. The four connectors are further joined to the four floats at the four corners respectively. In contrast, the tank is linked to a centre of the pail. For the convenience of illustration, a Cartesian coordinate has been shown in Fig. 1, which is further labelled with direction indications of left (L) as negative Y-axis, right (R) as positive Y-axis, front (F) as positive X-axis, hind (H) as negative X-axis, top (T) as positive Z-axis and bottom (B) as negative Z-axis. Accordingly, terminologies of relevant orientation in relevant description for all figures may be changed depending relative directions with respect to each other.

The pail 32 comprises a transparent sheet 52, four curved rods 54-60 and a mesh 62. The transparent sheet 52 is made of polyethylene, which is also known as polythene. The four curved rods consist of a first curved rod 54, a second curved rod 56, a third curved rod 58 and a fourth curved rod 60, which are joined together end-to-end. Each of the four curved rods 54-60 bulges towards the top. The transparent sheet 52 wraps over the four curved rods 54-60 tightly such that the transparent sheet 52 is divided into four regions 64-70. The four regions 64-70 are a first region 64, a second region 66, a third region 68 and a fourth region 70. Each of the four regions 64-70 is further separated into two areas 72-78, 80-86. In detail, the first region 64 consists of a first pail area 72 and a first rim area 80 that are divided by the first curved rod 54. Similarly, the second region 66 consists of a second pail area 74 and a second rim area 82 that are divided by the second curved rod 56. A third pail area 76 and a third rim area 84 are joined at the third curved rod 58, whilst a fourth pail area 78 and a fourth rim area 86 meet at the fourth curved rod 60. The mesh 62 is attached to the pail 32 at a geometrical centre of the pail 32. The mesh 62 is made of stainless steel wires that are woven together for passing thorough water and blocking debris. Joints 88-94 of the neighbouring pan areas 72-78 mark valleys that are low portions for guiding water flow to the mesh 62. A first joint 88 connects the fourth pan area 78 to the first pan area 72. A second joint 90 links the first pan area 72 to the second pan area 74. A third joint 92 ties the second pan area 74 to the third pan area 76 and a fourth joint 94

bonds the third pan area 76 to the fourth pan area 78. The four pan areas 72-78 provide an extended coverage horizontally such that the four pan areas 72-78 open towards the top (i.e. normal direction of the planar surface substantially pointing in the positive Z-axis). In contrast, the four rim areas 80-86 which extend from the curved rods 54-60 respectively are substantially perpendicular to the extended coverage. Each of the four rim areas 80-86 is parallel to a vertical direction (along Z-axis) such that the four rim areas 80-86 and the four pan areas 72-78 form a cap, which provides an enclosure 81 below the pail 32.

The tank 34 is connected to the mesh 62 below. The tank 34 comprises a funnel 96 (see Fig. 2), a balloon 98, a core cylinder 100 and a cross joint 102. The funnel 96, the core cylinder 100 and the cross joint 102 are sequentially connected together from top to bottom, whilst two ends of the balloon 98 wraps around the funnel 96 and the cross joint 102 respectively.

Referring to Fig. 2, the funnel 96 comprises a conical mouth 104, a stem 106 and a tube 108 that are fixed together. Particularly, the stem 106 is a cylindrical pipe that is directly connected to a narrow and bottom end of the conical mouth 104. In contrast, an internal diameter of the tube 108 is larger than an exterior diameter of the stem 106 such that the tube 108 encloses the stem 106, and further keeps a gap 107 between stem 106 and the tube 108.

The core cylinder 100 is connected to a bottom end of the tube 108 by screw threads (not shown), but detached from the stem 106. The core cylinder 100 is hollow and punctured over its length substantially such that the core cylinder 100 permits fluid communication between its interior and exterior through its cylindrical wall. In other words, the core cylinder 100 has a perforated surface 101, which may be formed by wire mesh(s) 101 or holes.

The cross joint 102 comprises three conduits, which include a first conduit 110 and two horizontally-aligned conduits 112,114 (i.e. second and third conduits). The first conduit 110 has a top end 116 and a bottom end 116 at opposing sides. The top end 116 is united to a lower/bottom end of the core cylinder 100 by screw threads. The second and third conduits 112,114 intersect each other perpendicularly, and their

intersection is further connected to the bottom end 116 of the vertically-aligned first conduit 110. Consequently, the three conduits 110, 112, 114 are all connected to the funnel 96 for fluid communication.

- 5 The balloon 98 is formed by a thin plastic film (known as skin) 99, which is transparent and made from polyethylene. The balloon 98 is inflatable such that the balloon 98 can be expanded for holding large amount of water inside. A top/first end 116 of the balloon 98 is fused to an exterior surface of the tube 108, whilst a bottom/second end 118 of the balloon 98 is united with an exterior surface of the first
10 conduit 110. Lower portion of the balloon 98 is partially filled with freshwater 119.

The four floats 36-42 are formed by four poles 120-126 and four floaters 128-134 respectively. Referring to Fig. 1, a first float 36 comprises a first pole 120 that is inserted into a first floater 128. An upper portion of the first pole 120 is exposed
15 outside the first floater 128 such that a top end of the first pole 120 is fused to two ends of the fourth curved rod 60 and the first curved rod 54. Similarly, a second float 38 comprises a second pole 122 that is inserted into a second floater 130. An upper portion of the second pole 122 is exposed outside the second floater 130 such that a top end of the second pole 122 is fused to two ends of the first curved rod 54 and the
20 second curved rod 56. Likewise, a third float 40 comprises a third pole 124 that is inserted into a third floater 132. An upper portion of the third pole 124 is exposed outside the third floater 132 such that a top end of the third pole 124 is fused to two ends of the second curved rod 56 and the third curved rod 58. Also, a fourth float 42 comprises a fourth pole 126 that is inserted into a fourth floater 134. An upper portion
25 of the fourth pole 126 is exposed outside a fourth floater 134 such that a top end of the fourth pole 126 is fused to two ends of the third curved rod 58 and the fourth curved rod 60. All these floaters 128-134 are made of styrene foam (i.e. Styrofoam), whilst all poles are made of stainless steel. As shown in Fig. 1, the four floaters 128-134 are partially immersed into sea water 136.

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The four pail connectors 44-50 are located at four corners of the pail 32. The four top ends of the poles 120-126 are further bonded to the four pail connectors 44-50 respectively. In other words, the four pail connectors 44-50 consist of a first pail connector 44 connected to the first pole 120, a second pail connector 46 connected to

the second pole 122, a third pail connector 48 connected to the third pole 124 and a fourth pail connector 50 connected to the fourth pole 126.

Both Figs. 1 & 2 show rainwater droplets 138 that reside on a top side 140 of the pail 32. The top side 140 includes the four pan areas 72-78. Condensate droplets 142 are attached an under/bottom side 144 of the pail 32. However, both the rainwater droplets 138 and the condensate droplets 142 are collected inside the balloon 98 as the freshwater 119.

Functionally speaking, the pail 32 resembles a funnel that can collect water with a wide area. The four curved rods 54-60 raises edges of the pail 32 such that collected water can flow to a central portion of the pail 32 under gravity. The four curved rods 54-60 further exert tension to the transparent plastic sheet 32 so that the pail 32 has a smooth and extended skin, facilitating water flowing to the central portion, which has the mesh 62. Accordingly, the four regions 64-70 of the pail 32 provide an opening mouth that can collect rain water from above. The mesh 62 prevents solid particles (e.g. debris) from entering the balloon 98 below. The balloon 98 serves as an inflatable or collapsible water container, which itself is partially immersed into the seawater 136. Since freshwater is stored inside the balloon 98, the balloon 98 further displaces surrounding fluid (e.g. seawater), and is supported by the surrounding fluid (e.g. seawater). Since the upper end 103 of the balloon 98 is tightly joined to the mesh 62 via the funnel 96, the rainwater droplets 138 can be collected and diverted into the balloon 98 via the stem 106. In contrast, condensate droplets 142 move along the underside 144, may be further collected by the tube 108 into the balloon 98. The core cylinder 100 sets collapsing limit to the balloon 98 such that thin skin of the balloon 98 cannot restrict fluid communication inside the balloon 98 when collapsed. Since the pail 32 also has four rim areas 80-86 enclosing lateral sides of the pail 32, the pail 32 form the enclosure 81 under the four pan areas 72-78. The floats 36-42 mainly provide support to the first freshwater collector 30 due to their buoyancy force. The span connectors 44-50 are anchor positions that facilitate connections to neighbouring objects of the first freshwater collector 30, such as other freshwater collectors.

Many parts of the first freshwater collector 30 may be replaced by other components or materials for performing similar functions. For example, the floats 36-42 may be made of hermetic stainless steel cylinders or glass floats or other devices that provide buoyancy force.

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In use, the first freshwater collector 30 is deployed offshore, but near coastline, floating on sea surface. The four floats 36-42 uphold the pail 32 such that the four pan areas 72-78 provides a large area, opening towards sky. The four rim areas 80-86 enclose lateral sides of the first freshwater collector 30 such that an enclosed space is formed by seawater 136 and the four rim areas 80-86. In the meantime, the balloon 98 is extended into the seawater 136 by the core cylinder 100 such that openings of the cross joint 102 can be joined to a pump (not shown). When raining, the rainwater droplets 138 are collected by the four pan areas 72-78, and are further accumulated at the balloon 98 via the mesh 62. On sunny days, sunlight shines onto the seawater 136 which causes evaporation of seawater 136. Since four rim areas 80-86, seawater surface below the pail 32 and the four pan areas 72-78 provide a greenhouse or glassroom, vapour of the seawater 136 condenses at the underside 144 of the pail 32. The condensate (condensed water vapour) congregates, forms the condensate water droplets 142, flow to the funnel 96 and are gathered at the balloon 98 below. The four pan areas 72-78 further collect dew 79 at its underside or upper side in the mornings or evenings when using the first freshwater collector 30. The dew 79 is again amassed by the balloon 98 immersed in the seawater 136.

When making the first freshwater collector 30, on one hand, the four curved rods 54-60 are moulded separately according to a smooth plane curve. The four curved rods 54-60 are made of expanded polypropylene (EPP) having a diameter of 12mm (millimetres) respectively. Ends of the four curved rods 54-60 are fused together via four couplings (not shown) respectively such that planes of the four curved rods 54-60 are perpendicular to their common base surface, which is determined by the span connectors 44-50. The transparent sheet 52 is wrapped over the four curved rods 54-60, thereby providing the pail 32. Centre of the pail 32 is punctured in forming a circular hole such that both the stem 106 and the tube 108 can pass through the hole for attaching the conical mouth 104 onto the pail 32.

On the other hand, the opposite ends of the thin plastic film are wrapped around opposing ends of the core cylinder 100 in forming the balloon 98. The balloon 98 has two orifices at the opposing ends for accessing exterior of the balloon 98. External surfaces of the two opposing ends have two screw threads (not shown) respectively.

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When assembling, the four poles 120-126 are inserted into the four couplings from a same/bottom side of the pail 32 respectively. A top end 109 of the core cylinder 100 is screw-tightened to the tube 108, whilst a bottom end 111 of the core cylinder 100 is further screw-tightened to a top end of the cross joint 102. Other openings of the cross joint 102 may be sealed off, or connected to other cross joints of neighbouring freshwater collectors.

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Fig. 3 relates illustrates a non-return valve 146 of the first freshwater collector 30. The non-return valve 146 comprises a valve membrane 148 with four sides that are attached below the transparent sheet 52 at four regions 64, 66, 68, 70 respectively. The valve membrane 148 is fixed at the four joints 88, 90, 92, 94 (rims or edges) of the transparent sheet 52 such that they 52, 148 become unitary. Referring to Fig. 3, the transparent sheet 52 and the valve membrane 148 are detached and have overlap areas at the four regions 64, 68 such that the transparent sheet 52 and the valve membrane 148 provide two slits (gaps or openings) 149 at the two regions 64, 66, 68, 70 respectively. The slits 149 are exaggerated in Fig. 3 for clarity of illustration. At bottom, the valve membrane 148 is connected to the tank 34 and the mesh 62. The structural arrangement of the transparent sheet 52 and the valve membrane 148 offer the non-return valve such that the excess freshwater (e.g. rainwater) can be drained from the slits 149 in order to prevent sinking of the first freshwater collector 30. In normal usage of freshwater collection, whereby the tank 34 still has room for storing rainwater 138, rainwater droplets 138 tend to slide down slopes 64, 66, 68, 70 of the pail 32 without leaking through the slits 149. However, if the tank 34 is full or blocked, excess rainwater 138 can be discharged from the non-return valve 146 via the slits 149, preventing overburdening or sinking of the first freshwater collector 30.

Fig. 4 relates to a second embodiment of the invention. The second embodiment comprises parts or method steps that are similar or identical to those of other embodiments. The similar parts or method steps are labelled by comparable or

identical reference numerals. Accordingly, description of the similar or identical parts or method steps is hereby incorporated by reference or the relevant reference numerals.

5 Specifically, Fig. 4 illustrates a first cluster 150 of freshwater collectors, which are similar to the first freshwater collector 30. The first cluster 150 comprises the first freshwater collector 30, a second freshwater collector 152, a third freshwater collector 154 and other freshwater collectors (not shown), which are linked together. Particularly, the fourth span connector 50 is connected to a span connector 156 of the
 10 second freshwater collector 30, whilst the third span connector 48 is connected to another span connector 158 of the second freshwater collector 152. Similarly, the other span connector 158 is connected to a span connector 160 of the third freshwater collector 154, whilst a further span connector 164 of the second freshwater collector 152 is joined to another span connector 166 of the third freshwater collector
 15 166. The third span connector 48 is linked to both the span connector 158 of the second freshwater collector 152, and the span connector 160 of the third freshwater collector 154. According to Fig. 4, more freshwater collectors (not shown) are connected to third freshwater collector 154 and the first freshwater collector 30 via their span connectors in their lateral directions 162,164 (i.e. along Y-axis) respectively.
 20 In a similar fashion, additional freshwater collectors (not shown) are connected to the first freshwater collector 30 and the third freshwater collector 154 in their longitudinal directions 166,168 (along X-axis). Below seawater surface, the cross joint 102 is connected to cross joints 170 of other freshwater collectors 152,154. All cross joints 102,152,154 are coupled together by water hoses, which are further joined to a pump
 25 172 and a water treatment plant 174. Accordingly, the first cluster 150 of freshwater collectors 30,152,154 includes a large quantity, which covers a seawater surface area of about 4km² (four square kilometres).

30 When in use, the freshwater collectors 30,152,154 of the first cluster 150 are deployed near seacoast, Floats of the first cluster 150 support their respective freshwater collectors 30,152,154 such that pails 32 of the first cluster 150 drift above the seawater surface 136. In rainy days, the first cluster 150 collects rainwater droplets 138 by top sides 140 of their pails 32 such that the rainwater droplets 138 are gathered by their balloons 98, and further transported to the water treatment plant 174

by the pump 172. In sunny days, undersides 144 of the pails 32 of the first cluster 150 accumulate condensate droplets 142 because seawater surface is heated up by sunlight, which projects onto the seawater surface through transparent sheets 52 of the pails 32. Hot air under the pails 32 is trapped by rim areas 80-86 of the freshwater collectors 30 respectively such that evaporation and condensation processes of seawater are enhanced. The first cluster 150 further amasses dew or dew droplets 79 at the pails 32, which are again transported to water treatment plant 174 via the pump and the cross joints 102.

Fig. 5 relates to a third embodiment of the invention. The third embodiment comprises parts or method steps that are similar or identical to those of other embodiments. The similar parts or method steps are labelled by comparable or identical reference numerals. Accordingly, description of the similar or identical parts or method steps is hereby incorporated by reference or the relevant reference numerals.

In particular, Fig. 5 illustrates a second cluster 200 of freshwater collectors 202-206 on a slope 208. The second cluster 200 comprises a large number of freshwater collectors 202-206 that are laterally connected, although only a first land freshwater collector 202, a second land freshwater collector 204 and a third land freshwater collector 206. The first land freshwater collector 202 comprises a pail 32, span connectors 44-50 and a funnel 96 connect to a bottom of the pail 32. The pail 32 has rim areas 80-86 around four lateral sides of the first land freshwater collector 202. Span connectors 44-50 of the first land freshwater collector 202 comprises shafts 209 extending towards the slope 208. The rim areas 80-86 are supported by their respective shafts 209 on the slope 208. Other two land freshwater collectors 204, 206 have structure and parts similar to those of the first land freshwater collector 202 such that the second cluster 200 of four land freshwater collectors 202-206 covers the slope 208 of about 64m². Bottom ends of the funnels 96 are linked linearly by troughs 210 on the slope 208. Low ends 212 of the troughs 210 lead to underground buckets 214 for water collection.

In rainy seasons, pails 32 of the second cluster 200 gather rainwater droplets 138 at the funnels 96, which are further transported to the underground buckets 214 via the troughs 210. In unclouded days, light rays 216 from the sun 218 heats up the slope

208 via the transparent pails 32 such that water vapour from the ground 208 is condensed at undersides 144 of the pails 32. Condensate droplets 142 are collected by the funnels 96 and the troughs 210 for accumulation at the bucket 214. Dew droplets 79 are collected by the pails 32 in the mornings and evenings, which are
5 stored at the underground buckets 214.

Fig. 6 relates to a fourth embodiment of the invention. The fourth embodiment comprises parts or method steps that are similar or identical to those of other embodiments. The similar parts or method steps are labelled by comparable or
10 identical reference numerals. Accordingly, description of the similar or identical parts or method steps is hereby incorporated by reference or the relevant reference numerals.

Particularly, Fig. 6 illustrates a front view of a fourth freshwater collector 220. The
15 fourth freshwater collector 220 comprises a first pot 222 that has four pail connectors 44-50 distributes around its rim 224 equally. The first pot 222 has a cylindrical profile, with a bottom 226 of semi-spherical profile. A pail 32, which is formed by a circular sheet material 226, is fused to the rim 224 and seals top opening of the fourth freshwater collector 220. A mesh 62 punctures through the circular sheet material 226
20 in the centre such that the fourth freshwater collector 220 has an orifice 62 at the lowest position of the pail 32. A cross joint 102 and a funnel 96 of the fourth freshwater collector 220 are directly connected at the bottom 226 at its lowest location.

In a raining day, the pail 32 collects rainwater droplets 138 as freshwater 119 inside
25 the fourth freshwater collector 220. The mesh 62 blocks leaves or other rubbish from entering the fourth freshwater collector 220. The mesh 62 further reduces evaporation of collected freshwater 119 from the fourth freshwater collector 220 by reducing opening size, as compared to size of rim 224. In dawns and dusks, dew water droplets 79 are further gathered by the pail 32. The cross joint 102 provides a conduit
30 for carrying the freshwater 119 away from the fourth freshwater collector 220. Since the fourth freshwater collector 220 is hermetic against its surrounding seawater 136, the fourth freshwater collector 220 floats over the seawater 136 when in use.

Fig. 7 relates to a fifth embodiment of the invention. The fifth embodiment comprises parts or method steps that are similar or identical to those of other embodiments. The similar parts or method steps are labelled by comparable or identical reference numerals. Accordingly, description of the similar or identical parts or method steps is hereby incorporated by reference or the relevant reference numerals.

In detail, Fig. 7 illustrates a third cluster 230 of freshwater collectors 220,232,234. The third cluster 230 comprises freshwater collectors 220 extending in both a longitudinal direction 166,168 and a lateral direction 162,164. For example, the third cluster 230 includes a fourth freshwater collector 220, a fifth freshwater collector 232 and a fifth freshwater collector 234, which are connected sequentially, extending linearly in the (+)Y-axis direction. Respective funnels 96 and cross joints 102 of the freshwater collectors 220-234 are linked by a network of hoses 236, which are further connected to a water treatment plant 172 via a pump 170 (not shown). Span connectors 44-50 of the freshwater collectors 220-234 are inter-connected to each other such that rims 224 of the freshwater collectors 220-234 are kept at the same level. The span connectors 44-50 prevent the freshwater collectors 220-234 from toppling when facing toss of waves 136.

In showery days, the third cluster 230 collects rainwater droplets 138 as freshwater 119 in the pots 222. The freshwater 119 is transported to the water treatment plant 172 by the pump 170 for examination and processing. Similar, dew water droplets 79 are gathered by the pots 222 too.

Fig. 8 relates to a sixth embodiment of the invention. The sixth embodiment comprises parts or method steps that are similar or identical to those of other embodiments. The similar parts or method steps are labelled by comparable or identical reference numerals. Accordingly, description of the similar or identical parts or method steps is hereby incorporated by reference or the relevant reference numerals.

In detail, Fig. 8 illustrates a front view of a seventh freshwater collector 250. The seventh freshwater collector 250 comprises a pot 222 and a tank 34 that are connected at a bottom end 252 of the pot 222. The tank 34 comprises a thin plastic

film (known as skin) 99 in forming whose opposite ends 103, 105 (i.e. top end or first end, bottom end or second end) are attached to a core cylinder 100. Accordingly, the tank 34 is inflatable by the freshwater 119 inside the balloon 98. The balloon 98 thus floats and is immersed in the seawater 136, which surrounds and supports the
5 seventh freshwater collector 250.

In use, rainwater droplets 138 fall onto a circular sheet material 226 fused to a rim 224 of the pot 222 such that the rainwater droplets 138 flow through a mesh 62 and are accumulated inside the pot 222, as well as the tank 34. The rainwater droplets
10 138, collected as fresh water 119, are further propelled away from the seventh freshwater collector 250 by a pump 170 (not shown), which is linked to the tank 34 via a cross joint 102.

Several freshwater collectors 250, which are similar to the seventh freshwater
15 collector 250, may be joined together in forming a cluster for covering a large area for rainwater collection. For example, the several freshwater collectors 250 may be united by their pan connectors 44-50, similar to those of other clusters 150, 200, 230.

In the application, unless specified otherwise, the terms "comprising", "comprise", and
20 grammatical variants thereof, intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, non-explicitly recited elements.

As used herein, the term "about", in the context of concentrations of components of
25 the formulations, typically means +/- 5% of the stated value, more typically +/- 4% of the stated value, more typically +/- 3% of the stated value, more typically, +/- 2% of the stated value, even more typically +/- 1% of the stated value, and even more typically +/- 0.5% of the stated value.

30 Throughout this disclosure, certain embodiments may be disclosed in a range format. The description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the disclosed ranges. Accordingly, the description of a range should be considered to have specifically disclosed all the possible sub-ranges as well as individual numerical values within that

range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed sub-ranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the
5 range.

It will be apparent that various other modifications and adaptations of the application will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the application and it is intended that all
10 such modifications and adaptations come within the scope of the appended claims.

Claims

1. Freshwater collector comprising:
 - a pail for collecting freshwater,
 - 5 – at least one float connected to the pail for supporting the pail on a water body, and
 - a tank for storing the freshwater, wherein the tank comprises a joint coupling the tank to the pail for draining the freshwater from the pail to the tank; and
 - 10 wherein the tank further comprises a balloon for storing the freshwater; and the balloon comprises a core cylinder for supporting the balloon.
2. Freshwater collector of Claim 1, wherein the pail comprises at least one slope for guiding flow of the freshwater on the
15 pail.
3. Freshwater collector of Claim 1 or 2, wherein the pail comprises at least one rod at an edge of the pail for supporting the pail structurally.
20
4. Freshwater collector of any of the preceding Claims, wherein the pail comprises a sheet material for providing at least one freshwater collection area.
- 25 5. Freshwater collector of any of the preceding Claims, wherein the pail further comprises a filter for connecting to the water tank.
6. Freshwater collector of any of the preceding Claims, wherein the pail further comprises at least one rim area for forming an enclosure.
30
7. Freshwater collector of any of the preceding Claims further comprising at least one connector for connecting the pail to other pails or freshwater collectors.

8. Freshwater collector of any of the preceding Claims, wherein the at least one float is connected to the edge.
- 5 9. Freshwater collector of any of the preceding Claims, wherein the tank is configured to be detachably connected to the pail.
- 10 10. Freshwater collector of Claim 1, wherein the core cylinder comprises a perforated surface for permitting fluid communication through the core cylinder.
- 11 11. Freshwater collector of any of the preceding Claims, wherein the tank further comprises a funnel for connecting the tank to the pail.
- 15 12. Freshwater collector of any of the preceding Claims, wherein the tank further comprises a stem for connecting to a top side of the pail and for guiding the freshwater following from the top side into the tank.
- 20 13. Freshwater collector of any of the preceding Claims, wherein the tank comprises a tube for connecting to an underside of the pail and for guiding the freshwater from the underside into the tank.
- 25 14. Freshwater collector of Claim 12 and 13, wherein the stem and the tube enclose each other having a gap in-between.
- 30 15. Freshwater collector of any of the preceding Claims further comprising: a water hose joint for connecting the freshwater collector to a pump.
16. Freshwater collector of Claim 15, wherein the water hose joint is connected to the core cylinder for draining.
17. Freshwater collector of Claim 15 or 16, wherein the water hose joint comprises a multiway joint.

18. Freshwater collector of any of the preceding Claims, wherein at least one component of the freshwater collector has a screw thread for detachably constructing the freshwater collector.
- 5 19. Freshwater collector of Claim 1, wherein the pail comprises a transparent sheet material.
20. Cluster of the freshwater collector according to any of the preceding Claims, the cluster comprising
- 10 two or more of the freshwater collectors of any of the preceding Claims, wherein the two or more of the freshwater collectors are connected to together by the at least one connector for covering a water surface area.

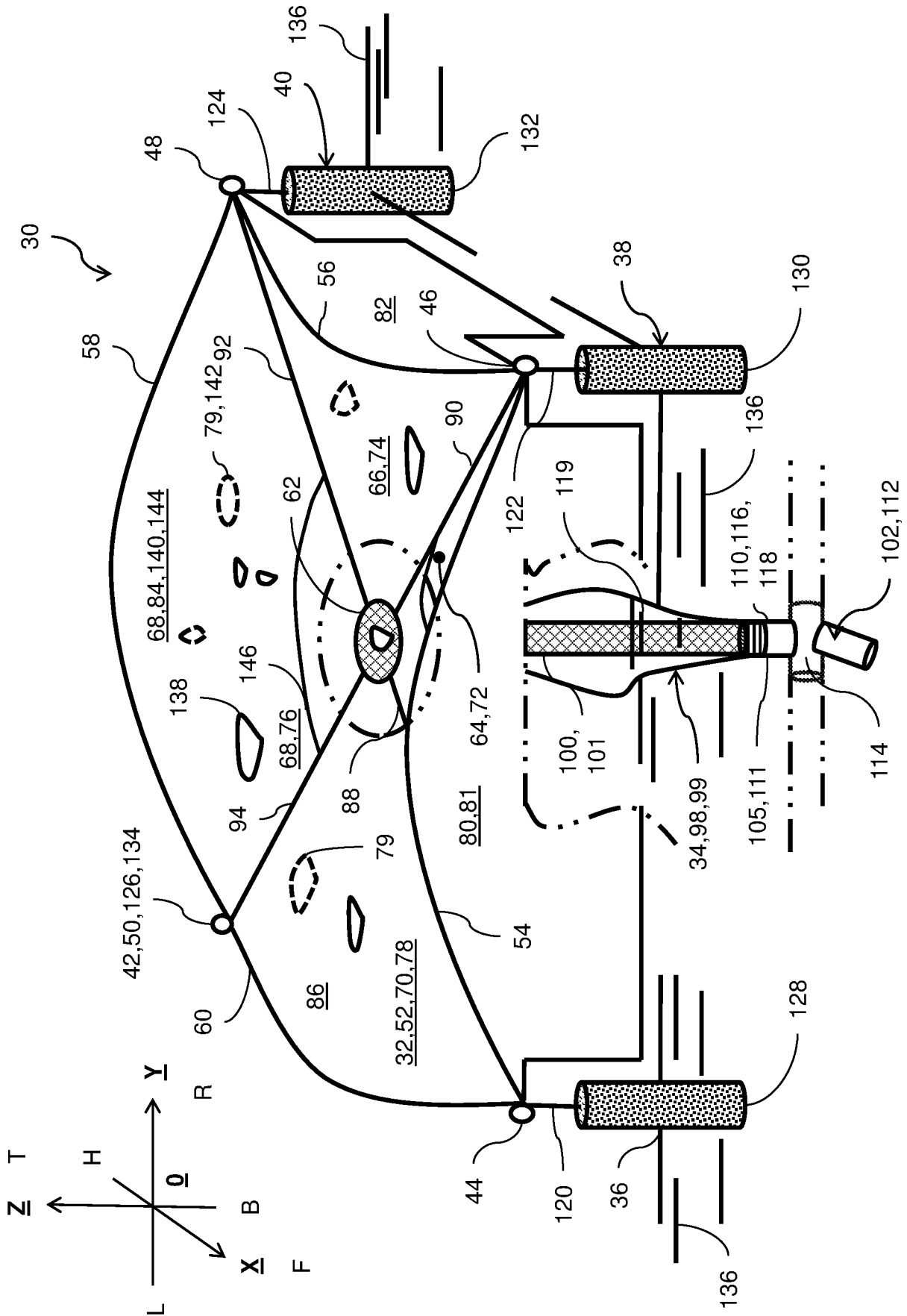


Fig. 1

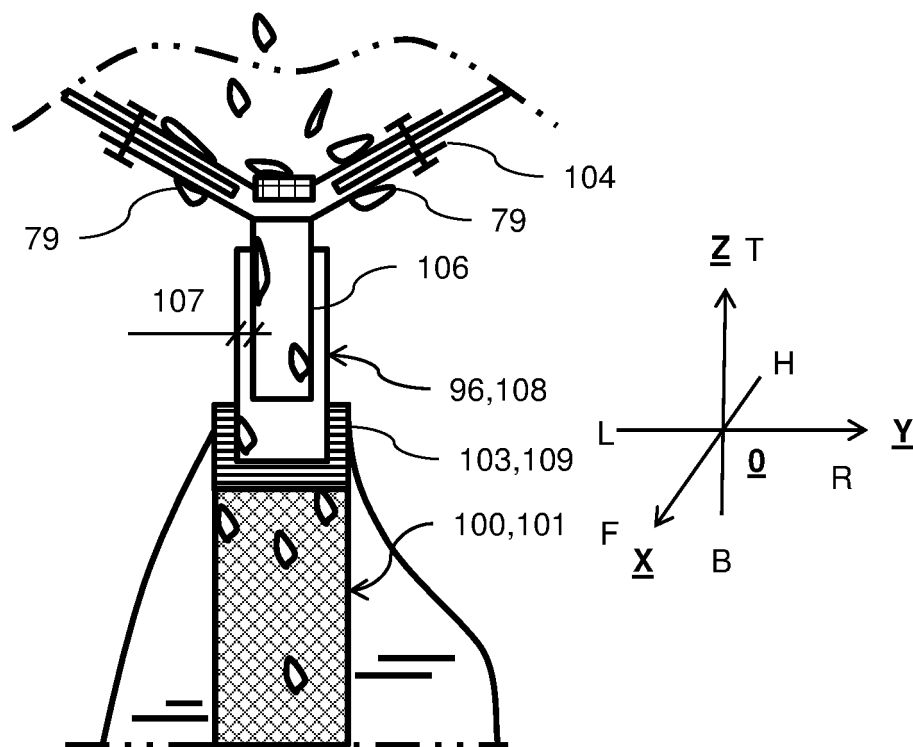


Fig. 2

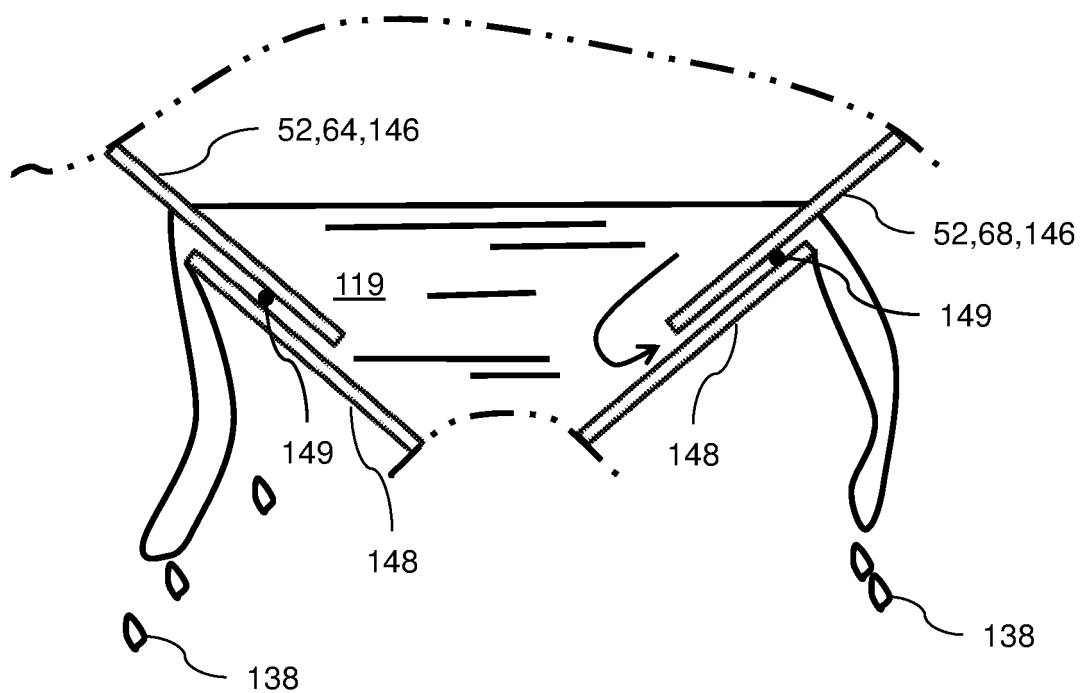


Fig. 3

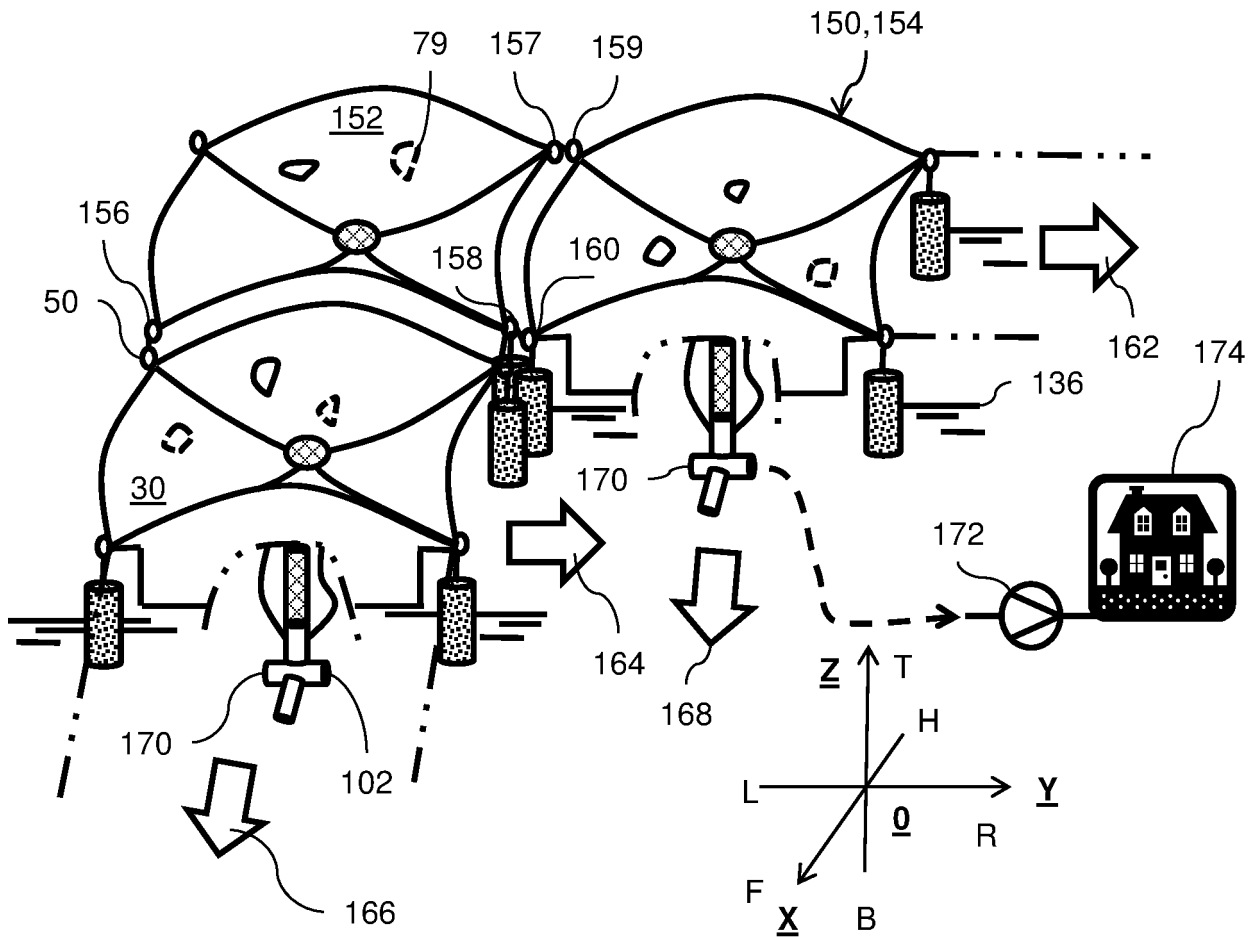


Fig. 4

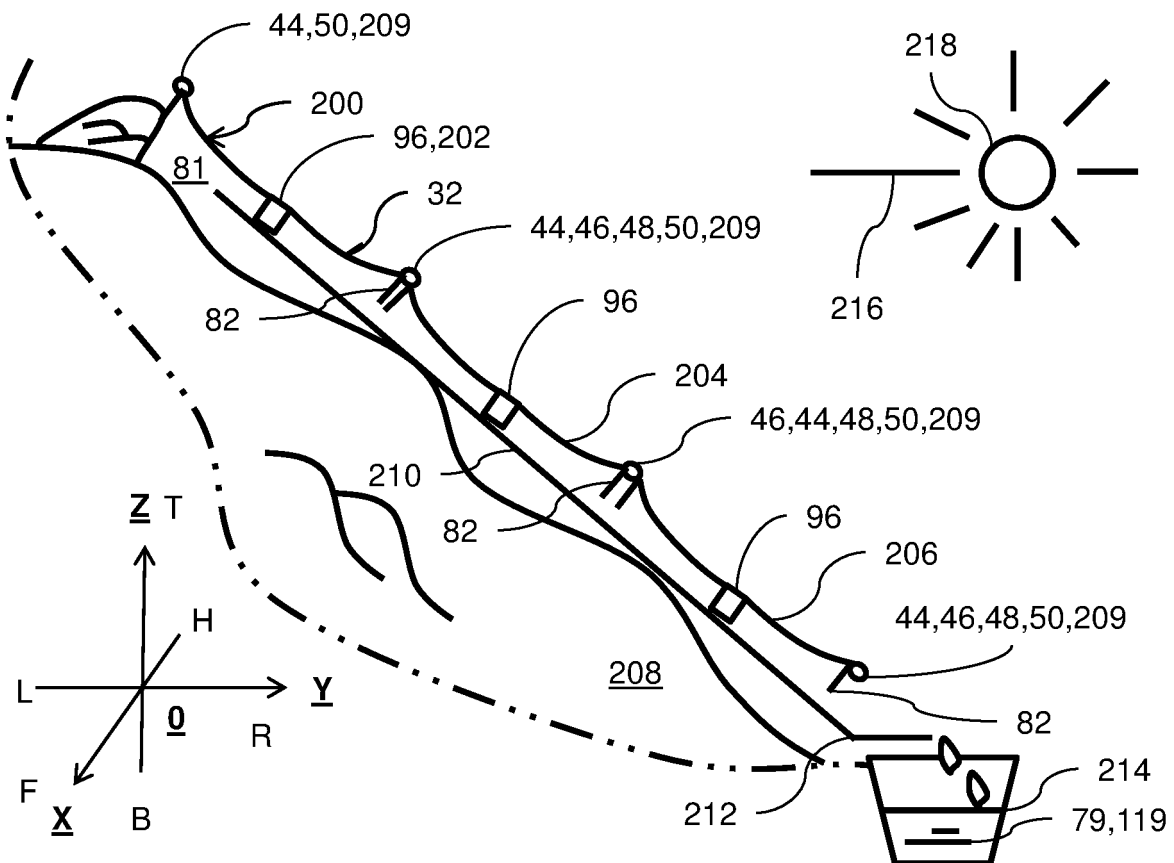


Fig. 5

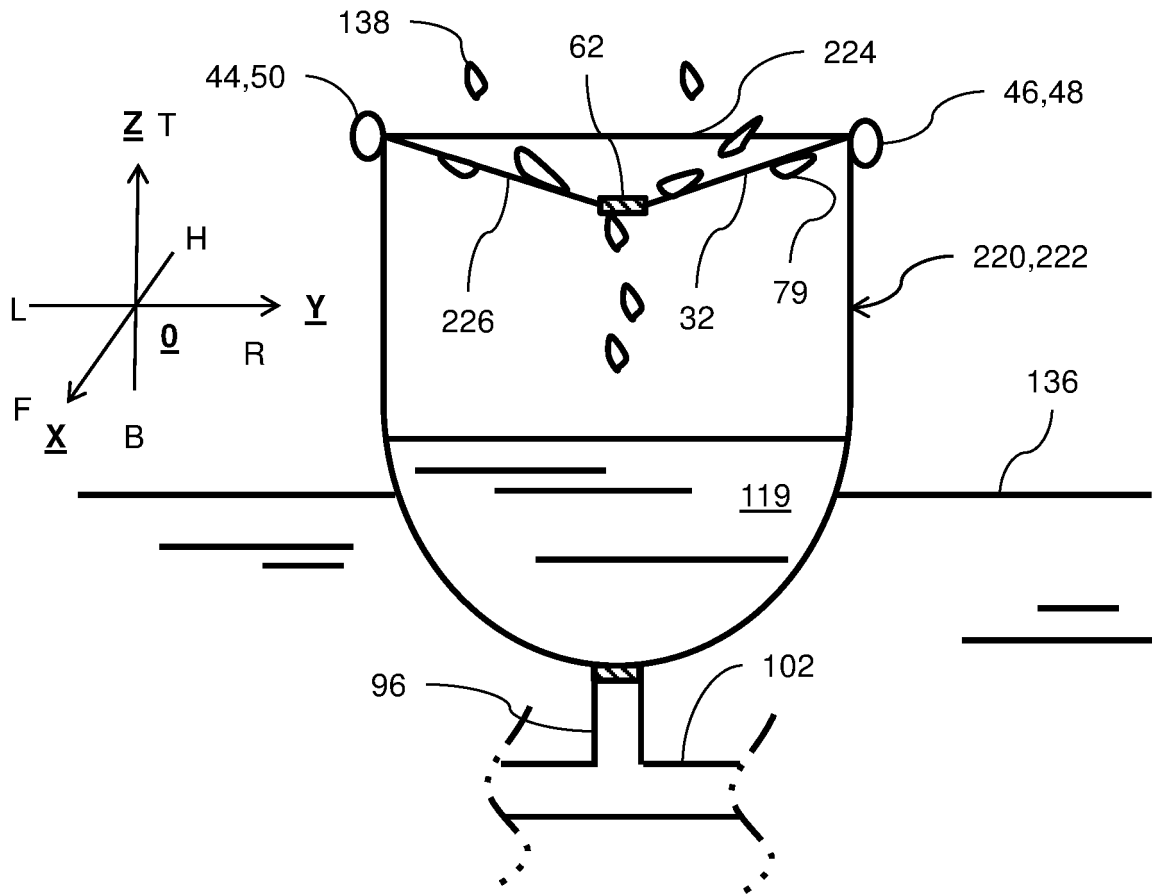


Fig. 6

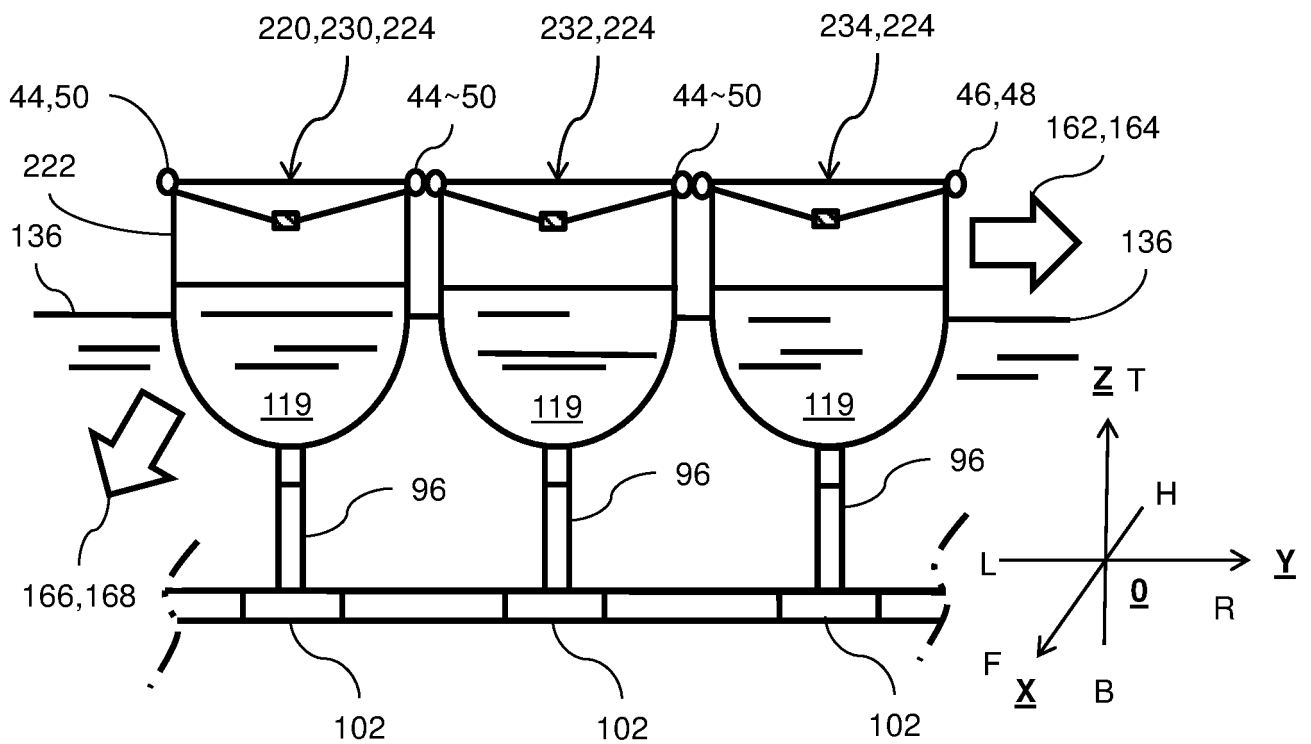


Fig. 7

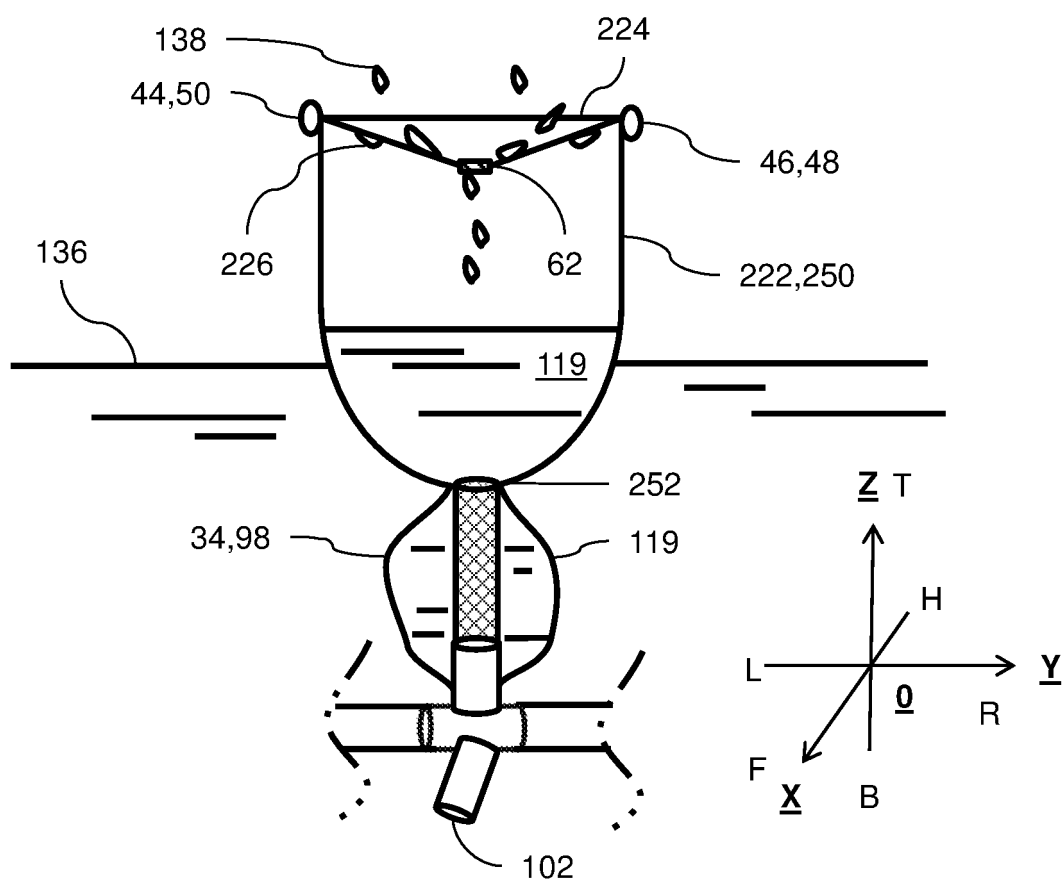


Fig. 8