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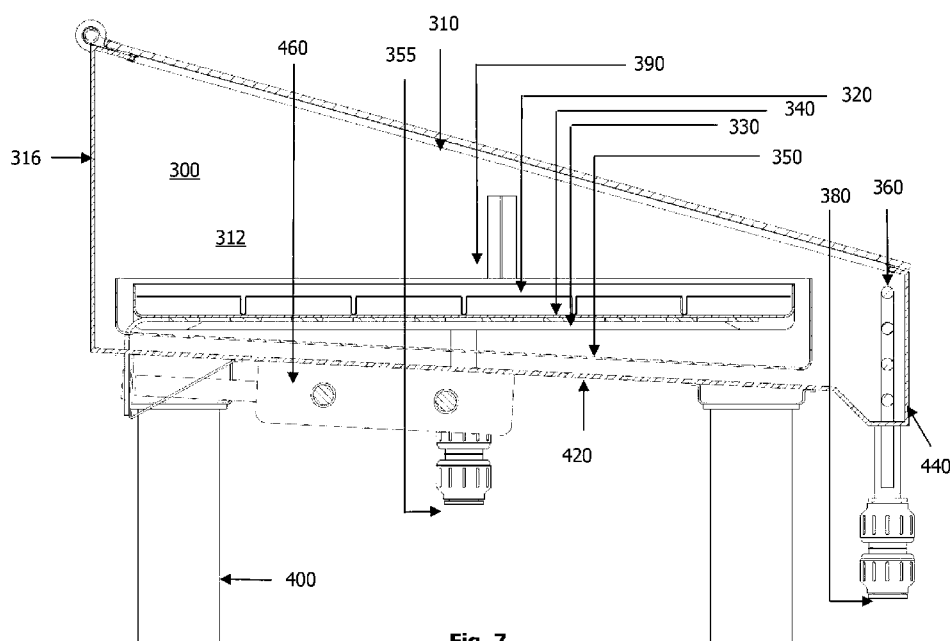


Fig. 7

(57) Abstract: A water distillation system (10) includes a distillation unit (20) having a longitudinally extending and enclosed first conduit (40) and a longitudinally extending channel (80) located within the first conduit (40), the channel (80) being connectable to an untreated water source, wherein an upper portion of the first conduit (40) is shaped to direct condensation into a base portion (60) of the first conduit (40).



Water distillation system

Technical Field

[0001] The present disclosure relates to a water distillation system and method. In particular, the present invention relates to a water distillation system intended for use in treating sea water, brackish water or water containing other contaminants or impurities. However, it will be appreciated by those skilled in the art that the invention may also be applied to the treatment of other liquids.

Background of the Invention

[0002] Fresh water for potable, agricultural, industrial and other purposes is in short supply in many parts of the world. In such locations, local rainfall precipitation is not sufficient to satisfy fresh water demand. For example, in Australia, a large percentage of the rain fall occurs in coastal regions, and the arid central region has very little rain fall or other naturally occurring sources of fresh water. As such, the inability to obtain sufficient quantities of suitable fresh surface water sources directly affects the suitability of land for residential or agricultural use.

[0003] In locations where sufficient fresh surface water supply is not naturally available, inhabitants may be forced to rely on other sources such as bore water which can be extracted from underground aquifers in some locations. Bores are the most common way of tapping groundwater sources. In most situations, bore water is not potable without first being treated.

[0004] Sea water is unsuitable for agricultural or other applications on account of the salinity. Bore water also typically contains impurities such as salts, metals and other minerals and biological pathogens such as bacteria, and pesticides. These contaminants may render the water unsuitable for agricultural or other applications. Most existing methods of removing these contaminants from the water are expensive and time consuming. In addition, the use of chemical treatments requires the operator to have ongoing supplies of the requisite chemicals.

[0005] Chlorination provides a means to treat bore water to remove microbiological contamination. However, chlorination alone is not sufficient to remove or deactivate other contaminants such as heavy metals or salt.

[0006] Settlement treatment provides a means of treating water for some contaminants such as iron and/or other metallic contaminants. However, settlement alone is not sufficient to address all possible sources of contamination. A further drawback with settlement systems concerns the amount of time required to settle the water before usage.

[0007] Water distillation is a process which includes evaporation followed by condensation for removing all contaminants from water. As such, distillation can be beneficial when treating sea water or bore sourced water which may contain various different contaminants. However, many known distillation systems are costly to operate with respect to power requirements and labour.

[0008] Experiments with solar powered water distillation have shown that solar cells can be used to power a distillation system in some scenarios. However, in practice existing solar powered distillation systems are generally only feasible on reasonably small scales as the volume of water that can be treated is typically low. In addition, the cost to run and service a suitable solar array can add significantly to the cost of the water distillation.

Object of the Invention

[0009] It is an object of the present invention to substantially overcome or ameliorate one or more of the above disadvantages, or at least to provide a useful alternative.

Summary

[0010] In a first aspect, the present invention provides a water distillation system comprising:

- a distillation unit having:

- a longitudinally extending and enclosed first conduit; and

- a longitudinally extending channel located within the first conduit, the channel being connectable to an untreated water source,

- wherein a portion of the first conduit is shaped to direct condensation into a base portion of the first conduit.

[0011] The upper portion of the first conduit is preferably fabricated from a transparent or translucent material.

[0012] A second conduit is preferably located adjacent to the first conduit and extends parallel to the first conduit, the second conduit being in fluid communication with the first conduit and adapted to receive and remove liquid from the first conduit.

[0013] The water distillation system further preferably comprises:
an inlet manifold located at a proximal end of the distillation unit;
a primary outlet manifold located at a distal end of the distillation unit; and
a secondary outlet manifold located at the distal end of the distillation unit;
wherein the inlet manifold is in fluid communication with the channel, the primary outlet manifold is in fluid communication with the second conduit, and the secondary outlet manifold is in fluid communication with the channel.

[0014] The first conduit and the second conduit are preferably integrally formed.

[0015] The water distillation system preferably includes a plurality of the distillation units arranged in an array such that each of the inlet manifolds are in fluid communication, each of the primary outlet manifolds are in fluid communication and each of the secondary outlet manifolds are in fluid communication.

[0016] The longitudinally extending channel is preferably generally semi-circular in cross-section and the first conduit is generally circular in cross-section.

[0017] The channel is preferably spaced above the base portion of the first conduit to define a clearance between the channel and the first conduit.

[0018] There are preferably regularly spaced liquid egression ports extending between the first conduit and the second conduit.

[0019] In a second aspect, the present invention provides a water distillation system comprising:

- a housing defining an internal chamber; and
- a cover forming a portion of the housing;
- a brine tray located within the chamber, the brine tray being in fluid communication with a brine inlet extending through the housing and a brine outlet extending through the housing;
- a distilled water outlet extending through the housing, the distilled water outlet being located at or near a low point of the chamber.

[0020] The brine tray is preferably located above an overflow tray, and the overflow tray is configured to direct liquid to the brine outlet. The overflow tray will also act as a heat shield between the brine tray above and the cooling tubes below.

[0021] A heating element is preferably associated with the brine tray and configured to heat the tray.

[0022] A metallic mesh is preferably located in the brine tray.

[0023] At least one fan is preferably located in the chamber, the fan being configured to circulate air over the brine tray.

[0024] At least one cooling tube is preferably located in the chamber.

[0025] The cooling tube is preferably positioned above or near the distilled water outlet and below the overflow tray/heat shield.

[0026] The cover and a base surface of the housing preferably both slope downwardly toward the distilled water outlet.

[0027] The cover is preferably at least partially fabricated from glass.

[0028] The cover preferably includes one planar portion which slopes downwardly toward the distilled water outlet.

[0029] The cover preferably has a generally "A" shaped cross-sectional profile including two generally planar portions which each slope downwardly.

Brief Description of the Drawings

[0030] A preferred embodiment of the invention will now be described by way of specific example with reference to the accompanying drawings, in which:

[0031] Fig. 1 is a perspective view depicting a single unit of a water distillation system according to a first embodiment of the present invention;

[0032] Fig. 2 is a cross sectional view of the water distillation system of Fig. 1 taken through a plane which is generally perpendicular to the longitudinal axis;

[0033] Fig. 3 is a schematic diagram depicting the water distillation system of Fig. 1 in use;

[0034] Fig. 4 depicts an interconnected array of the water distillation units of Fig. 1;

[0035] Fig. 5 is a top view showing the water distillation unit of Fig. 1;

[0036] Fig. 6 is a side, cross-sectional view of the water distillation unit of Fig. 1;

[0037] Fig. 7 is a partial cross-sectional view of a water distillation system according to a second embodiment of the invention;

[0038] Fig. 8 is a top, perspective view of the water distillation system according to the second embodiment;

[0039] Fig. 9 is a bottom, perspective view of the water distillation system according to the second embodiment;

[0040] Fig.10 is a partial cross-sectional view of a water distillation system according to a third embodiment of the invention; and

[0041] Fig. 11 is a top perspective view of the water distillation system according to the third embodiment.

Detailed Description of the Preferred Embodiments

[0042] A water distillation system 10 according to a first embodiment is disclosed herein. A single unit 20 (distillation unit 20) of the water distillation system 10 is shown in isolation in the perspective view of Fig. 1. The distillation unit 20 has a longitudinally extending body portion 30. In the embodiment depicted in the drawings, for example Fig. 2, the body portion 30 includes a first conduit in the form of tubular element 40 and a parallel, second conduit in the form of tubular element 50. In the depicted embodiment, the second tubular element 50 is smaller in diameter than the first tubular element 40, and integrally formed from a single extrusion.

[0043] Fig. 5 is a top view of a single distillation unit 20, and Fig. 6 is a side cross-sectional view of the distillation unit 20.

[0044] As shown in Fig. 2, the second tubular element 50 is integrally formed with the first tubular element 40. However, it will be appreciated by those skilled in the art that they may be separately manufactured.

[0045] Referring to Fig. 2, the first tubular element 40 has a generally circular internal cross sectional area. The lower or base portion 60 of the first tubular element 40 is manufactured from a suitable engineering material which is water resistant and non-corrosive such as galvanised steel, aluminium, stainless steel or various polymers.

[0046] In the embodiment depicted in the drawings, the upper portion 70 of the first tubular element 40 is fabricated from a transparent or translucent material such as glass or Perspex™, such that light can pass through the upper portion 70.

[0047] A third conduit or channel 80 is positioned within the first tubular element 40. In the embodiment depicted in the drawings, the channel 80 is a semi-circular channel element which is open, and raised relative to the base of the first tubular element 40. As such, a first

liquid flow path is defined with the channel 80 and a second, independent liquid flow path is defined in the lower portion 60 of the first tubular element 40.

[0048] The length of each distillation unit 20 is variable, and may be as short as several metres, or up to several kilometres in length. In such longer versions of the distillation unit 20, there are regularly spaced apertures or water egression ports 90 which link the lower portion 60 of the first tubular element 40 with the second tubular element 50.

[0049] Referring to Fig. 1, there is an inlet manifold 100 located at a proximal end of each distillation unit 20. The inlet manifold 100 is in fluid communication with the channel 80.

[0050] Again, referring to Fig. 1, there are two outlet manifolds 110, 120, located at a distal end of each distillation unit 20. The primary outlet manifold 110 is in fluid communication with the second tubular element 50. The secondary outlet manifold 120 is in fluid communication with the channel 80.

[0051] Referring to Fig. 4, an array 200 of interconnected distillation units 20 is disclosed which defines a water distillation system 10. In the array 200, each of the inlet manifolds 100 is in fluid communication and interconnected with a network of inlet pipes 210, which is connectable to a source of water (or other liquid) to be treated which is generally sea water. However, the water may be sourced from a bore tapped into a subterranean aquifer or other source.

[0052] In addition, each of the primary outlet manifolds 110 is in fluid communication with each other and interconnected with a network of clean water outlet piping 220. Furthermore, each of the secondary outlet manifolds 120 is in fluid communication with each other and interconnected with a network of brine (or other waste liquid) outlet piping 230.

[0053] The dimensions of the array 200 are designed for local specific factors such as the size of available land, the desired amount of treated water and anticipated input volume of water to be treated.

[0054] The operation of the water distillation system 10 will now be described. A source of water for treating is connected to the network of inlet piping 210. In practice this may be salt water from the ocean, brackish water from a bore water source or some other water supply.

[0055] The water to be treated is referred to herein as brine. Referring to Fig. 3, the water treatment process is depicted graphically. The brine initially enters into the channel 80.

Typically, the distillation units 20 are laid with a slight fall such as 1:100 so that the water moves gradually, by way of gravity, from the proximal end toward the distal end.

[0056] As depicted in Fig. 3, part A, sunlight passes through the upper portion 70 of the first tubular element 40. The sunlight evaporates (Fig. 3, part B) some of the water from the surface of the channel 80. Due to the effect of distillation, only the water molecules evaporate, and other contaminants such as salts and minerals and pathogens remain within the channel 80.

[0057] The evaporated water molecules condense on the internal glass or Perspex™ surface of the upper portion 70 of the first tubular element 40. This portion of the process is depicted schematically in Fig. 3 part C. As more water condenses, the water molecules form into drops. As the weight of the drops increases in size, the drops eventually move due to gravity down the walls of the first tubular element 40, settling in the base of the lower portion 60. This water is distilled and free of contaminants and impurities.

[0058] The distilled water exits from the apertures 90 into the second tubular element 50. The distilled water is then removed from the system through the interconnected primary outlet manifolds 110.

[0059] The interconnected secondary outlet manifolds 120 are used to remove the concentrated brine from the system. This typically consists of water with a higher concentration of the original impurities such as salts and minerals.

[0060] While the water distillation system 10 has been described in the first embodiment with the upper portion fabricated from a transparent or translucent material, it is envisaged that in an alternative embodiment the entire first tubular element 40 may be fabricated from the transparent or translucent material.

[0061] The channel 80 may be fabricated from a material such as stainless steel which has a desirable, low specific heat capacity to absorb energy from the sun light, and raise the temperature of the brine. In this embodiment, vaporisation of the liquid may occur due to or be assisted by the increased heat within the brine due to the heat absorption by the metallic channel 80.

[0062] The higher the temperature of the brine, the greater the kinetic energy of the molecules at its surface and therefore the faster the rate of evaporation of the water from the brine.

[0063] It is envisaged that in one embodiment, air may be pumped through the first tubular element 40. This may be advantageous to encourage faster evaporation.

[0064] The pressure within the first tubular element may in one embodiment be artificially lowered (by vacuum or otherwise) below atmospheric pressure to promote faster evaporation.

[0065] In one embodiment, one or more sensors may be included to provide feedback regarding operating variables within the distillation system 10. For example, one or more salinity sensors may be connected to the channel 80, near the distal end, or at locations along the length of the channel 80. Using such salinity sensors enables the water flow into the channel to be automatically increased if the evaporation level within the channel 80 becomes too high. This may prevent the brine from completely evaporating, which could result in undesirable salt scaling within the channel 80.

[0066] Alternatively, the channel 80 may be flushed, preferably when the distillation reaction is not occurring, to remove any build-up of salt scale from the channel 80. Such a flushing operation may be performed at night or when the sun's strength is low.

[0067] Alternatively, the volumetric flow rates of water out of the primary outlet manifold 110 and the secondary outlet manifold 120 may be measured to determine a suitable input flow rate into the inlet manifold 100.

[0068] The embodiment described above and depicted in the drawings relates to the channel 80, when viewed in cross-section, having a generally semi-circular profile defining a semi-annular clearance above the lower portion 60 of the first tubular element 40. However, it will be appreciated by those skilled in the art that the first tubular element 40 and channel 80 can be provided in different profiles. For example, the upper portion 70 may be defined by two planar surfaces defining an apex, with each planar surface directing condensate into one side of the lower portion 60 of the first tubular element 40.

[0069] Alternatively, the first tubular element 40 and channel 80 may be elliptical or oval shaped to provide greater surface area within the channel 80 for improved evaporation.

[0070] In one embodiment (not shown) the containment of the fresh water and brine may be reversed, such that the fresh water is contained in the channel 80 and the brine is contained in the lower portion 60 of the first tubular element 40. In such an alternative embodiment, the profile of the upper portion 70 would be shaped such that the condensate is directed downwardly above the channel 80. This could be achieved with any number of

profiles of the upper portion 70 such as an inverted apex or some other suitable concaved profile.

[0071] A second embodiment of the water distillation system 300 is disclosed in Figs. 7 to 9. The system 300 of the second embodiment is modular, such that a single unit of the system 300 can be used in isolation or alternatively, the units can be interconnected to provide a larger array of units interconnected in series or parallel, and capable of generating larger volumes of distilled water. Advantageously, the size of the array can be customised to achieve a desired output volume.

[0072] In contrast to the first embodiment described above, the system 300 has a roof or cover 310 defining an internal chamber 312. The cover 310 is planar and is hinged on one side with hinges 315 for accessing the interior of the system 300. When the system 300 is installed, the cover 310 can be directed with a preferred orientation, such as north facing in the southern hemisphere, to achieve optimal sun exposure in the cooler months. However, it will be appreciated that the cover 310 may be generally flat and horizontally extending.

[0073] In contrast to the first embodiment, the system 300 of the second embodiment differs because the first embodiment uses only a passive process of solar evaporation and distillation. In contrast, in the system 300 provides a more active process, using electrical energy (preferably drawn from solar cells) to augment the evaporation process with active heating of the brine tray 320, fan driven air movement, and refrigeration to assist condensation to substantially increase the production rates of distilled or fresh water.

[0074] Advantageously, in the system 300 of the second embodiment, the design has moved from a generally circular pipe profile to an angular shape design. This provides a reduction in manufacturing costs, and enables the system 300 to be fabricated using more readily available flat glass panels for the cover 310, rather than large custom glass tubes.

[0075] The system 300 is still airtight when operating, allowing for hot brines to be heated and the evaporated water vapour to be condensed and collected as liquid distilled water. The air pressure may be reduced below atmospheric pressure in the chamber 312.

[0076] In the system 300, a brine evaporation tray 320 is housed inside chamber 312 within the housing 316. The brine evaporation tray 320 is fabricated in a generally rectangular format. However other shapes, such as an oval, are also envisaged. The brine evaporation tray 320 is shallow, and the increased surface area for a given length of the water distillation system 300, increases the evaporation rates.

[0077] A further advantage is that the shallow evaporation tray 320 reduces the thermal mass of the cool inlet water, to improve the evaporation process.

[0078] The brine tray 320 includes at least one electrical heating element 330 to heat the brine to maximise evaporation rates. The element 330 is preferably powered by a solar power cell. However, other electrical input may be used.

[0079] The brine tray 320 is preferably fabricated from black coated copper which has a high thermal conductive index. Furthermore, the brine tray 320 also preferably contains a black copper mesh 340 which is located in a submerged position relative to the surface of the brine, to maximise the surface area of black copper in contact with the brine, and therefore maximise the transfer of heat energy from the brine tray 320 and mesh to the brine. It will be appreciated that the brine tray 320 and the mesh 340 may be fabricated from other metals with favourable thermal conductive properties.

[0080] Beneath the brine tray 320 is a brine overflow tray 350 which serves the following purposes:

a) catching any overflow/spillage of brine and directing it away from the distilled water and;

b) providing a heat shield between the heated brine tray 320 above and the cooled condensation or cooling tubes below (discussed below).

[0081] For this reason, the overflow tray 350 coated with a reflective material on its upper surface, to reflect sunlights and heat energy back toward the brine tray 320.

[0082] The brine overflow tray 350 is connected to a brine outlet 355. The brine outlet 355 may be used to return the brine to the brine reservoir or other source.

[0083] At the base of the water distillation system 300, beneath the brine overflow tray 350, are a series of cooling tubes 360 which extend longitudinally relative to the water distillation system 300. The cooling tubes 360 contain a refrigerant which is cooled by an external refrigeration unit 370, which is preferably also powered by solar generated electricity. The cooling tubes 360 increase the condensation rates of the distilled water vapour into liquid water, which is then collected in the distilled water outlet 380. Referring to Fig. 10, the cooling tubes 360 are cooled by coolant which is pumped into the system 300 through the coolant inlet and outlet ports 365, 375.

[0084] Evaporation rates are increased with increasing air velocity over the brine. Accordingly, the water distillation system 300 also includes one or more electrical fans 390.

The fans 390 are also preferably powered by solar generated electricity. The fans are designed to move air in a circular motion over the brine in the brine tray 320.

[0085] The water distillation system 300 needs to be positioned in a generally level orientation to achieve the correct flow of brine and collection of the distilled product. In order to achieve the correct horizontal position, the legs 400 and/or the connection between the legs 400 and the body 410 may be adjustable to accommodate installation on uneven terrain.

[0086] The brine tray 320 is intended to be mounted in a horizontal orientation. However, the base surface 420 of the water distillation system 300 is inclined and slopes downwardly to create a fall. Similarly, the cover 310 slopes in the same direction.

[0087] The cooling tubes 360 are located at or adjacent to the low point of the cover 310 and the base surface 420.

[0088] The water distillation system 300 includes at least one distilled water outlet 380, which is positioned in a base of a trough or channel 440 which is contiguous with the low point of the base surface 420. Evaporated water which collects on the base surface 420 flows under gravity into the trough 440 to exit the water distillation system 300 through the water outlet 380.

[0089] The cover 310 is also inclined such that the low edge of the cover 310 is located above the trough 440. As such, any water which has condensed on the cover 310 will flow under the effect of gravity toward the trough 440.

[0090] In the second embodiment of the water distillation system 300, when the system 300 is used in an array or matrix, the distilled water outlets 380 can be each coupled to a network of pipes which feed to a reservoir for pumping or other distribution.

[0091] In a similar manner, the brine inlets 450 may be provided by a network of pipes delivering brine from a brine reservoir or other source.

[0092] The brine tray 320 may include a depth sensor (not shown) which is configured to determine the level of brine contained in the tray 320. The brine tray 320 may also include temperature and/or salinity sensors. The flow rate of brine into the brine inlet 450 may be controlled based on feedback from the depth sensor, to avoid overflow of the brine tray. Alternatively, the flow rate of brine into the brine inlet 450 may be controlled based on ambient conditions such as the outside air temperature, such that brine is delivered at a rate equal to anticipated evaporation.

[0093] Alternatively, the vertical location of the brine inlet of the brine reservoir which feeds into the network of pipes supplying the brine inlet 450 may be located at a predetermined horizontal position which ensures that the amount of brine entering the system can never overflow the upper wall position of the brine tray 320. Alternatively, the level may be controlled by an s-bend.

[0094] The system 300 may be back flushed intermittently to remove salt scale and other unwanted build up. In order to achieve this, there may be a second brine outlet, in direct fluid communication with the brine tray 320, in addition to the brine outlet 355 connected to the overflow tray 350.

[0095] An electronic control box 460 is located on the underside of the water distillation system 300. The control box 460 is used to control the electric components of the system, such as a solar cell, the heating element 330, the cooling tubes 360, the fans 390 and any other sensors for brine flow rate etc. the electronic control box 460 may be in communication with a control centre to provide operating data regarding performance or any errors or failures. The electrical control box has an electrical connection input 465 and output 475 which are located on the underside of the distillation system 300.

[0096] A third embodiment of the water distillation system 500 is disclosed in Figs. 10 and 11. The third embodiment is operationally very similar to the second embodiment 300. However, the cover 510 is provided in two parts, similar to a gable roof, such that there is a central hinged support which supports the two opening covers 510. Whilst the covers 510 are described and depicted with hinges 515 along the upper most edge, it will be appreciated that the hinges 515 could in practice be mounted on any one of the four sides of each cover 510.

[0097] In the third embodiment, the trough 540 is centrally located, and the underside of the water distillation system 500 includes two base surfaces 620 which slope downwardly toward the trough 540.

[0098] As shown in Fig. 10, in the third embodiment, the network of cooling tubes 560 extends generally parallel to and slightly above the base surfaces 620, in the clearance between the overflow tray 550 and the base surface 620.

[0099] In a similar manner to the second embodiment 300, the water distillation system 500 of the third embodiment includes cooling tubes 560, overflow tray 550, fans 590,

distilled water outlet 580, brine inlet 650, brine outlet 555, brine tray 520, mesh 540, electrical element 530, overflow tray 550, cooling tubes 560, and legs 600.

[00100] Although the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms.

The claims defining the invention are as follows:

1. A water distillation system comprising:
a distillation unit having:
a longitudinally extending and enclosed first conduit; and
a longitudinally extending channel located within the first conduit, the channel being connectable to an untreated water source,
wherein an upper portion of the first conduit is shaped to direct condensation into a base portion of the first conduit.
2. The water distillation system of claim 1, wherein the upper portion of the first conduit is fabricated from a transparent or translucent material.
3. The water distillation system of claim 1 or 2, wherein a second conduit is located adjacent to the first conduit and extends parallel to the first conduit, the second conduit being in fluid communication with the first conduit and adapted to receive and remove liquid from the first conduit.
4. The water distillation system of claim 3, further comprising:
an inlet manifold located at a proximal end of the distillation unit;
a primary outlet manifold located at a distal end of the distillation unit; and
a secondary outlet manifold located at the distal end of the distillation unit;
wherein the inlet manifold is in fluid communication with the channel, the primary outlet manifold is in fluid communication with the second conduit, and the secondary outlet manifold is in fluid communication with the channel.
5. The water distillation system of claim 3 or 4, wherein the first conduit and the second conduit are integrally formed.
6. The water distillation system of any one of claim 3 to 5 including a plurality of said distillation units arranged in an array such that each of the inlet manifolds are in fluid communication, each of the primary outlet manifolds are in fluid communication and each of the secondary outlet manifolds are in fluid communication.

7. The water distillation system of any one of the preceding claims, wherein the longitudinally extending channel is generally semi-circular in cross-section and the first conduit is generally circular in cross-section.

8. The water distillation system of claim 7 wherein the channel is spaced above the base portion of the first conduit to define a semi-annular clearance between the channel and the first conduit.

9. The water distillation system of claim 3, wherein regularly spaced liquid egression ports extend between the first conduit and the second conduit.

10. A water distillation system comprising:
a housing defining an internal chamber; and
a cover forming a portion of the housing;
a brine tray located within the chamber, the brine tray being in fluid communication with a brine inlet extending through the housing and a brine outlet extending through the housing;
a distilled water outlet extending through the housing, the distilled water outlet being located at or near a low point of the chamber.

11. The water distillation system of claim 10, wherein the brine tray is located above an overflow tray, and the overflow tray is configured to direct liquid to the brine outlet.

12. The water distillation system of any one of claims 10 or 11, wherein a heating element is associated with the brine tray and configured to heat the tray.

13. The water distillation system of any one of claims 10 to 12, wherein a metallic mesh is located in the brine tray.

14. The water distillation system of any one of claims 10 to 13, wherein at least one fan is located in the chamber, the fan being configured to circulate air over the brine tray.

15. The water distillation system of any one of claims 10 to 14, wherein at least one cooling tube is located in the chamber.

16. The water distillation system of claim 15, wherein the cooling tube is positioned above or near the distilled water outlet.

17. The water distillation system of any one of claims 10 to 16, wherein the cover and a base surface of the housing both slope downwardly toward the distilled water outlet.

18. The water distillation system of any one of claims 10 to 17, wherein the cover is at least partially fabricated from glass.

19. The water distillation system of claim 18, wherein the cover includes one planar portion which slopes downwardly toward the distilled water outlet.

20. The water distillation system of claim 18, wherein the cover has a generally "A" shaped cross-sectional profile including two generally planar portions which each slope downwardly.

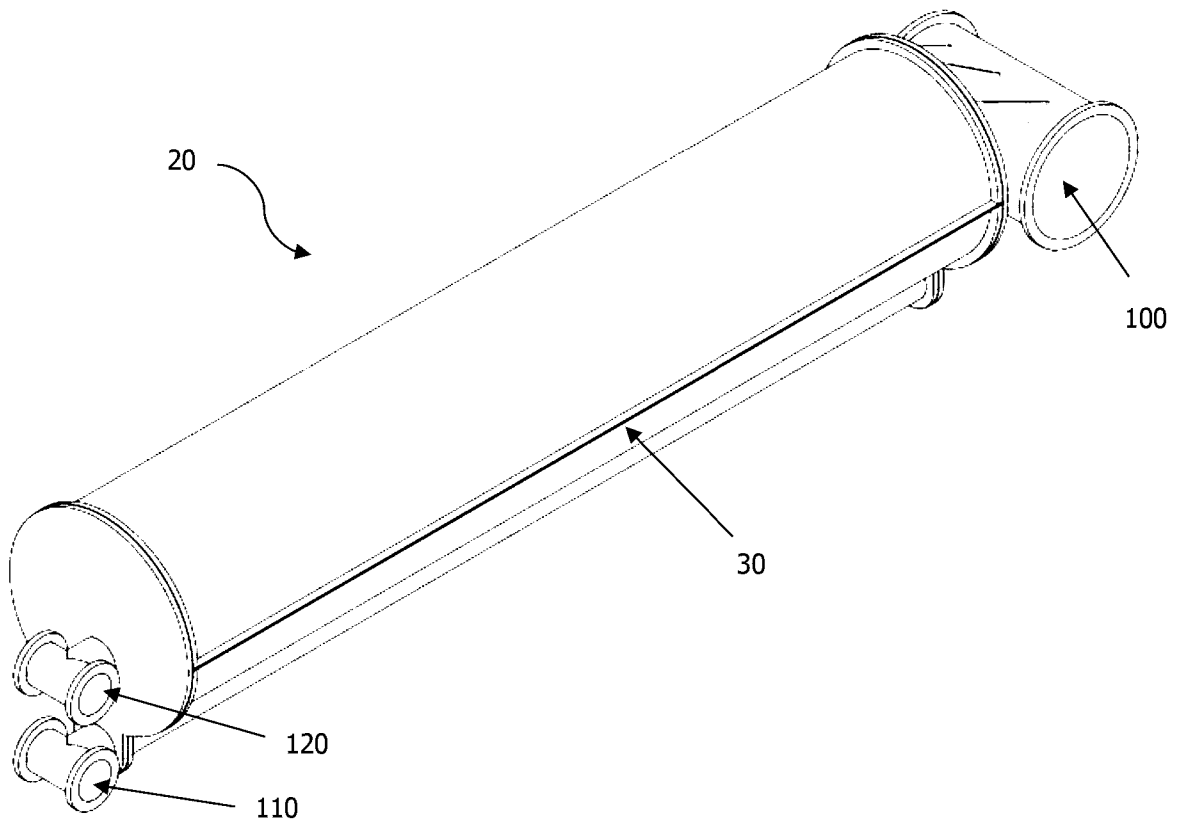


Fig. 1

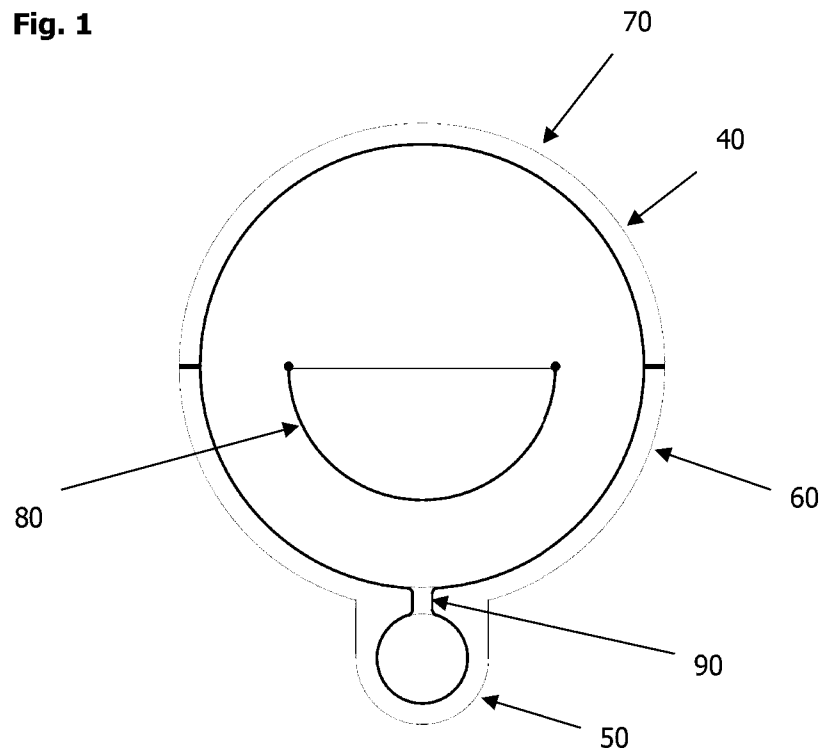
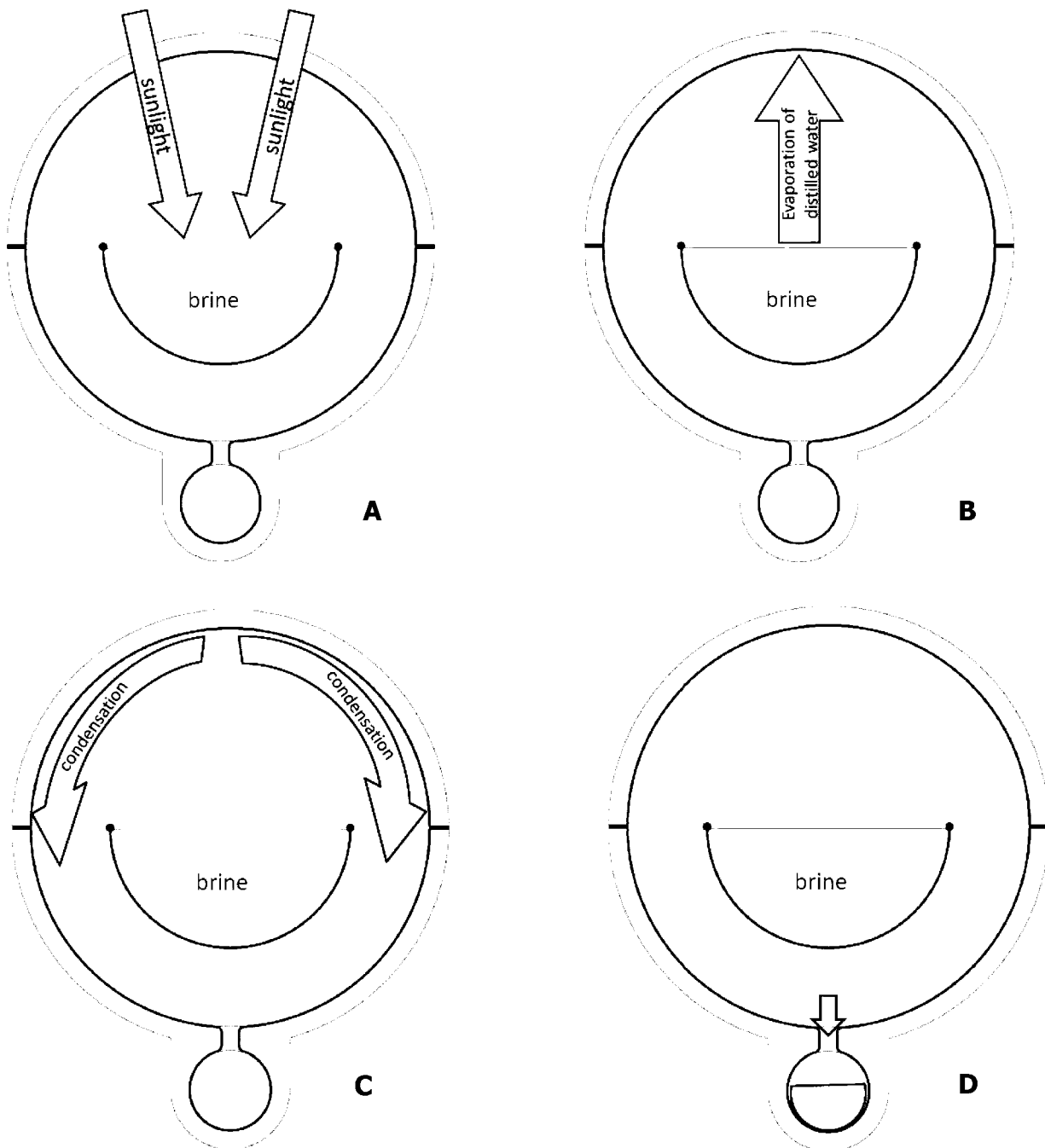


Fig. 2

**Fig. 3**

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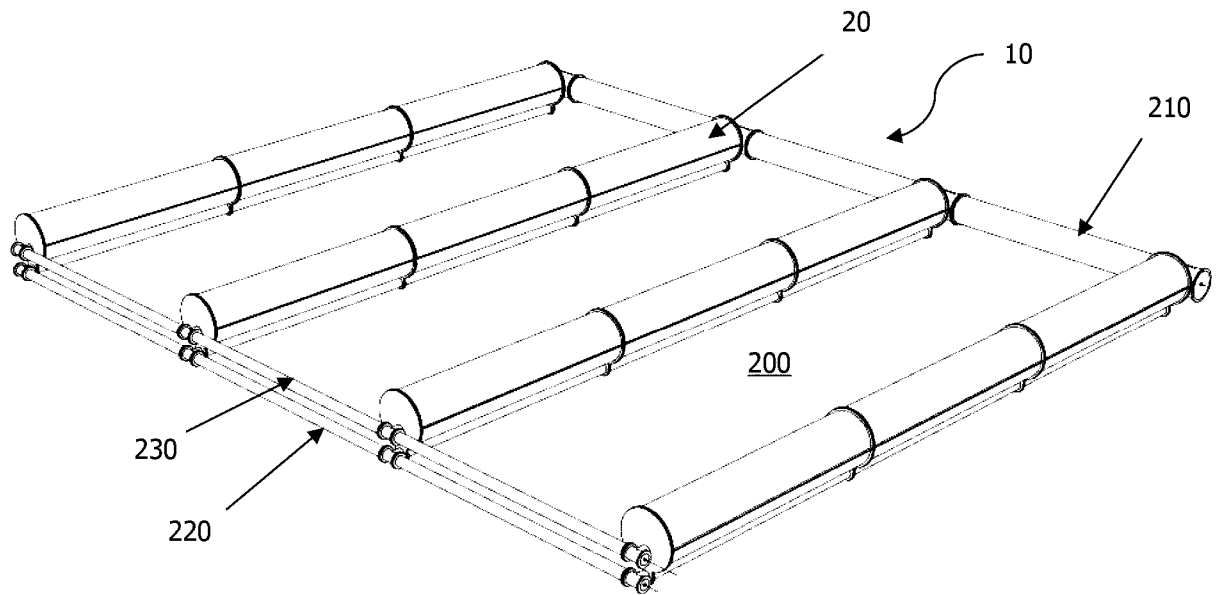


Fig. 4

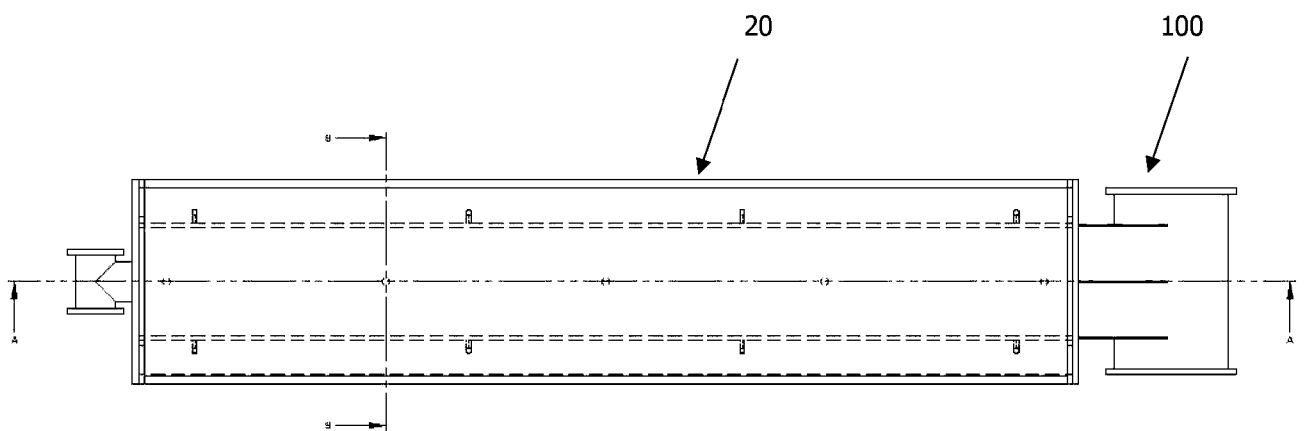
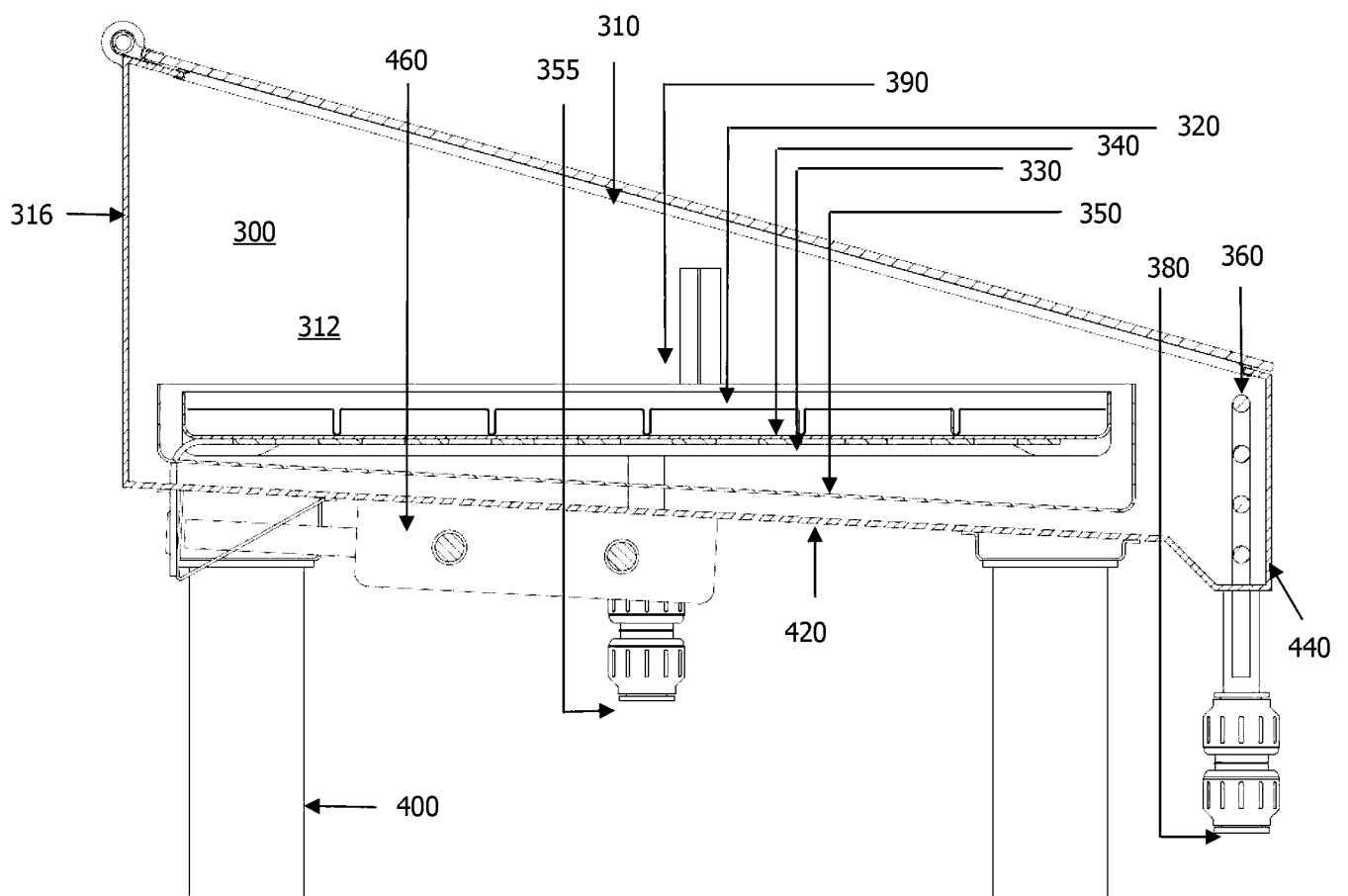
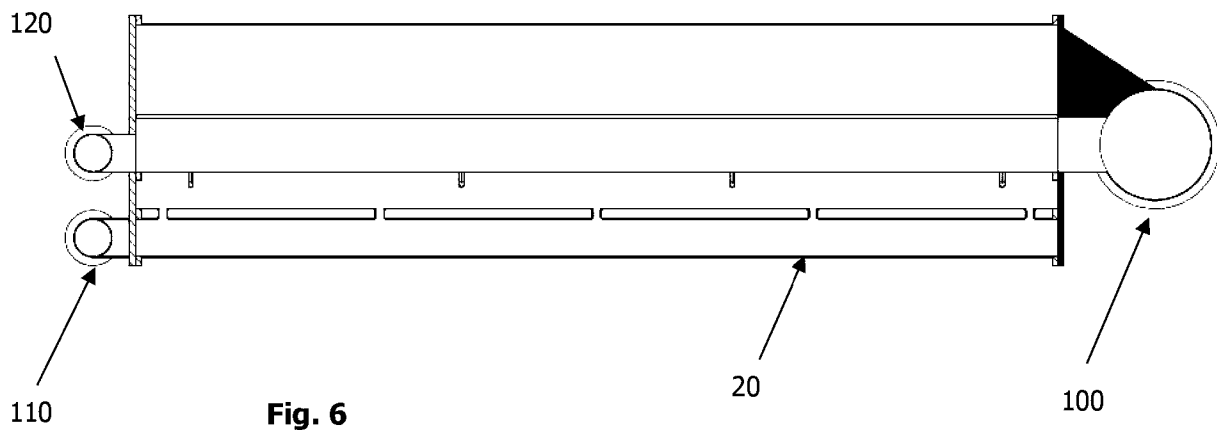
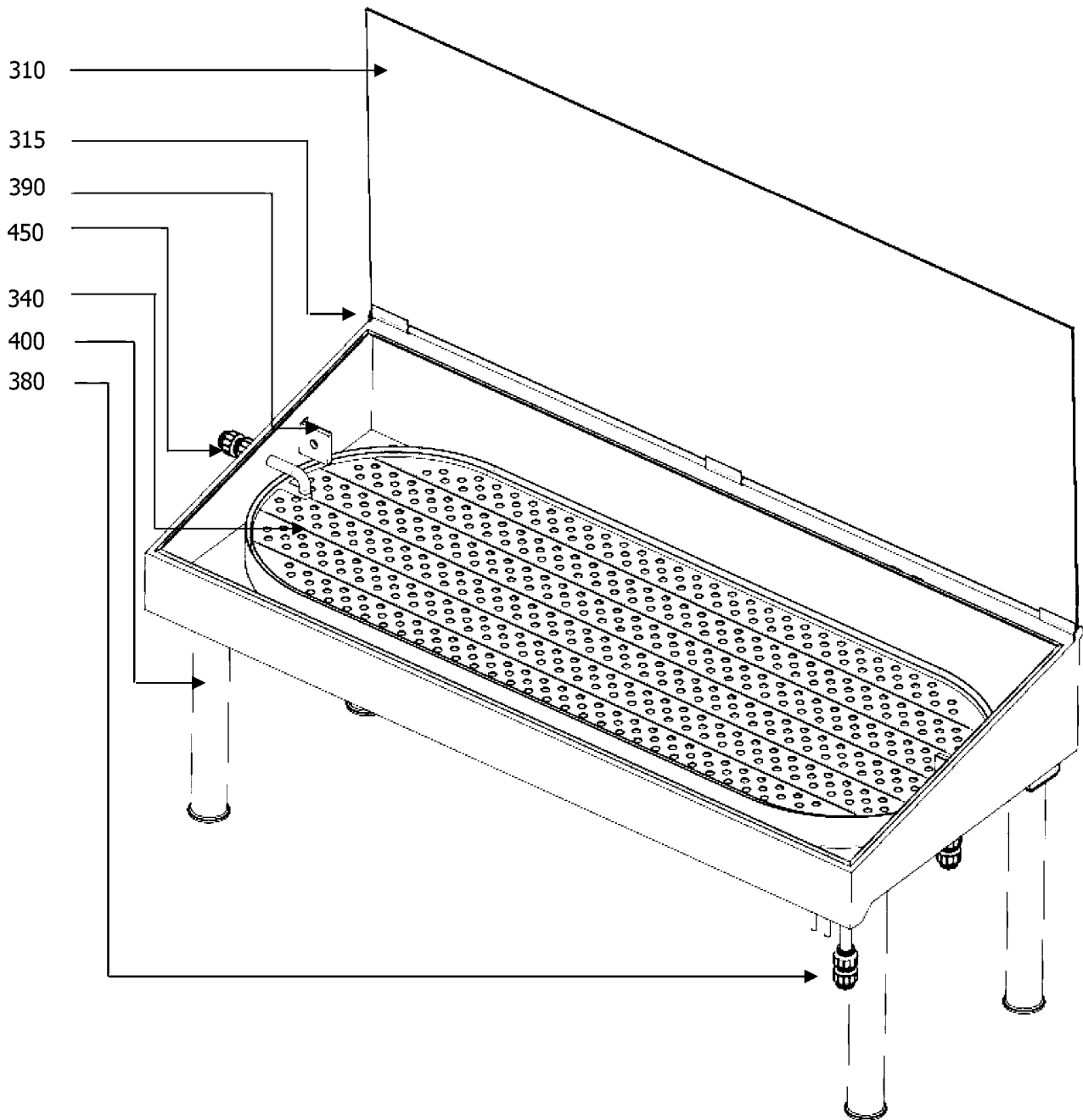


Fig. 5



**Fig. 8**

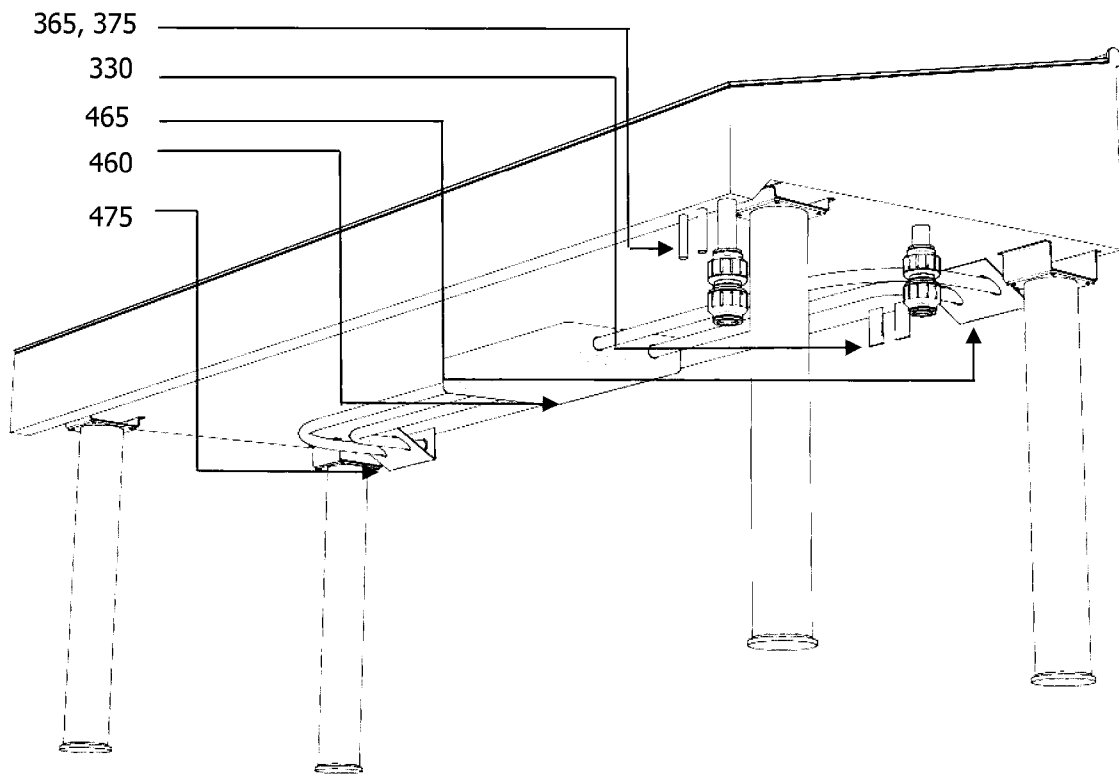


Fig. 9

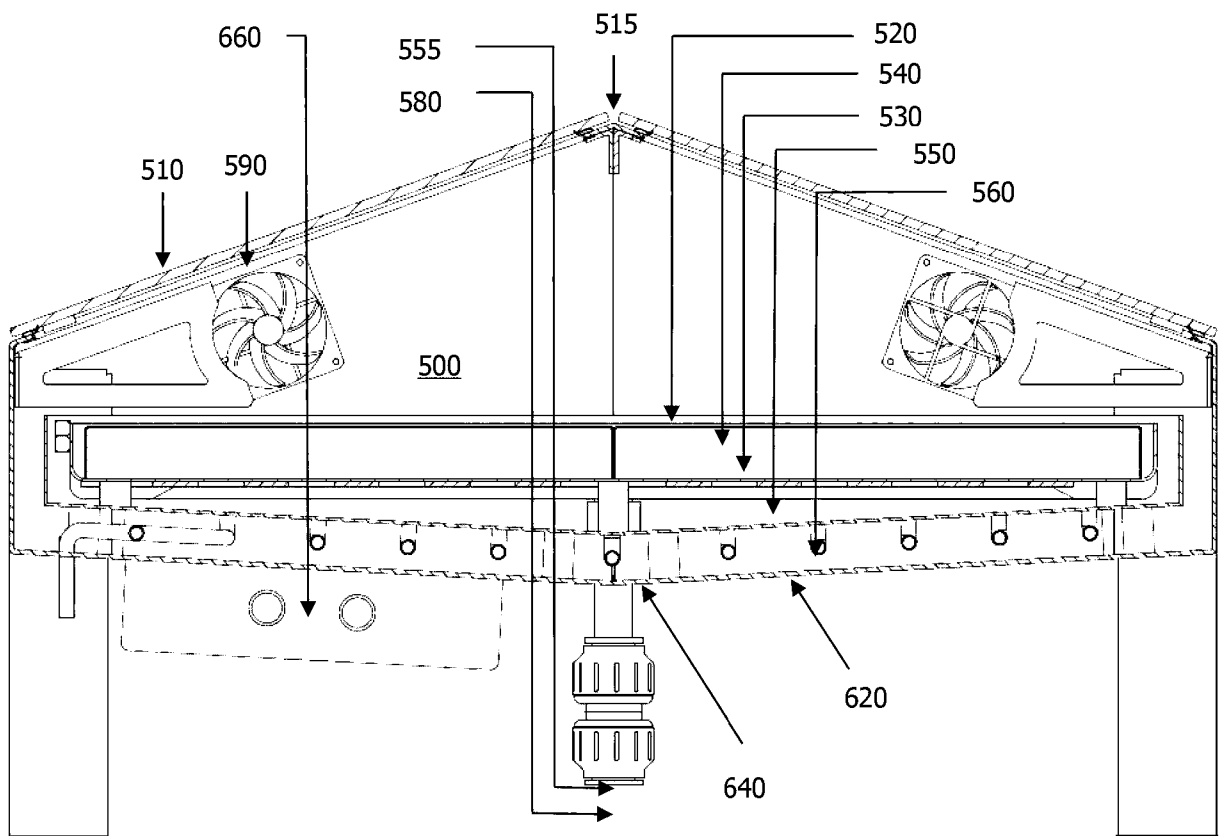
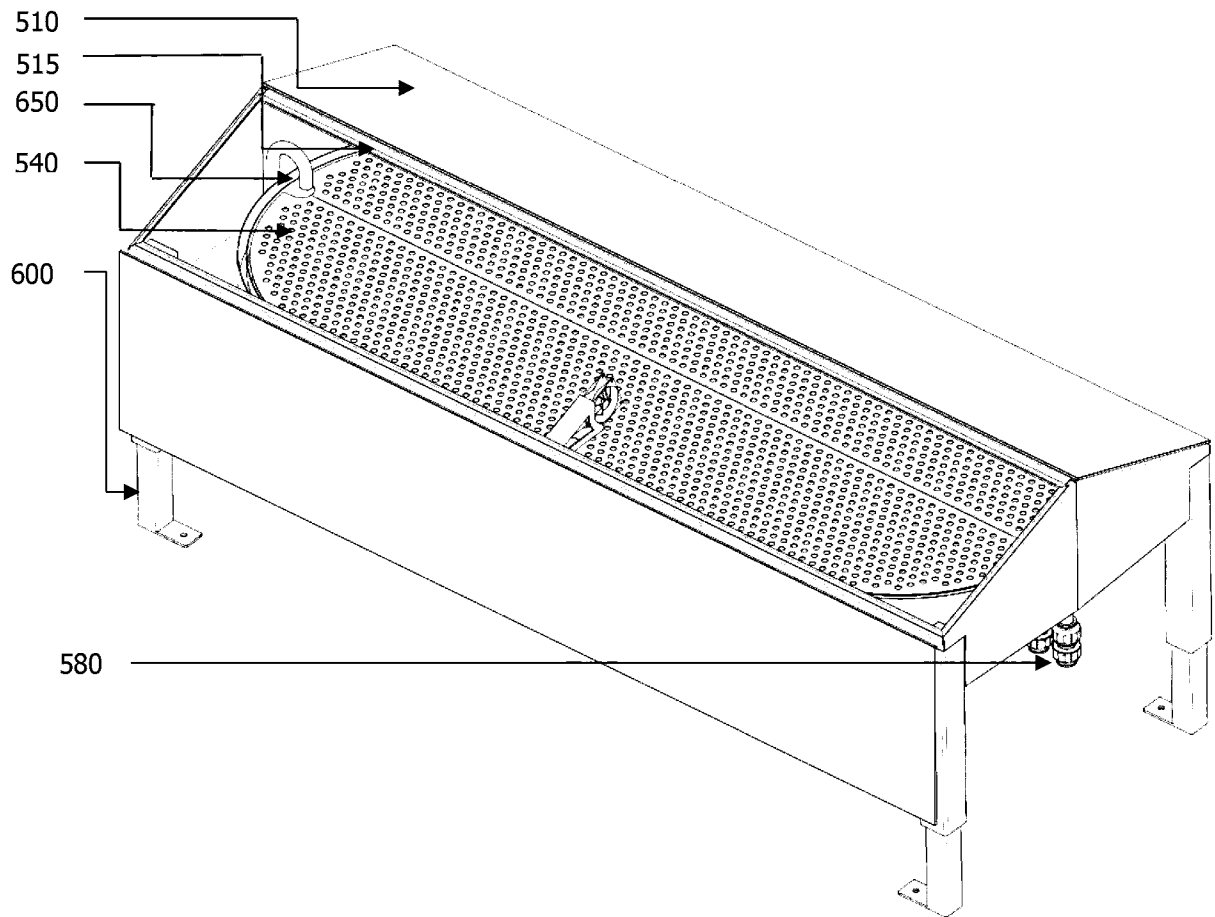


Fig. 10

**Fig. 11**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2017/050402

A. CLASSIFICATION OF SUBJECT MATTER

C02F 1/14 (2006.01) B01D 5/00 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PATENW (EPODOC, WPIAP, TXPEA, TXPEB, TXPEC, TXPEE, TXPEF, TXPEH, TXPEI, TXPEP, TXTPEPEA, TXTPEPEB, TXPES, TXPEU, TXPEY, TXPUSE0A, TXPUSE1A, TXPUSEA, TXPUSEB, TXPWOEA); IPC/CPC - C02F1/14; CPC - B01D1/0035, B01D5/0066, C02F2103/08; IPC - B01D5/00, C02F103/08; keywords (conduit, pipe, piping, tube, tubing, housing, channel, passage, chamber, two, dual, double, second, pair, couple, parallel, adjacent, alongside and like terms); Google, Google Patents, Google Scholar and Espacenet searched using a combination of the following IPC/CPC symbols, keywords and like terms: IPC/CPC - C02F1/14; CPC - B01D1/0035, B01D5/0066, C02F2103/08; IPC - B01D5/00, C02F103/08; distillation, desalination, evaporation, condensation, solar, seawater, brine, conduit, channel, transparent, translucent, overflow, heating element, mesh, fan, cooling tube, glass; Applicant/Inventor name search using AusPat, Espacenet, and internal databases provided by IP Australia

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	



Further documents are listed in the continuation of Box C



See patent family annex

* "A"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier application or patent but published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search 30 August 2017		Date of mailing of the international search report 30 August 2017	
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA Email address: pct@ipaustalia.gov.au		Authorised officer Keiara Moodley AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No. +61262832628	

INTERNATIONAL SEARCH REPORT		International application No.
C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		PCT/AU2017/050402
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 19522239 A1 (HELMUT GOLF et al) 02 January 1997, English translation retrieved from Google Patents abstract, description, figures 1 and 2	1-9
X Y	US 2015/0353379 A1 (JAMES WEIFU LEE) 10 December 2015 figures 1 and 4, paragraphs [0041]-[0042], [0073], [0082]-[0085] figures 1 and 4, paragraphs [0041]-[0042], [0073], [0082]-[0085]	10, 11, 15, 16, 18, 20 14
X Y	DE 20010476 U1 (HOLZ, JOACHIM) 23 November 2000, English translation retrieved from Espacenet description, figures 1 and 2, claim 10 description, figures 1 and 2, claim 10	10-12, 17, 18 14
X Y	US 4135985 A (LA ROCCA) 23 January 1979 abstract, figures 1 and 2, column 2 line 35-column 5 line 14 abstract, figures 1 and 2, column 2 line 35-column 5 line 14	10, 11, 13, 18, 19 14
Y	US 2011/0088423 A1 (IEARDI) 21 April 2011 figure 2, paragraphs [0017], [0067]-[0071]	14

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
the subject matter listed in Rule 39 on which, under Article 17(2)(a)(i), an international search is not required to be carried out, including
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Supplemental Box for Details

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

Supplemental Box**Continuation of: Box III**

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- Claims 1 to 9 are directed to a water distillation system. The feature of a distillation unit having a longitudinally extending channel within a longitudinally extending conduit is specific to this group of claims.
- Claims 10 to 20 are directed to a water distillation system. The feature of a housing, a cover, a brine tray in communication with a brine inlet and outlet, and a distilled water outlet is specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all the claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claimed inventions and therefore cannot provide the required technical relationship. Therefore there is no special technical feature common to all the claimed inventions and the requirements for unity of invention are consequently not satisfied *a priori*.

INTERNATIONAL SEARCH REPORT		International application No.	
Information on patent family members		PCT/AU2017/050402	
This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.			
Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	Publication Date	Publication Number	Publication Date
DE 19522239 A1	02 January 1997	DE 19522239 A1	02 Jan 1997
US 2015/0353379 A1	10 December 2015	US 2015353379 A1	10 Dec 2015
		CN 102027116 A	20 Apr 2011
		CN 103429306 A	04 Dec 2013
		US 2009261166 A1	22 Oct 2009
		US 8141780 B2	27 Mar 2012
		US 2012241519 A1	27 Sep 2012
		US 8622300 B2	07 Jan 2014
		US 2011120854 A1	26 May 2011
		US 8673119 B2	18 Mar 2014
		US 2010330639 A1	30 Dec 2010
		US 8753837 B2	17 Jun 2014
		US 2014120986 A1	01 May 2014
		US 8944328 B2	03 Feb 2015
		US 2015189067 A1	02 Jul 2015
		US 9154602 B2	06 Oct 2015
		US 2012298499 A1	29 Nov 2012
		US 9259662 B2	16 Feb 2016
		US 2016026726 A1	28 Jan 2016
		US 9311419 B2	12 Apr 2016
		US 2016217359 A1	28 Jul 2016
		US 9679233 B2	13 Jun 2017
		US 2017132503 A1	11 May 2017
		WO 2009105714 A2	27 Aug 2009
		WO 2012087935 A2	28 Jun 2012
DE 20010476 U1	23 November 2000		
US 4135985 A	23 January 1979	US 4135985 A	23 Jan 1979
		IT 1062845 B	11 Feb 1985
US 2011/0088423 A1	21 April 2011	US 2011088423 A1	21 Apr 2011
		CA 2756563 A1	01 Oct 2009
		WO 2009117801 A1	01 Oct 2009
End of Annex			
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001. Form PCT/ISA/210 (Family Annex)(July 2009)			