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(54) **SYSTEMS AND METHODS FOR SOLAR WATER PURIFICATION**

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(51) **Int. Cl.**

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B01D 3/10	(2006.01)
C02F 1/14	(2006.01)
C02F 1/04	(2006.01)
B01D 21/00	(2006.01)

(52) **U.S. Cl.**

USPC **203/10**; 203/47; 203/48; 203/100; 203/DIG. 1; 202/154; 202/167; 202/234; 202/261; 159/903

(58) **Field of Classification Search** 203/DIG. 1, 203/10, 47, 48, 100; 202/154, 167, 234, 202/261; 159/903

See application file for complete search history.

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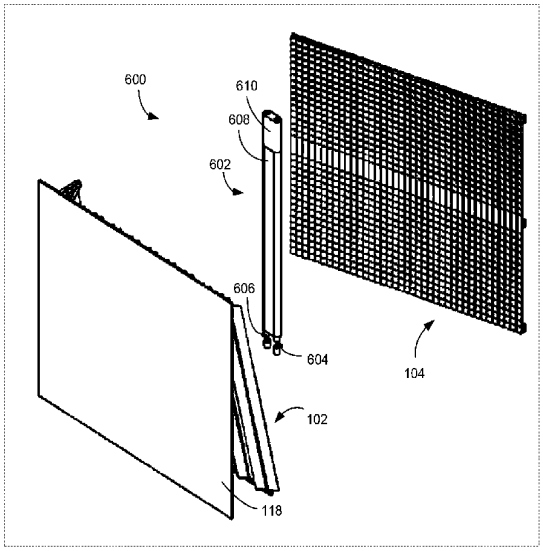
(57) **ABSTRACT**

Systems and methods for solar water purification are described. In one exemplary aspect, the system includes a sun-tracking reflecting mirror unit, and a two-axis Fresnel concentrator mirror unit to collect sunlight reflected from the sun-tracking reflecting mirror unit and focus the sunlight. A central water purification boiler module includes a heating zone upon which the sunlight is focused by the two-axis Fresnel concentrator mirror unit. The focused sunlight heats the water contained therein to create steam which is redirected to heat water coming into the boiler and to condense as purified water.

20 Claims, 13 Drawing Sheets



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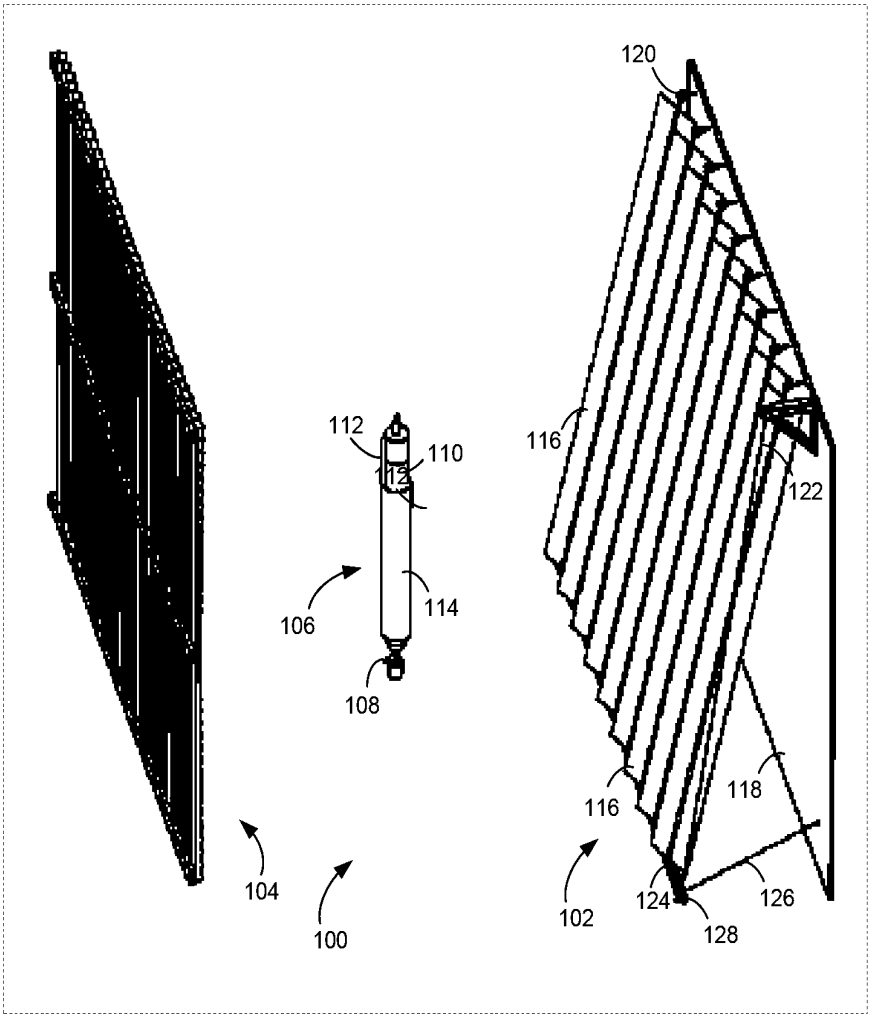

Fig. 1

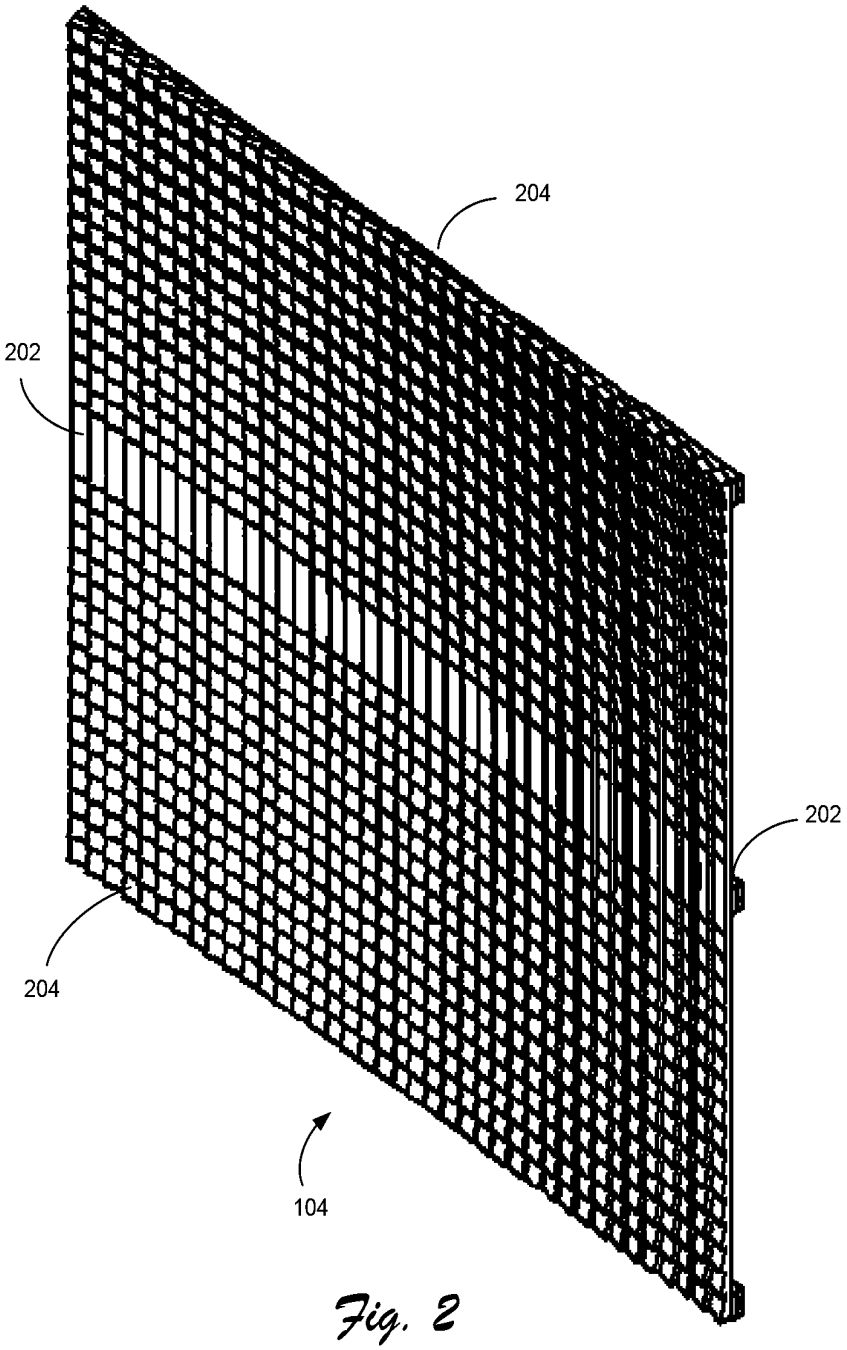

Fig. 2

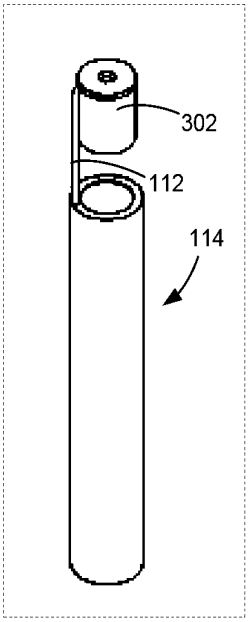

Fig. 3

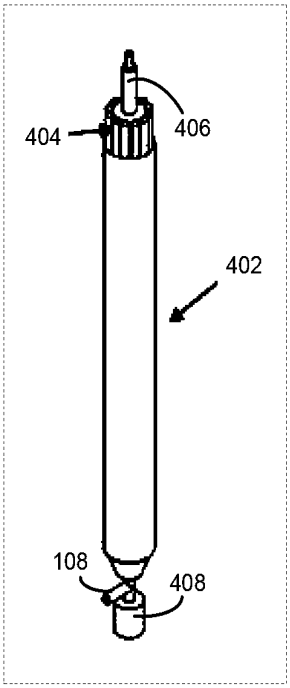

Fig. 4

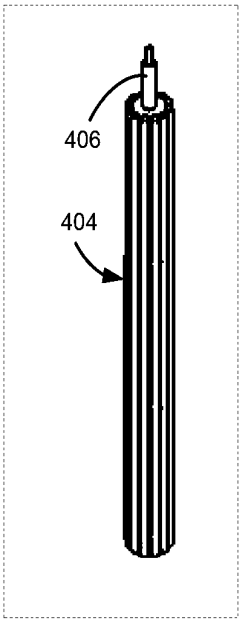

Fig. 5

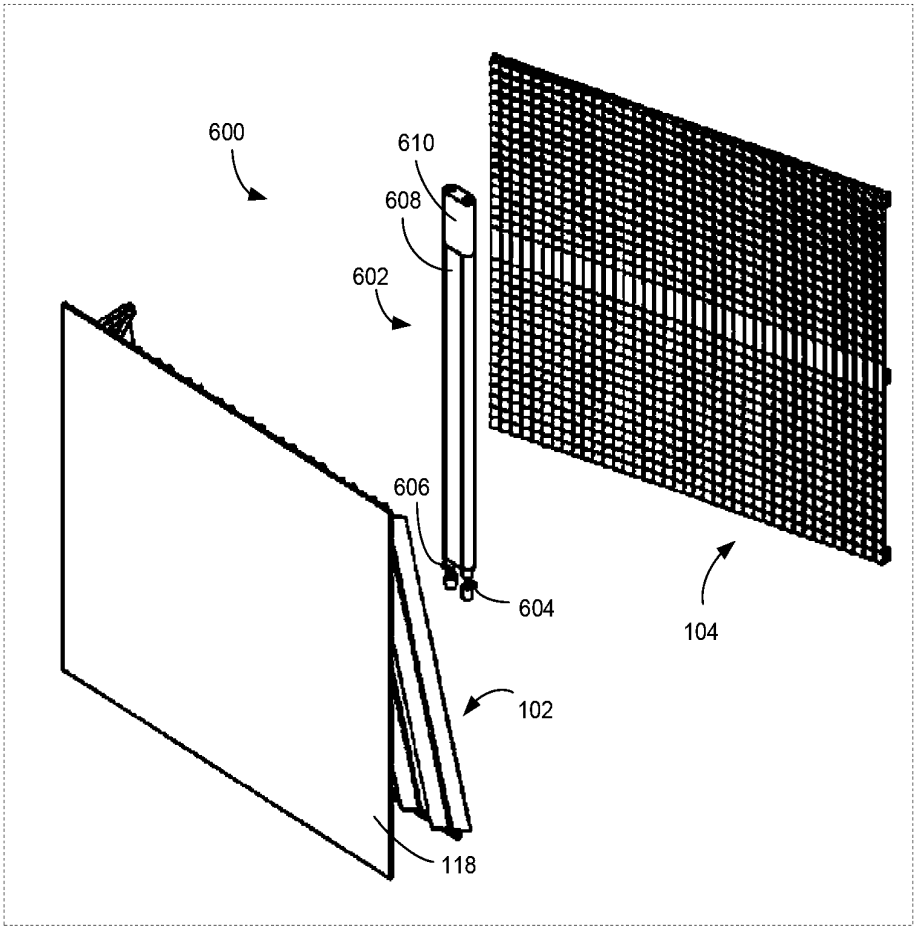

Fig. 6

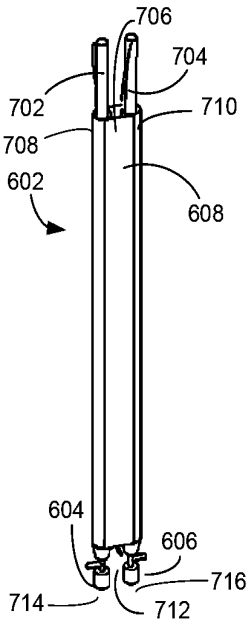

Fig. 7

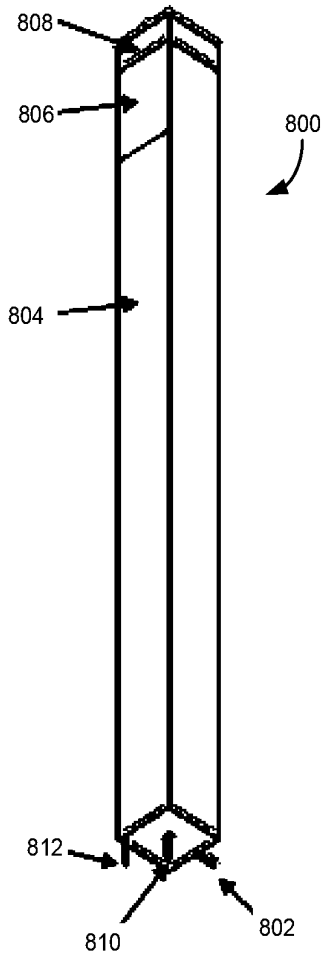

Fig. 8

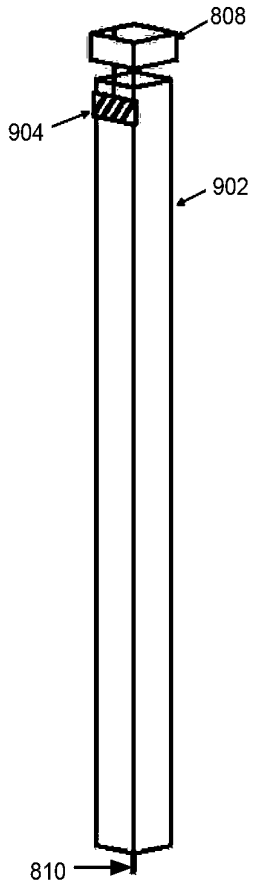

Fig. 9

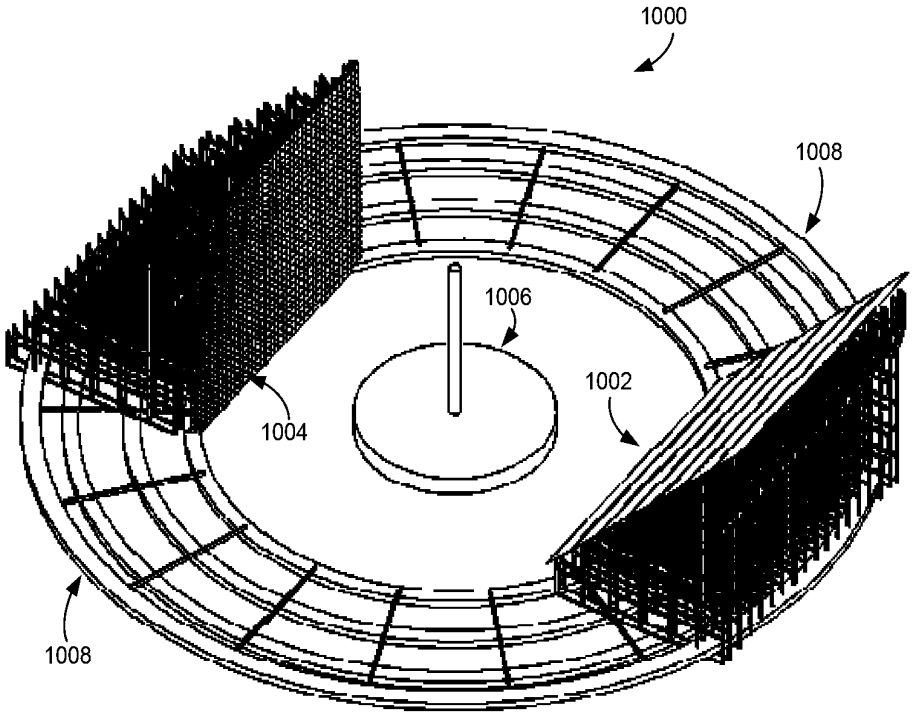

Fig. 10

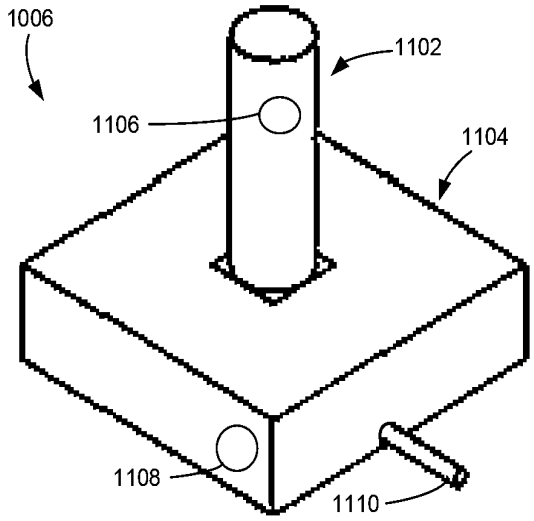

Fig. 11

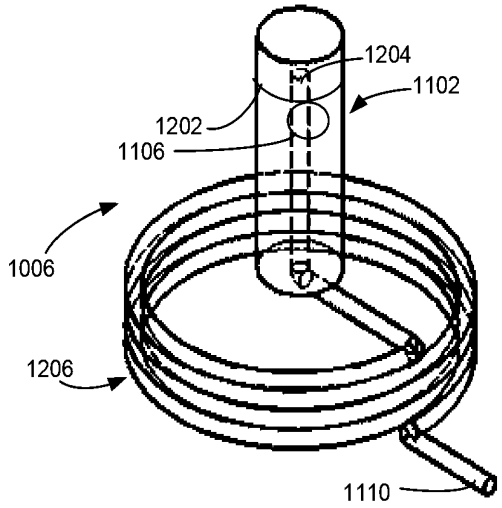

Fig. 12

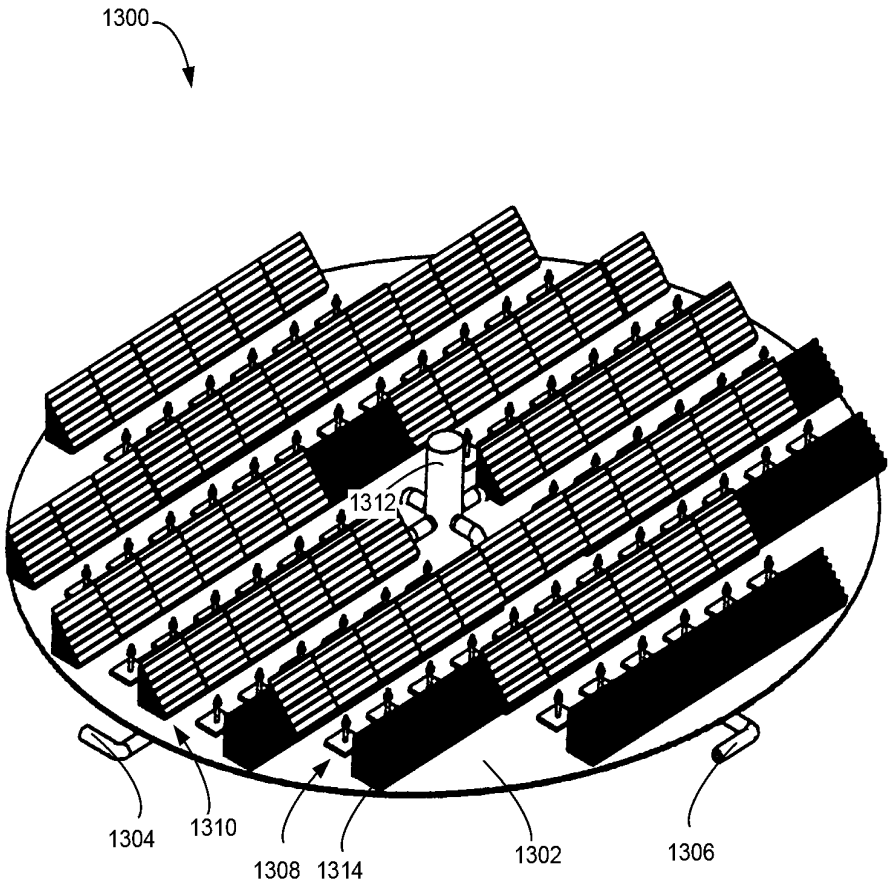

Fig. 13

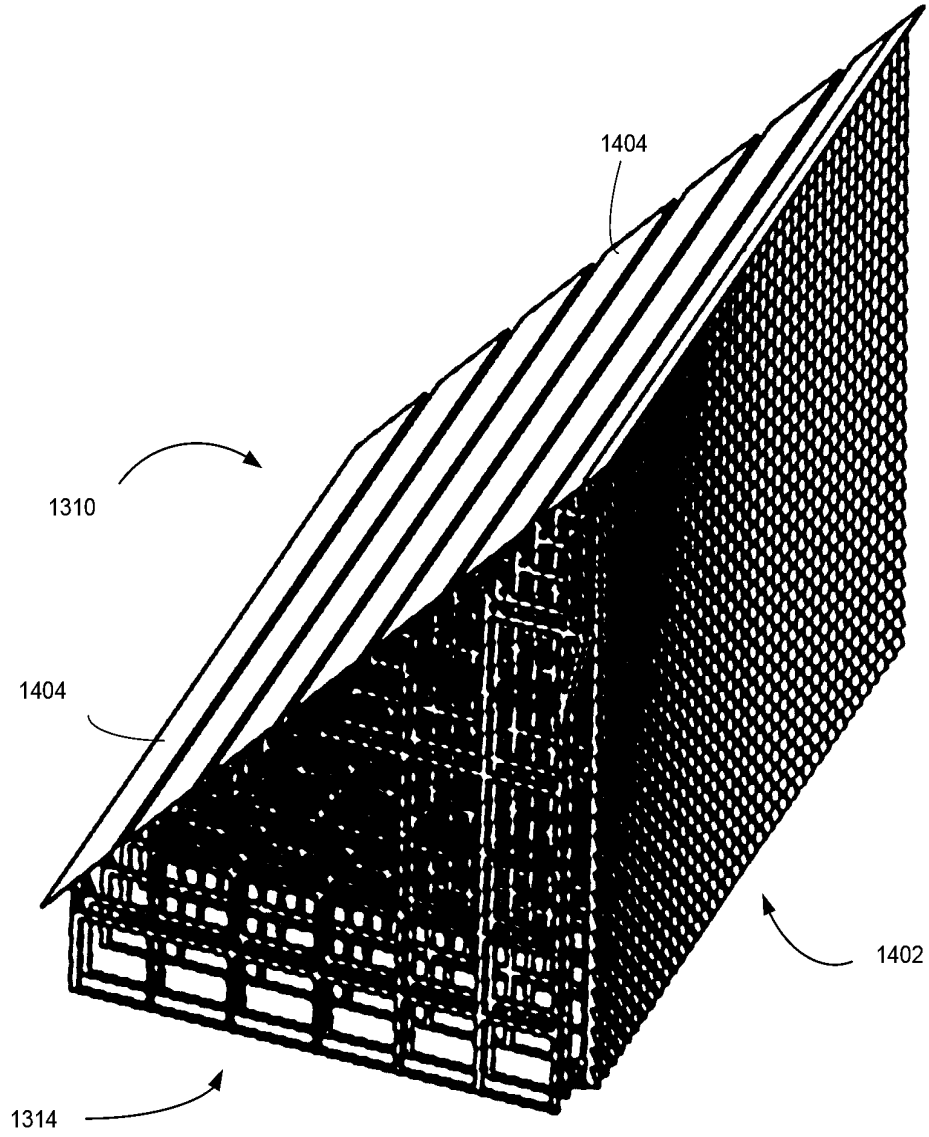

Fig. 14

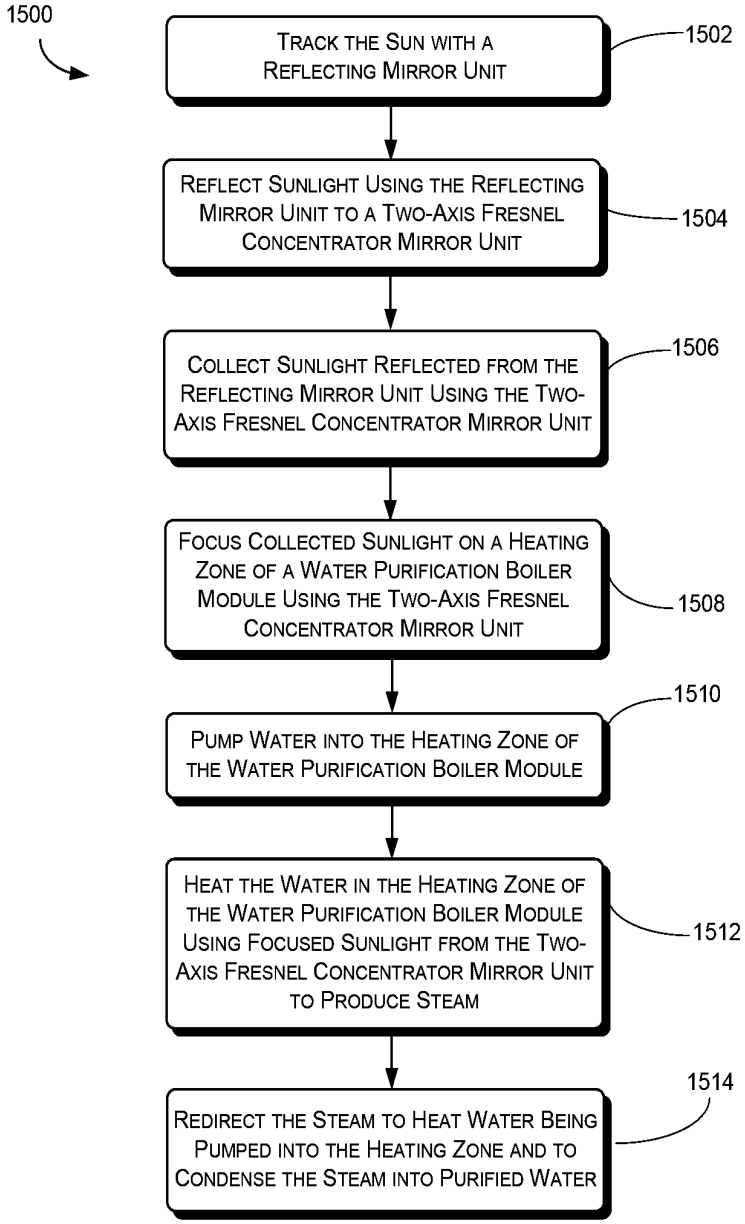
1500
TRACK THE SUN WITH A REFLECTING MIRROR UNIT
1502
REFLECT SUNLIGHT USING THE REFLECTING MIRROR UINIT TO A TWO-AXIS FRESNEL CONCENTRATOR MIRROR UNIT
1504
COLLECT SUNLIGHT REFLECTED FROM THE REFLECTING MIRROR UNIT USING THE TWO-AXIS FRESNEL CONCENTRATOR MIRROR UNIT
1506
FOCUS COLLECTED SUNLIGHT ON A HEATING ZONE OF A WATER PURIFICATION BOILER MODULE USING THE TWO-AXIS FRESNEL CONCENTRATOR MIRROR UNIT
1508
PUMP WATER INTO THE HEATING ZONE OF THE WATER PURIFICATION BOILER MODULE
1510
HEAT THE WATER IN THE HEATING ZONE OF THE WATER PURIFICATION BOILER MODULE USING FOCUSED SUNLIGHT FROM THE TWO-AXIS FRESNEL CONCENTRATOR MIRROR UNIT TO PRODUCE STEAM
1512
REDIRECT THE STEAM TO HEAT WATER BEING PUMPED INTO THE HEATING ZONE AND TO CONDENSE THE STEAM INTO PURIFIED WATER
1514

Fig. 15

SYSTEMS AND METHODS FOR SOLAR WATER PURIFICATION

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to U.S. Provisional Patent Application Ser. No. 61/347,452, titled "Solar Water Purification System," filed 23 May 2010, which is hereby incorporated by reference.

BACKGROUND

Conventional water desalination and/or purification systems require considerable amounts of energy and/or equipment. Additionally, existing solar systems to purify water (e.g. solar stills) are generally cost prohibitive and typically inefficient. Such conventional systems may also produce concentrated brine discharges that can harm the environment.

SUMMARY

Systems and methods for solar water purification are described. In one exemplary aspect, the system includes a sun-tracking reflecting mirror unit, and a two-axis Fresnel concentrator mirror unit to collect sunlight reflected from the sun-tracking reflecting mirror unit and focus the sunlight. A central water purification boiler module includes a heating zone upon which the sunlight is focused by the two-axis Fresnel concentrator mirror unit. The focused sunlight heats the water contained therein to create steam which is redirected to heat water coming into the boiler and to condense as purified water.

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the following Detailed Description section. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

In the Figures, the left-most digit of a component reference number identifies the particular Figure in which the component first appears.

FIG. **1** shows an example of a wall-mounted solar water purification system, according to one embodiment.

FIG. **2** shows an example two-axis Fresnel concentrator mirror unit adapted for use in the present solar water purification system, according to one embodiment.

FIG. **3** shows an example of a steam-condensing jacket for use with the water purification boiler module of FIG. **1**, according to one embodiment.

FIG. **4** shows an example inner column of the water purification boiler module of FIG. **1**, according to one embodiment.

FIG. **5** shows an example of a cleaning shaft adapted for use in the water purification boiler module shown in FIGS. **1**, **3** and **4**, according to one embodiment.

FIG. **6** shows another example of a wall-mounted solar water purification system employing an alternative embodiment water purification boiler module, according to one embodiment.

FIG. **7** shows the water purification boiler module of FIG. **6**, with the steam collection box removed to show the screw-type cleaning shafts, according to one embodiment.

FIG. **8** shows a third example water purification boiler module adapted for use with the present solar water purification system, according to one embodiment.

FIG. **9** shows a steam-condensing inner column and cleaning rack of the water purification boiler module of FIG. **8**, according to one embodiment.

FIG. **10** shows an example of a track mounted solar water purification system, according to one embodiment.

FIG. **11** shows an example water purification boiler module adapted for use with the track mounted water purification system of FIG. **10**, according to one embodiment.

FIG. **12** is a partially fragmented view of water purification boiler module of FIG. **11** with the casing removed, according to one embodiment.

FIG. **13** is a perspective view of a cascaded solar water purification system, according to one embodiment.

FIG. **14** is a perspective view of a support structure mounting a sun-tracking reflector mirror unit on one side and mounting a two-axis Fresnel concentrator mirror unit on the other side for cascaded arrangement, such as shown in FIG. **13**, according to one embodiment.

FIG. **15** shows an example procedure for solar water purification, according to one embodiment.

DETAILED DESCRIPTION

Overview

The systems and methods described herein relate to solar water purification. The present systems and methods may be wall-mounted, are relatively easy to maintain, assemble and disassemble, and have considerably zero discharge with substantially no brine water blow-down. This gives the present systems and methods the ability to purify sea, sewage water, drainage water, manufacturing process wastewater, etc., without any or substantially any liquid discharge that may be harmful to the environment. In one implementation, for example, the system is wall-mounted and uses a curtain-style hanging sun-tracking reflector mirror arrangement to direct sunlight onto a two-axis Fresnel mirror that works as a collector to concentrate solar radiation by point focusing the solar radiation. Other implementations may employ additional similar fixed two-axis Fresnel type mirrors that work as paired collectors to point focus solar radiation, with corresponding reflecting mirrors. Paired mirrors, for example, may be track mounted or cascaded. In accordance with various embodiments, use of low cost anti-scalant, such as acetic acid, allows dissolved and suspended water contaminates to be extracted as solids. Exemplary system embodiments may also re-circulate latent steam heat to increase heat use efficiency. Other than basic filtration, the present exemplary systems and methods are independent of pre-treatment of water. The salts and other dissolved solids can be reclaimed for beneficial use.

The particular examples discussed herein use solar energy and may refer to desalination of salt water. However, the present systems and methods for water purification may use any source of thermal energy and may be used to purify any number of water sources such as sewage water, drainage water, manufacturing process wastewater, and/or so on.

Example Wall-Mounted Solar Water Purification System

FIG. **1** shows example wall-mounted solar water purification system **100**, according to one embodiment. Solar water purification system **100** comprises sun-tracking reflector mirror unit **102** and two-axis Fresnel concentrator mirror unit **104**, which collects sunlight reflected from sun-tracking reflector mirror unit **102** and focuses the sunlight on central coaxial water purification boiler module **106**. Raw, contami-

nated water enters illustrated coaxial water purification boiler module **106** from the bottom at raw water inlet **108**, where it is mixed with an anti-scalant such as acetic acid in an inner column of the coaxial water purification boiler module tube. The mixture is pumped such that its level reaches heating zone **110**. Solar rays are reflected from wall-mounted curtain-like solar sun-tracking reflector mirror unit **102** to multiple (e.g., two) axis Fresnel concentrator mirror unit **104** which focuses the solar radiation along two axes to point focus the solar radiation on heating zone **110** of water purification boiler module **106**. The resulting high temperature at heating zone **110** boils the acid-raw water mixture. In accordance with various implementations, the heated surface temperature at heating zone **110** may be around 700° C. However, the type and concentration of the anti-scalant present raises the boiling temperature of the water mixture to about 118-200° C., which is the inner surface temperature at heating zone **110** in such implementations. Since the water has lower boiling temperature than the anti-scalant (e.g., acetic acid boils at 118° C.), the water leaves the boiling mixture as steam that exits heating zone **110** at the top and is redirected, via steam collection tube **112** to steam condenser jacket **114** at the bottom by the water purification boiler module.

In accordance with various implementations, sun-tracking reflector mirror unit **102** includes sun tracking mirror slides **116** that are pivotally mounted to a wall (**118**) or similar (existing) structure using swivel joints **120**. Mirror slides **116** may be connected by cable **122**, and their bases may be connected by rack **124**. Rack **124**, and hence the bases of mirror slides **116** may be stood-off from wall **118** by brace **126**. Two-axis sun tracking motor **128** adjusts the angle mirror slides **116** at the same time by movement along brace **126** and movement of cable **122**. In this implementation, flat mirrors slides **116** are connected together and are moved by a single motor.

FIG. **2** shows an example two-axis Fresnel concentrator mirror unit **104** adapted for use in the present solar water purification system, according to one embodiment. In accordance with various implementations, two-axis Fresnel solar concentrator mirror **104** is affixed to a wall, or similar structure (not shown for clarity). Two-axis Fresnel concentrator mirror unit **104** is comprised of a number of flat, rectangular (**202**) and generally square mirrors (**204**) oriented to provide two axes of focus with respect to the overall face of two-axis Fresnel concentrator mirror unit **104** to provide the aforementioned point focus, along two axes at the heating zone of the water purification boiler module. In accordance with particular implementations, low cost flat rectangular mirrors that are of the same size are arranged in two directions to give point focus for two-axis Fresnel concentrator mirror unit **104**. Each mirror is tilted in two directions, relative to the flat frame of the unit, such that the incident normal rays are reflected in one place. At the same time these flat rectangular mirrors have flat edge that can be easily mounted on a flat frame. This arrangement reduces the cost of the system. Despite being relatively flat, the present two-axis Fresnel solar concentrator mirror unit reflects and focuses light in the manner of a paraboloid dish. That is, the present two-axis Fresnel solar concentrator mirror unit focuses the normal parallel incident light into a single point at the focus of the unit, i.e. at the focus of the paraboloid.

FIG. **3** shows an example of steam-condensing jacket **114** for use with coaxial water purification boiler module **106** of FIG. **1**, according to one embodiment. Steam collection cap **302** collects steam, which is redirected to steam-condensing jacket **114** via steam collection tube **112**. Steam-condensing jacket **114** is insulated from the outside but exchanges heat with the inner column of coaxial water purification boiler module **102**, which contains the water and acid mixture. Thus, the redirected steam pre-heats the mixture and condenses when cooled by the incoming relatively cold raw water and acid mixture. The distilled condensed water is collected from the open bottom of steam-condensing jacket **114**.

FIG. **4** shows example inner column **402** of water purification boiler module **106** of FIG. **1**, according to one embodiment. Inner column **402** contains the water and anti-scalant mixture. The solids that are dissolved in the raw water are continuously scrubbed from the inside of inner column **402** by cleaning rods **404** operatively coupled, mounted, or otherwise fixed to/on rotating shaft **406**, which is driven by a motor (not shown) mounted atop water purification boiler module **106**. The solids settle at solids collection container **408** at the bottom of the water purification boiler module. FIG. **5** shows an example of cleaning shaft **406** with cleaning rods **404** adapted for use in the water purification boiler module of FIGS. **1**, **3** and **4**, according to one embodiment.

Another Example Solar Water Purification System

FIG. **6** shows an alternative example wall-mounted solar water purification system **600** which employs alternative embodiment water purification boiler module **602**, according to one embodiment. In this example system, raw contaminated water enters water purification boiler module **602** from the bottom at raw water inlets **604** and **606** where it is mixed with an anti-scalant such as acetic acid. The mixing occurs in columns that are located at the sides of water purification boiler module **602**. The mixture is pumped such that its level reaches heating zone **608**. Solar rays are reflected from wall-mounted sun-tracking reflector mirror unit **102** to two-axis Fresnel concentrator mirror unit **104** which provides heat at heating zone **608**. The resultant high temperature at heating zone **608** makes the acid-raw water mixture boil. Since the water has lower boiling temperature than the anti-scalant, the water leaves the boiling mixture as steam and exits heating zone **608** via steam collection box **610** at the top of water purification boiler module **602**. The steam is redirected by steam collection box **610** to a steam condenser column in the middle of water purification boiler module **602**, between the raw water and anti-scalant mixture columns.

FIG. **7** shows water purification boiler module **602** of FIG. **6**, according to one embodiment, with steam collection box **610** removed to show screw-type cleaning shafts **702** and **704**. Also shown in FIG. **7** is steam-condensing column **706**, which exchanges heat with outer tubes **708** and **710** that contain the water and acid mixture, thereby pre-heating the mixture and condensing the steam when cooled by the incoming relatively cold raw water. The resulting distilled condensed water is collected from distilled water outlet **712** at the bottom of steam-condensing column **706**. In this implementation, the solids that are dissolved in the raw water are continuously scrubbed from outer columns **708** and **710** by rotating screw-type cleaning shafts **702** and **704**, which are driven by one or more motors (not shown for purposes of clarity) mounted atop water purification boiler module **602**. Solids settle at solids collection containers **714** and **716** at the bottom of water purification boiler module **602**.

An Exemplary Solar Water Purification System with a Square Column Water Purification Boiler Module

FIG. **8** shows third example water purification boiler module **800** adapted for use with the present solar water purification system. In this exemplary system, raw water enters water purification boiler module **800** from the bottom, via inlet port **802**. The raw water mixes with an anti-scalant such as acetic acid and is kept between outer casing **804** and an inner steam-condensing tube. The raw water is pumped such that its pres-

sure will allow the mixture of raw water and anti-scalant to rise to heating zone **806**. Concentrated solar energy such as provided by solar sun-tracking reflector mirror unit **102** and two-axis Fresnel concentrator mirror unit **104**, as discussed above, heats heating zone **806** to about 118°-200° C. The mixture boils and the resulting steam rises to upper cap **808** where it flows down inside the steam-condensing inner column. The steam condenses at the bottom of water purification boiler module **800** and exits as distilled water, via distilled water outlet **810**. Due to the presence of the anti-scalant, salt in the raw water precipitates down the unit between the outer casing and the steam-condensing tube, as loose solid where it is discharged from salt exit port **812**.

FIG. **9** shows steam-condensing inner column **902** and cleaning rack **904** of water purification boiler module **800** of FIG. **8**, according to one embodiment. As noted, as the water and anti-scalant mixture boils, the resulting steam rises to upper cap **808** where it flows down inside steam-condensing inner column **902**. The steam exchanges its latent heat with the raw water mixture present in the space between inner column **902** and outer casing **804**. Resultantly, the steam condenses at the bottom of steam-condensing inner column **902** and exits as distilled water, via distilled water outlet **810**. Cleaning rack **904** periodically scrapes heating zone **806**, between the outer casing's inner surface and the steam-condensing inner column's outer surface, to remove any attached solids and allow them to precipitate down and exit water purification boiler module **800** via exit port **812** (FIG. **8**). A venting hole (not shown) in upper cap **808** allows any non-condensable gases to vent.

An Exemplary Track-Mounted System for Solar Water Purification

FIG. **10** shows example track mounted solar water purification system **1000**, according to one embodiment. In this exemplary system, solar rays are reflected by sun tracking reflecting mirror unit **1002** to two-axis Fresnel concentrator mirror unit **1004**. Two-axis Fresnel concentrator mirror unit **1004** reflects focused solar rays at water purification boiler module **1006**. Both mirror units **1002** and **1004** rotate on tracks **1008** to follow the sun's movement.

FIG. **11** shows example water purification boiler module **1006** adapted for use with track mounted water purification system **1000** of FIG. **10**, according to one embodiment. Referring to FIG. **11**, water purification boiler module **1006** includes hollow tower **1102** and hollow base **1104**. Concentrated solar rays heat heated zone **1106** at upper part of tower **1102**. Raw water enters water purification boiler module **1006** via opening **1108** at one side of hollow base **1104**. Distilled water exits water purification boiler module **1006** from pipe **1110** at one side of base **1104**. Salt exits the water purification boiler module from the bottom.

FIG. **12** is a partially fragmented view of water purification boiler module **1006** of FIGS. **10** and **11** with the hollow base casing removed, according to one embodiment. Raw water and anti-scalant mixture pumped into hollow base **1104** via opening **1108** raises to upper liquid level **1202**. Heated zone **1106** of tower **1102** is just below upper liquid level **1202**. The mixture is heated by the concentrated solar rays and water is boiled off of the mixture. Steam is collected from the top of the unit by steam collection pipe **1204**. Steam collection pipe **1204** carries the steam downward to steam condensation coil **1206**, which is immersed in the liquid mixture inside hollow base **1104**. The steam in coil **1206** is cooled by the raw water and anti-scalant mixture and in turn, the steam in coil **1206** preheats the raw water and anti-scalant mixture. Salt is deposited from the bottom of the unit as it is allowed to precipitate.

An Exemplary Cascaded System for Solar Water Purification

FIG. **13** is a perspective view of cascaded solar water purification system **1300**, according to one embodiment. Example cascaded solar water purification system **1300** is shown on circular platform **1302**, which may float in a (circular) lake of raw water. The raw water is sucked into system **1300** by suction pipes **1304**, **1306**, etc. The water suction will rotate system **1300** around the center of disc **1302** to track the sun. Floats may be installed or otherwise incorporated into platform **1302** to provide floatation and rotational stability. Water purification boiler modules **1308** are located between rows of sun-tracking reflector mirror units **1310** and rows of two-axis Fresnel concentrator mirror units (obscured in FIG. **13**). Raw water may be sucked into central raw water storage tank **1312** to provide raw water with enough pressure to enter each water desalination module **1308**. The mirror units are sandwiched on support structures **1314**. One face of each support structure mounts a sun-tracking reflector mirror unit **1310** and the other side mounts a two-axis Fresnel concentrator mirror unit.

FIG. **14** is a perspective view of support structure **1314** mounting sun-tracking reflector mirror unit **1310** on one side and mounting two-axis Fresnel concentrator mirror unit **1402** on the other side for cascaded arrangement, such as shown in FIG. **13**, according to one embodiment. Sun-tracking reflector mirror unit slides **1404** are shown disposed at a 45° angle. Solar rays inclined at 90° (i.e. directly overhead) are reflected horizontally by mirror slides **1402**. In accordance with various embodiments, mirror slides are rotated between a maximum 45°, for 90° solar elevation, and a minimum of 10°, for 20° solar elevation. Mirror slides **1404** are connected by a cable (not visible) that allows them to be moved at the same time by motor (not shown) behind the upper mirror slide. The weight of the mirror slides allows them to rotate downward (as shown in FIG. **14**), while the motor rotates them upward. As noted, two-axis Fresnel concentrator mirror unit **1402** is mounted on the back of support structure **1314**, in a generally vertical position for use in a cascaded arrangement, such as shown in FIG. **13**.

An Exemplary Procedure for Solar Water Purification

FIG. **15** shows example procedure **1500** for solar water purification, according to one embodiment. In this example, the sun is tracked with a reflecting mirror unit at **1502**. At block **1504**, sunlight is reflected, using the reflecting mirror unit, to a two-axis Fresnel concentrator mirror unit. The reflected sunlight from the reflecting mirror unit is collected at block **1506** by the two-axis Fresnel concentrator mirror unit. The collected sunlight is focused on a heating zone of a water purification boiler module using the two-axis Fresnel concentrator mirror unit at **1508**. Particularly, in certain implementations, the two-axis Fresnel concentrator mirror unit reflects incident radiation along two intersecting axes, generally intersecting at the heating zone of the water purification boiler module. At block **1510**, water is pumped into the heating zone of the water purification boiler module. The water in the heating zone of the water purification boiler module is heated at block **1512** using focused sunlight from the two-axis Fresnel concentrator mirror unit to produce steam. Then, at block **1514**, the steam is redirected to heat water being pumped into the heating zone and to condense the steam into purified water.

CONCLUSION

Although systems and methods for solar water purification have been described in language specific to structural features and/or methodological operations or actions, it is understood that the implementations defined in the appended claims are

not necessarily limited to the specific features or actions described. Rather, the specific features and operations of solar water purification are disclosed as exemplary forms of implementing the claimed subject matter.

The invention claimed is:

1. A solar water purification method comprising:

tracking the sun with a reflecting mirror unit;

reflecting sunlight using the reflecting mirror unit to a two-axis Fresnel concentrator mirror unit;

collecting sunlight reflected from the reflecting mirror unit using the two-axis Fresnel concentrator mirror unit;

focusing collected sunlight on a heating zone of a water purification boiler module using the two-axis Fresnel concentrator mirror unit;

pumping water into the heating zone of the water purification boiler module;

heating the water in the heating zone of the water purification boiler module using focused sunlight from the two-axis Fresnel concentrator mirror unit to produce steam; and

redirecting the steam to heat water being pumped into the heating zone and to condense the steam into purified water.

2. The method of claim **1**, wherein the two-axis Fresnel concentrator mirror unit reflects incident radiation along two intersecting axes, intersecting at the heating zone of the water purification boiler module.

3. The method of claim **1**, further comprising:

mounting the sun-tracking reflecting mirror unit on a sun-facing surface;

mounting the two-axis Fresnel concentrator mirror unit on a surface opposite the sun-facing surface; and

fixing the water purification boiler module therebetween.

4. The method of claim **1**, further comprising:

mounting the sun-tracking reflecting mirror unit and the two-axis Fresnel concentrator mirror unit on a circular track opposite one another; and

fixing the water purification boiler module therebetween.

5. The method of claim **1**, further comprising mounting the two-axis Fresnel concentrator mirror unit on a back of a support structure for another sun-tracking reflecting mirror unit.

6. A solar water purification system comprising:

a sun-tracking reflecting mirror unit;

a two-axis Fresnel concentrator mirror unit collecting sunlight reflected from the sun-tracking reflecting mirror unit and focusing the sunlight; and

a central water purification boiler module comprising a heating zone, upon which the sunlight is focused by the two-axis Fresnel concentrator mirror unit, heating water contained therein to create steam which is redirected to heat water coming into the boiler and to condense the steam into purified water.

7. The system of claim **6**, wherein the sun-tracking reflecting mirror unit is mounted on a sun-facing surface and the two-axis Fresnel concentrator mirror unit is mounted on a surface opposite the sun-facing surface, with the central water purification boiler module fixed therebetween.

8. The system of claim **6**, wherein the sun-tracking reflecting mirror unit and the two-axis Fresnel concentrator mirror unit are mounted on a circular track opposite one another, with the central water purification boiler module fixed therebetween.

9. The system of claim **6**, wherein the two-axis Fresnel concentrator mirror unit is mounted on a back of a support structure for another sun-tracking reflecting mirror unit.

10. The system of claim **6**, wherein the two-axis Fresnel concentrator mirror unit comprises a plurality of flat mirrors oriented to reflect incident radiation along two intersecting axes, intersecting at the heating zone of the central water purification boiler module.

11. The system of claim **6**, wherein the sun-tracking reflecting mirror comprising a plurality of parallel disposed, rectangular mirror slides, each mirror slide pivotally mounted along an axis of the mirror slide, the plurality of slides connected together to pivot together.

12. The system of claim **6**, wherein the central water purification boiler module is coaxial, comprising an inner column holding water to be purified and an outer jacket to which the steam is redirected to heat water in the inner column and to condense the steam into purified water.

13. The system of claim **6**, wherein the central water purification boiler module comprises spaced apart outer columns holding water to be purified and a central steam condenser column between the outer columns, the steam being redirected into the steam condenser column to heat water in the outer columns and to condense the steam into purified water.

14. The system of claim **6**, wherein the central water purification boiler module comprises an outer casing and an inner steam condensing tube, water to be purified disposed in a space between the outer casing and the inner steam condensing tube, the steam being redirected into the steam condenser tube to heat water disposed in the in the space between the outer casing and the inner steam condensing tube and to condense the steam into purified water.

15. The system of claim **6**, wherein the central water purification boiler module comprises a hollow base and a hollow tower in fluid flow communication with the hollow base, the tower extending upwardly from the base and defining the heating zone in an upper portion of the tower, the base and tower receiving water to be purified up into the heating zone, the central water purification boiler module further comprising a steam collection pipe collecting steam from a top of the tower and redirecting the steam downward into a steam condensation coil, the coil immersed in water to be purified heating the water to be purified and condensing the steam in the coil into purified water.

16. A cascaded solar water purification system comprising:

a plurality of sun-tracking reflecting mirror units;

a plurality of two-axis Fresnel concentrator mirror units, each two-axis Fresnel concentrator mirror unit mounted vertical to a side of a suntracking mirror unit support structure opposite a supported sun-tracking mirror unit, each two-axis Fresnel concentrator mirror unit collecting sunlight reflected from another sun-tracking reflecting mirror unit and focusing the sunlight; and

a plurality of water purification boiler modules, each comprising a heating zone upon which the sunlight is focused by an associated two-axis Fresnel concentrator mirror unit, heating water contained therein to create steam which is redirected to heat water coming into the water purification boiler module and to condense the steam into purified water.

17. The system of claim **16**, wherein each of the two-axis Fresnel concentrator mirror units comprises a plurality of flat mirrors oriented to reflect incident radiation along two intersecting axes, intersecting at the heating zone of an associated water purification boiler module.

18. The system of claim **16**, wherein each of the sun-tracking reflecting mirror units comprise a plurality of parallel disposed, rectangular mirror slides, each mirror slide pivotally mounted along an axis of the mirror slide, the plurality of slides connected together to pivot together.

19. The system of claim 16, wherein the cascaded solar water purification system is mounted on a floating platform floating in a lake of water to be purified.

20. The system of claim 16, further comprising at least one suction pipe providing water to be purified to the plurality of water purification boiler modules, suction of the water to be purified by the suction pipe, tangential to the platform, rotating the platform to track the sun.

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