(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 November 2006 (09.11.2006)

PCT

(10) International Publication Number
WO 2006/118912 A2

(51) International Patent Classification:
B01D 3/02 (2006.01)

(21) International Application Number:
PCT/US2006/015859

(22) International Filing Date: 28 April 2006 (28.04.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/676,870 2 May 2005 (02.05.2005) US

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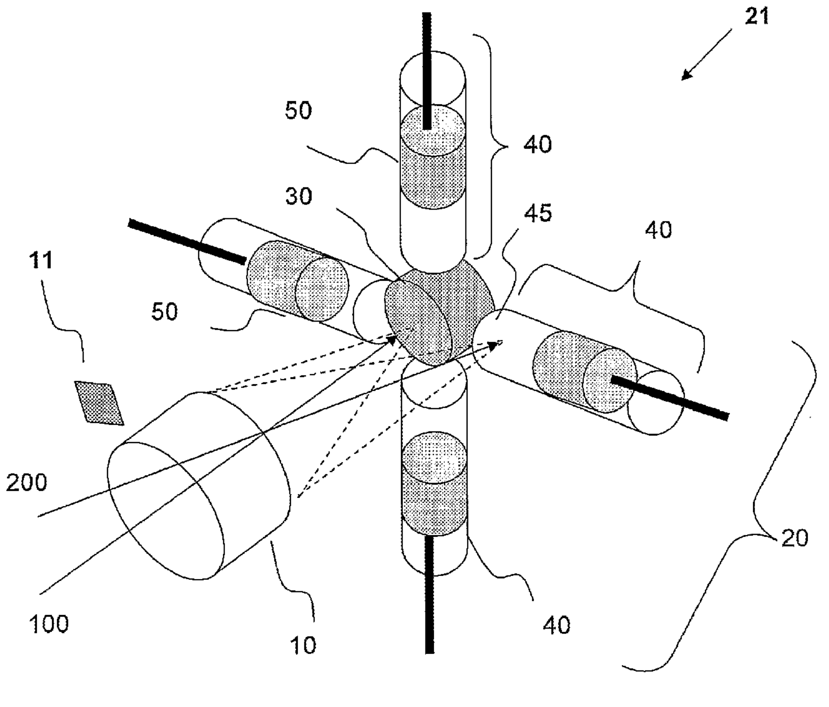
(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SOLAR ALIGNMENT DEVICE



(57) Abstract: A device that keeps an alignment with a light source is provided. The device is self-sufficient, in that the light source both directs the movement of the device and provides the energy for the device to realign itself if the source of illumination changes position.

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SOLAR ALIGNMENT DEVICE

REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the priority benefit under 35 U.S.C. §119(e) of U.S. Provisional Application No. 60/676870, filed May 2, 2005, incorporated in its entirety by reference.

FIELD OF THE INVENTION

[0002] This invention relates to the field of solar energy collection. In particular, embodiments of the invention relate to a device for aligning a solar collector with the position of the sun.

BACKGROUND OF THE INVENTION

[0003] Solar stills take energy in the form of light and use it to generate other forms of energy. There are a variety of such devices available. Solar stills can include mirrors and reflecting surfaces that concentrate solar rays into a volume containing a boiler or a heat-transfer tube where the solar energy is converted into another form of energy by heating the boiler.

[0004] While such devices use very little or no external energy in simply collecting solar energy, such systems generally require constant adjustment to ensure that the solar collector follows the movement of the sun. This, of course, requires some form of energy to reposition the solar collector as the sun moves to optimize the collection of energy. One example of overcoming this problem is by way of flexible strips that modify their shape in response to incoming solar radiation (US Patent No:.4,770,162), and infrared radiation systems (US Patent 4,235,222). In addition to the daily movement of the sun, the position of the sun in the sky, and thus the position of the solar collector, also changes throughout the seasons. Other systems employ electric motors to compensate for the daily movement of the sun.

SUMMARY OF THE INVENTION

[0005] The devices mentioned above suffer from various flaws. For example, flexible metallized strips are expensive and are subject to mechanical fatigue and failure over time. Additionally, infrared sensors are also expensive, especially when they rely on waxes or salicylic acid, and such control systems still require seasonal manual adjustment. Fluid control devices are heavy and can be expensive to manufacture. In addition, most solar alignment devices stop working when solar radiation is weakened by fog or rain. In some embodiments, what is needed is a simple, mechanical, inexpensive method of solar collection that will automatically adjust for the movement of the sun across the sky during the day. In some embodiments, the device can function even when sunlight is weakened by fog or rain. In some embodiments, the device can return to its original position after sunset so it can start functioning again the next morning. Additionally, the ability to track the position of the sun throughout the various seasons can also be desirable. Of course, an alignment device with any one of the above advantages can also be useful.

[0006] In one aspect of the invention, a solar alignment device is provided that functions via light sensitive movement chambers. A focusing lens is preferably used to direct and concentrate light from a light source (*e.g.*, the sun) to be followed onto a movement chamber. The movement chamber involves a low temperature boiling point liquid (LBPL, for example anything that boils at less than 100 °C, or anything that expands when heated in the apparatus described herein) or water and the movement chamber allows light energy (*e.g.*, solar energy) to heat the liquid. The light can pass through an open, empty aperture (e.g., a ring) to strike either the collector if the device is aligned correctly, or a movement chamber if the device is out of the desired alignment with the light source.

[0007] In some embodiments, a lens and a movement chamber are arranged so that when the device to be aligned with the sun is aligned with the sun, light from the sun passes through the lens and misses the movement chamber. However, when the device is out of alignment with the sun, the light passes through the lens and heats a movement chamber, resulting in the activation of the movement chamber, which aligns part of the device with the sun. In a preferred embodiment, the movement chamber is connected to a framework that supports the solar collector so that activation of the movement chamber results in a movement of the solar collector in a desired direction. In a preferred embodiment, the movement chamber includes a displacer, such as a displacer, driveably connected to a stationary framework so that an increase in pressure in said movement chamber results in a force being exerted to drive said displacer against said framework.

[0008] In a preferred embodiment, there are four movement chambers to direct the solar collector in the points of a compass, for example, up, down, left, and right. In a more preferred embodiment, the four movement chambers are arranged at 90 degrees from each other in an array and the center of the array is a ring through which concentrated light from the lens can pass.

[0009] In some embodiments the surface of the solar collector is made of an inflatable membrane that maintains its shape due to internal air pressure. In some embodiments, the inflatable membrane has a valve to prevent over-pressure build-up, and another valve to allow air into the inflatable membrane when it cools after sundown.

[0010] In some aspects, a solar alignment device is provided. The solar alignment device involves a light path aperture and at least one movement chamber moveably associated with the light path aperture. The movement chamber involves a low boiling point liquid and a displacer driveably associated in the movement chamber. The light path aperture is positioned with respect to the movement chamber such that 1) when light passes perpendicularly through the light path aperture the light misses the movement chamber, and 2) when light passes through the light path aperture at, at least one nonperpendicular angle, the light falls on the movement chamber. The movement chamber allows light to heat a low boiling point liquid inside the movement chamber. The movement chamber is configured so that an increase in pressure in said movement chamber results in a force being exerted to drive the displacer out of said movement chamber. The outward driving of the displacer positions the light path aperture so that light passes perpendicularly through the light path aperture. In some embodiments, the light path aperture involves a lens. In some embodiments, the lens is adapted to focus and concentrate light passing therethrough. In some embodiments, there are at least four movement chambers. In some embodiments, the four movement chambers are positioned in 90 degree intervals in a single plane around a central position. In some embodiments, the central position involves a ring, through which light can pass if light enters through the light path aperture perpendicularly.

[0011] In some aspects, a solar still is provided. The solar still involves an energy transforming chamber, a solar collector for directing radiation onto the energy transforming chamber, a framework connected to the solar collector and allowing its movement, and a solar alignment device moveably associate with the solar collector and the framework to allow the solar alignment device to position the solar collector to increase the amount of radiation hitting the energy transforming chamber. The solar alignment device involves a lens for focusing radiation, a center target that is positioned so that when the solar collector is optimally positioned, radiation passing through the lens will be directed to the center target and at least one movement chamber. The movement chamber has a low temperature boiling liquid. The chamber is positioned around the center target. The movement chamber is capable of receiving radiation from the lens when the radiation is not directed to the center target. The movement chamber can transmit radiation or heat to the liquid contained within it. The movement chamber further involves a displacer. The displacer is driveably connected with the rest of the movement chamber so that heating of the liquid results in moving the displacer to an extended position. The displacer is also driveably connected to the framework to allow movement of the displacer to move the solar collector, wherein the movement chamber, lens, and solar collector are also associated with the framework so that the movement chamber, lens, and solar collector are repositioned by the movement of the displacer.

[0012] In some embodiments, the solar collector involves a parabolic surface and is made of an inflatable membrane that maintains its shape due to internal air pressure. In some embodiments, the inflatable membrane has a valve to prevent over-pressure build-up, and another valve to allow air into the inflatable membrane when it cools after sundown.

[0013] In some aspects, a solar still is provided. The solar still involves an energy transforming chamber, a parabolic mirror for directing radiation onto the energy transforming chamber, a solar alignment device connected to the parabolic mirror to allow the solar alignment device to position the mirror to increase the amount of radiation hitting the energy transforming chamber. The solar alignment device involves a lens for focusing radiation, a ring positioned so that when the parabolic mirror is optimally positioned to gather light from a light source, the lens will direct radiation passing through the lens through the ring. The solar alignment device further involves four movement chambers. Each movement chamber involves a low temperature boiling liquid, wherein each chamber is positioned at approximately 90 degree intervals around the ring. A chamber is capable of receiving radiation from the lens that is not passing through the ring. A chamber can transmit energy from the lens to the liquid. A chamber further involves a piston that is driveably connected to a shell of the chamber so that heating of the chamber results in moving a piston to an extended position. The solar alignment device further involves four prisms positioned between the movement chambers and positioned to redirect radiation that falls outside of the ring and between the movement chambers onto the movement chambers. The solar still further involving a framework supporting the parabolic mirror. At least one piston is driveably connected to the framework to allow the movement of the piston to exert a force against the framework in order to move the movement chambers, lens, and parabolic mirror. In some embodiments, the inflatable membrane includes a first valve to prevent over-pressure build-up, and a second valve to allow air into the inflatable membrane when it cools after sundown. In some embodiments, the solar still is configured to provide steam to the surface of the inflatable membrane. In some embodiments, the solar collector includes a parabolic trough assembly configured to collect and concentrates solar radiation. In some embodiments, the solar still further involves a photocell and a photocell sensor that detects sunlight conditions and discriminates between direct sunlight radiation and diffuse light conditions. In some embodiments, there is a control system that allows the parabolic mirror to track the movement of the sun, regardless of sunlight or cloudy conditions. In some embodiments, the solar alignment device is configured to stop operating during nighttime conditions. In some embodiments, the frame is further associated an electric motor to effect movement of the solar collector device during conditions of diffuse light.

[0014] In a preferred embodiment, there are four movement chambers in each solar alignment device. The movement chambers can direct the solar collector, up, down, left, and right. In a more preferred embodiment, the four movement chambers are arranged at 90 degrees from each other in an array and the center of the array is a ring through which concentrated light from the lens can pass. In other embodiments, there are five (5), six (6), seven (7), eight (8) or a greater number of movement chambers, all of which arranged on a plane perpendicular to the light rays from the sun. In a preferred embodiment, the four movement chambers have four triangular prisms placed on the same plane as the movement chambers such that light that falls in between two movement chambers will be reflected by the prism into the movement chamber that is closest to it. Mirrors, lenses, and other optical manipulation devices can also be used.

[0015] In some embodiments, there is a spring system or counterweight system configured to return said mirror to a starting position after a period of tracking a movement of a light source. In some embodiments the energy transforming chamber involves a heat pipe. In some embodiments, the parabolic mirror involves an inflatable membrane that maintains its shape due to internal air pressure. In some embodiments, the inflatable membrane further involves a mirror attached to a surface of the inflatable membrane. In some embodiments, the inflatable membrane involves a first valve to prevent over-pressure build-up, and a second valve to allow air into the inflatable membrane when it cools after sundown. In some embodiments, the solar collector is configured to provide steam to the surface of the inflatable membrane.

[0016] In some embodiments, any one or combinations of the above elements is used in combination with the initial embodiment of the solar alignment device or a self-aligning solar still.

DESCRIPTION OF THE FIGURES

[0017] FIG. 1 is a schematic and assembly diagram of one embodiment of an optical solar alignment device.

[0018] FIG. 2 is a schematic diagram of a parabolic trough solar collector showing the position of an optional electric motor and a gear assembly for tracking the sun under diffuse light conditions.

[0019] FIG. 3 is a schematic diagram of a single movement chamber 40 in the array assembly 20 and the ratcheting device 60.

[0020] FIG. 4a and FIG. 4b are diagrams of one embodiment of how the solar alignment array 20, solar collector and spring system 75 can interrelate.

[0021] FIG. 5a and FIG. 5b are schematics of one embodiment of the rotation mechanism that can support and allow movement of the solar collector assembly into alignment with the solar energy.

[0022] FIG. 6 depicts some of the various angles that can be considered in setting up and initially aligning a solar alignment device.

[0023] FIG. 7 depicts the angle of mounting of a first rotational ring so it corresponds to the proper latitude when installed.

[0024] FIG. 8 provides a simplified view of a rack and pinion mechanism and framework that can change position in response to movement of the movement chamber and it can help support the device after it has been repositioned and once the light is no longer heating the movement chamber.

[0025] FIG. 9 is a schematic diagram of another embodiment of how the solar alignment device, an energy transforming chamber 400, such as a heat pipe, and inflatable parabolic membrane 350 can interrelate.

[0026] FIG. 10a and FIG. 10b are simplified views of the inflatable parabolic membrane 350 and individual mirrors on that membrane

[0027] FIG. 11 depicts another embodiment of how a solar collector 300 and the movement assemblies 120 and 130 can be mounted.

[0028] FIG. 12 depicts how the solar collector 300 with the movement assemblies 120 and 130 can be mounted on the fixed base 70, and the position of the springs 75 that restore the position of the solar collector after sundown.

[0029] FIG. 13 is a schematic diagram on another embodiment for mounting the positioning arms 65 on the entire solar collector assembly.

[0030] FIG. 14 depicts another embodiment of the entire solar collector system.

DESCRIPTION

[0031] In one aspect of the invention, the solar alignment device is configured to use light to position a solar still so that light more efficiently falls onto a solar collector. In some embodiments, the solar alignment device uses a lens to focus light onto various parts of the solar alignment device, in particular, onto movement chambers. These movement chambers include a low boiling point liquid ("LBPL"), such as water or low-boiling alcohols (e.g., methanol, ethanol), ketones (e.g., acetone) and heat produced as a result of the light from the lens evaporates the LBPL so that the pressure of said vapor can activate the movement chambers, which results in the solar alignment device moving. When the solar alignment device is aligned with the sun, the focused light from the lens does not significantly hit the movement chambers of the solar alignment device. However, when the solar collector is not aligned with the sun, the light from the lens can hit one of the movement chambers of the solar alignment device, heat the liquid, which causes the device to move and reposition both the solar collector, and the solar alignment device so that the solar collector will again be directed towards the sun and light focused through the lens will once again avoid hitting the movement chambers.

[0032] One embodiment of a solar alignment device is shown in FIG. 1. This embodiment includes an energy focusing device, such as a lens 10 that focuses sunlight onto an array 20 of the solar alignment device. In this embodiment, the array 20 contains a center point 30 that can reflect, transmit or disperse sunlight, and four movement chambers 40 that are filled with a low boiling liquid 45, such as water. As will be appreciated by one of skill in the art, the LBPL need not be limited to any particular compound, as long as it will expand sufficiently when heated by the lens to produce the desired movement, any liquid or gas can be used. As described below, the center point 30, can also be a ring, allowing light to pass through it. By "ring," all that is meant is a closed loop. The center point 30 can also be generally referred to as a light path aperture.

[0033] As will be appreciated by one of skill in the art, the relationship between the lens 10 and the array 20, and how sunlight is directed along the array, can determine whether the solar alignment device is stationary or adjusting itself into alignment with the sun. When sunlight passes perpendicularly through the lens along path 100, the light will be focused onto the center of the array 30, thereby minimally heating any of the movement chambers. However, when the light switches its incoming direction so that light is entering in a non-perpendicular manner 200, light focused from the lens will no longer hit the center and instead can hit a movement chamber 40. This causes the LBPL 45 to expand, which can drive the displacer 50 outward, repositioning the lens 10 and the array 20 so that light again enters through path 100 and hits the center 30, instead of the movement chambers 40.

[0034] In some embodiments, when more than one movement chamber 40 is illuminated, both can drive the movement of the solar alignment device at the same time. As will be appreciated by one of skill in the art, the arrangement of the lens and the array can allow for more than one cylinder to function at one time. However, cylinders positioned opposite one another are typically not significantly illuminated at the same time. In such a situation, no movement will result from the heating of the cylinders. Thus, the lens can focus the light in a manner such that light from the lens will primarily only hit movement chambers that are not working opposite one another. However, as will be appreciated by one of skill in the art, numerous chambers can be heated to some extent, so long as at least one is heated more than the others.

[0035] As will be appreciated by one of skill in the art, the illustrated embodiment in FIG. 1 has areas where light from a lens can pass without hitting either the center 30 or a movement chamber 40. While this is sufficient for some embodiments, in other embodiments, mirrors, prisms, or other light directing devices can be positioned between the movement chambers so that the light gathering area of the array effectively takes up more space and allows for larger variation in the incoming light. Of course other modifications can also be made, such as altering the shape of the movement chambers 40 so that they have a larger surface area that can absorb more sunlight. For example, the movement chambers can be quarter circles (or other fractions of a circle) whose entire surface area allows for the heating of the liquid. There can be four, quarter circle sections, each one placed next to the others so as to form a full circle. Thus, any light not passing through or hitting the center 30 will hit a movement chamber. To minimize the volume of liquid to heat, the chambers can be thin and can have a heat absorbing backing to them. Of course, the center 30 will still be separate from the movement chambers, at least as far as heat energy, light energy, or both are concerned. In some embodiments, prisms can be used. As will be appreciated by one of skill in the art, prisms have the added benefit of redirecting light in both directions, which can help reposition the solar alignment device, as two displacers will expand and reposition the array and lens accordingly.

[0036] While the center 30 is depicted as a solid object in FIG. 1, one of skill in the art will realize that the center need not be solid. In some embodiments, the center

30 only provides support for a movement chamber to push against. Thus, the center can be a ring, allowing light from the lens, when the solar alignment device and solar collector are aligned with the sun, to pass through to the boiling chamber. Alternatively, the center 30 can be made out of any material.

[0037] In some embodiments, the displacer 50 is a piston. However, as will be appreciated by one of skill in the art, the displacer need not be limited to a piston, as any system or device which allows for the expansion of the liquid or gas inside of the movement chamber to result in a mechanical displacement could be used. For example, the displacer 50 could be a flexible membrane which can bulge under pressure and push an arm outward from the movement chamber. Alternatively, for example, the displacer could be a screw device, which is slow spun outward under pressure. Other embodiments will be understood by one of skill in the art, given the present disclosure.

[0038] In some aspects, the solar still has the ability to track the sun during daylight hours even when the sun is obscured by fog, rain, or heavy cloud cover. This can be achieved through a combination of a photocell and an electric motor. In one embodiment of the invention, as shown in FIG. 1, a photocell 11 is mounted on the side of lens 10 and the photocell is part of an optical tracking device.

[0039] The light being detected by the photocell need not result in an all or nothing reaction. In some embodiments, in the absence of light, such as during the night, the signal from the photocell is below a given or predetermined threshold, which is interpreted by the system as night-time, and no action takes place. During daylight hours and in the absence of cloud cover or rain or fog, the signal from the photocell is at a maximum, and this is interpreted by the system as normal operating conditions for solar tracking. Under such conditions, the signal from the photocell actuates a relay that disconnects power from the electric motor. When the signal from the photocell is weak (but still present), this is interpreted by the system as cloudy and diffuse light conditions, and under such conditions the sensor activates an electric motor 15 connected by mechanical gears 12 to the parabolic assembly, so that the entire solar collector assembly follows and tracks the movement of the sun, as shown in FIG. 2. The particular settings for no signal, weak signal, and strong signal can vary on a number of facts, such as, the frequency of light obstruction, the need for supplemental power (apart from the solar alignment device), the particular liquid used, temperature of the environment, altitude of the device (and thus boiling point characteristics of the liquid in the movement chambers), etc. The tracking of the sun itself can be achieved in a variety of ways. For example, 4 photocells can be used, each positioned next to a movement chamber and detecting light that passes through the lens at a less than optimal angle in regard to the solar collector. Each photocell can be linked to a gear or motor to drive the arms and move the framework supporting the solar collector in the appropriate direction. The direction and amount of movement can also be achieved in a calculated or predictive manner, in which one has a computer that calculates where the sun will be and engages the appropriate motors to move the solar collector into the appropriate alignment.

[0040] FIG. 2 shows a different embodiment that can be especially useful when there are low levels of light, for example, cloudy conditions. In this embodiment, the solar collector 300 is a parabolic trough 310 that is mounted on a horizontal base 70 with a plurality of rotational rings (not shown) that can pivot in any direction. Under conditions of diffuse light, an electric motor 15 is engaged that causes gear 12 to rotate, thus keeping the solar collector 300 aligned with the movement of the sun. Because the electric motor 15 is switched on only when the system detects conditions of diffuse light, the optical tracking device is not operating, so that the positioning arms 65 are free to move as the solar collector 300 rotates. When direct sunlight radiation is detected, the operation of the electric motor is switched off and the solar alignment device is allowed to operate.

[0041] As shown in FIG. 1, the array 20 of the solar alignment device can involve multiple movement chambers 40. As shown in FIG. 3, the movement chambers 40, include a shell 41, which contains the LBPL 45 and a displacer 50. The displacer has an arm 51 attached to it, with any of a number of various types of force transferring structures, such as teeth, 52, that transfer the outward movement of the displacer (in the figure a piston) to a rotational movement of a rack and pinion ratchet mechanism 60. The ratcheting device allows for the displacer to readily reposition the solar alignment device, provide support for the device when light is no longer focused on the movement chamber, and can allow for the arm 51 to retract at a later point in time. Thus, even though the repositioning of the device will remove the light from the movement chamber, allowing the chamber to cool, the solar alignment device will stay in its new position and the arm and teeth on the displacer can return to their initial position, ready to again push outward and further track the movement of the sun upon heating of a movement chamber. In some embodiments, the heating, or cooling, or both of the movement chamber alters the ability of the system to transfer force to the frame or through the ratchet system. For example, when a movement chamber 40 is heated, the ratchet mechanism 60 associated with it can be engaged in one direction, allowing force to be transferred from the first movement chamber to the frame. At the same time, for an opposing movement chamber, for example the one on the opposite side of the array 20, which will not be heated, the ratchet mechanism associated with the opposing movement chamber can be reversed or disengaged, allowing the system as a whole to operate without opposing forces being applied to the frame. This can be achieved in a variety of ways, a heat sensitive metal or material can be operatively connected between the movement chamber and the ratchet associated with the opposing movement chamber so as to allow the release of a ratcheting mechanism upon the heating of the chamber. Alternatively, the release can be achieved through an actuator or electrical motor and light sensor associated with each movement chamber. Of course, in embodiments in which there are only one or two movement chambers (or the chambers are not positioned so as to oppose the other's movement, these additional ratcheting aspects are not required, as any force created by a movement chamber will not be opposed by another movement chamber.

[0042] While the array 20 in FIG. 1 is shown with four movement chambers 40, one of skill in the art will appreciate that the number can be increased or decreased as desired. For example, in one embodiment, only two movement chambers are used. This can be sufficient when the device itself has other guiding means to limit or redirect the position of the lens and solar alignment device. In such an embodiment, the starting position of the device can be such that any light that does not hit the center portion will hit the movement chamber(s) (either directly or by a light redirecting device such as a reflective surface). In some embodiments, only a single movement chamber is used. Thus, in some embodiments, the solar alignment device can include a single movement chamber 40, a lens 10, and a frame system for transferring movement of the displacer to movement of the solar alignment device.

[0043] While the array 20 is depicted as a "plus," other arrangements are also feasible. In some embodiments, one is only concerned with movement in the y-axis, thus a single vertical array can be used. Similarly, if one is only concerned with movement along the x- axis, a set of cylinders along the x-axis can be used. Any number or orientation of movement chambers can be used and a particular number or arrangement can depend upon the particular environment in which the solar alignment device is to be used.

[0044] As discussed above, while the array system 20 provides the movement and direction of the solar alignment device, in some embodiments in order to continue such movement or allow repeated movement, an additional framework around the array is used. In part, this can involve the ratchet and pinion system 60 discussed above, which intermittently supports the new position of the solar collector and the solar alignment device as the sun moves, based on repeated movements of the displacer 50 in the movement chamber 40. This ratchet system drives another arm 65 that allows for reorientation of the solar collector 300, and optimal heating of the energy transforming chamber 400, such as a boiler. In some embodiments, the frame or framework involves arms 65 associated with the ratchet system 65. The arms 65 can be attached to a base 70 (described below). The solar collector 300 and the solar alignment device 21 can be mounted to allow for the required mobility through the use of a movement assembly 130 and 120. The parts that allow the movement of the solar alignment device to move the solar collector (as well as the solar alignment device itself), can generally be called the framework of the device.

[0045] FIG. 4a and FIG. 4b show one embodiment of a solar still and the interaction between the array 20 of solar alignment device with the ratchet mechanism 60 and the positioning arms 65, so as to effect continuous focusing of the solar collector with the sun. The lens is not depicted but is located above the array 20. FIG. 4a also shows the boiler or heat collecting chamber inside the solar collector 300. As will be appreciated by one of skill in the art, the solar still can be used to heat water or some other item, for a variety of uses. Thus, a solar still can be used to heat water, if desired, for water purification or other purposes. Alternatively, for example, the solar still can be used to create electricity or other energy through the use of the solar energy gathered by the solar collector.

[0046] FIG. 4a depicts the mounting of the solar collector 300 onto a base 70, and the position of the springs 75 that restore the original position of the solar device after sundown. FIG. 4b shows the details of the ratchet mechanism 60, which allows for continuous movement of the arm 65 as the solar collector focuses on the sun. Also shown in FIG. 4b is the mechanism for positioning the solar collector when the solar alignment device is not operating. This low light aspect can rely on electric motor 15 and, for example, a mechanical gear 12. As will be appreciated by one of skill in the art, while the term “gear” is used frequently in this application, any other mechanically similar device for transferring force can also be used.

[0047] FIG. 5a and FIG. 5b show one embodiment of the rotation mechanism or framework upon which the solar collector and solar alignment device sit so that the solar collector and solar alignment device can be moved into alignment with light from the sun. The framework can include two interconnected circular rings, or movement assemblies 120 and 130, one for movement along the angle of latitude, and one for movement along the azimuth of the sun. The two interconnected rings allow for free movement along the horizontal x and y axis, so the parabolic collector assembly can take any position as it follows the sun. This movement is caused by the 4 arms 65 which are connected to the base 70. The ratchet mechanism allows for free movement of these arms (metal rods) in one direction, and a similar ratchet re-positions the unit to the original position at sun-up by means of either a spring or pulleys. As will be appreciated by one of skill in the art, only one movement assembly 120 may actually be required to allow for movement along the x and y axis, as shown in FIG. 5b.

[0048] As will be appreciated by one of skill in the art, the initial positioning of the device can take into account the current angle of the sun. FIG. 6 illustrates the movement of the earth around the sun and the corresponding angles that can be set into the device to compensate for this variation depending on current latitude. FIG. 7 depicts the mounting of the first rotational ring, so it corresponds to the proper latitude when installed. The mounting of the rings need not be very precise, because the unit will seek and achieve the right position when the sun comes up in the morning. There is an advantage in this type of arrangement over a timing mechanism or a mechanical adjustment for the declination of the sun each passing day.

[0049] In addition to this optically powered system, which actively tracks the sun throughout the day, there is return system 75 as well, as shown in FIG. 4a. This return system can reposition the entire device back to its starting position (or a new starting position) at the end of each day so that the solar collector 300 and solar alignment device 21 will be positioned to start collecting light at the beginning of the following day. In one embodiment, a spring based system is used that automatically pulls the device back to an initial starting point. Thus, at the end of the day, the ratchets 60 can be released and the force of the spring 75 used to pull the system to an initial point. The spring can be extended throughout the day by the same process that drives the movement of the solar alignment device itself. As will be appreciated by one of skill in the art, other mechanisms can be used as well, for example, a gravity or weight based return device.

[0050] As noted above, this return system returns the solar still and the solar alignment device to an initial starting position. However, the initial starting position need not be the same every day of the year. For example, in some embodiments the initial starting position changes throughout the various seasons, thus following the movement of the sun in the sky throughout the year. Because changes in the angle of incidence of the sun vary very little from one day to the next, the spring return mechanism will position the alignment of the solar collector at a slight angle with the incident light from the sun, thus immediately actuating the heating of the positioning chambers and correcting for such slight miss-alignment. Alternatively, the solar alignment device can further include additional gears and rotational rings to compensate for changes in the angle of incidence of the light throughout the year. The position of the sun for the next starting day can be "set" into the gear system so that at the end of each day the gears advance, lock into a new position, and when the return system 75 is operated, the initial starting direction for the solar still and the solar alignment device will be correspondingly different. For example, a one-way ratcheting gear device can be used that locks in a northward tendency of azimuth change during the period between winter and summer solstice in the Northern Hemisphere, and the ratcheting gear device can be reversed at summer solstice to lock in daily southward changes of azimuth. However, since the displacer arrangement permits dynamic adjustment of the collector to any angle throughout the day and year, azimuth adjustment gears and the like constitute a purely optional feature.

[0051] In some embodiments, no secondary gear system is used for adjusting for the position or variations of the sun throughout the season. For example, in embodiments in which the gears allow for a large enough movement, and the size of the movement chambers is great enough to catch the light from the lens regardless of the incoming angle, the solar alignment device can handle the seasonal differences, as the displacers will move the dish into a more optimal position as they are heated. One advantage of this particular embodiment is that the device will automatically adjust its position throughout the year, reversing the direction of the adjustment movement of the positioning device every solstice.

[0052] As will be appreciated by one of skill in the art, the solar alignment device can provide for continuous operation as the unit automatically adjusts for the movement of the sun. In some embodiments, no user intervention is necessary. As such, in some embodiments, it provides for an automatic correction of the angle of declination of the sun as seasons advance. Thus, in some embodiments, the solar alignment device can be used to optimize solar collection efficiency at all times and seasons. Thus, it can provide for efficient heat collection to be used for water purification purposes or other uses, such as electricity generation.

[0053] In some embodiments, the system is configured for an alternative light source, for example the moon or an artificial light source. As will be appreciated by one of skill in the art, the device can be readily adjusted based on the above teachings.

[0054] FIG. 9 shows another embodiment of a solar still, in which the parabolic surface is cylindrical rather than a spheroid. In some embodiments, this particular arrangement offers advantages in manufacturing. For example, the weight of the solar collector system in this embodiment can be significantly lower than for a spheroidal shape of similar surface area. In addition, the embodiment of FIG. 9 can be less expensive to manufacture than the spheroidal embodiment previously discussed.

[0055] FIG. 9 depicts how the solar aligning device 21 can be mounted on the solar collector 300, which can involve an inflatable membrane 350 for providing the parabolic shape required with minimal weight, and a heat transfer tube (the energy transforming chamber 400) for transferring the heat collected into an external boiler. In a preferred embodiment, the energy transforming chamber 400 can be a heat pipe, which uses enthalpy transfer as the method of transferring heat. The use of an inflatable membrane can be particularly advantageous over the use of rigid metal or plastic parabolic surfaces because of the low cost and weight of an inflatable device. The inflatable membrane can maintains its parabolic shape because of internal gas pressure, which is regulated with two valves, one to prevent over-pressure and one to allow air into the membrane as it cools after sundown.

[0056] FIG. 10a and FIG. 10b illustrate one embodiment for mounting reflecting mirror surfaces 370 onto an inflatable membrane 350, so as to create a parabolic trough surface. Of course, in some embodiments, individual mirrors are not used and the surface of the collector itself can be reflective. The membrane 350 is composed on individual inflatable cells 360 that collectively define a parabolic trough. One advantage of an embodiment using cells is that it can provide for resilience against punctures or mechanical damage to the membrane surface. Another advantage of this specific embodiment is that the membrane surface provides for a parabolic surface that is significantly light and inexpensive to manufacture.

[0057] FIG. 11 depicts an embodiment for mounting the solar collector 300 onto two movement assemblies 120 and 130, which allow for free movement of the solar collector along two orthogonal axes. As noted above, the outer movement assembly can be optional or part of the base.

[0058] FIG. 12 illustrates an alternative embodiment for mounting the solar collector 300 and the movement assemblies 120 and 130 onto a fixed base 70, which has any number of springs 75 that restore the original position of the solar collector after sundown. In some embodiments, one spring is used for each movement chamber used in the device and can be aligned to center the device. However, in some embodiments, the springs are positioned so as to return the solar collector to a "morning position," which is the position the solar collector should be in for the first light to be collected. As will be appreciated by one of skill in the art, the springs need not return the device exactly to this position, as the depicted device involves a solar alignment device that can further adjust the solar collector. Thus, the return system, in this figure the springs, need not align the solar collector perfectly for the following day's light. In some embodiments, the return system is set or slowly set over the entire day. For example, as the solar alignment device moves the solar collector, it also pulls against the springs, providing the energy to later return the solar collector, when there is no or little light left. In some embodiments, the activation of the return system is triggered by a light sensor or a timer. In some systems, the trigger for the return system is simply a mechanical force from the positioning of the solar alignment device, solar collector, arms, etc. While the solar alignment device and solar collector, as well as the entire still, can be reset for the next day in a variety of ways, in one embodiment this is achieved by releasing the ratchets 60 and allowing the return system to move the device back to a starting position. FIG. 13 depicts the mounting of positioning arms 65 onto the base and the solar collector and solar alignment device. FIG. 14 depicts the arrangement of the various components of this embodiment.

[0059] One additional feature shown in FIG. 14 is a self-cleaning mechanism for maintaining the surface of the parabolic collector free of dust or particulates that can diminish its radiation collection efficiency. This mechanism involves a tube 325, optionally with a nozzle, that periodically sprays the surface of the solar collector with hot water 330. The spray can be powered by a separate source of waste steam, such as that from a water purification still that has a degasser or simply from the water from the separate container. In some embodiments, the spray can instead or also clean the lens and the movement chambers.

[0060] In some embodiments, any one of the above embodiments does not use mirrors, but rather only an optical lens for controlling and focusing the light for the solar alignment device. In some embodiments, any one of the above embodiments does not involve a central divider to separate the various angles of incoming light. In some embodiments, any one of the above embodiments does not involve or require shading the reservoir(s) containing the fluid. In some embodiments, any one of the above embodiments does not involve differential shading of two fluid reservoirs to achieve a pressure differential that moves and aligns the solar collector. Additionally, in some embodiments, the movement chambers are on a single plane. In some embodiments, any one of the above embodiments does not involve a splitter plate or a reflector plate in the solar alignment device. In some embodiments, any one of the above embodiments does not involve a bellows to effect movement.

[0061] In some embodiments, the device is part of a larger system for purifying water. For example, the device can be included in or with any of the devices or methods disclosed in U.S. Provisional Patent Application No: 60/697,104, filed July 6, 2005 entitled, VISUAL FILTER FLOW INDICATOR, attorney docket number SYLVAN.003PR; U.S. Provisional Patent Application No: 60/697,106, filed July 6, 2005 entitled, APPARATUS FOR RESTORING THE MINERAL CONTENT OF DRINKING WATER attorney docket number SYLVAN.005PR; U.S. Provisional Patent Application No: 60/697,107, filed July 6, 2005 entitled, DEMISTER APPARATUS, attorney docket number SYLVAN.006PR; and PCT Application No: US2004/039993, filed December 1, 2004; PCT Application No: US2004/039991, filed December 1, 2004; and U.S. Provisional Patent Application No: 60/526,580, filed December 2, 2003; U.S. Provisional Patent Application No: 60/748496, filed December 7, 2005, entitled ENERGY-EFFICIENT DISTILLATION SYSTEM; U.S. Provisional Patent Application No: 60/727106, filed October 14, 2005, entitled ENERGY-EFFICIENT DISTILLATION SYSTEM; U.S. Provisional Patent Application No: 60/779201, filed March 3, 2006, entitled CONTAMINANT PREVENTION; U.S. Provisional Patent Application No: 60/778680, filed March 3, 2006, entitled DEMISTER-CYCLONE; and U.S. Patent Application No: 11/255083, filed October 19, 2005, entitled WATER PURIFICATION SYSTEM incorporated by reference in their entireties.

[0062] The methods, procedures, and devices described herein are presently representative of preferred embodiments and are exemplary and are not intended as limitations on the scope of the invention. Changes therein and other uses will occur to those skilled in the art which are encompassed within the spirit of the invention and are defined by the scope of the disclosure.

[0063] It will be apparent to one skilled in the art that varying substitutions and modifications can be made to the invention disclosed herein without departing from the scope and spirit of the invention. For example, in some embodiments, the solar alignment device is used without a heating chamber or a solar still. For example, the solar alignment device can be used in any situation in which there is a changing position of light and one wishes to track the change in the position of the light.

[0064] Those skilled in the art recognize that the aspects and embodiments of the invention set forth herein can be practiced separate from each other or in conjunction with each other. Therefore, combinations of separate embodiments are within the scope of the invention as disclosed herein.

[0065] All patents and publications are herein incorporated by reference to the same extent as if each individual publication was specifically and individually indicated to be incorporated by reference.

[0066] The invention illustratively described herein suitably can be practiced in the absence of any element or elements, limitation or limitations that is not specifically disclosed herein. The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention that in the use of such terms and expressions indicates the exclusion of equivalents of the features shown and described or portions thereof. It is recognized that various modifications are possible within the scope of the invention disclosed. Thus, it should be understood that although the present invention has been specifically disclosed by preferred embodiments and optional features, modification and variation of the concepts herein disclosed may be resorted to by those skilled in the art, and that such modifications and variations are considered to be within the scope of this invention as defined by the disclosure.

WHAT IS CLAIMED IS:

1. A solar alignment device comprising:

a light path aperture; and

at least one movement chamber moveably associated with said light path aperture, said movement chamber comprising a low boiling point liquid and a displacer driveably associated in said movement chamber, wherein said light path aperture is positioned with respect to the movement chamber such that 1) when light passes perpendicularly through the light path aperture the light misses the movement chamber, and 2) when light passes through the light path aperture at, at least one nonperpendicular angle, the light falls on the movement chamber, wherein the movement chamber allows light to heat a low boiling point liquid inside the movement chamber, and wherein the movement chamber is configured so that an increase in pressure in said movement chamber results in a force being exerted to drive the displacer out of said movement chamber, said outward driving of the displacer positioning said light path aperture so that light passes perpendicularly through the light path aperture.

2. The solar alignment device of Claim 1, wherein the light path aperture comprises a lens.

3. The solar alignment device of Claim 2, wherein the lens is adapted to focus and concentrate light passing therethrough.

4. The solar alignment device of Claim 1, comprising at least four movement chambers.

5. The solar alignment device of Claim 4, wherein the four movement chambers are positioned in 90 degree intervals in a single plane around a central position.

6. The solar alignment device of Claim 5, wherein the central position comprises a ring, through which light can pass if light enters through the light path aperture perpendicularly.

7. A solar still comprising:

an energy transforming chamber;

a solar collector for directing radiation onto the energy transforming chamber;

a framework connected to said solar collector and allowing its movement;

a solar alignment device moveably associate with said solar collector and said framework to allow the solar alignment device to position the solar collector to increase the amount of radiation hitting the energy transforming chamber, wherein said solar alignment device comprises:

a lens for focusing radiation;

a center target, said center target positioned so that when the solar collector is optimally positioned, radiation passing through the lens will be directed to the center target; and

at least one movement chamber, wherein the at least one movement chamber has a low temperature boiling liquid, wherein the chamber is positioned around said center target, wherein at least one movement chamber is capable of receiving radiation from the lens when the radiation is not directed to the center target, and wherein each movement chamber can transmit radiation or heat to the liquid contained within, wherein each movement chamber further comprises a displacer, each displacer driveably connected with the rest of the movement chamber so that heating of the liquid results in moving the displacer to an extended position, wherein each displacer is driveably connected to the framework to allow movement of the displacer to move the solar collector, wherein the movement chamber, lens, and solar collector are also associated with the framework so that the movement chamber, lens, and solar collector are repositioned by the movement of the displacer.

8. A solar still device of Claim 7, wherein the solar collector comprises a parabolic surface and is made of an inflatable membrane that maintains its shape due to internal air pressure.

9. A solar still device of Claim 8, wherein the inflatable membrane has a valve to prevent over-pressure build-up, and another valve to allow air into the inflatable membrane when it cools after sundown.

10. A solar still comprising:

an energy transforming chamber;

a parabolic mirror for directing radiation onto the energy transforming chamber;

a solar alignment device connected to said parabolic mirror to allow the solar alignment device to position the mirror to increase the amount of radiation hitting the energy transforming chamber, wherein said solar alignment device comprises:

a lens for focusing radiation;

a ring positioned so that when the parabolic mirror is optimally positioned to gather light from a light source, the lens will direct radiation passing through the lens through the ring;

four movement chambers, wherein each movement chamber comprises a low temperature boiling liquid, wherein each chamber is positioned at approximately 90 degree intervals around the ring, wherein a chamber is capable of receiving radiation from the lens that is not passing through the ring, wherein each chamber can transmit energy from the lens to the liquid, wherein each chamber further comprises a piston that is driveably connected to a shell of the chamber so that heating of the chamber results in moving a piston to an extended position;

four prisms positioned between the movement chambers and positioned to redirect radiation that falls outside of the ring and between said movement chambers onto said movement chambers; and

a framework supporting the parabolic mirror, wherein at least one piston is driveably connected to the framework to allow movement of the piston to exert a force against the framework in order to move the movement chambers, lens, and parabolic mirror.

11. The solar still of Claim 10, wherein the energy transforming chamber comprises a heat pipe.

12. The solar still of Claim 10, wherein the parabolic mirror comprises an inflatable membrane that maintains its shape due to internal air pressure.

13. The solar still of Claim 12, wherein the inflatable membrane further comprises a mirror attached to a surface of the inflatable membrane.

14. The solar still of Claim 12, wherein the inflatable membrane comprises a first valve to prevent over-pressure build-up, and a second valve to allow air into the inflatable membrane when it cools after sundown.

15. The solar still of Claim 12, wherein the solar still is configured to provide steam to the surface of the inflatable membrane.

16. The solar still of Claim 10, further comprising a parabolic trough assembly configured to collect and concentrates solar radiation.

17. The solar still of Claim 10, further comprising a photocell and a photocell sensor that detects sunlight conditions and discriminates between direct sunlight radiation and diffuse light conditions.

18. The solar still of Claim 10, wherein the solar alignment device is configured to stop operating during nighttime conditions.

19. The solar still of Claim 10, wherein the frame is further associated an electric motor to effect movement of the solar collector device during conditions of diffuse light.

20. The solar still of Claim 10, further comprising a spring system or counterweight system configured to return said parabolic mirror to a starting position after a period of tracking a movement of a light source.

FIG. 1

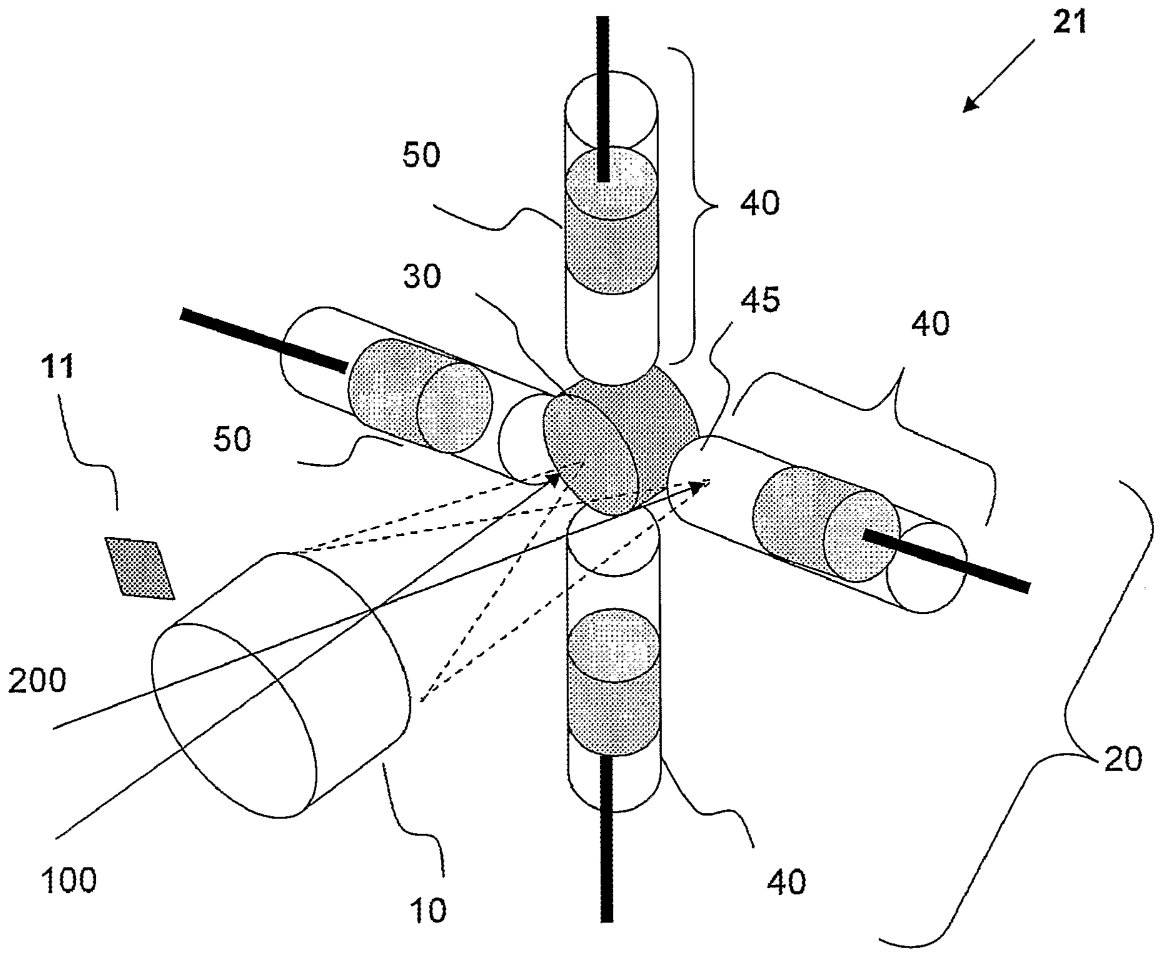

FIG. 2

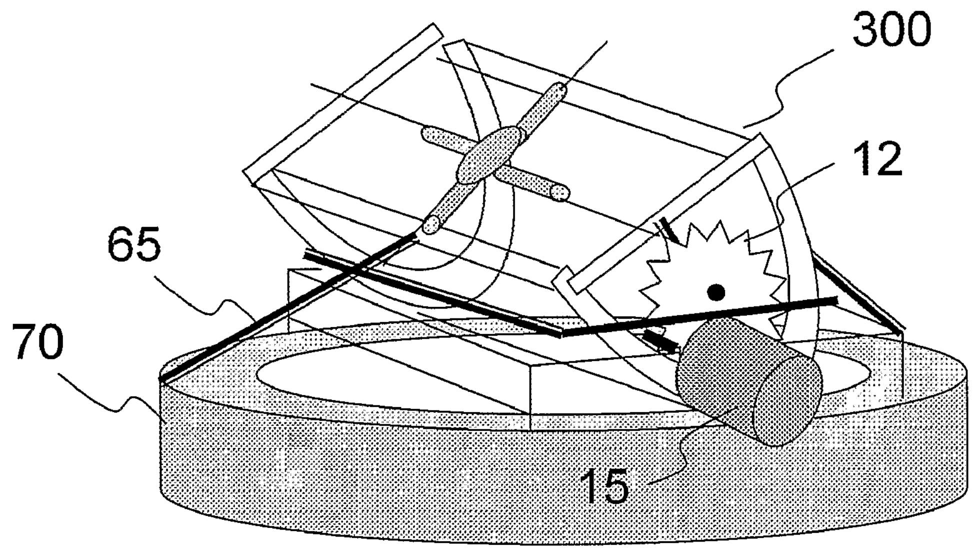

FIG. 3

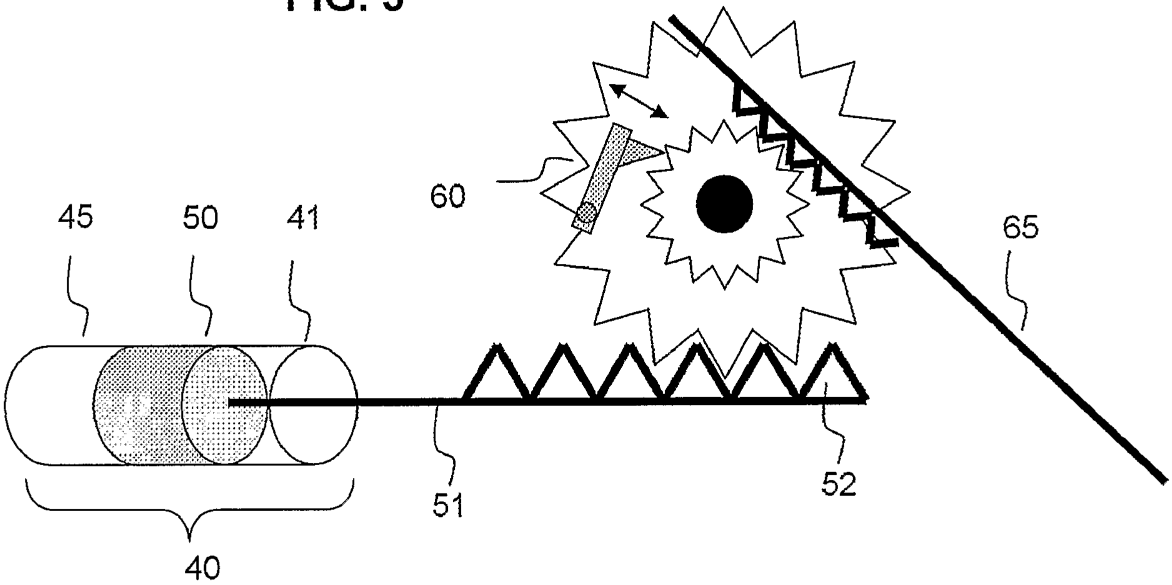

FIG. 4a

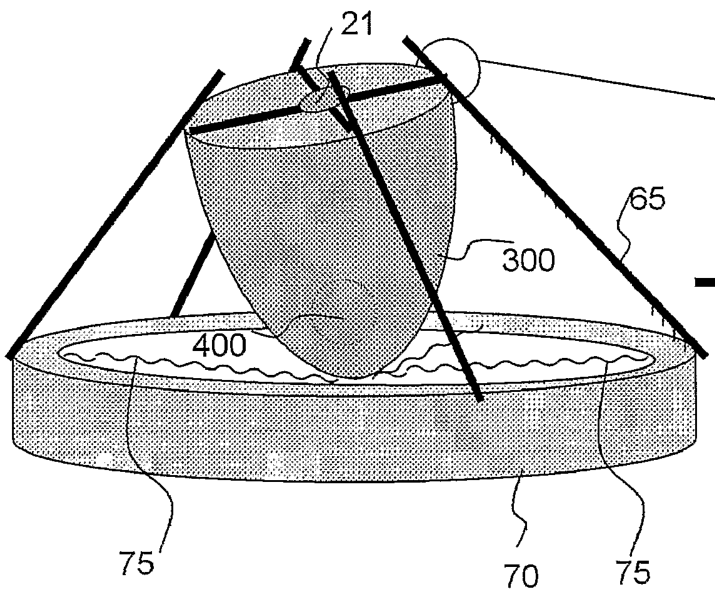

FIG. 4b

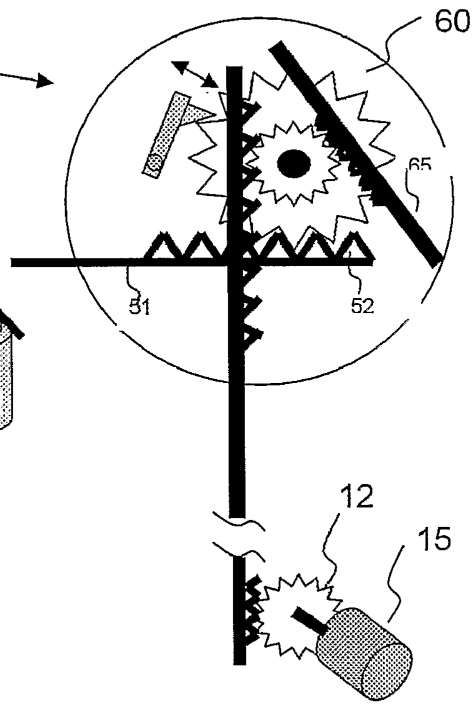

Figure 5a

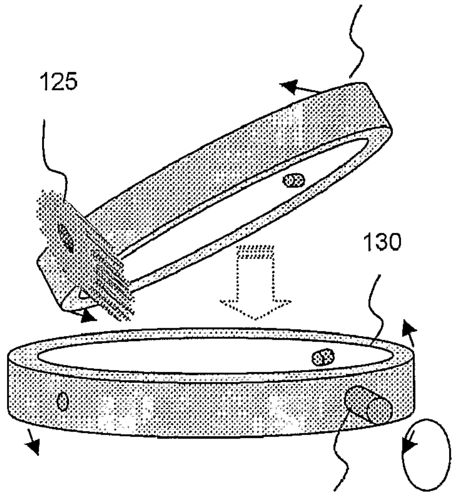

Figure 5b

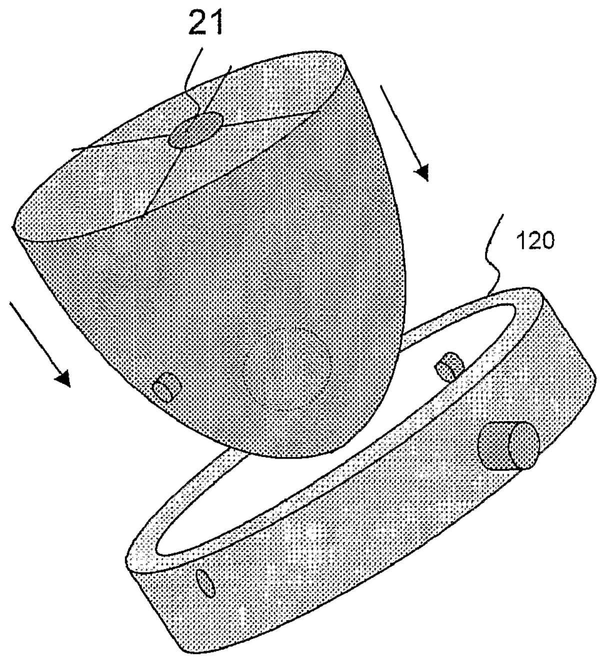

Figure 6

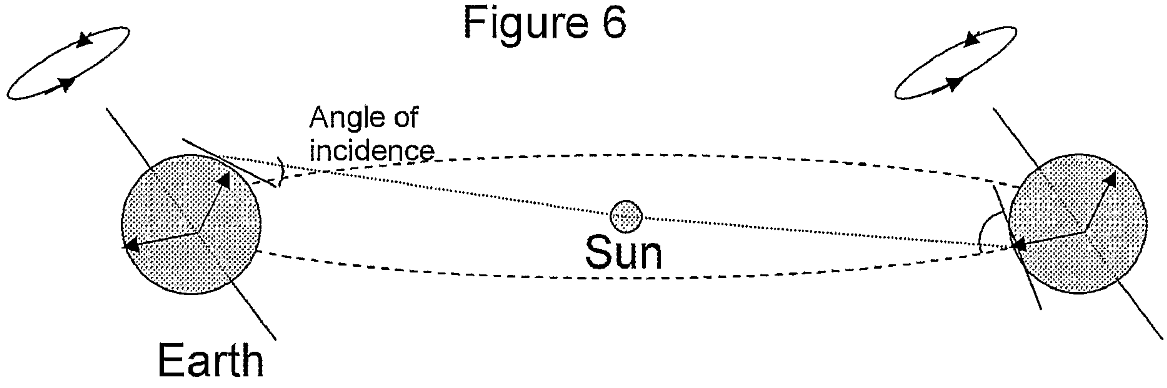

Figure 7

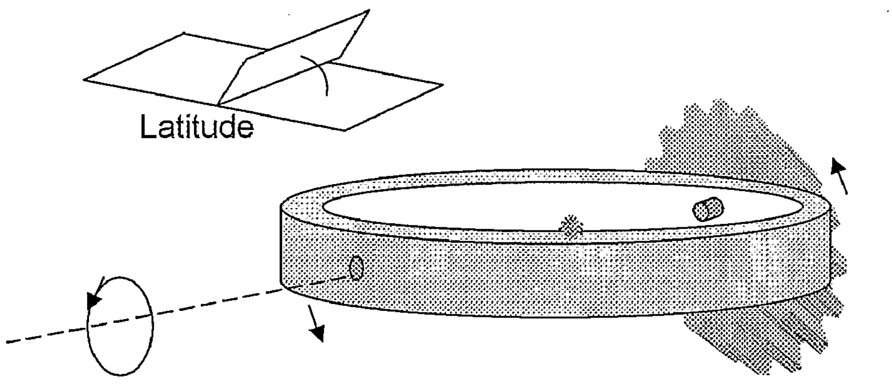

Figure 8

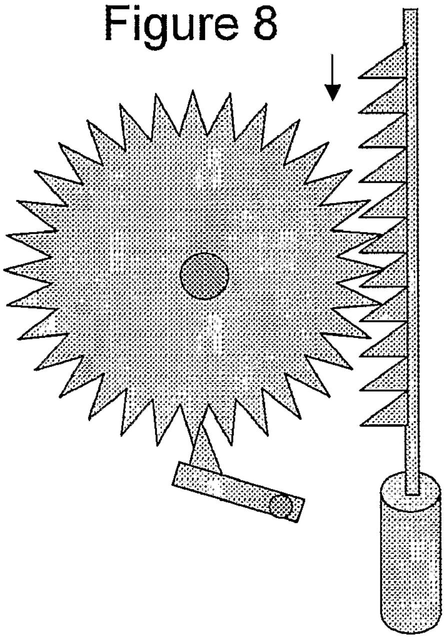

Figure 9

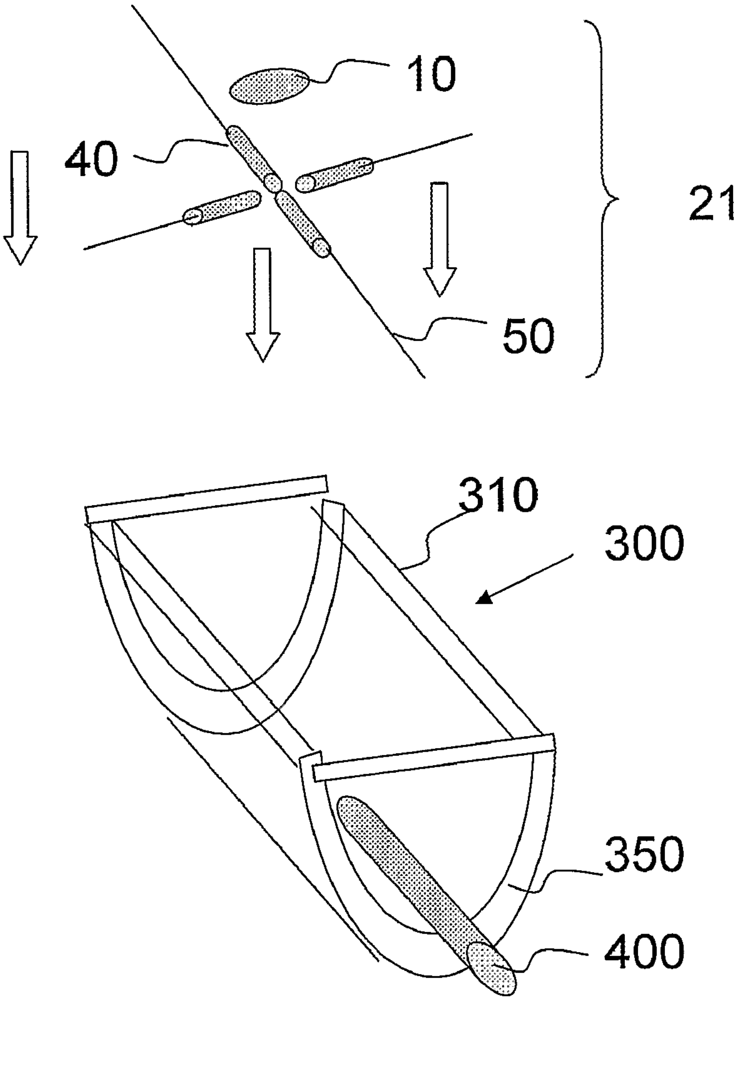

Figure 10a

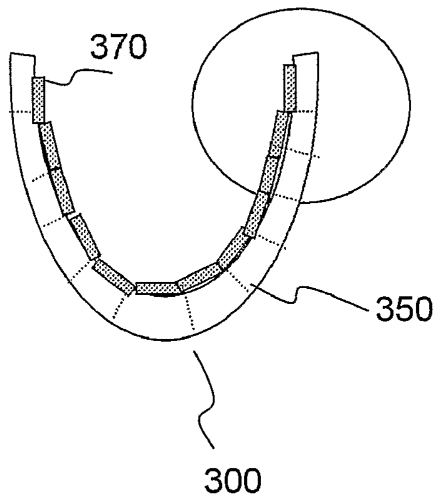

Figure 10b

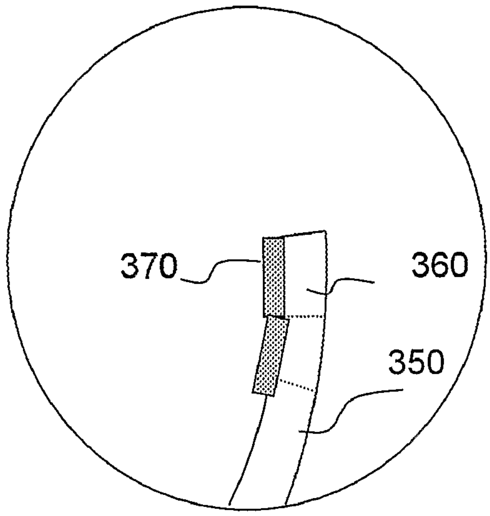

Figure 11

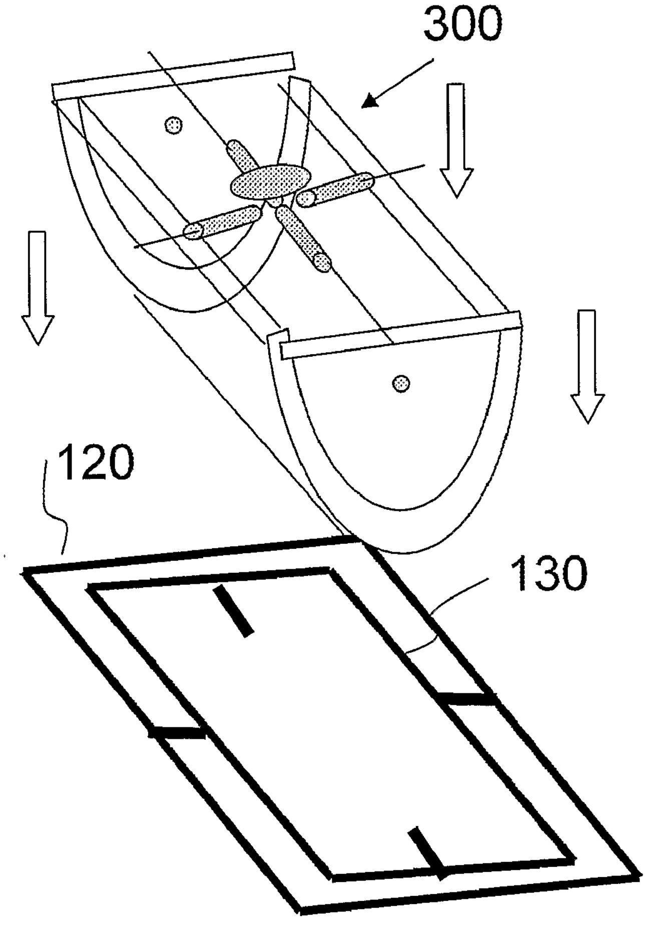

Figure 12

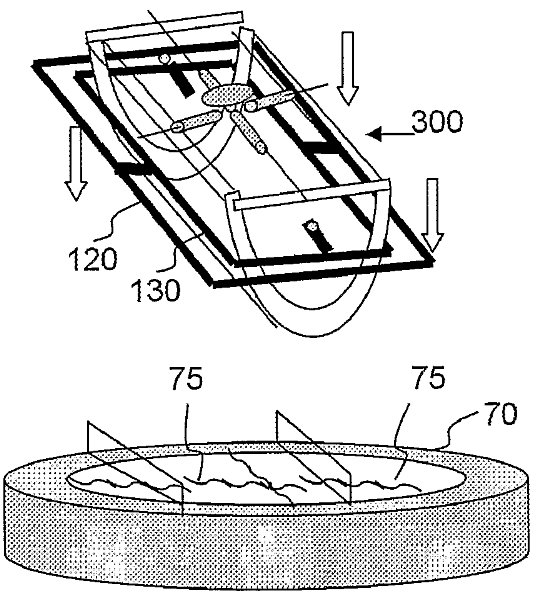

Figure 13

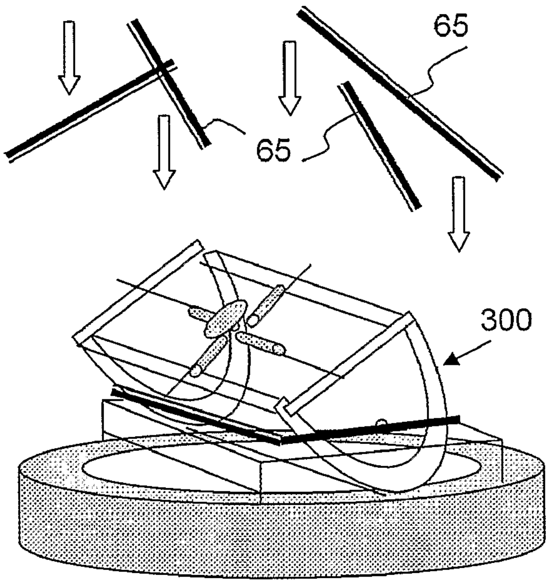

Figure 14