



US 20100263659A9

(19) **United States**
(12) **Patent Application Publication**
Taylor et al.

(10) **Pub. No.: US 2010/0263659 A9**
(48) **Pub. Date: Oct. 21, 2010**
CORRECTED PUBLICATION

(54) **SOLAR TRACKER SYSTEM AND METHOD OF MAKING**

(65) US 2010/0126497 A1 May 27, 2010

(75) Inventors: **William F. Taylor**, Bend, OR (US);
Chris Edwards, Bend, OR (US)

Correspondence Address:

K&L Gates LLP

**STATE STREET FINANCIAL CENTER, One
Lincoln Street**

BOSTON, MA 02111-2950 (US)

(73) Assignee: **PV Trackers, LLC**, Bend, OR (US)

(21) Appl. No.: **12/621,939**

(22) Filed: **Nov. 19, 2009**

Prior Publication Data

(15) Correction of US 2010/0126497 A1 May 27, 2010
See (60) Related U.S. Application Data.

Related U.S. Application Data

(63) Continuation-in-part of application No. 12/276,245,
filed on Nov. 21, 2008.

(60) Provisional application No. 61/058,195, filed on Jun.
2, 2008.

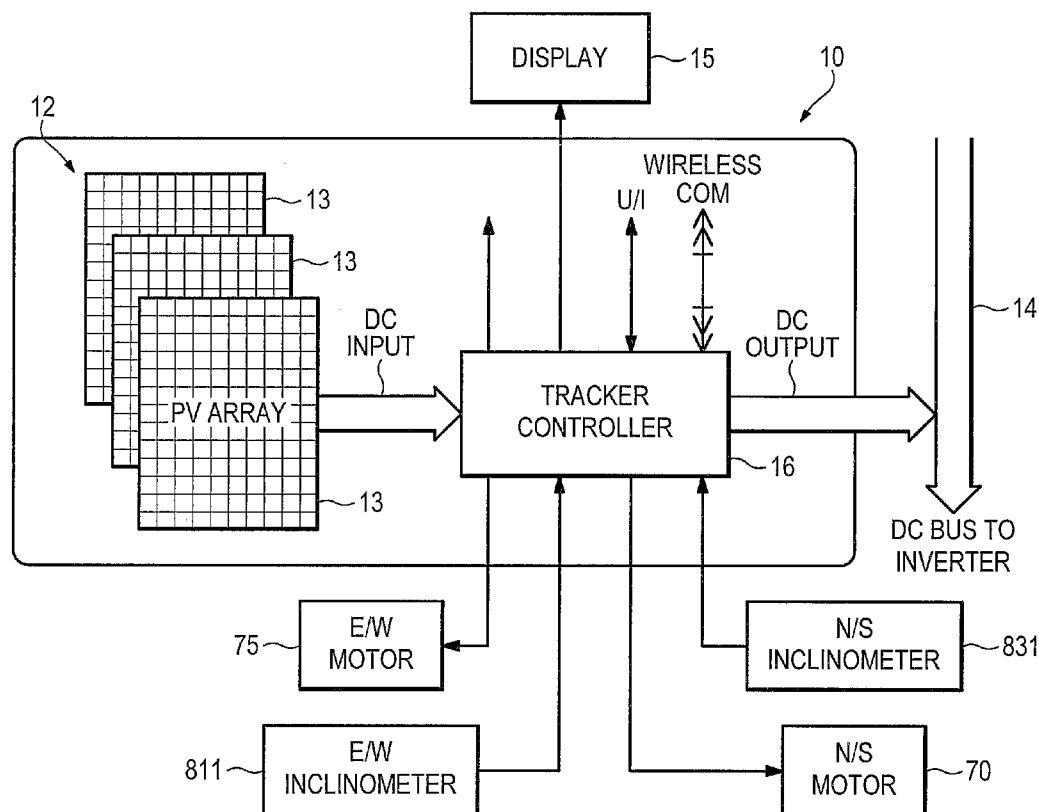
Publication Classification

(51) **Int. Cl.**
F24J 2/38 (2006.01)
F24J 2/00 (2006.01)

(52) **U.S. Cl.** **126/600; 126/714**

(57) ABSTRACT

The solar array is attached to a support structure which permits it to pivot about two non-parallel and non-intersecting axes. The array may then be easily moved to track the sun, maintaining the production of electricity. The structure may be adapted for attachment to a surface such as the ground.



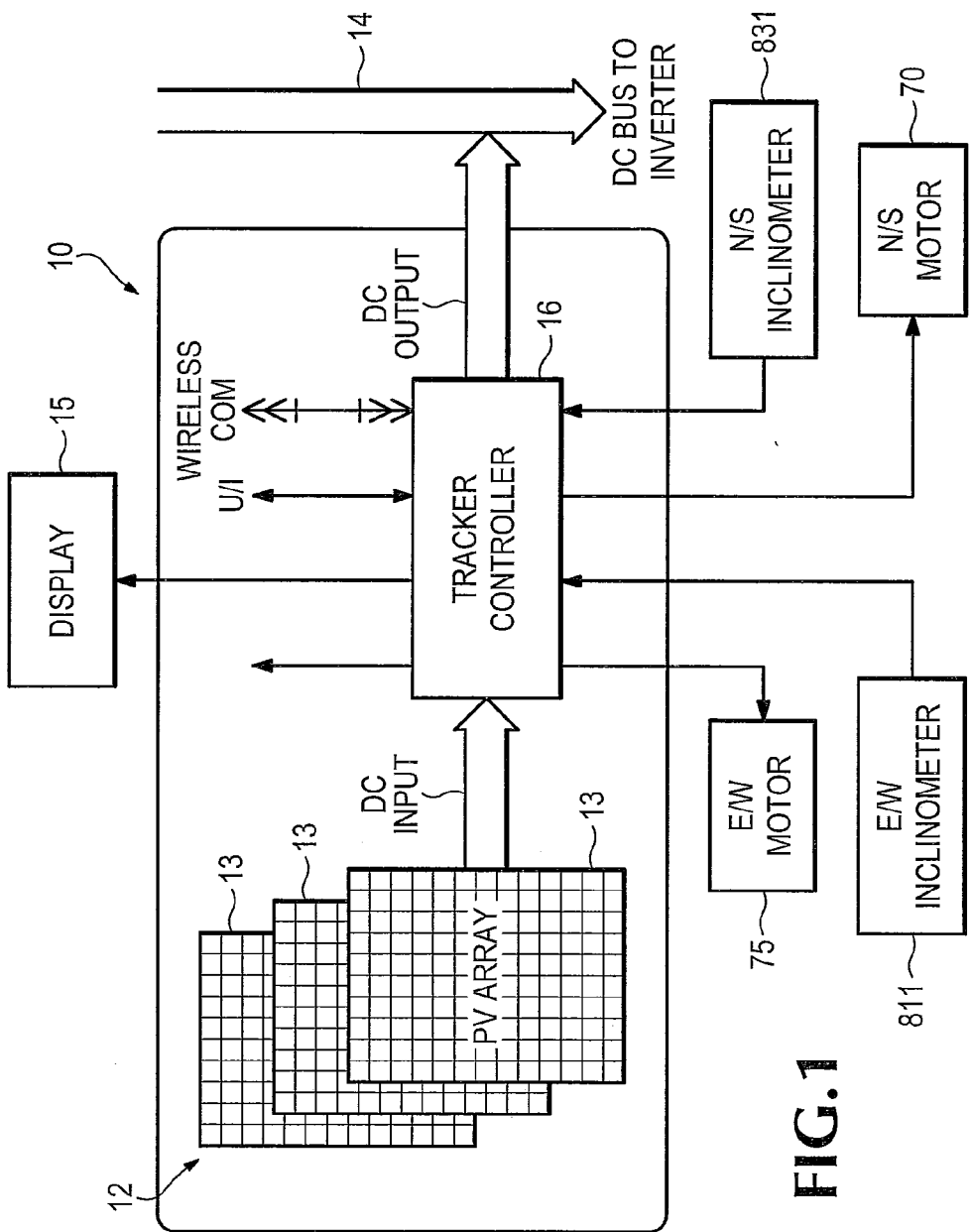


FIG. 1

FIG.2

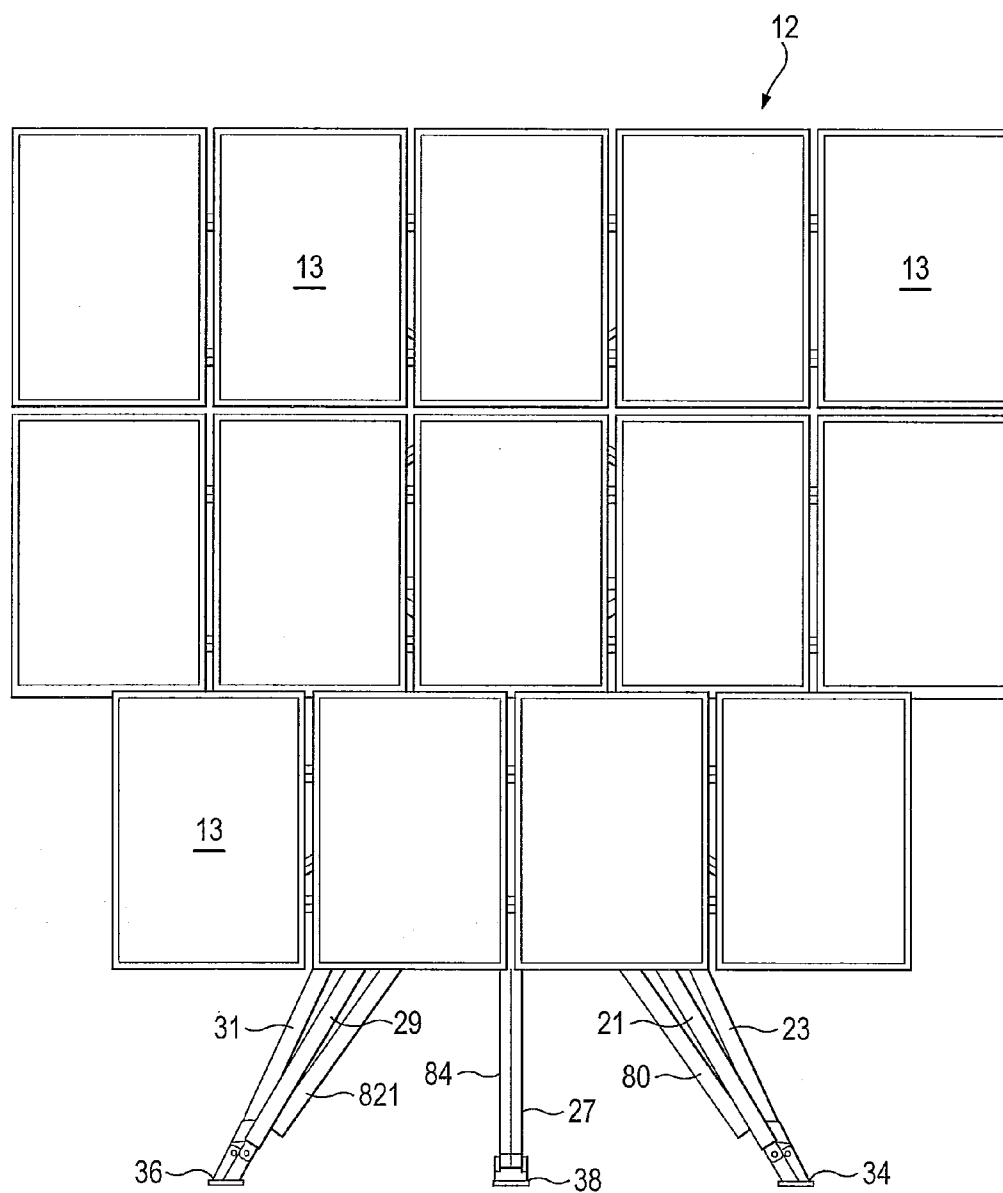
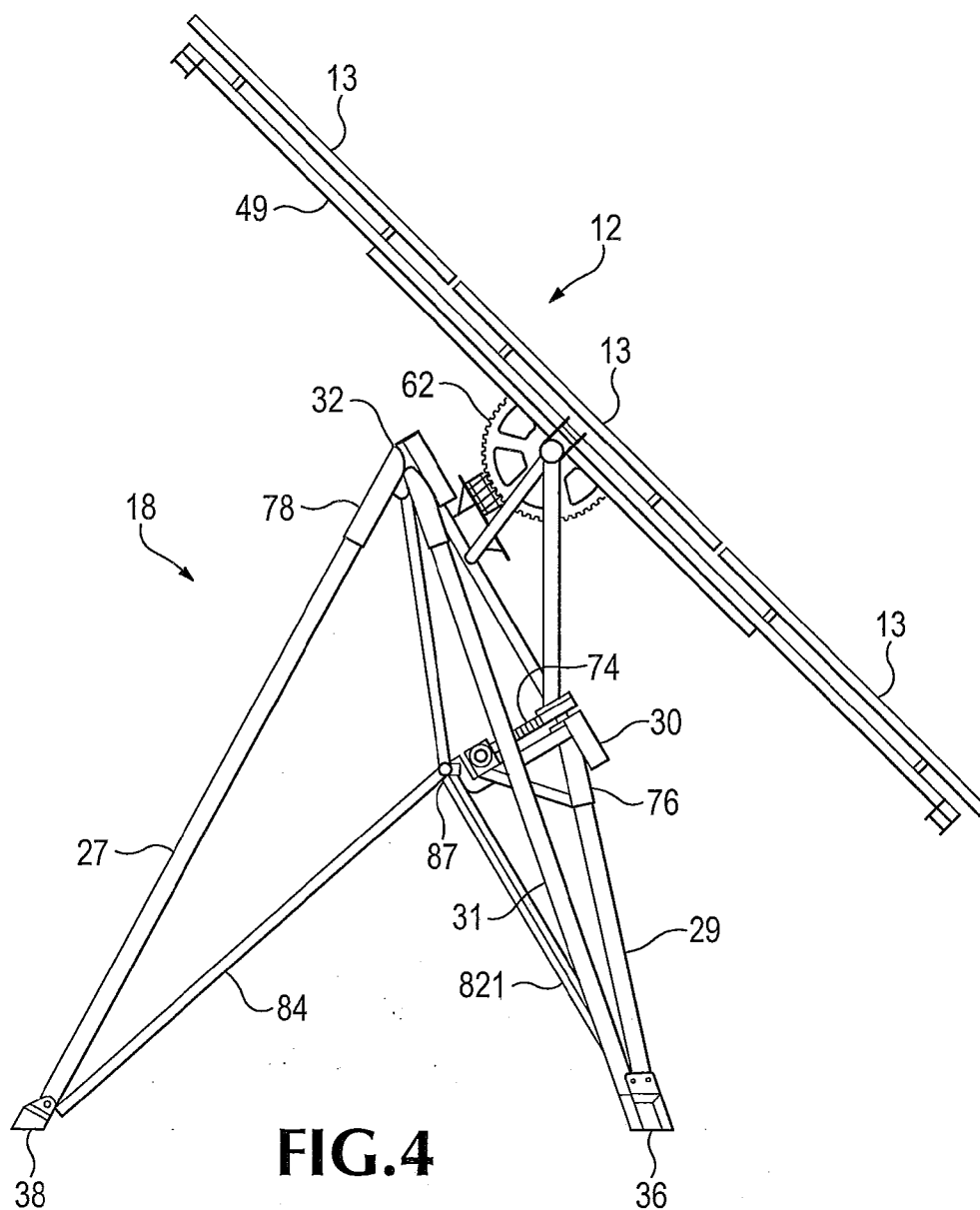


FIG.3



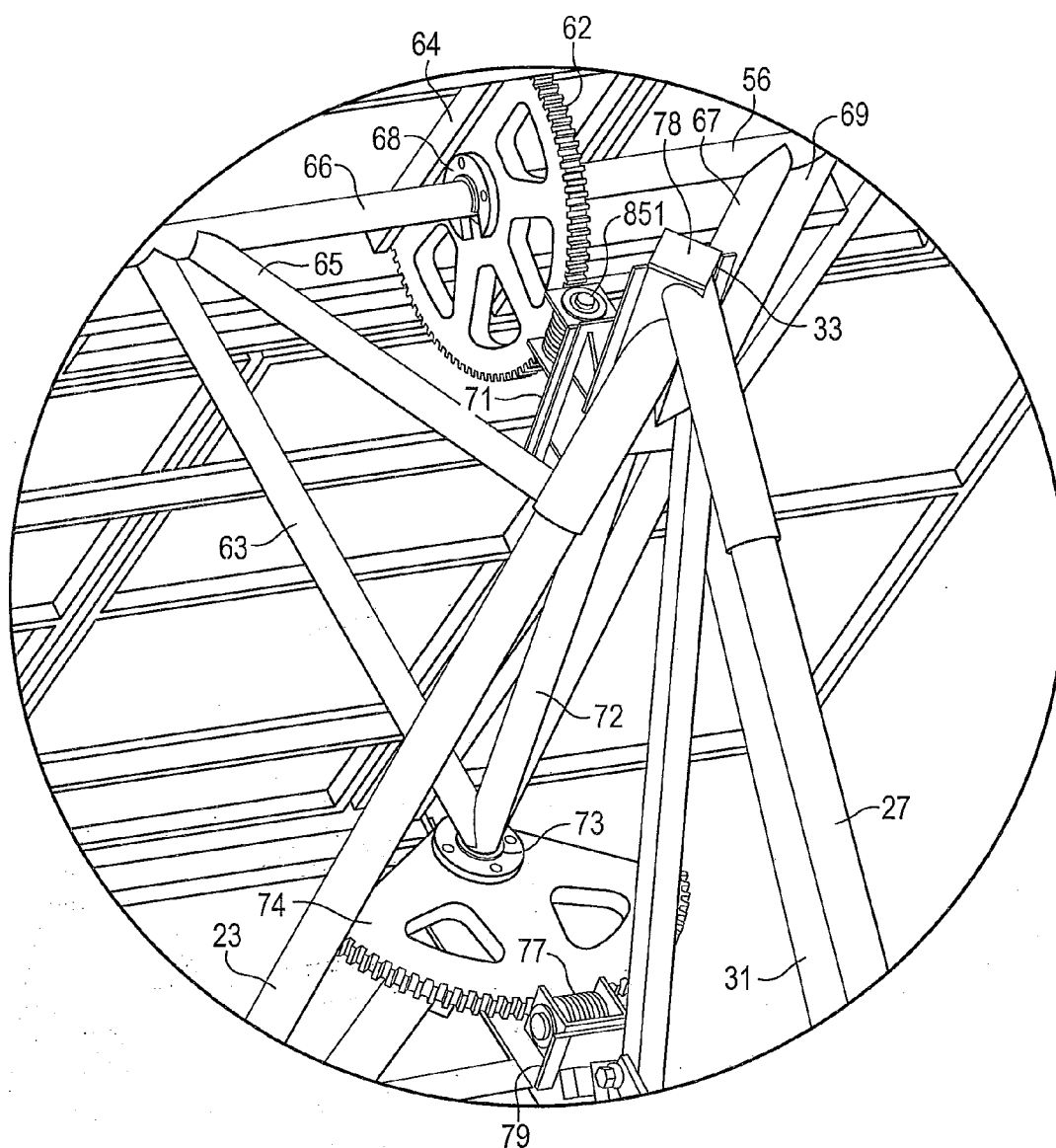
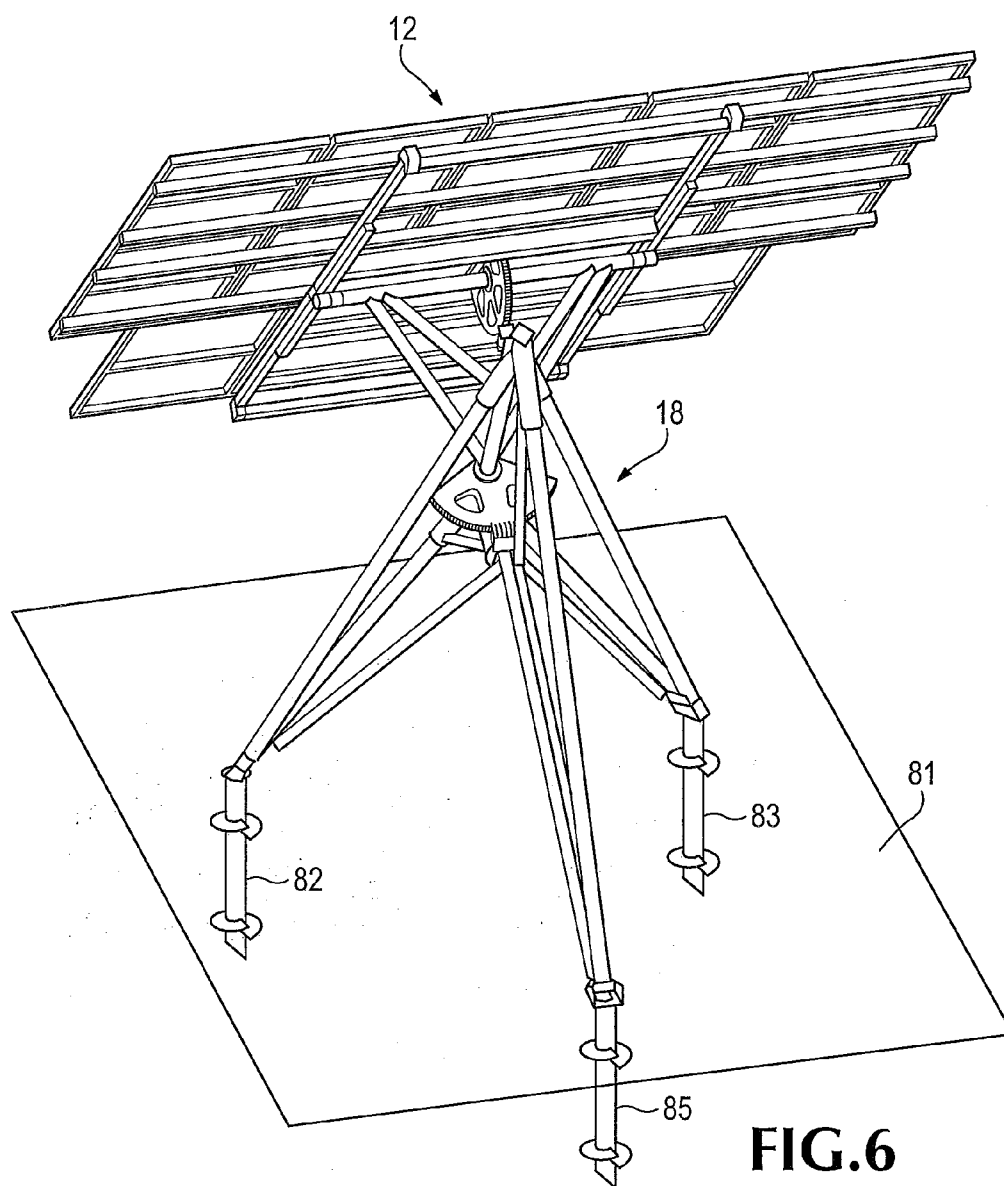
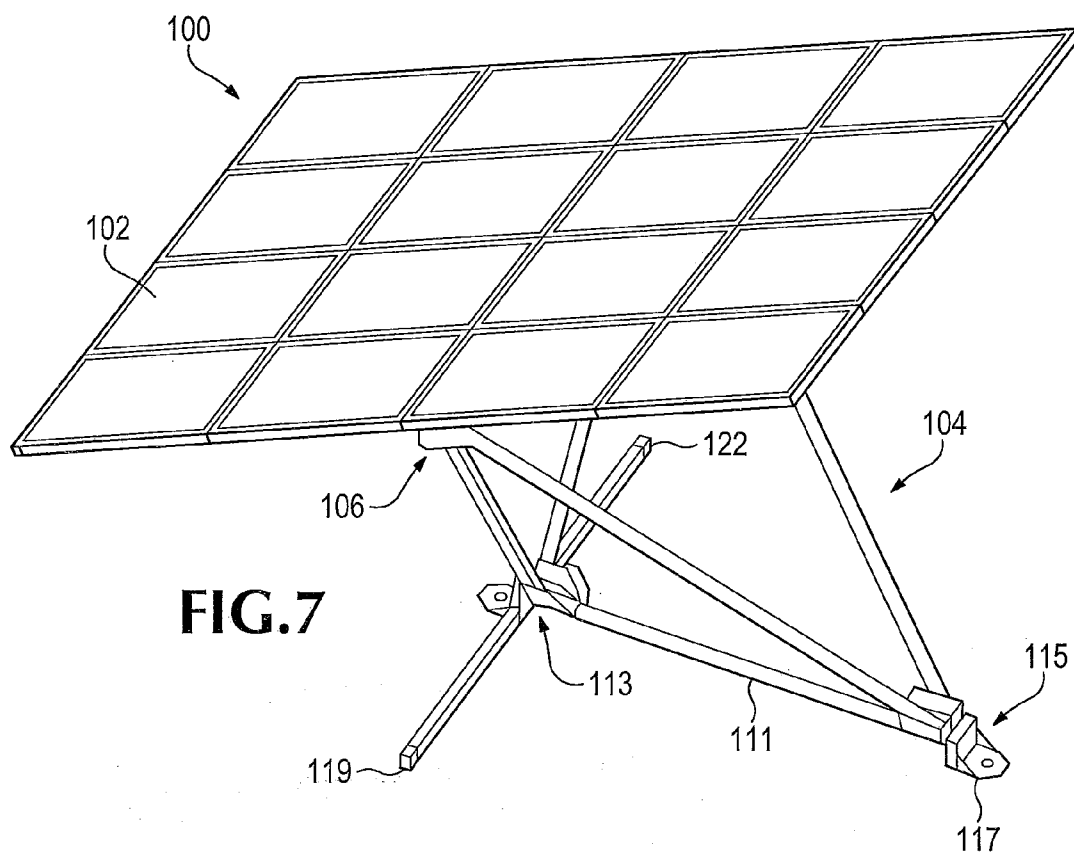
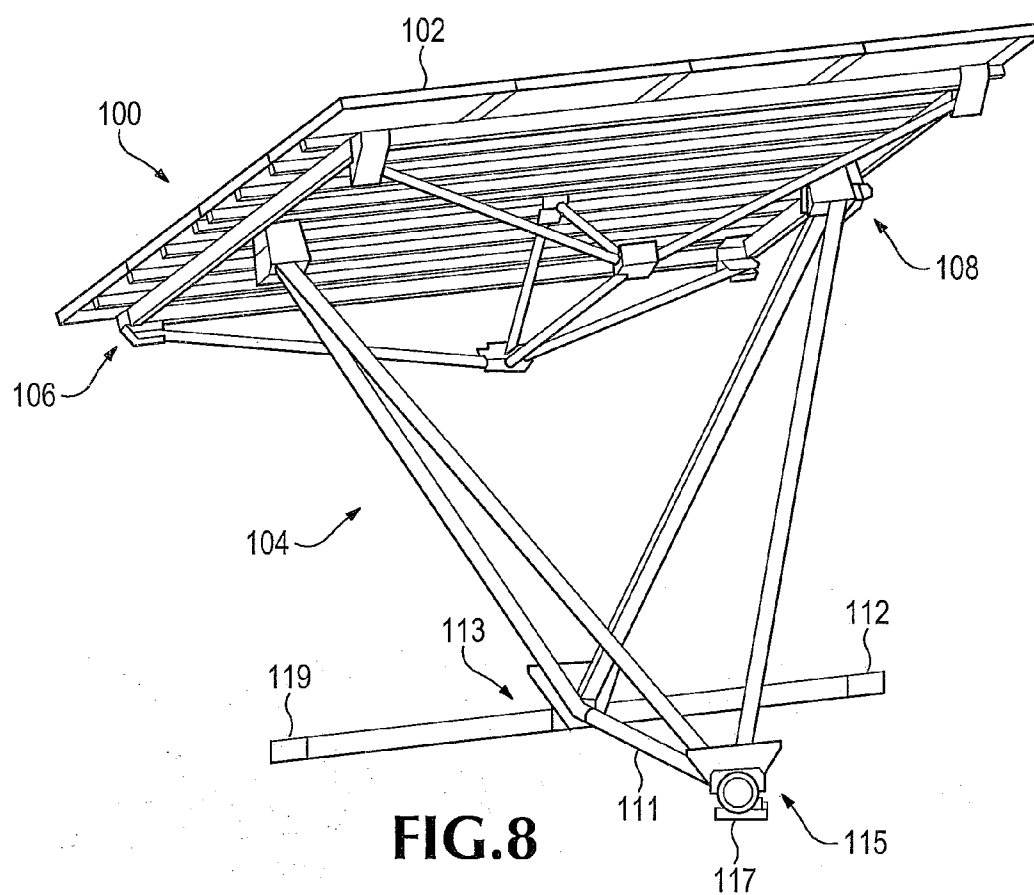


FIG.5







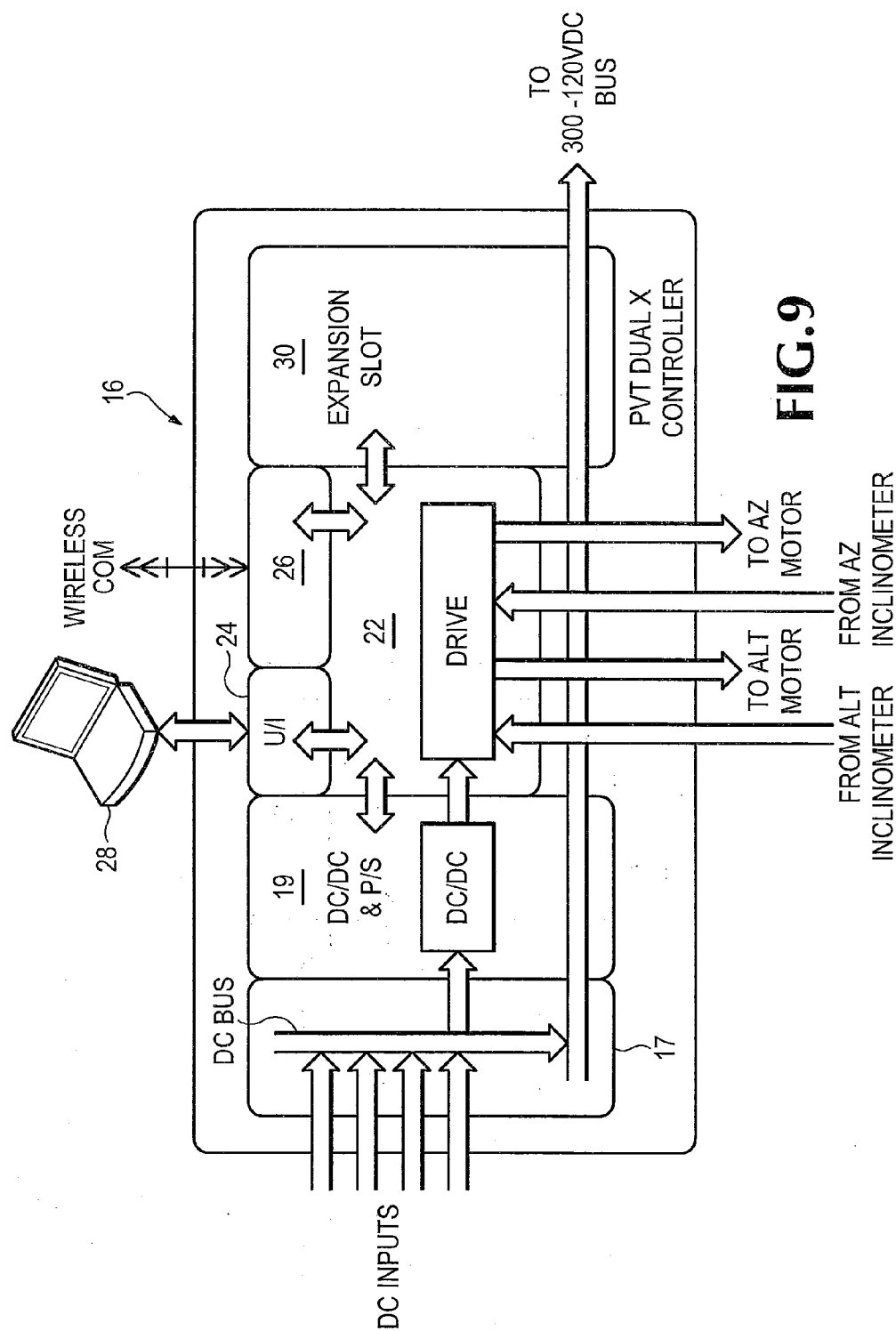
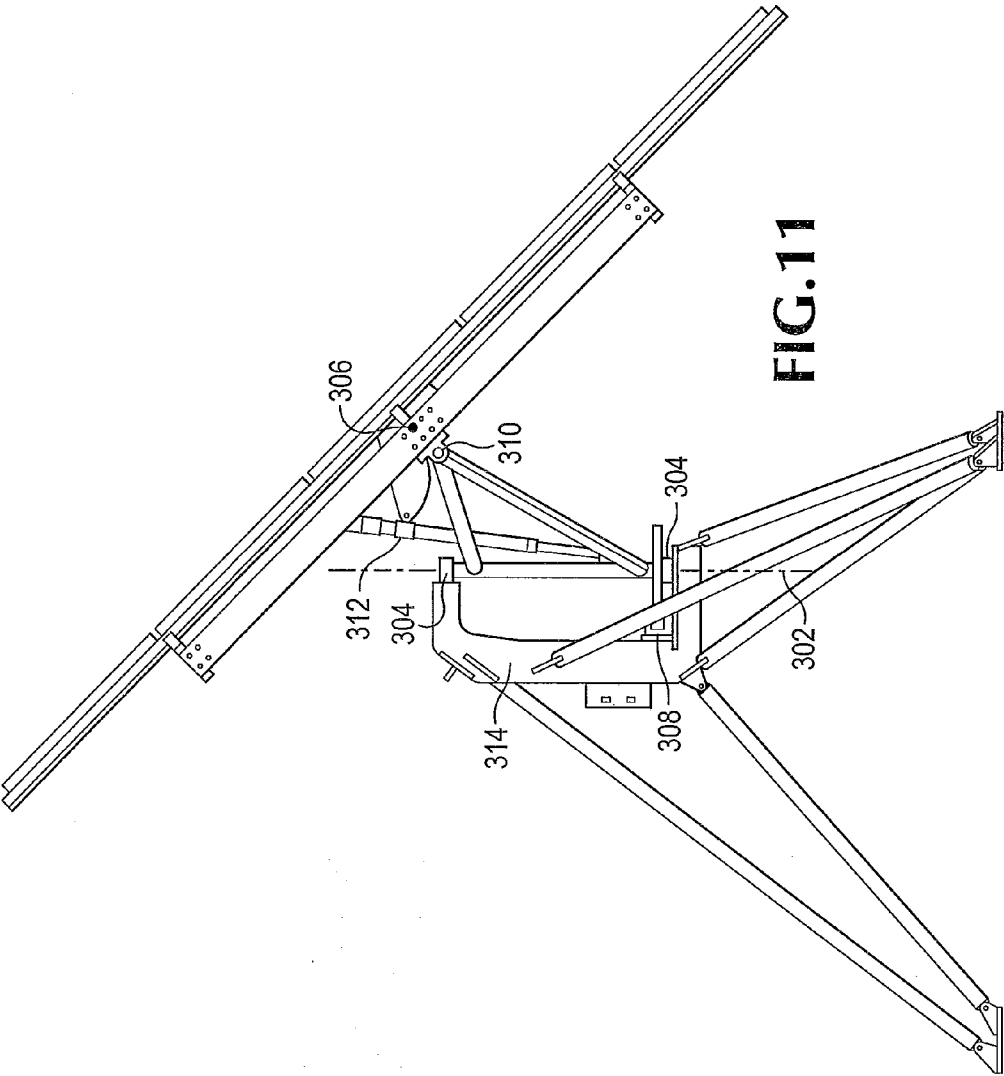


FIG. 9





SOLAR TRACKER SYSTEM AND METHOD OF MAKING

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. patent application Ser. No. 12/276,245 filed Nov. 21, 2008.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

NAMES OF PARTIES TO A JOINT RESEARCH AGREEMENT

[0003] Not applicable.

REFERENCE TO SEQUENCE LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING COMPACT DISC APPENDIX

[0004] Not applicable.

BACKGROUND OF THE INVENTION

[0005] 1. Field of the Invention

[0006] The present invention relates in general to a system and method for making a solar tracker system. It more particularly relates to a system and method for making a robust solar tracker system that is easy and inexpensive to install.

[0007] 2. Description of Related Art Including Information Disclosed Under 37 CFR 1.97 and 1.98

[0008] There is no admission that the background art disclosed in this section legally constitutes prior art.

[0009] Conventional solar trackers employ controllably moveably mounted solar panels to expose them continuously to the path of the sun both throughout the day and throughout the year. For example, reference may be made to U.S. Pat. No. 6,058,930.

[0010] Such solar trackers may be prohibitively expensive to install on a large commercial scale primarily due to the installation cost of large concrete footing anchorage or the like. Also, conventional trackers have not been entirely satisfactory for some applications due to their inability to adequately withstand adverse weather conditions such as high winds. In this regard, conventional solar tracking systems typically employ a single point of connection from the anchorage to the large projected area of the solar panel array.

BRIEF SUMMARY OF THE INVENTION

[0011] A solar tracker is disclosed that is capable of rapid installation at low cost. The tracker is built from lightweight components designed to be placed on a surface and anchored thereto. The tracker features a broad base which does not require a deep or heavy foundation. Additionally, one solar array is attached to the tracking mechanism by two spatially separated axes, each with at least two spatially separate and

pivoting points of attachment. This reduces the forces on the pivots and allows them to be built with lighter and cheaper components.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0012] The features of this invention and the manner of attaining them will become apparent, and the invention itself will be best understood by reference to the following description of certain embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

[0013] FIG. 1 is a diagrammatic view of a solar tracker system according to an embodiment of the present invention;

[0014] FIG. 2 is a pictorial view of a solar tracker system attached to a rooftop according to an embodiment of the present invention;

[0015] FIG. 3 is a front pictorial view of the solar tracker system of FIG. 2;

[0016] FIG. 4 is a side pictorial view of the solar tracker system of FIG. 2;

[0017] FIG. 5 is an enlarged view of the underside of the solar panel array of the solar tracker system of FIG. 2 showing the axes of rotation;

[0018] FIG. 6 is a pictorial view of a solar tracker system having anchors that screw into the ground;

[0019] FIGS. 7 and 8 are pictorial views of another embodiment of a solar tracker system according to the present invention;

[0020] FIG. 9 is a diagrammatic view of the tracker controller of the solar tracker system of FIG. 1;

[0021] FIG. 10 is a pictorial view of solar tracker system having a single anchoring point for attaching the system to the ground; and

[0022] FIG. 11 is a side view of another embodiment of the solar tracker system.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

[0023] A solar tracker system and method for making it are disclosed. By utilizing an embodiment of the invention, incident solar radiation may be more efficiently and effectively collected throughout the day and throughout the year by a system that is relatively inexpensive and simple to install. The embodiments of the present invention are structurally strong and are able to withstand severe weather conditions including high winds in a more secure manner.

[0024] In accordance with certain embodiments of the present invention, there is provided a solar tracker system, which may comprise a solar panel array assembly having at least two attachments for mounting the system on a surface such as the ground, a structure or other. A support anchor assembly for attaching to the surface and having at least two attachments, and a support structure including a plurality of elongated support rods for securing the array assembly above the support anchor assembly. Each support rod may be attached at one end to one of the attachments of the solar panel array and attached at the other end to one of the attachments of the support anchor assembly. The number of support rods connected to each attachment of the solar panel array assembly may equal the number of attachments of the support anchor assembly, and the number of support rods connected to each attachment of the support anchor assembly may equal the number of attachments of the solar panel assembly.

[0025] In accordance with another embodiment of the present invention, there is provided a solar tracker system for mounting on a surface. The system may comprise a solar panel array assembly having at least two attachments, at least three anchors for attaching to the surface, and a support structure including a plurality of elongated support rods for securing the array assembly above the support anchor assembly. Each support rod may attach at one end to one of the attachments of the solar panel array and attach at the other end to one of the anchors. The number of support rods connected to each attachment of the solar panel array assembly may equal the number of anchors, and the number of support rods connected to each anchors may equal the number of attachments of the solar panel assembly.

[0026] In accordance with yet another embodiment of the present invention, there is provided a solar tracker system for mounting on a surface. The system may comprise a solar panel array assembly having a rotating support, a support anchor assembly for attaching to the surface and having a rotating support, and a support structure disposed between the rotating support of the solar panel array assembly and the rotating support of the support anchor assembly to provide two axes of movement of the solar panel array assembly relative to the support anchor assembly. The support structure may include a plurality of elongated support rods configured in the shape of a tetrahedron for securing the array assembly above the support anchor assembly.

[0027] In accordance with yet another embodiment of the present invention, there is provided a solar tracker system for mounting to an anchor in a surface. The system may include a support structure having at least three legs, a solar panel array assembly mounted to the support structure, and an anchoring point disposed on the support structure and adapted for attaching to the anchor in the surface.

[0028] Referring to FIG. 1, a solar tracker system 10 is shown for collecting incident solar radiation throughout the day and throughout the year. The solar tracker system 10 may include a solar panel array assembly 12 having a plurality of solar panels 13 and a tracker controller 16 for controlling the position of the solar panel array assembly 12 and for transferring the DC power generated by the solar panel array assembly 12 to a DC bus 14. The DC power may range from 300 to 1,200 VDC. The DC bus 14 may be connected to a storage device (not shown) containing one or more batteries or to a converter (not shown) for converting the DC power to AC power. In brief, the solar panel array assembly 12 as controlled by tracker controller 16 may daily track the sun from approximately sunrise to sunset for collecting incident solar radiation and converting it into DC power for immediate use or storage. Also, the tracker controller 16 selectively energizes East/West (E/W) and North/South (N/S) motors 75 and 70, respectively, to move the solar panel array assembly 12 along a pair of axes using signals from East/West (E/W) and North/South (N/S) inclinometers 811 and 831, respectively, as hereinafter explained in greater detail.

[0029] Referring now to FIG. 9, the tracker controller 16 is shown in more detail. The tracker controller 16 may include a DC combiner for receiving DC power inputs from each of the solar panels. Most of the DC power may be placed on a DC power bus that may be outputted from the controller 16 to a DC power bus connected to storage devices or a converter. A portion of the DC power may be provided to a DC/DC converter and power supply 19 to produce and supply suitable DC power to the controller 16. A control/drive module 22

may be provided in the controller 16 to control the position of the solar panel array assembly. The control/drive module 22 may receive the suitable DC power from the power supply 19, an input from the altitude inclinometer 831 (N/S inclinometer) (FIG. 1), and an input from the azimuth inclinometer 811 (E/W inclinometer) (FIG. 1); and provide drive outputs to the altitude motor 70 (N/S motor) (FIG. 1) and the azimuth motor 75 (E/W motor) (FIG. 1). The control/drive module 22 may include firmware and/or software that utilize the inclinometer inputs to appropriately drive the motors to enable the solar panel array assembly to track the position of the sun throughout the day and throughout the year. A USB interface 24 and a wireless communication module 26 may also be provided in the controller 16 to provide access to the control/drive module 22 using a laptop computer 28 or other suitable device. The control/drive module 22 may provide outputs that control one or more external displays 15 (FIG. 1) and status LEDs.

[0030] Referring now to FIGS. 2 through 5, the solar panel array assembly 12 may be moveably supported from a mounting surface by a stationary support structure 18 having a plurality of support rods or struts 21, 23, 27, 29, 31 connected between the solar panel array assembly 12 and a plurality of anchors 34, 36, 38 for supporting the solar panel array assembly 12 above the mounting surface in a convenient and secure manner to withstand adverse weather conditions including high winds. One end of support rods 21 and 29 may be connected together at a point 30 with a connector 76, and one end of support rods 23, 27, and 31 may be connected together at a point 32 with a connector 78. When the mounting surface is a rooftop 45, the anchors 34, 36, 38 may be attached to support beams 41, 43 of the rooftop 45 using a plurality of fasteners 47, such as bolts and nuts, as shown in FIG. 2. When the mounting surface is the ground 81, helical screw anchor 82, 83, 85 may be utilized by screwing them directly into the ground 81 as shown in FIG. 6.

[0031] The arrangement of support rods or struts provides the system 10 with a structurally strong configuration to enable the system to withstand strong winds and other adverse weather conditions. Also, the anchors such as the anchors 34, 36 and 38 enable the system 10 to be conveniently installed in many different locations.

[0032] The solar panel array assembly 12 may include a frame 49 (FIG. 2) for holding the plurality of solar panels 13 in a planar configuration. As shown in FIG. 3, according to one embodiment, fourteen solar panels 13 may be fixedly attached to the front of the frame 49 in a typical configuration, but other larger or smaller number of panels may be employed. The number of solar panels attached to the frame may vary due to the size or shape of the frame and/or the size of the solar panels.

[0033] As best seen in FIGS. 2 and 5, a pair of support beams 52, 54 may be fixedly attached to the back of the frame 49 in a parallel, spaced apart manner. In order to moveably support the array assembly 12 on the stationary support structure 18, a spindle 56 rotatable about its axis may extend between the support beams 52, 54 approximately midway between the top and bottom of the frame 49 and be rotatably connected to each support beam 52, 54 at its ends 58 and 61, respectively, by means of a pair of sleeve connectors or bearings 59 and 60 (FIG. 2), respectively, fixed to the support beams 52, 54. In this manner, the assembly 12 can be moved in a North/South (N/S) inclination to adjust for seasonal changes.

[0034] A gear section 62 may be attached fixedly to a support beam 64 of the frame 49 and rotatably connected to the spindle at point 66 using a connector 68. The gear section 62 may be driven by the North/South (N/S) motor 70 (FIG. 1) using a gear 851 in communication with the gear section 62. The N/S motor 70 (FIG. 1) may be controlled by the tracker controller 16 (FIG. 1) to pivot controllably the frame 49 with solar panels 13 in the N/S orientation. The N/S inclinometer 831 (FIG. 1) may be attached to the frame 49 in a manner to provide feedback to the tracker controller 16 regarding the N/S orientation of the solar panels 13. A plurality of support arms 63, 65, 67, 69 may connect the spindle 56 to a shaft 72 disposed below the spindle 56 and extending perpendicularly thereto. The N/S motor 70 (FIG. 1) may be mounted on the shaft 72 using motor support 71.

[0035] The shaft 72 may extend between and be rotatably connected to the support rods 21, 23, 27, 29, 31 at the opposite ends of the shaft 72 by a pair of bearings such as bearing 33 (FIG. 5) using a pair of connectors such as connector 78. A gear section 74 may be fixedly and drivably attached to the shaft 72 at point 73. The shaft 72 and gear section 74 may be driven by the East/West (E/W) motor 75 (FIG. 1) using a gear 77 meshing with the gear section 74. The E/W motor 75 (FIG. 1) may be controlled by the tracker controller 16 (FIG. 1) to pivot the frame 49 with solar panels 13 in the E/W orientation. The E/W inclinometer 811 (FIG. 1) may be attached to the frame 49 in a manner to provide feedback to the tracker controller 16 regarding the E/W orientation of the solar panels 13. The E/W motor 75 (FIG. 1) may be mounted on motor support 79 supported by support arms 80, 821, and 84 attached to anchors 34, 36, and 38, respectively. Support arms 80, 821 and 84 may be connected together at a point 87.

[0036] The frame 49 with solar panels may tilt drivably controllably north to south about the spindle 56 which may be pivotally attached at its ends at points 58 and 61 by means of the pair of sleeve connectors 59 and 60, respectively, fixed to the frame 49. The frame with solar panels may swing drivably controllably east to west when the shaft 72 is rotated about its ends using the bearings in connectors 76, 78 fixedly attached to the support rods 21, 23, 27, 29, 31 at points 30, 32, which in turn moves the spindle 56 by means of the four support arms 63, 65, 67, 69 connecting the shaft 72 to the spindle 56. The spindle 56 and shaft 72 may be oriented perpendicular to one another, so that their axes of rotation are orthogonal.

[0037] The north to south tilting may provide the ability for adjusting the altitude of solar panels 13 above the horizon. The altitude adjustment may be necessary for the solar panels 13 to optimally track incident to the sun's position throughout the year while collecting incident solar radiation. The east to west tilting may provide the ability for adjusting the position of the solar panels 13 relative to true south, commonly referred to as an azimuth adjustment. The azimuth adjustment of the solar panels 13 may be necessary to allow the solar panels 13 to track incident to the sun's position from the East to the West throughout the day while collecting incident solar radiation.

[0038] The support rods 21, 23, 27, 29, 31 may be of varying lengths depending on the desired set-up angle of the solar panel array assembly 12 and the slope of the surface to which the solar panel array assembly 12 is being mounted. Each of the support rods 21, 23, 27, 29, 31 may connect at one end to one of the ends 76, 78 of rotating support 72 and at the other end to one of the anchors 34, 36, 38; for example, the support

rod 21 is attached to the anchor 34 and the end 76 of the rotating support 72, and the support rod 23 is attached to the anchor 34 and the end 78 of the rotating support 72. Each pair of support rods attached to the same anchor may create a V-shaped configuration in connecting to the solar panel array assembly 12, such as support rods 29 and 31 attached to the anchor 36 as shown in FIG. 4. The support rods may be attached to the anchors and the ends of the rotating support utilizing one or more fasteners, such as bolts and nuts, rivets, or other suitable fasteners.

[0039] The support rods, anchors, frame, rotating supports, and support arms may all be made of a suitable rigid material, such as steel, composites or other materials.

[0040] The method of installing the solar panel array assembly may include the following steps. First, the anchors may be securely attached to the mounting surface using the appropriate anchors. Next, the support rods connecting the front two anchors and bottom end of the rotating support of the solar panel array assembly may be attached to the appropriate anchors and end of the rotating support. Then the support rod connecting the back anchor and the top end of the rotating support of the solar panel array assembly may be attached to the back anchor and top end of the rotating support by maneuvering without lifting the solar panel array assembly. The solar panel array assembly may then be raised into the desired position at least partially supported by the attached support rods, and the remaining support rods may now be attached. This support structure using a plurality of support rods may be very robust and capable of withstanding the desired loads.

[0041] Referring now to FIGS. 7 and 8, another embodiment of the solar tracker system of the present invention is shown and generally referenced as 100. The solar tracker system 100 may include a solar panel array 102, a tetrahedron-type structure 104 connected at two points 106, 108 to the solar panel array 102, and a ground surface support 111 connection at two points 113, 115 to the tetrahedron-type structure 104 in a structurally secure manner. The ground surface support 111 may also be connected to three anchors 117, 119, 122 attached to the ground surface or structure.

[0042] The solar panel array 102 may be a device for collecting solar radiation and converting the solar radiation to electricity. The solar panel array may include an aggregation of individual solar panels fastened in a coplanar manner to a supporting structure.

[0043] The two connection points 106, 108 securely attaching the solar panel array 102 to the tetrahedron-type structure 104 may allow a rotational degree of freedom about an axis orthogonal to the solar panel array 102. This rotational degree of freedom about an axis orthogonal to the solar panel array 102 may provide the ability for adjusting the solar panel array's 102 altitude above the horizon, which may be necessary for the solar panel array 102 to track incident to the sun's position throughout the year while collecting incident solar radiation.

[0044] The tetrahedron-type structure 104 may structurally support the two connection points 106, 108 to the solar panel array 102 and the two connection points 113, 115 to the ground surface support 111. The multiple points of connection utilized with the tetrahedron-type structure 104 may provide sufficient rigidity to withstand the typical loads applied at the solar panel array 102, such as the dead load of the solar panel array 102, the live load of possible environ-

mental element accumulation, for example, snow or ice, and other typical environmental conditions, for example, steady winds and wind gusts.

[0045] The two connections points **113**, **115** securely attaching the tetrahedron-type structure **104** to the ground surface support **111** may allow a rotational degree of freedom about an axis orthogonal to the line created by the two connection points **106**, **108**. The rotation degree of freedom about an axis orthogonal to the line created by the two connection points **106**, **108** may provide the ability for adjusting the solar panel array's **102** position relative to true south, commonly referred to as an azimuth adjustment. The azimuth adjustment of the solar panel array **102** may be necessary to allow the solar panel array **102** to track incident to the sun's position from the East to the West throughout the day while collecting incident solar radiation.

[0046] The altitude and azimuth adjustments of the solar panel array **102** may be accomplished in a manner similar to the adjustments of the solar panels **13** on frame **49** of the solar tracker system **10**.

[0047] The ground surface support **111** may structurally support the two connection points **113**, **115** to the tetrahedron-type structure and connect to the three anchors **117**, **119**, **122**. This configuration may eliminate all degrees of freedom between the ground surface support **111** and the ground surface or structure to allow the solar tracker system **100** to withstand the typical loads described above and functionally operate tracking incident to the sun's position throughout the day and throughout the year while collection solar radiation.

[0048] The anchors **117**, **119**, and **122** may be as previously described for the solar tracker system **10**, such as ground penetrating fasteners, structure fasteners, or fasteners constrained by blocks of sufficient weight. Each of the fasteners may constrain the solar tracker system **100** from any degree of freedom at the ground surface or structure.

[0049] Referring now to FIG. **10**, still another embodiment of the solar tracker system of the present invention is shown and generally referenced as **200**. The solar tracker system **200** may be substantially identical to the solar tracker system **10** shown in FIGS. **2** through **5** except for its anchoring mechanism. The solar tracker system **200** may include an attachment point **202**, such as ring, disposed at a location substantially the same as the point **87** referenced in FIG. **4**. Attachment point **202** may be anchored to the ground **204** or other surface using a ground anchor **206** or other suitable anchor. The ground anchor **206** may be connected to the attachment point **202** using a connector **208**, such as a cable. The connector **208** may further include a tightening device **210**, such as a turnbuckle. With the attachment point **202** connected to the ground anchor **206** via connector **208**, the turnbuckle **210** may be rotated to draw the feet of the system, such as foot **212**, into a firmly planted and immovable position with the ground **204** and prevent movement of the system due to wind gusts. Other connectors may be used to connect the attachment point **202** to the ground anchor **206**, such as an individual cable, a chain, or other suitable connector.

[0050] The solar tracker may also be oriented so that the azimuth axis **302** is vertical (that is, parallel to a plumb line), as shown in FIG. **11**. This arrangement has the advantage that the weight of the solar array is borne entirely by the bearings **304** of the azimuth pivot **302**, and the center of gravity **306** of the moving array does not shift up or down as the array rotates. The East/West motor **308** need only overcome the friction of the system, rather than both the friction and the

weight of the solar array, as it must do in cases where the azimuth pivot is not vertical. This design permits even lower-power motors to be used than in other embodiments.

[0051] Additionally, the North-South axis **310** may be controlled by a linear actuator **312** rather than a gear **62**, further reducing the weight of the suspended solar array and accommodating greater tolerances in the moving portions of the structure for reduced manufacturing costs.

[0052] The array need not be mounted on a surface which is level (that is, perpendicular to a plumb line), but rather may be adapted to sloping or uneven ground by varying the length of the legs so that the azimuth axis **302** remains vertical.

[0053] A sturdy C-shaped bracket **314** may be used as the heart of the support structure, providing a unitary means of support and therefore withstanding greater weight and wind stresses. This design permits larger arrays to be deployed, gathering greater amounts of sunlight.

[0054] A further advantage of the lightweight construction is the ease of removal or reconfiguration of installations. Should development needs dictate that land be reallocated to a different use, the helical anchors **82**, **83**, **85** may be removed and the trackers may be easily disassembled and transported to a different location. This relatively easily removal lowers the financial risk of installing solar trackers, permits shorter-term leases on land used for energy production, and increases the potential financial recovery upon equipment resale.

[0055] A further advantage of easy removal is the replacement of damaged trackers. In the event that some catastrophe such as a tornado damages installed trackers, they may be easily replaced with identical units with little interruption in service. The trackers are detachably secured to the helical anchors **82**, **83**, **85** at ground level, permitting removal without disturbing the anchors. If the helical anchors are themselves damaged or their engagement with the soil is disrupted, they may be easily removed, or even simply abandoned in place, and replaced with new anchors a very short distance from the originals. The cost of these repair and replacement operations is minimal. Concrete piers, on the other hand, cannot be easily replaced or repaired if they incur damage or shift in their positions, are very expensive to remove, and tend to prevent the installation of replacement piers in nearby locations. It is therefore much more difficult to replace trackers that depend on such piers for support.

[0056] A further advantage of the disclosed trackers is recyclability. Concrete piers as used by prior art trackers undergo an irreversible chemical reaction during curing, so that even if they are removed from the ground, they cannot be conveniently recycled. The metals which comprise the disclosed trackers and their anchors is not chemically altered by the installation process, and thus may be easily recycled at the end of their service life or when damaged beyond repair.

[0057] The terms and expressions that have been employed in the foregoing specification are used therein as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described or portions thereof, it being recognized that the scope of the invention is defined and limited only by the claims which follow.

What is claimed is:

1. An apparatus for tracking the sun, comprising:
 - a) a solar panel array having at least two rotating array supports disposed to pivot about a first axis; and
 - b) a support structure having at least two rotating structure supports disposed to pivot about a second axis;

- c) wherein said first and second axes are non-parallel and non-intersecting; and
- d) wherein said array supports and said structure supports are connected to one another so as to support said solar panel array and permit it to pivot about the two axes.
- 2. The apparatus of claim 1 wherein the first and second axes are substantially perpendicular.
- 3. The apparatus of claim 1 wherein said second axis is adapted to be mounted substantially parallel to a plumb line.
- 4. The apparatus of claim 1 wherein said first axis is adapted to be mounted substantially perpendicular to a plumb line.
- 5. The apparatus of claim 1 wherein each of said array supports is directly connected to each of said structure supports.
- 6. The apparatus of claim 1 wherein said array supports and said structure supports are connected by elongate rods.
- 7. The apparatus of claim 1 wherein said support structure is adapted to be rigidly attached to a surface.
- 8. The apparatus of claim 1 wherein said attachment is accomplished with at least one helical screw anchor.
- 9. An apparatus for gathering solar energy, comprising:
 - a) a solar panel array;
 - b) a support structure adapted for moving the array to track the movement of the sun; and
 - c) at least one helical anchor fastened to the support structure.
- 10. The apparatus of claim 9 wherein the support structure is adapted for placement on a surface.

- 11. The apparatus of claim 10 wherein the surface is not perpendicular to a plumb line.
- 12. The apparatus of claim 10 wherein the surface is not flat.
- 13. The apparatus of claim 10 wherein the surface is the ground.
- 14. The apparatus of claim 10 wherein the helical anchors are the primary means of attachment to the surface.
- 15. The apparatus of claim 10 wherein the support structure has at least three points of contact with the surface.
- 16. The apparatus of claim 9 wherein the at least one anchor is rigidly attached to the support structure.
- 17. A method for gathering solar energy, comprising:
 - a) providing a planar solar panel array;
 - b) providing a support structure having a first and a second pivoting joint attached to the array so as to permit the array to pivot on two axes;
 - c) detachably securing the support structure to a surface; and
 - d) pivoting the array around the two axes so as to substantially maximize its exposure to sunlight.
- 18. The method of claim 17 wherein the support structure is secured to the surface using helical anchors.
- 19. The method of claim 17 wherein the surface is the ground.
- 20. The method of claim 17 wherein the array pivots automatically.

* * * * *