A two-axis solar tracker that orientates and adjusts the angular position of associated solar collector panels. The tracker may be hydraulically operated all movements of the tracker may be produced by three hydraulic cylinders.
TWO-AXIS HYDRAULIC SOLAR TRACKER
RELATED APPLICATIONS AND PRIORITY CLAIM


BACKGROUND

The systems and methods described herein are generally related to the energy sector and electrical energy production by photovoltaic panels with a solar tracker. The orientation of the photovoltaic panels perpendicular to the sun provides greater output compared to fixing the photovoltaic panels to a static support structure. The considerable cost of these energy capture devices and conversion into electricity justifies the greater complexity and prices of these moving support structures. In the simplest case, the moving support structures provide the associated photovoltaic panels with a daily east-west movement that is based on an axis with a determined inclination. The determined inclination may correspond to the elevation angle (N-S orientation) which depends on the area’s latitude, while the movement of the azimuth angle (E-W orientation) is almost always achieved with an electrical-mechanical operation. Many of these trackers are driven by two gear motors which allow movements operated with electric motors.

Given the absolute regularity of the solar displacement, the tracker positioning can be controlled in open loop with trajectory predetermined by a clock included in the control system, predetermined in a fixed movement throughout each day of the year, or in a closed loop by angular position coders or light sensors of the sun position with respect to the panel.

BRIEF DESCRIPTION OF THE DRAWINGS

For the purpose of complementing this description and helping to better understand the example embodiments disclosed herein, a set of drawings in accordance with some particular example embodiments has been included as an integral part of this specification, wherein the following have been represented in an illustrative and non-limiting manner.

FIG. 1 shows a general perspective view of a tracker in accordance with one non-limiting embodiment.

FIG. 2 shows a perspective view of a collector support structure in accordance with one non-limiting embodiment.

FIG. 3 shows a front view of the movement structure in E-W direction, referred to herein as module A, in accordance with one non-limiting embodiment.

FIGS. 4 and 5 show front views of module A in various rotated positions.

FIG. 6 shows a side view of the movement structure in N-S direction, referred to herein as module B, in accordance with one non-limiting embodiment.

FIG. 7 shows a front view of module B in a rotated position, in accordance with one non-limiting embodiment.

FIG. 8 is a schematic diagram of a complete tracker, in accordance with one non-limiting embodiment.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

One embodiment comprises a two-axis hydraulic solar tracker that orients and adjusts the angular position of associated solar collector panels. In some embodiments, there may be a 30 and 40% increase in energy capture compared to fixed panel arrangements. The tracker may be hydraulically operated, and therefore not use an electric or gear motor. In some embodiments, all movements of the tracker are produced by three hydraulic cylinders placed in the arrangement shown in FIG. 1.

This tracking device can be part of an collection of trackers. The movement speed of the tracker may be relatively slow and the motor pump unit for the hydraulic system may only require a small capacity. Therefore, several of the trackers may all use the same hydraulic system (i.e. a single motor pump unit).

In some embodiments, the movement mechanism of the tracker can be made with very light materials, such as composite materials made of thermostable resins and glass fiber. Support members of the movement mechanism are used as substitutes for traditional materials such as galvanized steel, painted or stainless, aluminum and concrete which are used in other trackers.

The use of composite materials may have substantial advantages compared to traditional materials, such as versatility, functionality, ease of assembly and lack of maintenance, and lack of corrosion issues. Additionally, the use of hydraulic cylinders and the ability of either using a single pump for a single system or for several systems, makes this system a cheap, low weight option for solar panel solar tracking.

In various embodiments, the hydraulically operated two-axis tracker may be comprise of a support frame of the collector panels (illustrated in FIG. 2), a movement structure with two-axis rotation using three cylinders, and a carrying and anchoring base mounted to the ground or other surface.

Referring to FIG. 2, the structure support of the panels may have dimensions suitable for the number of panels used with the tracker. The support structure may be formed by metal or synthetic composite support members joined by a suitable fixing system. As is to be appreciated, the dimensions of these support members shall be those required to support the panel weight and the stress caused by the wind at a maximum speed in the installation area.

The movement structure may also be composed of the same steel or synthetic material, in some embodiments, square tubes can be used, of suitable dimensions for the number of panels. This system can also be separated in two modules, module A allows the movement of the tracker in accordance with east-west orientation, and module B allows us the north-south orientation.

Referring to FIG. 3, module A may be formed by a long central support member 1. The central support member 1 may have ball joints 2 with one degree-of-freedom at its ends. Another two central support members 3 may be coupled to the ball joint 2. These central support members 3 may be smaller that central support member 1 and identical to one another. The central support member 4 may also be coupled to the panel support structure with ball joints 4. Module A may also comprise two hydraulic cylinders 5. One of the ends of
two cylinders 5 may be coupled to the central support members 3 and the other ends may be coupled to the central support member 1 with ball joints 6. The cylinders 5 permit movement of the parallelepiped by rotation of the ball joints its four vertices. Furthermore, in the middle point of central support member 1, a piece 7 may be placed with a bore and a friction bearing or bushing which enables the east-west rotation of the module A. FIGS. 4 and 5 show front views of module A in varying rotational positions.

[0020] Referring to FIG. 6, module B may be formed by a structure which generally may have a V-shape composed of two central support members 8 of identical length, joined at one of their ends. The other ends of the central support members 8 may be joined to the panel support structure by ball joints 9 having one degree-of-freedom. A solid shaft 10 may be joined to the two central support members 8 and may be used join module B to module A through the piece 7, thereby allowing for relative movement between the two modules that are generally situated in two perpendicular planes.

[0021] Still referring to FIG. 6, a bored piece 11 may be inserted at the joining point of the two central support members 8 which form the V. An end of a hydraulic cylinder 12 may be coupled to at least one of the central support members 8 with the other end of the cylinder 12 coupled to the tracker support structure. As illustrated in FIG. 7, such configuration enables the north-south movement of the panel support structure.

[0022] The tracker support structure may be formed by a tower 13, for example, or any other suitable tower of frame of the necessary height according to the dimensions of the upper platform and the obstacles and shadows of the surroundings. As illustrated in FIG. 6, a ball joint 14 may be coupled to the tower 13 at an upper end to join module B and the tower 13. The opposite end of the tower is anchored to the ground or other surface.

[0023] FIG. 8 is a schematic diagram of a complete tracker, in accordance with one non-limiting embodiment. In various embodiments, the tracker's movements may be controlled by a processor 20 that manages all the information supplied to it by sensors 22. Through this information, the positioning of the panels may be maintained perpendicular to the solar energy.

[0024] In various embodiments, the tracker may comprise a real-time clock 24 for calculating the solar coordinates at all times. Additionally, the tracker may comprise an energy diagnosis and supervision module 26. In some embodiments, the tracker may have a network connection 28 in communication with a remote supervision and security system 30.

[0025] Having sufficiently described the nature of the various example embodiments, it should be stated that the aforementioned devices and those represented in the drawings may have their details modified provided it does not alter the fundamental principle.

[0026] The embodiments are, of course, not limited to the examples described but covers all the variants defined in the claims. The terms "a" and "an" and "the" and similar referents used in the context of the following claims are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. All methods described herein can be performed in any suitable order unless otherwise indicated herein or clearly contradicted by context. The use of any and all examples, or exemplary language (e.g. "such as") provided herein is intended merely to better illuminate the embodiments and does not pose a limitation on the scope of the embodiments otherwise claimed. No language in the specification should be construed as indicating any non-claimed element essential to the practice of the embodiments.

[0027] The use of the term "or" in the claims is used to mean "and/or" unless explicitly indicated to refer to alternatives only or the alternatives are mutually exclusive, although the disclosure supports a definition that refers to only alternatives and "and/or." Groupings of alternative elements or embodiments disclosed herein are not to be construed as limitations. Each group member may be referred to and claimed individually or in any combination with other members of the group or other elements found herein. It is anticipated that one or more members of a group may be included in, or deleted from, a group for reasons of convenience and/or patentability. When any such inclusion or deletion occurs, the specification is herein deemed to contain the group as modified thus fulfilling the written description of all Markush groups used in the appended claims.

[0028] Preferred embodiments are described herein, including the best mode known to the inventors for carrying out the invention. Of course, variations on those preferred embodiments will become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventor expects that those of ordinary skill in the art to employ such variations as appropriate, and the inventors intend for the embodiments to be practiced otherwise than specifically described herein. Accordingly, these embodiments include all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof are encompassed by the embodiments unless otherwise indicated herein or otherwise clearly contradicted by context.

[0029] Further, it is to be understood that the example embodiments disclosed herein are illustrative. Other modifications that may be employed are within the scope of the embodiments. Thus, by way of example, but not of limitation, alternative configurations of the present embodiments may be utilized in accordance with the teachings herein. Accordingly, the present embodiments are not limited to that precisely as shown and described in the specification and drawings.

1-9. (canceled)
10. A hydraulic solar tracker, comprising:
   a support frame configured to receive solar collector panels; and
   a totally hydraulically-operated movement structure configured to provide two-axis rotation of a solar collector panel received by the support frame, the movement structure including three hydraulic cylinders coupled to the support frame.

11. The hydraulic solar tracker of claim 10, wherein the movement structure further comprises a first, second, and third support member each manufactured from a synthetic composite material, the first support member coupled to the first hydraulic cylinder, the second support member coupled to the second hydraulic cylinder, and the third support member coupled to the third hydraulic cylinder.

12. The hydraulic solar tracker of claim 10, wherein the support frame is coupled to the movement structure via a plurality of ball joints.

13. The hydraulic solar tracker of claim 10, wherein the support frame is configured to move about a first axis and a second axis, and where in the first axis is substantially perpendicular to the second axis.
14. The hydraulic solar tracker of claim 13, wherein the movement structure further comprises at least a first, second, and third support member, at least one of the support members forming an articulated parallelepiped and providing orientation in the first axis.

15. The hydraulic solar tracker of claim 10, further comprising:
   a processor; and
   at least one sensor configured to supply information to the processor, wherein the processor is configured to angularly position the support frame based on the information received from the sensor.

16. The hydraulic solar tracker of claim 10, further comprising:
   a processor; and
   a real-time clock, the processor configured to receive information from the real time clock and configured to angularly position the support frame based on the information received from the real time clock.

17. The hydraulic solar tracker of claim 10, further comprising:
   a network connection providing communication with a remote supervision system, the position of the support frame being controlled at least in part based on instructions received from the remote supervision system.

18. A hydraulic solar tracker, comprising:
   a support frame configured to receive solar collector panels;
   a totally hydraulically powered movement structure coupled to the support frame and configured for two-axis movement; and
   a plurality of hydraulic cylinders coupled to the movement system.

19. The hydraulic solar tracker of claim 18, wherein the plurality of hydraulic cylinders comprises a first, second, and third hydraulic cylinder.

20. The hydraulic solar tracker of claim 19, wherein the first and second hydraulic cylinder are configured to move the support frame about a first axis and the third hydraulic cylinder is configured to move the support frame about a second axis.

21. The hydraulic solar tracker of claim 20, wherein the first axis is substantially perpendicular to the second axis.

22. A method, comprising:
   exposing a hydraulic solar tracker configured in accordance with claim 1 to solar energy; and
   hydraulically adjusting the angle of the support frame.

23. The method of claim 22, further comprising:
   receiving information regarding the solar energy from a sensor;
   processing the information with a processor; and
   determining the desired angle of the support frame based on the information.

24. The method of claim 22, further comprising:
   receiving information from a real time clock; and
   angularly positioning the support frame based on the information received from the real time clock.

25. The method of claim 22, further comprising:
   communicating with a remote supervision system via a network connection; and
   hydraulically adjusting the position of the support frame based at least in part on instructions received from the remote supervision system.

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