(12) STANDARD PATENT (11) Application No. AU 2011235479 B2
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Automatic sunlight-tracking device

(51) International Patent Classification(s)
G05D 3/00 (2006.01)

(21) Application No: **2011235479** (22) Date of Filing: **2011.01.06**

(87) WIPO No: **WO11/120324**

(30) Priority Data

(31) Number	(32) Date	(33) Country
201010244994.3	**2010.07.27**	**CN**
201010138078.1	**2010.04.02**	**CN**

(43) Publication Date: **2011.10.06**
(44) Accepted Journal Date: **2014.08.21**

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(56) Related Art
DE 102008023549
WO 2008/154945
US 4469938
WO 2008/092195
CN 101577512
CN 101599723
US 4890599
US 2913583
KR 20100023937
US 2003/0048551
DE 202008013209
DE 10144601
US 4343294

(12) 按照专利合作条约所公布的国际申请

(19) 世界知识产权组织
国 际 局

(43) 国际公布日
2011 年 10 月 6 日 (06.10.2011)

PCT

(10) 国际公布号
WO 2011/120324 A1

(51) 国际专利分类号:
H02N 6/00 (2006.01) *G05D 3/00* (2006.01)

(21) 国际申请号: PCT/CN2011/000029

(22) 国际申请日: 2011 年 1 月 6 日 (06.01.2011)

(25) 申请语言: 中文

(26) 公布语言: 中文

(30) 优先权:
201010138078.1 2010 年 4 月 2 日 (02.04.2010) CN
201010244994.3 2010 年 7 月 27 日 (27.07.2010) CN

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(81) 指定国 (除另有指明，要求每一种可提供的国家保护): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW。

(84) 指定国 (除另有指明，要求每一种可提供的地区保护): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), 欧洲 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)。

本国际公布:
— 包括国际检索报告(条约第 21 条(3))。

(54) **Title**: AUTOMATIC SUNLIGHT-TRACKING DEVICE

(54) **发明名称**: 自动跟踪太阳光装置

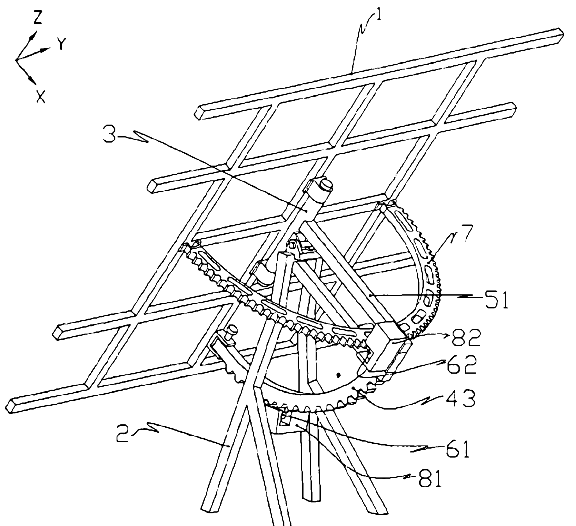

图1 / FIG. 1

(57) **Abstract**: An automatic sunlight-tracking device comprises a solar panel-mounting bracket (1), a supporting bracket (2), a pitch tracking member and a left-and-right tracking member. The solar panel-mounting bracket (1) is connected with the supporting bracket (2) through a three-dimensional subassembly (3). The pitch tracking member comprises a first transmission component and a first driving device (81) which is matched with the first transmission component. The left-and-right tracking member comprises a second transmission component and a second driving device (82) which is matched with the second transmission component. The three-dimensional subassembly (3) comprises two rotary supporting shafts (31, 32) in cross connection. The automatic sunlight-tracking device has high operating precision and a reasonable structure, and reduces operation energy consumption, and is easy to be controlled and convenient to be installed and maintained.

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(57) 摘要:

一种自动跟踪太阳光装置，包括太阳能电池板固定架（1）、支撑架（2）、俯仰跟踪构件和左右跟踪构件。太阳能电池板固定架（1）通过三维组件（3）与支撑架（2）连接，俯仰跟踪构件包括第一传动部件和与其配合的第一驱动装置（81）。左右跟踪构件包括第二传动部件和与其配合的第二驱动装置（82）。三维组件（3）包括十字状连接的两个旋转支撑轴（31，32）。该自动跟踪太阳光装置操作精度高，结构合理，运转能耗低，易于控制以及便于安装和维护。

AUTOMATIC SUNLIGHT TRACKING DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a solar energy utilizing device, and particularly to an automatic sunlight tracking device having a function of tracking sunlight with two shafts.

2. Description of the Related Art

Since fossil energy is being exhausted and problems such as environmental pollution and greenhouse effect are generated during production and use of the fossil energy become more and more serious, countries have attached increasing importance to development and utilization of new energy source. The solar energy is new energy that is effective, clean, widely distributed, and can be nearly limitedly utilized, this attracts people to gradually and significantly increase investment in development of the solar energy. However, nowadays the rate of utilization is generally low and generation cost is generally expensive in application of the solar energy especially in a field of photovoltaic generation. This is particularly true in the following two aspects. Firstly, since existing photovoltaic cell for photovoltaic generation technique mainly employs semiconductor material such as monocrystalline silicon and polycrystalline silicon, the price of the photovoltaic cell is expensive. Secondly, currently monocrystalline silicon panel of high-quality has only a photovoltaic conversion efficiency of up to about 17% and only a maximal lift time of twenty to thirty years so that cost of solar generation is enlarged and difficulty in marketing of solar generation is increased. Therefore, how to improve generation efficiency per unit of the existing photovoltaic panel becomes one of main ways to decrease the cost of solar generation while people manage to decrease cost of the panel and develop and utilize new panel material of a higher photovoltaic conversion efficiency.

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The solar panel is usually fixedly mounted in an existing solar photovoltaic generation system so that it is ensured the sunlight irradiates the panel at an optimum angle only at one time of a day in every year. Therefore, that utilization efficiency of the sunlight is relatively low. If the solar panel is always maintained at an optimum angle to the sunlight or a light condensation technique is employed, more electrical energy can be obtained with the solar panel of the same area. All of this requires a mature reliable sunlight tracking technique. According to research, an amount of electrical energy generalized by the solar panel by using the sunlight tracking technique can be increased by more than 30-50% compared with the fixedly mounted solar panel depending upon sunlight irradiation conditions in different regions. However, most of the existing sunlight tracking techniques result in a high cost even a cost exceeding 30% of total investment in a generation device due to reasons such as complex structure. Furthermore, the tracking itself necessitates electrical energy consumption. A generation system using the tracking technique occupies more land area than that using the fixed solar panel, needs additional technical staff for maintenance of equipment, and has more operation risk than that using the fixed solar panel. In addition, in order to decrease tracking cost, currently, tracking devices made by manufacturers become increasingly bulky. This in turn results in a series of problems such as greater wind resistance, increased difficulty in installation and maintenance, and improved requirements for road and foundation. As a result, attraction of effect generated by the tracking technique is greatly decreased and commercialization of the sunlight tracking technique is hindered.

Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present disclosure as it existed before the priority date of each claim of this application.

Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or

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steps.

SUMMARY OF THE INVENTION

Disclosed herein is a sunlight tracking device comprising a solar panel holder, a mounting, a pitching angle tracking member, and a swing angle tracking member, wherein:

the solar panel holder is coupled with the mounting through a three-dimensional joint, the three-dimensional joint includes a pitching angle rotation supporting shaft and a swing angle rotation supporting shaft arranged in a cross shape, the three-dimensional joint is hingedly coupled to the mounting through the pitching angle rotation supporting shaft, and the three-dimensional joint is hingedly coupled to the solar panel holder through the swing angle rotation supporting shaft;

a rigid support is fixedly connected to the swing angle rotation supporting shaft of the three-dimensional joint, and the rigid support is only capable of rotating synchronously with a pitching angle of the solar panel holder;

the swing angle tracking member at least comprises a second transmission part which is capable of rotating the solar panel holder around the swing angle rotation supporting shaft of the three-dimensional joint, and a second drive device for driving the second transmission part to act, and

the pitching angle tracking member comprises:

a rigid arc body which is capable of rotating the solar panel holder by means of the pitching angle rotation supporting shaft of the three-dimensional joint, wherein the rigid arc body has an end fixedly connected to the rigid support or the swing angle rotation supporting shaft, or hingedly connected to the solar panel holder, and the rigid arc body has a groove-shaped or hole-shaped positioning structure;

a fixing hole disposed in the mounting; and

a positioning pin which is capable of being inserted in the fixing hole and the groove-shaped or hole-shaped positioning structure of the rigid arc body, wherein the pitching angle of the solar panel holder can be manually adjusted and the rigid arc body is locked to the mounting by inserting the positioning pin in the

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fixing hole of the mounting and the groove-shaped or hole-shaped positioning structure of the rigid arc body.

The second transmission part may be a rigid semi-circular arc body provided with a transmission structure, both ends of the rigid semi-circular arc body may be fixedly connected to the solar panel holder, and the second drive device may drive the rigid semi-circular arc body to rotate.

Furthermore, the rigid semi-circular arc body may have a tooth-shaped transmission structure, the second drive device may comprise an electric motor and a worm speed reducer, and a gear meshing with the tooth-shaped transmission structure may be mounted on an output shaft of the worm speed reducer.

Moreover, the rigid semi-circular arc body may have a chain-shaped transmission structure, the second drive device may comprise an electric motor and a worm speed reducer, and a sprocket cooperating with the chain-shaped transmission structure may be mounted on an output shaft of the worm speed reducer.

The second transmission part may be a rope-like body including a first transmission rope and a second transmission rope, the second drive device may comprise an electric motor and a worm speed reducer, and a pulley which is capable of cooperating with the rope-like body may be mounted on an output shaft of the worm speed reducer. The pulley may have a cylindrical shape with a small diameter at a middle portion and a large diameter at both ends. First and second helical guide grooves symmetrical about an intermediate cross section of the pulley may be disposed on a cylindrical surface of the pulley. The first and second transmission ropes may be disposed in the first and second helical guide grooves, respectively. Each of the first and second transmission ropes may have an end fixed to an inside of the corresponding helical guide groove, and another end connected to the solar panel holder. The first and second transmission ropes may be configured in a wound and unwound relationship. When the pulley rotates, one of the two transmission ropes may be wound and the other may be unwound, and an amount of the wound rope and an amount of the unwound rope may be different from each other so as to effectively absorb different linear amounts of the wound rope and the unwound rope.

Also disclosed herein is a sunlight tracking device comprising:

a solar panel holder;

a mounting;

a pitching angle tracking member; and

a swing angle tracking member,

wherein the solar panel holder is coupled with the mounting through a three-dimensional joint, the three-dimensional joint includes a pitching angle rotation supporting shaft and a swing angle rotation supporting shaft arranged in a cross shape, the three-dimensional joint is hingedly coupled to the mounting through the pitching angle rotation supporting shaft, and the three-dimensional joint is hingedly coupled to the solar panel holder through the swing angle rotation supporting shaft, and

a support is hingedly connected to the solar panel holder or fixedly connected to the swing angle rotation supporting shaft of the three-dimensional joint, and the support is only capable of rotating synchronously with a pitching angle of the solar panel holder, wherein

the pitching angle tracking member comprises:

an arc body which is capable of rotating the solar panel holder by means of the pitching angle rotation supporting shaft of the three-dimensional joint, wherein the arc body has a groove-shaped or hole-shaped positioning structure;

a fixing hole disposed in the mounting; and

a positioning pin which is capable of being inserted in the fixing hole and the groove-shaped or hole-shaped positioning structure of the arc body, wherein the pitching angle of the solar panel holder can be manually adjusted and the arc body is locked to the mounting by inserting the positioning pin in the fixing hole of the mounting and the groove-shaped or hole-shaped positioning structure of the arc body.

(1) According to an embodiment of the present invention, the sunlight tracking device has a simplified, reasonable and firm structure, and good mechanical performance. The device can be configured by multiple flexible combinations. Therefore, the device can be easily produced on mass production

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basis.

(2) According to an embodiment of the invention, a driving power required by the device can be considerably decreased due to reasonable and simplified structure of the invention. Operation energy consumption of the device itself can be greatly reduced by means of an operation timing control program and self-locking of the worm wheel and worm.

(3) According to an embodiment of the invention, the control program of the device can be simplified by cooperation of the pitching angle tracking member and the swing angle tracking member so that accurate tracking can be achieved by an open-loop control system. The cost of the control system can be reduced while probability of failure of the device can be decreased, and installation and everyday maintenance of the device can be facilitated.

(4) According to an embodiment of the invention, the device is widely applicable. Tracking of sunlight with either large or small panels can produce considerable economic benefit.

(5) According to an embodiment of the invention, the device is able to solve the problem that the efficiency of the solar energy device varies as a point where the direct sunlight occurs moves between tropic of Capricorn and the tropic of Cancer. Therefore, the device can be widely used.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a structural view of an automatic sunlight tracking device according to a first embodiment of the invention;

FIG. 2 is a schematic view of a part of components of the first embodiment;

FIG. 3 is a schematic view of various forms of a three-dimensional joint;

FIG. 4 is a schematic view showing installation of solar panels;

FIG. 5 is a structural view of an automatic sunlight tracking device according to a second embodiment of the invention;

FIG. 6 is a structural view of an automatic sunlight tracking device according to a third embodiment of the invention;

FIG. 7 is a structural view of a pulley;

FIG. 8 is a structural view of an automatic sunlight tracking device according to a fourth embodiment of the invention;

FIG. 9 is a structural view of an automatic sunlight tracking device according to a fifth embodiment of the invention;

FIG. 10 is a structural view of an automatic sunlight tracking device according to a six embodiment of the invention; and

FIG. 11 is a structural view of an automatic sunlight tracking device according to a seventh embodiment of the invention.

List of reference numbers

1 Solar panel holder

11 Solar panel

2 Mounting

3 Three-dimensional joint

31 Pitching angle rotation supporting shaft

32 Left-right swing angle rotation supporting shaft

41 Third transmission rope

42 Fourth transmission rope

43 Rigid arc body

44 Positioning hole

45 Positioning pin

46 linearly-pushing rod

51 Rigid support

51' Rigid support

61 First gear

62 Second gear

7 Rigid semi-circular arc body

71 First transmission rope

72 Second transmission rope

81 First drive device

81 Second drive device

9 Pulley

91 Third helical guide groove

92 Fourth helical guide groove

DETAILED DESCRIPTION OF THE EMBODIMENTS

The automatic sunlight tracking device comprises a solar panel holder 1, a mounting 2, a pitching angle tracking member, and a left-right swing angle tracking member.

Embodiment 1

As illustrated in FIGS. 1-4, for purpose of clarity description, firstly, a Y direction is defined as a direction which is parallel to a plane in which the solar panel holder 1 is located and which is directed along a movement locus of the sun during one day, a Z direction is defined as a direction which is parallel to the plane in which the solar panel holder 1 is located and which is directed along a movement locus of the sun during one year, and then an X direction is defined as a direction which is perpendicular to a YZ plane and directed towards a back of the solar panel holder 1.

As shown in FIG. 4, the solar panel holder 1 can be a welded frame structure (or an aluminum section composite frame structure) for fixing a solar panel 11. Depending upon different latitude of regions where the solar panel is used, the solar panel 11 may be mounted parallel or at an inclination angle to the solar panel holder 1.

The mounting 2 is a lambdoid steel structure formed by welding, and a lower end of the mounting 2 is fastened to a foundation by fastening bolts, and an upper end of the mounting 2 is coupled to the solar panel holder 1 through a three-dimensional joint 3.

As shown in FIG. 3, the three-dimensional joint 3 includes a pitching angle rotation supporting shaft 31 and a left-right swing angle rotation supporting shaft 32 arranged in a cross shape. The two shafts can be arranged in various forms.

Depending upon whether the two shafts are located in the same plane, the arrangement of the two shafts may be divided into two basic forms: a non-intersecting cross shaft in which the two shafts are not located in the same plane, and an intersecting cross shaft in which the two shafts are located in the same plane.

The intersecting cross shaft has two specific forms of which one is that the two shafts are integrated by welding as shown in FIG. 3(A), and the other is that the pitching angle rotation supporting shaft 31 passes through the left-right swing angle rotation supporting shaft 32, and the pitching angle rotation supporting shaft 31 is rotatable with respect to the left-right swing angle rotation supporting shaft 32 so as to form a joint.

The non-intersecting cross shaft has two forms of which one is that the two shafts welded to a connection piece and the two shafts are not located in the same plane as shown in FIG. 3(B), and the other is that one shaft is welded to the connection piece and the other shaft passes through a through hole disposed in the connection piece to form a configuration as shown in FIG. 3(C).

All of the above cross shafts can achieve the function that the solar panel holder 1 rotates about the swing angle rotation supporting shaft 32 and the pitching angle rotation supporting shaft 31, respectively. The three-dimensional joint 3 can be disposed at a center of gravity of the solar panel holder 1 to reasonably distribute gravity of the solar panel 11 and the solar panel holder 1, and is a main force-applied point.

The pitching angle tracking member comprises a first transmission part. Preferably, the first transmission part is a rigid circular arc body provided with a transmission structure, which is indicated by the rigid arc body 43. One end of the rigid arc body 43 is hinged to a back of the solar panel holder 1. Most preferably, the hinged point should be located on a downwardly-extended elongation line of the swing angle rotation supporting shaft of the three-dimensional joint 3. The other end of the rigid arc body 43 is fixed to a free end of a rigid support 51 by welding or by means of a bolt. Therefore the rigid arc body, the rigid support and the swing angle rotation supporting shaft are integrally connected and located in the same plane. The rigid support 51 is an H-shaped bracket, and is welded to the swing angle rotation supporting shaft of the three-dimensional joint 3 so that the rigid support is only capable of rotating synchronously with a pitching angle of the solar panel holder 1 and is not capable of rotating with respect to the solar panel holder 1. A first drive device 81 is fixedly mounted on the mounting 2. Preferably, the first drive device is a synchronous motor provided with a worm speed reducer. A gear is mounted on an output shaft of the worm speed reducer and indicated by the first gear 61. The first gear 61 meshes with teeth disposed on the rigid arc body 43. The first gear 61 controls operation of the rigid arc body 43. The rigid arc body 43 drives the solar panel holder 1 to rotate with the pitching angle rotation supporting shaft 31 of the three-dimensional joint serving as a center so as to adjust a pitching angle.

In order to ensure that tracking is accurate and setting of control program is simple and reasonable, in an example, the teeth on the rigid arc body 43 is disposed in a reasonable proportion to 180 degrees. A sector plane formed by the rigid arc body 43 is perpendicular to the ground level in a direction of a longitude of the earth, and is perpendicular to a sector plane in which a rigid semi-circular arc body 7 is located.

The swing angle tracking member comprises the rigid semi-circular arc body 7 provided with a transmission structure. The transmission structure comprises teeth proportionally disposed on the rigid semi-circular arc body according to data of variation in an angle of the sun during one day to form a shape of a large gear ring. Both ends of the rigid semi-circular arc body 7 are fixed to the solar panel holder 1 by bolts or are welded to the solar panel holder 1. Most preferably, two fixation points of the two ends are located on an imaginary elongation line of the pitching angle rotation supporting shaft of the three-dimensional joint to control the solar panel holder to rotate around the swing angle rotation supporting shaft of the three-dimensional joint. Preferably, the second drive device 82 is a synchronous motor provided with a worm speed reducer. The second drive device 82 is fixedly mounted at the free end of the rigid support 51. A gear is mounted on an output shaft of the worm speed reducer and indicated by the second gear 62. The second gear meshes with the rigid semi-circular arc body 7 to control operation of the rigid semi-circular arc body 7 for purpose of controlling the solar panel holder 1 to adjust a swing angle.

Take the Northern Hemisphere as an example, the sun initially rises or sets at a northern angle in most regions on the earth after the vernal equinox and before the autumnal equinox in every year. In an example, the mountings 2 are installed in a lambdoid shape to be inclined at an inclination angle depending upon different latitudes of regions where the device is used, or the solar panels 11 on the solar panel holder 1 are divided into groups to be installed at an inclination angle, so that an initial actuation position of the solar panel holder 1 can be expanded to an angle of east by north.

In order to ensure that the tracking is accurate and control program is simplified, the sector plane in which the rigid semi-circular arc body 7 is located is perpendicular to the plane in which the solar panel holder 1 is positioned.

A program control box for controlling operation of the first drive device 81 and the second drive device 82 may be mounted on the mounting 2, or a central control system may be employed. A motor operation control program is set based on astronomical constants. The two drive devices cooperate with each other by setting reasonable program to simulate a movement locus of the sun during one day, so that the device has a function of accurately tracking sun with the two shafts.

Specifically, before sunrise in the morning, the automatic sunlight tracking device is positioned in an initial state where the device is faced directly to the sunrise orientation. From the initial state after the sunrise in the morning, the program controls operation of the second drive device, so that the second transmission part drives the solar panel holder to swing along the left-right direction, and the solar panel holder is stopped until a set time before sunset. At the same time, the program controls operation of the first drive device, so that the first transmission part drives the solar panel holder to operate according to an angle set by the program. Until the solar panel holder reaches a point corresponding to the highest altitude angle of the sun at noon on a day, the first drive device rotates to a set angle in a reverse direction under the control of the program. Hence, complicated astronomical calculation is simplified in such a way that the two particularly crossed transmission parts, i.e., the rigid arc body 43 and the rigid semi-circular arc body 72, cooperate by means of a number of teeth corresponding to a prescribed swing angle rotated in a prescribed period of time and a number of teeth corresponding to a prescribed pitching angle rotated in each prescribed period of time in order to achieve corresponding coordinate points. Correction is achieved in a direction of the pitching angle to ensure that the solar panel 11 is always maintained to be perpendicular to the sunlight.

The two drive devices cooperate with each other, and operation of the two drive devices is stopped until a prescribed time before sunset in the afternoon. Finally, the program controls the automatic sunlight tracking device to return to the initial state for the next morning.

When a wind force reaches a set level, the program controls the solar panel holder to be positioned in a horizontal state as a wind avoiding state. When it snows, the program controls the solar panel holder to be positioned in a vertical state as a snow avoiding state.

The above operation of the automatic sunlight tracking device has the advantages that the tracking is accurate, and refraction loss of the sunlight is minimized, which is especially suitable for a concentrated solar power generation device which requires high tracking accuracy, and achieves accurate tracking of the sunlight. In addition, the polar panels are divided into groups to be installed at an inclination angle so as to effectively reduce wind resistance. The above operation of the automatic sunlight tracking device has only the drawbacks that all of the two drive devices must operate in an appropriate time and power consumption of the automatic sunlight tracking device is relatively large.

Embodiment 2

As shown in FIG. 5, the second embodiment is different from the first embodiment in that the rigid arc body 43 has a hole-shaped positioning structure. The positioning structure is an array of positioning holes 44 uniformly distributed on the rigid arc body so that angle adjustment and fixation can be achieved. The mounting 2 is provided with a fixation hole corresponding to the positioning holes 44 at a position adjacent to the rigid arc body 43. A positioning pin 45 (such as a cylindrical pin) can be inserted between the positioning hole 44 and the fixation hole to lock the rigid arc body 43 and the mounting 2 together. Therefore, a simple manual first drive device is formed so as to manually adjust the pitching angle.

The swing angle tracking member of the second embodiment is substantially the same as that of the first embodiment.

The embodiment can automatically track the sunlight with a single shaft, but the pitching angle needs to be manually adjusted at intervals. The second transmission part rotates by a number of teeth corresponding to a prescribed degree in a prescribed period of time. Hence, the solar panel holder 1 is driven to track variation in a position of the sun on each day. Operation of the solar panel holder is stopped until a prescribed time before sunset in the afternoon. Finally, the solar panel holder returns to the initial state for the next morning. The pitching angle is manually adjusted according to variation in an altitude angle, occurring during a year, of the sun every preset days. The synchronous motor in the first embodiment may be omitted, and the positioning pin 45 is used for locking. Because of gravity balancing design of the device itself and lever action of the rigid support 51, the operation of the device is simple and easy. The pitching angle can be adjusted by locking by means of the manual positioning device mounted on the mounting 2. The automatic sunlight tracking device thus achieves a function of automatically tracking the sun with a single shaft.

The automatic sunlight tracking device has the advantages that cost is reduced, power consumption for tracking is decreased, the drive program needs to control only regular swing, the automatic sunlight tracking device is further simplified, and the cost is greatly reduced. However, the automatic sunlight tracking device has the only drawbacks that the pitching angle needs to be manually adjusted, and the automatic sunlight tracking device has a tracking error (less than 5% on average during one year) so that it cannot maximize utilization of the solar energy.

Embodiment 3

As showed in FIGS. 6 and 7, the third embodiment is different from the first embodiment in that the first transmission part is a transmission rope of a rope-like body and includes a third transmission rope 41 and a fourth transmission rope 42.

The first drive device comprises an electric motor and a worm speed reducer. A pulley 9 cooperating with the transmission ropes is mounted on an output shaft of the worm speed reducer. The pulley 9 has a cylindrical shape with a small diameter at a middle portion and a large diameter at both ends. The diameters are gradually changed from the middle portion to both sides. Third and fourth helical guide grooves 91 and 92 symmetrical about an intermediate cross section of the pulley are disposed on a cylindrical surface of the pulley. Helical directions of the two helical guide grooves are opposite to each other. Depths of the two helical guide grooves are designed according to requirements for winding of the transmission ropes. The third transmission rope 41 and the fourth transmission rope 42 are disposed in the third and fourth helical guide grooves, respectively. The third transmission rope 41 is fixed at an end to a right side of the third helical guide groove 91, and connected at the other end to the solar panel holder 1. The fourth transmission rope 42 is fixed at an end to a right side of the fourth helical guide groove 92, and connected at the other end to the rigid support 51. When the pulley rotates, the third transmission rope is wound and the fourth transmission rope is unwound so that the two transmission ropes are configured in a wound and unwound relationship, and vice versa. It can be ensured that the pitching angle can be smoothly adjusted by setting reasonable parameters of the helical guide grooves.

Embodiment 4

As shown in FIG. 8, the fourth embodiment is different from the first embodiment in that the pitching angle tracking member is a linearly-pushing rod 46 having two ends respectively hingedly connected to the rigid support 51 and the mounting 2. The linearly-pushing rod 46 extends and retracts by driving a screw by means of an electric motor so as to control the solar panel holder 1 to rotate by a corresponding angle around the pitching angle rotation supporting shaft 31.

Similarly, a hydraulic linearly-pushing rod and pneumatic linearly-pushing rod can substitute for the electrical linearly-pushing rod equivalently.

During actual use, the accurate tracking manner, in the first embodiment, in which the regular movements of the pitching angle tracking member and the swing angle tracking member cooperate with each other can be employed, but the tracking angle of the device is limited due to limitation of the linearly-pushing rod 46 itself; and a method in which the angle is adjusted by the linearly-pushing rod 46 according to law of variation of an altitude angle, occurring during a year, of the sun every preset days can be utilized.

The pitching angle may be adjusted by hingedly connecting the two ends of the linearly-pushing rod 46 to the solar panel holder 1 and the mounting 2.

Embodiment 5

As shown in FIG. 9, the three-dimensional joint 3, the solar panel holder 1, the mounting 2, and the swing angle tracking member in the fifth embodiment are substantially the same as those in the first embodiment, but the fifth embodiment is different from the first embodiment in that both the first transmission part and the second transmission part are rigid arc bodies with tooth-shaped structures indicated by the rigid arc body 43 and the rigid semi-circular arc body 7. The rigid arc body 43 is a quadrant, while the rigid semi-circular arc body 7 is a semi-circular arc. A rigid support 51' is a quadrant having the same radius as the rigid arc body 43, and the rigid support 51' and the rigid arc body 43 are connected and combined to form a semi-circular arc.

The pitching angle tracking member comprises the solar panel holder 1, the rigid arc body 43, the rigid support 51', the mounting 2, the three-dimensional joint 3, and the first drive device 81.

The rigid arc body 43 and the arc-shaped rigid support 51' are integrally connected to constitute a semi-circular arc of 180 degrees as a whole. Both ends of the semi-circular arc are hingedly connected to the solar panel holder 1 along the Z axis. Most preferably, the two hingedly connection points are located on an elongation line of the swing angle rotation supporting shaft of the three-dimensional joint 3. An outer or inner periphery of the rigid arc body 43 is proportionally provided with teeth according to data of annual variation of an altitude angle of the sun.

The first drive device 81 mounted on the mounting 2 can effectively drive the rigid arc 43 to move by a gear on an output shaft of the first drive device 81. The rigid arc body 43 is controlled by the control program to rotate by a number of teeth corresponding to the annual variation of an altitude angle of the sun. The solar panel holder 1 is thus driven to rotate by a corresponding angle, thereby tracking variation in the angle of the sun in one year.

The gear transmission of the transmission structure on the rigid semi-circular arc body in the fifth embodiment may be replaced with a chain transmission structure and a frictional wheel transmission structure. The same transmission effect can be achieved with the chain transmission structure and the frictional wheel transmission structure.

Embodiment 6

As shown in FIG. 10, the sixth embodiment is different from the fifth embodiment in that the second drive device 82 is disposed within the mounting 2 so that an operation range of the second drive device 82 is located within an angular space of an upper end of the mounting 2.

The mounting 2 is an A-shaped framework structure as a whole, and the

A-shaped framework structure has the angular space at an upper portion. The mounting 2 is fixedly mounted on a base.

When an operation environment of the automatic sunlight tracking device operates is located in a lower-latitude region (between the Tropic of Capricorn and the Tropic of Cancer), a point at which the sun shines directly will exceed the zenith. Accordingly, the pitching angle of the solar panel holder 1 will exceed 180 degrees. In order to prevent the mounting 2 from inhibiting movement of the second drive device 82 mounted on the rigid support 51 so as to affect a range of operation of the solar panel holder 1, the upper portion of the mounting 2 needs to be designed as a structure with an open angular space and the effective angle of the open angular space should be larger than 46°52'. As result, the solar panel holder 1 can accurately track south and north variation of 23.5 degrees of the altitude angle of the sun occurring during one year in the proximity of the equator.

Embodiment 7

As shown in FIG. 11, the three-dimensional joint, the solar panel holder, the mounting, and the rigid support in the seventh embodiment are substantially the same as those in the first embodiment, and the pitching angle tracking member in the seventh embodiment is substantially the same as that in the third embodiment.

The seventh embodiment differs from the previous embodiments in that the second transmission part comprises a rope-like body including a first transmission rope 71 and a second transmission rope 72. The second drive device 82 comprises an electric motor and a worm speed reducer, and a pulley which is capable of cooperating with the transmission ropes is mounted on an output shaft of the worm speed reducer. The pulley has the same structure as that in the third embodiment, and also has a cylindrical shape with a small diameter at a middle portion and a large diameter at both ends. First and second helical guide grooves symmetrical about an intermediate cross section of the pulley are disposed on a cylindrical surface of the pulley. The first and second transmission ropes 71 and 72 are disposed in the first and second helical guide grooves, respectively. Each of the first and second transmission ropes has an end fixed to an inside of the corresponding helical guide groove, and another end connected to the solar panel holder 1. The first and second transmission ropes are configured in a wound and unwound relationship. A surplus amount generated by relationship between a straight line and an arc can be effectively absorbed. As a result, the solar panel holder 1 is controlled to adjust the swing angle.

The above embodiments can be used by mutual combinations of the embodiments in different environments and conditions.

In an application in a large-scale photovoltaic power station system, the control box can be replaced with centralized control performed by a master control center to achieve various controls such as a light-sensing tracking function, a wind resisting function, and a snow prevention function. The device itself is designed to have excellent sand prevention and rust prevention functions.

The above embodiments of the present invention are only intended to describe the preferable embodiments of the present invention, and shall not be construed to limit the present invention. All of modifications and improvements to these embodiments by those skilled in the art without departing from the design spirit of the invention shall fall within the scope of the present invention as defined in the claims of the present invention.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:-

1. A sunlight tracking device comprising a solar panel holder, a mounting, a pitching angle tracking member, and a swing angle tracking member, wherein:

the solar panel holder is coupled with the mounting through a three-dimensional joint, the three-dimensional joint includes a pitching angle rotation supporting shaft and a swing angle rotation supporting shaft arranged in a cross shape, the three-dimensional joint is hingedly coupled to the mounting through the pitching angle rotation supporting shaft, and the three-dimensional joint is hingedly coupled to the solar panel holder through the swing angle rotation supporting shaft;

a rigid support is fixedly connected to the swing angle rotation supporting shaft of the three-dimensional joint, and the rigid support is only capable of rotating synchronously with a pitching angle of the solar panel holder;

the swing angle tracking member at least comprises a second transmission part which is capable of rotating the solar panel holder around the swing angle rotation supporting shaft of the three-dimensional joint, and a second drive device for driving the second transmission part to act, and

wherein the pitching angle tracking member comprises:

a rigid arc body which is capable of rotating the solar panel holder by means of the pitching angle rotation supporting shaft of the three-dimensional joint, wherein the rigid arc body has an end fixedly connected to the rigid support or the swing angle rotation supporting shaft, or hingedly connected to the solar panel holder, and the rigid arc body has a groove-shaped or hole-shaped positioning structure;

a fixing hole disposed in the mounting; and

a positioning pin which is capable of being inserted in the fixing hole and the groove-shaped or hole-shaped positioning structure of the rigid arc body, wherein the pitching angle of the solar panel holder can be manually adjusted and the rigid arc body is locked to the mounting by inserting the positioning pin in the fixing hole of the mounting and the groove-shaped or hole-shaped positioning structure of the rigid arc body.

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2. The sunlight tracking device of claim 1, wherein:

the second transmission part is a rigid semi-circular arc body provided with a transmission structure, both ends of the rigid semi-circular arc body are fixedly connected to the solar panel holder, and the second drive device drives the rigid semi-circular arc body to rotate.

3. The sunlight tracking device of claim 2, wherein:

the rigid semi-circular arc body has a tooth-shaped transmission structure, the second drive device comprises an electric motor and a worm speed reducer, and a gear meshing with the tooth-shaped transmission structure is mounted on an output shaft of the worm speed reducer.

4. The sunlight tracking device of claim 2, wherein:

the rigid semi-circular arc body has a chain-shaped transmission structure, the second drive device comprises an electric motor and a worm speed reducer, and a sprocket cooperating with the chain-shaped transmission structure is mounted on an output shaft of the worm speed reducer.

5. The sunlight tracking device of claim 1, wherein:

the second transmission part is a rope-like body including a first transmission rope and a second transmission rope, the second drive device comprises an electric motor and a worm speed reducer, and a pulley which is capable of cooperating with the rope-like body is mounted on an output shaft of the worm speed reducer, the pulley has a cylindrical shape with a small diameter at a middle portion and a large diameter at both ends, first and second helical guide grooves symmetrical about an intermediate cross section of the pulley are disposed on a cylindrical surface of the pulley; the first and second transmission ropes are disposed in the first and second helical guide grooves, respectively, each of the first and second transmission ropes has an end fixed to an inside of the corresponding helical guide groove, and another end connected to the solar panel holder, and the first and second transmission ropes are configured in a wound and unwound relationship.

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6. A sunlight tracking device comprising:

a solar panel holder;

a mounting;

a pitching angle tracking member; and

a swing angle tracking member,

wherein the solar panel holder is coupled with the mounting through a three-dimensional joint, the three-dimensional joint includes a pitching angle rotation supporting shaft and a swing angle rotation supporting shaft arranged in a cross shape, the three-dimensional joint is hingedly coupled to the mounting through the pitching angle rotation supporting shaft, and the three-dimensional joint is hingedly coupled to the solar panel holder through the swing angle rotation supporting shaft, and

a support is hingedly connected to the solar panel holder or fixedly connected to the swing angle rotation supporting shaft of the three-dimensional joint, and the support is only capable of rotating synchronously with a pitching angle of the solar panel holder,

wherein the pitching angle tracking member comprises:

an arc body which is capable of rotating the solar panel holder by means of the pitching angle rotation supporting shaft of the three-dimensional joint, wherein the arc body has a groove-shaped or hole-shaped positioning structure;

a fixing hole disposed in the mounting; and

a positioning pin which is capable of being inserted in the fixing hole and the groove-shaped or hole-shaped positioning structure of the arc body, wherein the pitching angle of the solar panel holder can be manually adjusted and the arc body is locked to the mounting by inserting the positioning pin in the fixing hole of the mounting and the groove-shaped or hole-shaped positioning structure of the arc body.

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7. The sunlight tracking device of claim 6, wherein:

the swing angle tracking member comprises a second transmission part which is capable of rotating the solar panel holder around the swing angle rotation supporting shaft of the three-dimensional joint, and a second drive device configured to drive the second transmission part to act.

8. The sunlight tracking device of claim 7, wherein:

the second drive device is fixed to the support.

9. The sunlight tracking device of claim 7, wherein:

the second transmission part is a semi-circular arc body provided with a transmission structure, both ends of the semi-circular arc body are fixedly connected to the solar panel holder, and the second drive device drives the semi-circular arc body to rotate.

10. The sunlight tracking device of claim 9, wherein:

the semi-circular arc body has a tooth-shaped transmission structure, the second drive device comprises an electric motor and a worm speed reducer, and a gear meshing with the tooth-shaped transmission structure is mounted on an output shaft of the worm speed reducer.

11. A sunlight tracking device substantially as hereinbefore described with reference to the accompanying drawings.

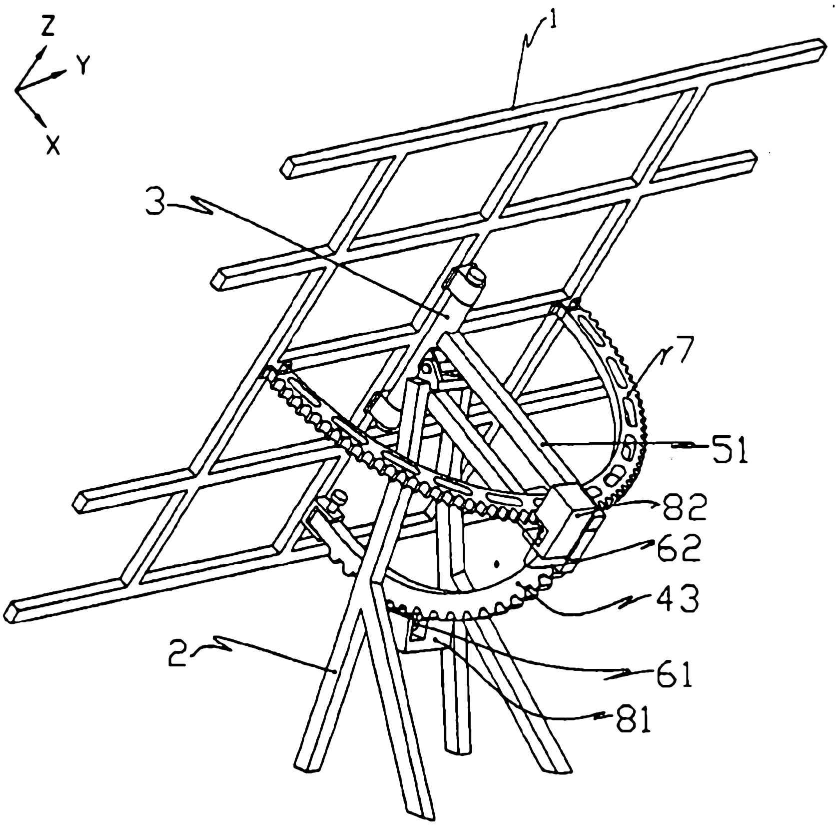

Fig. 1

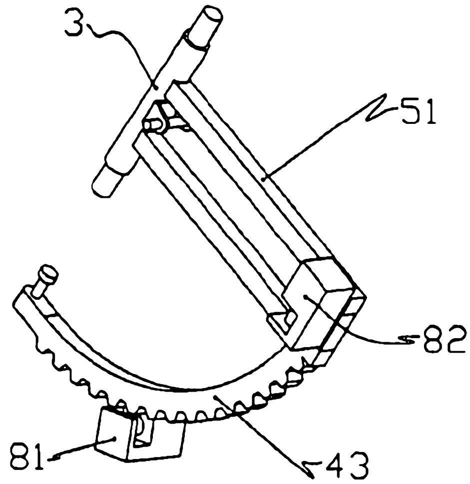

Fig. 2

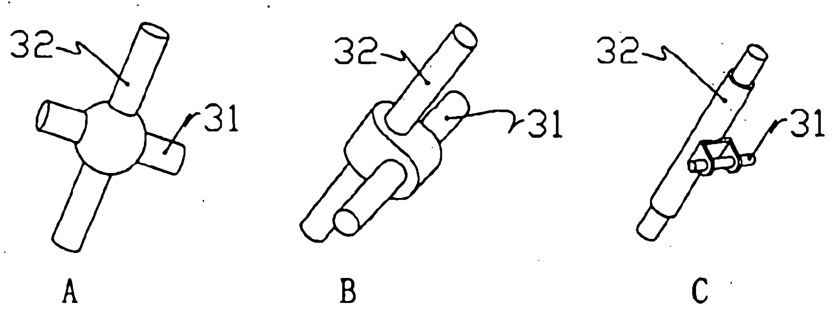

Fig. 3

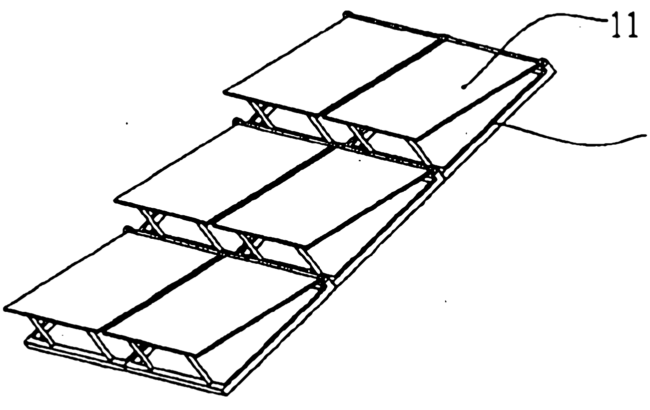

Fig. 4

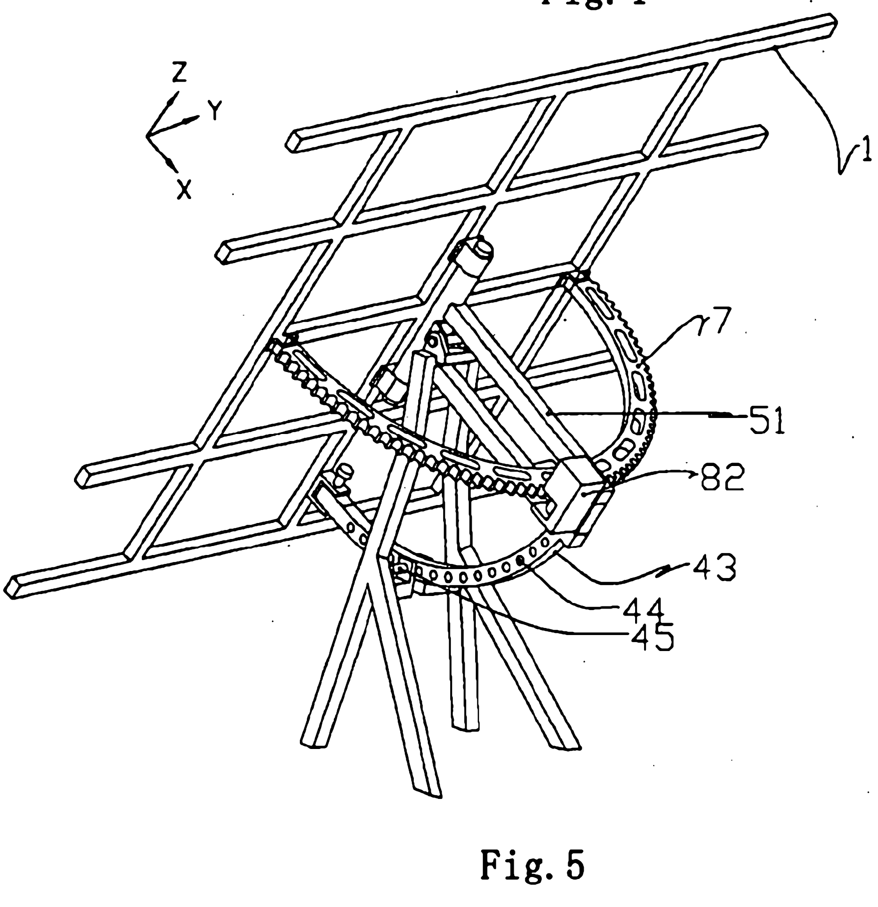

Fig. 5

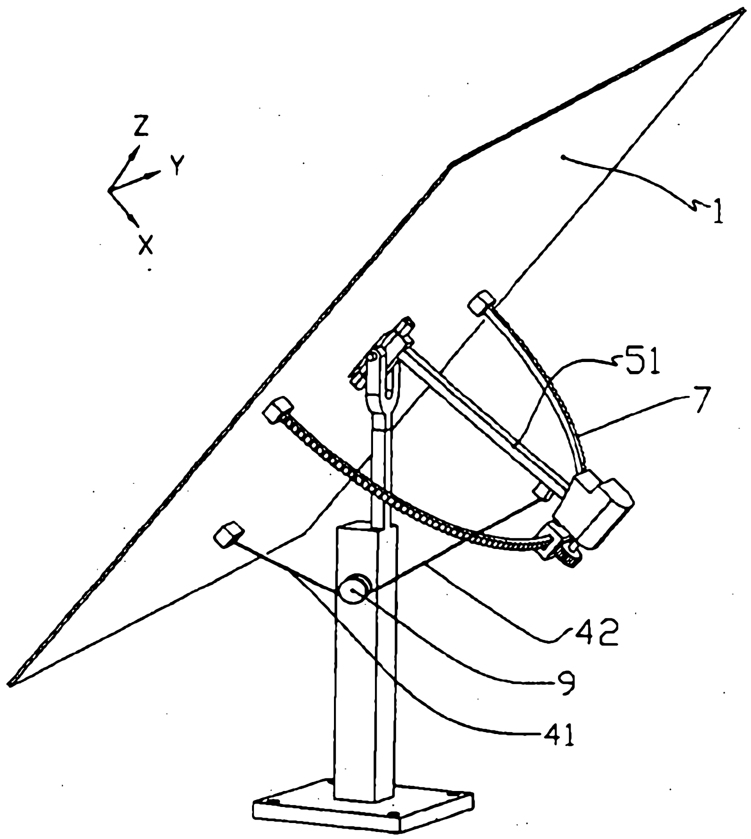

Fig. 6

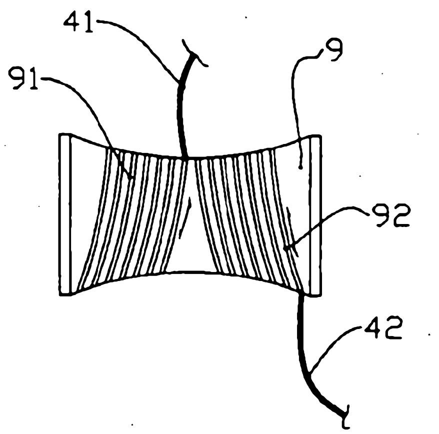

Fig. 7

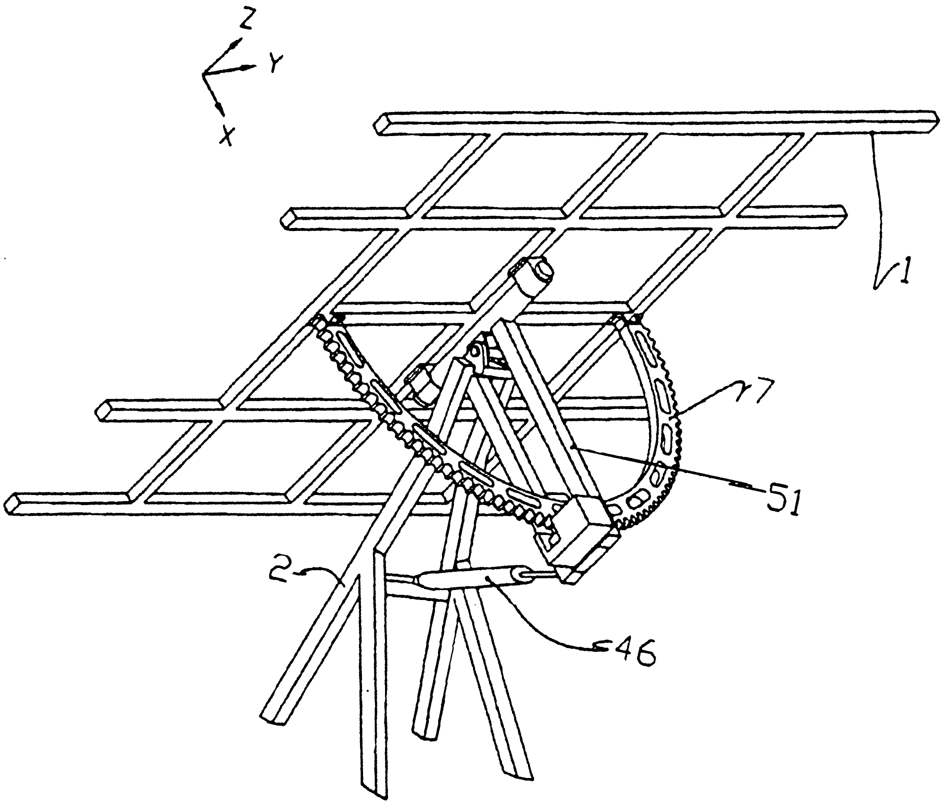

Fig. 8

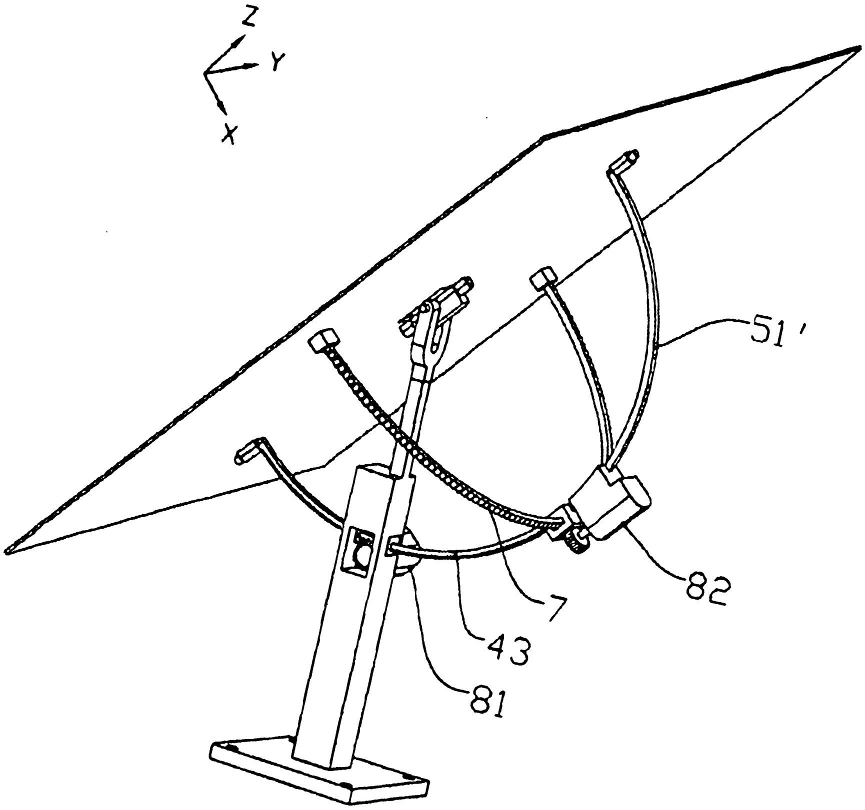

Fig. 9

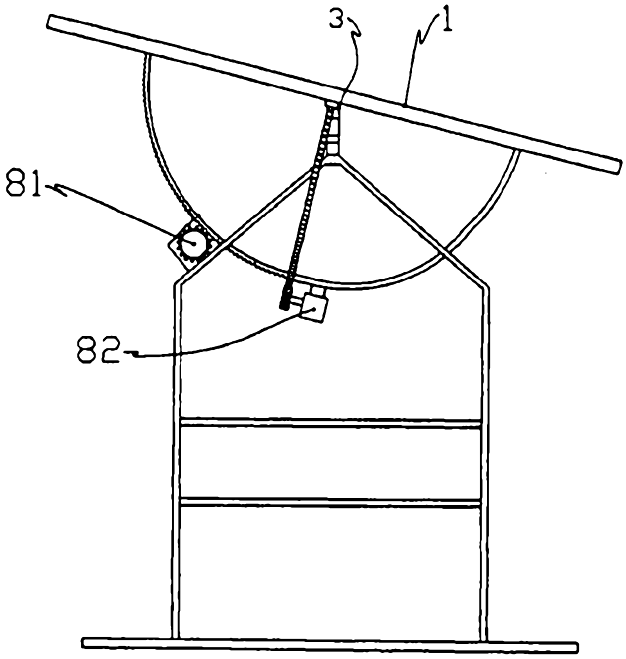

Fig. 10

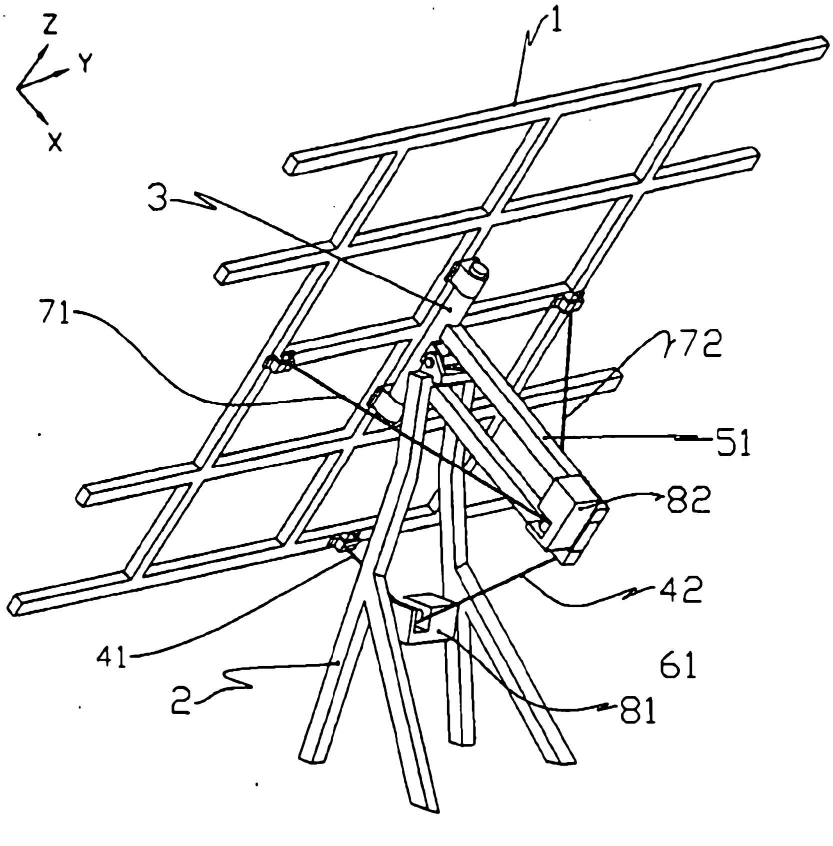

Fig. 11