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(54) **SUN TRACKING MECHANISM**

(71) Applicant: **National Chiao Tung University**, Hsinchu (TW)

(72) Inventors: **Edward-Yi Chang**, Hsinchu (TW); **Wei-Hua Chieng**, Hsinchu (TW); **Shyr-Long Jeng**, Hsinchu (TW); **Stone Cheng**, Hsinchu (TW); **Binhan Lue**, Hsinchu (TW); **Yuang Ming Hsu**, Hsinchu (TW); **Chih-Chiang Wu**, Hsinchu (TW); **Ching-Wei Shih**, Hsinchu (TW)

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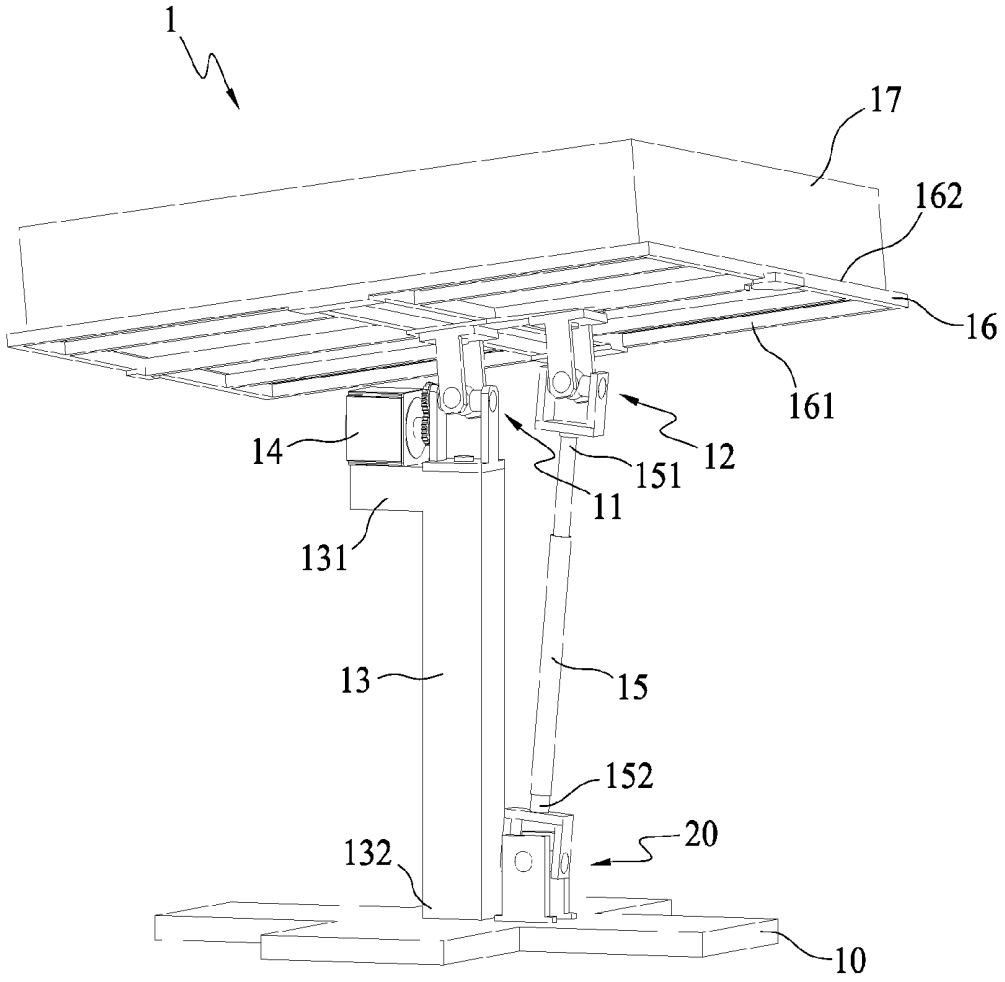
(57) **ABSTRACT**

A sun tracking mechanism is provided for solar power generation, including a power unit, a linear actuator and at least two universal joints. The sun tracking mechanism outputs an angle of high precision by two axial directions provided from the universal joints, the power unit and the linear actuator. A solar power module disposed on the sun tracking mechanism generates electricity in the best light incident angle. In addition, the linear actuator provides an auxiliary supporting force to improve the wind-resistant capability.



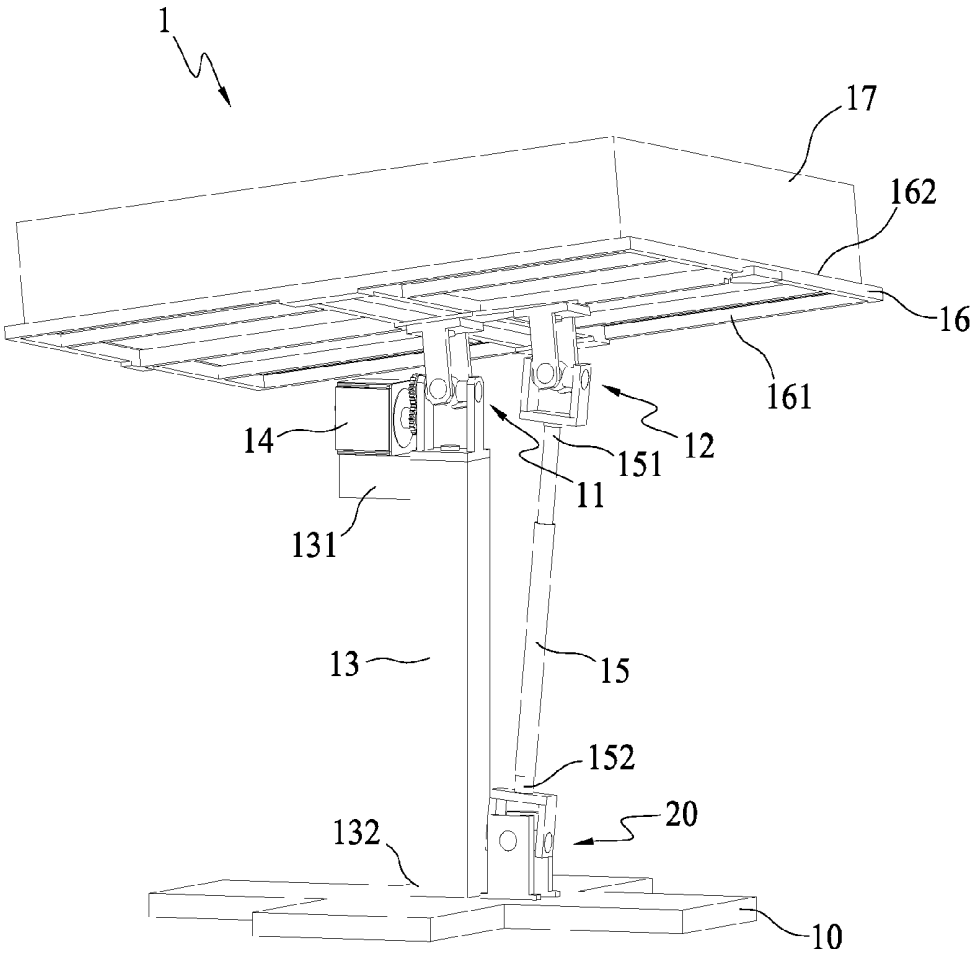


FIG. 1

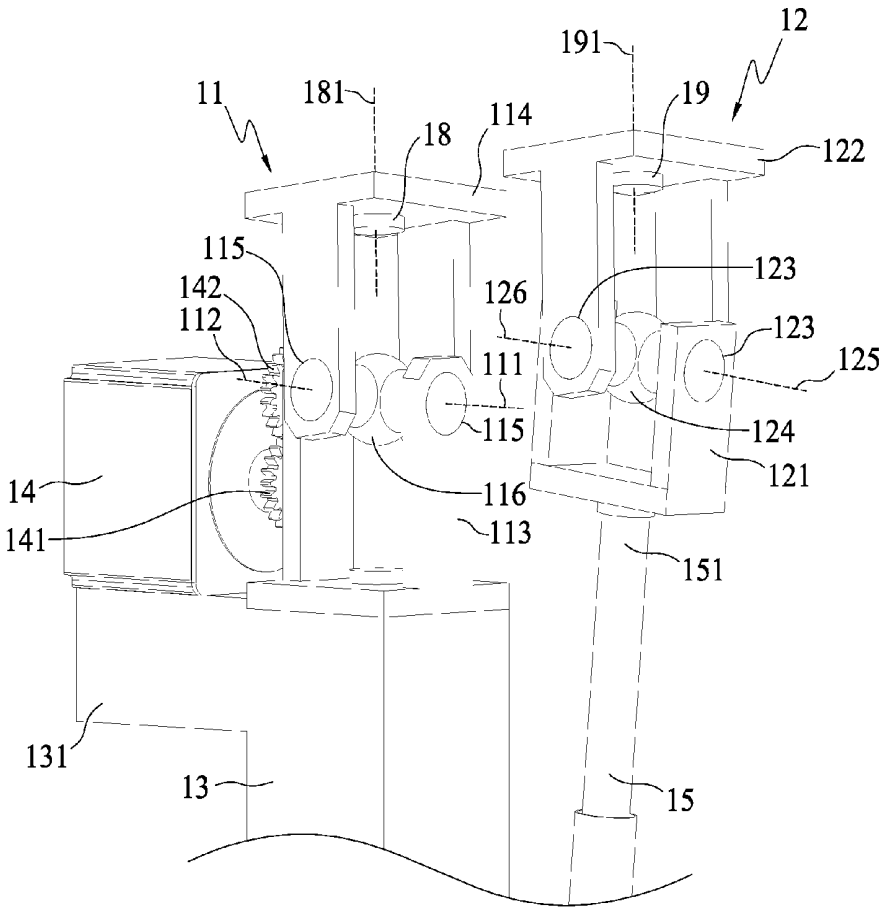

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FIG. 2

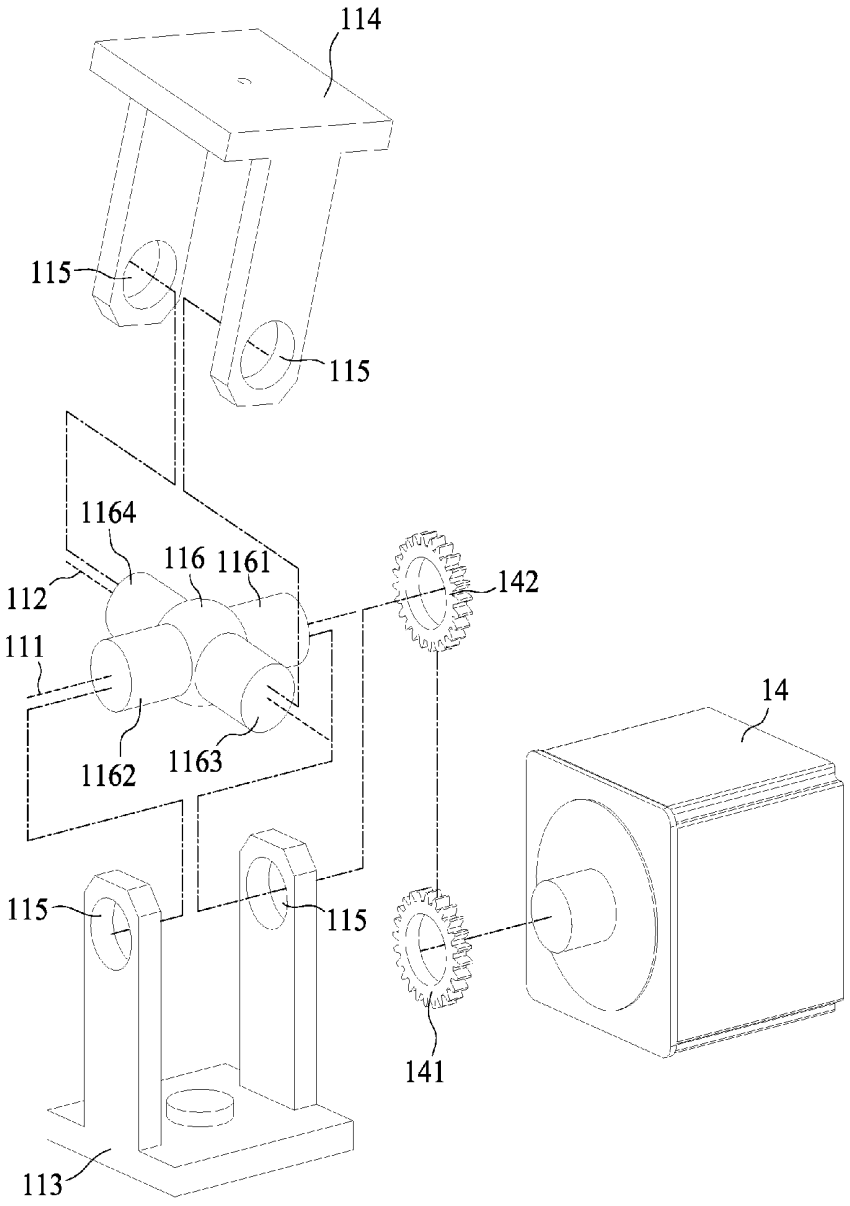
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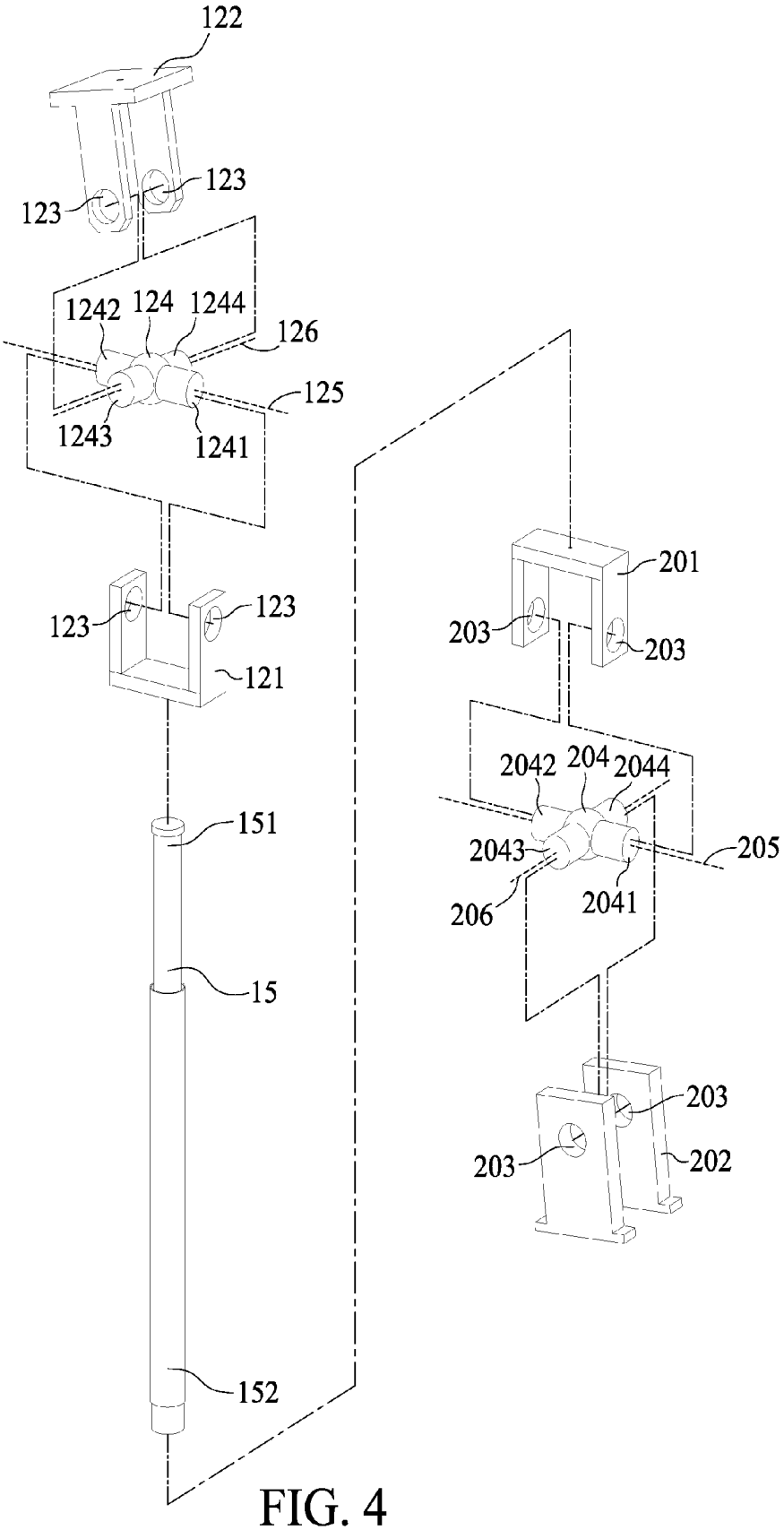
FIG. 3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202

FIG. 4

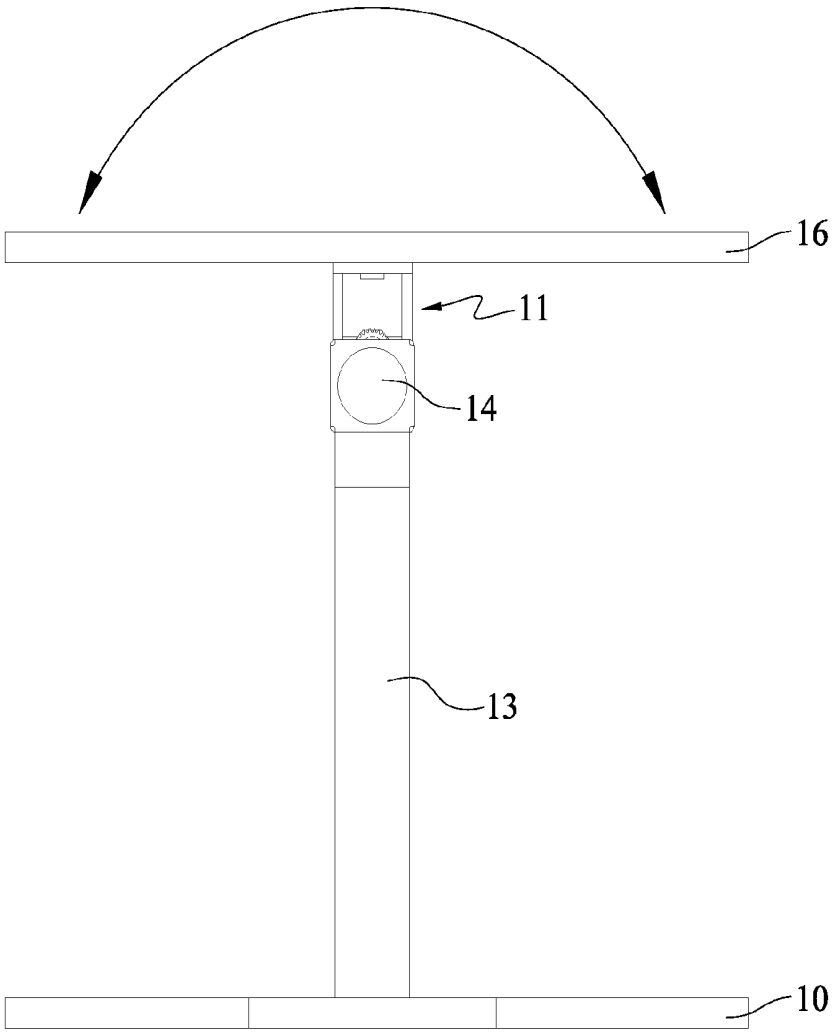

FIG. 5

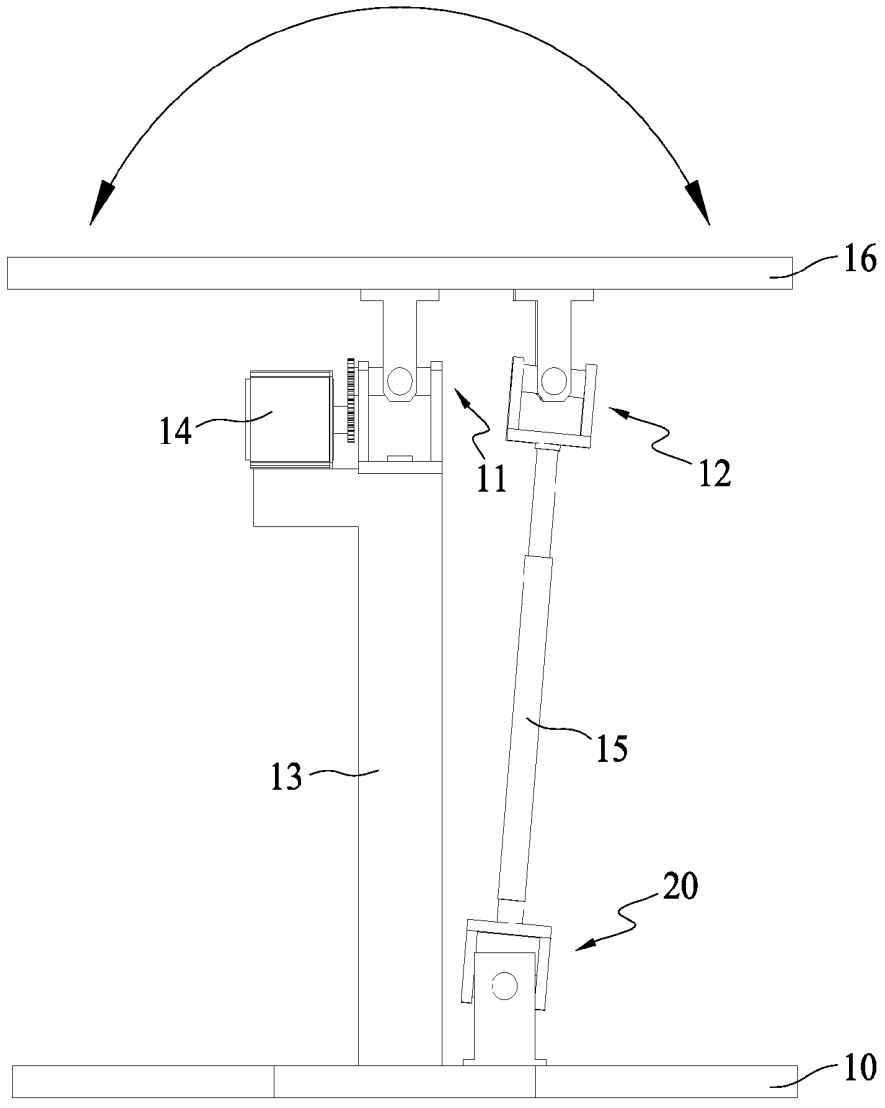

FIG. 6

SUN TRACKING MECHANISM

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This invention relates to sun tracking mechanisms, and, more particularly, to a sun tracking mechanism for solar power generation.

[0003] 2. Description of Related Art

[0004] With the rapid development of technology, demands for power grow steadily. Solar power is becoming one of the most indispensable power sources. A modern solar power module has a power conversion efficiency greatly increased. However, the location and light incident angle of the Sun is not always unchangeable. Thus, a sun tracking mechanism to which a solar power module is mounted is evolved from a fixed mode to an adjustable mode. The adjustable sun tracking mechanism employs a motor to adjust a tilted angle or deflected angle of a solar panel. Therefore, the solar panel tracks the Sun constantly, and the solar power module absorbs the sunlight at a best light incident angle and achieve a best power conversion efficiency.

[0005] However, the modern adjustable sun tracking mechanism is complicated and hard to be assembled, and has a high manufacturing cost. Further, the whole sun tracking mechanism cannot operate normally if a single component malfunctions. The modern adjustable sun tracking mechanism comprises a solar power module board and a single-axis supporting pole. Because the solar power module board has a large windward surface and the single-axis supporting pole is not robust enough to stabilize the solar power module board, the modern adjustable sun tracking mechanism is easily to shake severely and be deformed when wind blows the windward surface. Therefore, the modern sun tracking mechanism has a precision of tracking the Sun reduced. Moreover, the sun tracking mechanism outputs small angles, since the single-axis supporting pole is restricted by a limited rotation angle.

[0006] Therefore, how to design a sun tracking mechanism for solar power generation that has fewer components, stronger wind-resistant capability, high precision and a low manufacturing cost, and outputs great angles, is one of the most urgent issues in the art.

SUMMARY OF THE INVENTION

[0007] In view of the above-mentioned problems of the prior art, it is an objective of the present invention to provide a sun tracking mechanism for solar power generation. Compared with the prior art, the sun tracking mechanism has few components, stronger wind-resistant capability, and greater output angles. Joints of multiple degrees of freedom make the sun tracking mechanism to act nimbly, achieve higher precision, have a lower manufacturing cost, and allow a solar power module to absorb sunlight at a best light incident angle constantly and achieve a best power generation efficiency.

[0008] To achieve the above-mentioned and other objectives, the present invention provides a sun tracking mechanism, comprising: a base; a first universal joint; a second universal joint; a pole having a fixing end fixed to the base and a connecting end connected to the first universal joint; a power unit disposed on the connecting end of the pole for providing a transmission force to the first universal joint; a linear actuator having a first end connected to the second universal joint and a second end connected to the base and switching between a stretching state and a contracted state; and a plate having a first surface pivotally connected to the first universal joint and the second universal joint and a second surface, wherein the first universal joint allows the plate to rotate around a first axial direction and/or a second axial direction, wherein the plate rotates around the first axial direction with the first universal joint as a pivot when the power unit provides the transmission force to the first universal joint, and rotates around the second axial direction with the first universal joint as the pivot when the linear actuator is switching between the stretching state and the contracted state.

[0009] The sun tracking mechanism according to the present invention, through the power unit, the linear actuator and the first axial direction and the second axial direction provided by the first universal joint, outputs great angles. The joints of multiple degrees of freedom, i.e., the first universal joint and the second universal joint, allow the sun tracking mechanism to act nimbly, improve the angle precision, and facilitate a solar power module disposed on a sun tracking module to absorb sunlight at a best light incident angle constantly and have a best solar power generation efficiency. In addition to the supporting force provided from the pole, the linear actuator of the sun tracking mechanism according to the present invention further provides an auxiliary supporting force, which provides the sun tracking mechanism with improved wind-resistant capability and reduces the possibility that the sun tracking mechanism is deformed. Therefore, the sun tracking mechanism according to the present invention has its sun tracking precision been unaffected and a low manufacturing cost.

BRIEF DESCRIPTION OF DRAWINGS

[0010] The invention can be more fully understood by reading the following detailed description of the preferred embodiments, with reference made to the accompanying drawings, wherein:

[0011] FIG. **1** is a schematic diagram of a sun tracking mechanism according to the present invention;

[0012] FIG. **2** is a locally enlarged view of the sun tracking mechanism shown in FIG. **1**;

[0013] FIG. **3** is a schematic connection view of a first universal joint and a power unit of the sun tracking mechanism shown in FIG. **1**;

[0014] FIG. **4** is a schematic connection view of a second universal joint, a third universal joint and a linear actuator of the sun tracking mechanism shown in FIG. **1**;

[0015] FIG. **5** is a schematic view of the sun tracking mechanism shown in FIG. **1** when operating in a first axial direction; and

[0016] FIG. **6** is a schematic view of the sun tracking mechanism shown in FIG. **1** when operating in a second axial direction.

DETAILED DESCRIPTION OF THE INVENTION

[0017] The following illustrative embodiments are provided to illustrate the disclosure of the present invention, these and other advantages and effects can be apparently understood by those in the art after reading the disclosure of this specification. The present invention can also be performed or applied by other different embodiments. The details of the specification may be on the basis of different

points and applications, and numerous modifications and variations can be devised without departing from the spirit of the present invention.

[0018] Referring to FIGS. **1** and **2**, a sun tracking mechanism **1** according to the present invention comprises a base **10**, a first universal joint **11**, a second universal joint **12**, a pole **13**, a power unit **14**, a linear actuator **15** and a plate **16**. The pole **13** has a connecting end **131** connected to the first universal joint **11** and a fixing end **132** fixed to the base **10**. The power unit **14** is disposed on the pole **13**. In an embodiment, the power unit **14** is disposed on the connecting end **131** of the pole **13** and around the first universal joint **11**. In other words, both the power unit **14** and the first universal joint **11** are disposed on the connecting end **131** of the pole **13**. Therefore, the power unit **14** can provide a transmission force to the first universal joint **11** easily. Of course, the power unit **14** can be disposed on other positions of the pole **13**, as long as the transmission force generated by the power unit **14** can be provided to the first universal joint **11**. In an embodiment, the power unit **14** is a servo motor, a stepping motor or a linear motor.

[0019] The linear actuator **15** has a first end **151** connected to the second universal joint **12** and a second end **152** connected to the base **10**. In an embodiment, the linear actuator **15** has a variety of components, such as a driving motor, a reduction gear, a pushing rod, a screw rod, a slide base and a spring. Through these components, the linear actuator **15** transforms a rotation movement of the driving motor into a linear motion of the pushing rod, and drives the pushing rod to move back and forth along an axis through forward and backward rotating movements of the driving motor. Therefore, the pushing rod can operate in a stretching state by stretching itself to a region outside of the linear actuator **15**, or in a contracted state by contracting itself back to the linear actuator **15**. The switching mechanism between the stretching state and the contracted state is a back-and-forth linear motion that the linear actuator **15** and the pushing rod disposed therein can achieve.

[0020] The plate **16** has a first surface **161** pivotally connected to the first universal joint **11** and the second universal joint **12** and a second surface **162** having a solar power module **17** disposed thereon. In an embodiment, the first universal joint **11** is pivotally connected to a central point of the first surface **161** of the plate **16**, and the second universal joint **12** is pivotally connected to a position of the first surface **161** of the plate **16** spaced from the central point at a distance.

[0021] In an embodiment according to the present invention, the first universal joint **11** provides a first axial direction and a second axial direction in which a member can rotate around. Refer to FIGS. **2** and **3**. The first universal joint **11** comprises a first socket **113**, a second socket **114** and a cross shaft **116**. The first socket **113** is connected to the connecting end **131** of the pole **13**. The second socket **114** is pivotally connected to the first surface **161** of the plate **16**. The first socket **113** has two openings **115** for two opposing shaft ends **1161** and **1162** of the cross shaft **116** to be disposed therein. The second socket **114** also has two openings **115** for another two opposing shaft ends **1163** and **1164** of the cross shaft **116** to be disposed therein. Therefore, a relative motion between the first socket **113** and the second socket **114** allows the first socket **113** or the second socket **114** and the cross shaft **116** as a whole to rotate around a first axial direction **111** formed by the shaft ends **1161** and **1162**. The first universal joint **11** provides the first axial direction **111** in which a member can rotate around, through the rotation of the shaft ends **1161** and **1162** of the cross shaft **116** in the two openings **115** of the first socket **113**. Similarly, the second socket **114** or the first socket **113** and the cross shaft **116** as a whole can rotate around a second axial direction **112** formed by the shaft ends **1163** and **1164**. The first universal joint **11** provides the second axial direction **112** in which a member can rotate around, through the rotation of the shaft ends **1163** and **1164** of the cross shaft **116** in the two openings **115** of the second socket **114**.

[0022] The power unit **14** outputs the transmission force to the cross shaft **116** of the first universal joint **11** directly by engaging gears or coupling a transmission axle of the power unit **14** to any one of the shaft ends **1161**, **1162**, **1163** and **1164** of the cross shaft **116**. In an embodiment according to the present invention, the transmission force of the power unit **14** is transmitted by a gear set. The power unit **14** has a first gear **141** disposed thereon. The cross shaft **116** has a second gear **142** disposed on the shaft end **1161** along the first axial direction **111**. In order form the transmission force of the power unit **14** to be transmitted to the first universal joint **11**, the first gear **141** and the second gear **142** have to be engaged. Therefore, the power unit **14** can transmit the transmission force to the cross shaft **116** through the engagement of the first gear **141** and the second gear **142**, and the cross shaft **116** can acquire a force that it needs to rotate around the first axial direction **111**. A gear ratio and gear distance between the first gear **141** and the second gear **142** can be adjusted according to an output power of the power unit **14**. In an embodiment, the first gear **141** and the second gear **142** include a combination of a spur gear, a helical gear, a double helical gear, a bevel gear and a worm gear.

[0023] When the power unit **14** provides the transmission force to the first universal joint **11**, the cross shaft **116** disposed on the first socket **113** can rotate around the first axial direction **111** and drive the second socket **114** to also rotate around the first axial direction **111**, and the plate **16** pivotally connected to the second socket **114** of the first universal joint **11** moves accordingly. Therefore, the plate **16** rotates around the first axial direction **111** directly, with an axial center of the shaft ends **1161** and **1162** of the cross shaft **116** in the first universal joint **11** as a pivot. Please also refer to FIG. **5**. FIG. **5** illustrates the plate **16** when rotating around the first axial direction **111**. When the linear actuator **15** is switching between the stretching state and the contracted state, the power generated as the linear actuator **15** and the pushing rod disposed therein move back and forth along a line drives the plate **16** to rotate around the second axial direction **112**, with a distance between the central point of the first surface **161** and the location where the second universal joint **12** is disposed on the first surface **161** of the plate **16** as a torque and an axial center of the shaft ends **1163** and **1164** of the cross shaft **116** in the first universal joint **11** as a pivot. Please refer to FIG. **6**, which illustrates the plate **16** when rotating around the second axial direction **112**.

[0024] In an embodiment, the first universal joint **11** is pivotally connected via a first pivot member **18** to the plate **16**. As shown in FIG. **2**, the first pivot member **18** passes through the second socket **114** such that the second socket **114** props against the plate **16**. In an embodiment, the first pivot member **18** is a cylinder. The first pivot member **18** does not fix the second socket **114** to the plate **16**, and the second socket **114** can rotate on the plate **16** through the first pivot member **18**. In other words, the first pivot member **18** allows the second socket **114** to rotate, with respect to the plate **16**, around a

third axial direction **181**. Therefore, the first universal joint **11** provides a three dimensional degree of freedom, including the first axial direction **111**, the second axial direction **112** and the third axial direction **181**, in which the first axial direction **111** is perpendicular to the second axial direction **112** and the third axial direction **181** is perpendicular to the first axial direction **111** or to the second axial direction **112**.

[0025] In an embodiment, the second universal joint can also provide a fourth axial direction and a fifth axial direction in which a member can rotate around. Please refer to

[0026] FIGS. **1** and **4**. The second universal joint **12** further comprises a third socket **121** connected to the first end **151** of the linear actuator **15**, a fourth socket **122** pivotally connected to the first surface **161** of the plate **16**, and a cross shaft **124**. The third socket **121** comprises two openings **123** for two opposing shaft ends **1241** and **1242** of the cross shaft **124** to be disposed therein. The fourth socket **122** also has two openings **123** for another two opposing shaft ends **1243** and **1244** of the cross shaft **124** to be disposed therein. Therefore, a relative motion between the third socket **121** and the fourth socket **122** allows the third socket **121** or the fourth socket **122** and the cross shaft **124** as a whole to rotate around the fourth axial direction **125**. In other words, the second universal joint **12** provides the fourth axial direction **125** in which a member can rotate around, through the rotation of the shaft ends **1241** and **1242** of the cross shaft **124** in the two openings **123** of the third socket **121**. Similarly, the fourth socket **122** or the third socket **121** and the cross shaft **124** as a whole can rotate around the fifth axial direction **126** formed by the shaft ends **1243** and **1244**. In other words, the second universal joint **12** provides the fifth axial direction **126** in which a member can rotate around, through the rotation of the shaft ends **1243** and **1244** of the cross shaft **124** in the two openings **123** of the fourth socket **122**.

[0027] In an embodiment, the second universal joint **12** is pivotally connected via a second pivot member **19** to the plate **16**. As shown in FIG. **2**, the second pivot member **19** passes through the fourth socket **122**, and the fourth socket **122** props against the plate **16**. In an embodiment, the second pivot member **19** is a cylinder. The second pivot member **19** does not fix the fourth socket **122** to the plate **16**, and the fourth socket **122** can rotate on the plate **16** through the second pivot member **19**. In other words, the second pivot member **19** allows the plate **16** to rotate around the sixth axial direction **191**. Therefore, the second universal joint **12** provides a three dimensional degree of freedom, including the fourth axial direction **125**, the fifth axial direction **126** and the sixth axial direction **191**, any two of which are perpendicular to each other. In an embodiment, the fourth axial direction **125**, the fifth axial direction **126** and the sixth axial direction **191** are the same as the first axial direction **111**, the second axial direction **112** and the third axial direction **181**, respectively.

[0028] The first universal joint **11** and the second universal joint **12** according to the present invention provide the three dimensional degree of freedom through the adoption of the cross shaft and pivotal members. In an embodiment, the first universal joint **11** and the second universal joint **12** are a ball joint. After the first universal joint **11** rotates around the first axial direction **111** and the plate **16** is tilted at a certain angle, if the linear actuator **15** drives the plate **16** to rotate around the second axial direction **112**, the second universal joint **12** also has to rotate around the fourth axial direction **125** or the fifth axial direction **126**. Since further having the third axial direction **181** and the sixth axial direction **191**, the first universal joint **11** and the second universal joint **12** can thus provide a greater angle output, an angle adjustment of high precision, and a greater degree of freedom.

[0029] In an embodiment, the second end **152** of the linear actuator **15** is fixed to the base **10** directly, or through a third universal joint **20** to the base **10** indirectly. The third universal joint **20** comprises a fifth socket **201** fixed to the second end **152** of the linear actuator, a sixth socket **202** fixed to the base **10**, and a cross shaft **204**. The fifth socket **201** has two openings **203** for two opposing shaft ends **2041** and **2042** of the cross shaft **204** to be disposed therein. The sixth socket **202** also has two openings **203** for another two opposing shaft ends **2043** and **2044** of the cross shaft **204** to be disposed therein. Therefore, a relative motion between the fifth socket **201** and the sixth socket **202** allows the fifth socket **201** or the sixth socket **202** and the cross shaft **204** to rotate around the fourth axial direction **205** formed by the shaft ends **2041** and **2042**. In other words, the third universal joint **20** provides the fourth axial direction **205** in which a member can rotate around, through the rotation of the shaft ends **2041** and **2042** of the cross shaft **204** in the openings **203** of the fifth socket **201**. Similarly, the sixth socket **202** or the fifth socket **201** and the cross shaft **204** as a whole can rotate around the fifth axial direction **206** formed by the shaft ends **2043** and **2044**. In other words, the third universal joint **20** provides the fifth axial direction **206** in which a member can rotate around, through the rotation of the shaft ends **2043** and **2044** of the cross shaft **204** in the openings **203** of the sixth socket **202**.

[0030] According to the sun tracking mechanism of the present invention, a power unit, a linear actuator, and a first universal joint and a second universal joint that have a multiple degree of freedom allow the sun tracking mechanism to act nimbly, output a great angle, improve the angle precision, and facilitate a solar power module disposed on a sun tracking module to absorb sunlight at a best light incident angle constantly and have a best solar power generation efficiency. According to the sun tracking mechanism, a linear actuator provides an auxiliary supporting force, which provides the sun tracking mechanism with improved wind-resistant capability and reduces the possibility that the sun tracking mechanism is deformed. Therefore, the sun tracking mechanism according to the present invention has its sun tracking precision been unaffected and a low manufacturing cost.

[0031] The foregoing descriptions of the detailed embodiments are only illustrated to disclose the features and functions of the present invention and not restrictive of the scope of the present invention. It should be understood to those in the art that all modifications and variations according to the spirit and principle in the disclosure of the present invention should fall within the scope of the appended claims.

What is claimed is:

1. A sun tracking mechanism, comprising:

a base;

a first universal joint;

a second universal joint;

a pole having a fixing end fixed to the base and a connecting end connected to the first universal joint;

a power unit disposed on the connecting end of the pole for providing a transmission force to the first universal joint;

a linear actuator having a first end connected to the second universal joint and a second end connected to the base and being switched between a stretching state and a contracted state; and

a plate having a first surface pivotally connected to the first universal joint and the second universal joint and a second surface opposing the first surface, wherein the first universal joint allows the plate to rotate around a first axial direction and/or a second axial direction,

wherein the plate rotates around the first axial direction with the first universal joint as a pivot when the power unit provides the transmission force to the first universal joint, and rotates around the second axial direction with the first universal joint as the pivot when the linear actuator is switched between the stretching state and the contracted state.

2. The sun tracking mechanism of claim **1**, wherein the first universal joint further comprises:

a first socket connected to the connecting end of the pole and having two openings;

a second socket pivotally connected to the first surface of the plate and having two openings; and

a cross shaft having four shaft ends wherein, two opposing ones of which are disposed in the openings of the first socket to allow the first universal joint to rotate around the first axial direction through a relative motion between the cross shaft and the first socket, and the others of which are disposed in the openings of the second socket to allow the first universal joint to rotate around the second axial direction through a relative motion between the cross shaft and the second socket.

3. The sun tracking mechanism of claim **2**, further comprising a first pivot member passing through the second socket such that the second socket props against the plate, and the second socket rotates around a third axial direction through the first pivot member when a relative motion is performed between the second socket and the plate.

4. The sun tracking mechanism of claim **3**, wherein the power unit has a first gear disposed thereon, one of the shaft ends of the cross shaft along the first axial direction has a second gear disposed thereon, and the first gear and the second gear are engaged to transmit the transmission force of the power unit to the cross shaft, for providing a force needed by the cross shaft to rotate around the first axial direction.

5. The sun tracking mechanism of claim **1**, wherein the second universal joint further comprises:

a third socket connected to the first end of the linear actuator and having two openings;

a fourth socket pivotally connected to the first surface of the plate and having two openings; and

a cross shaft having four shaft ends, wherein two opposing ones of which are disposed in the openings of the third socket to allow the second universal joint to rotate around a fourth axial direction through a relative motion between the cross shaft and the third socket, and the others of which are disposed in the openings of the fourth socket to allow the second universal joint to rotate around a fifth axial direction through a relation motion between the cross shaft and the fourth socket.

6. The sun tracking mechanism of claim **5**, further comprising a second pivot member passing through the fourth socket such that the fourth socket props against the plate, and the fourth socket rotates around a sixth axial direction through the second pivot member when a relative motion is performed between the fourth socket and the plate, wherein when the plate rotates around the first axial direction or the second axial direction, the second universal joint, by rotating itself around the fourth axial direction, the fifth axial direction or the sixth axial direction, provides a degree of freedom needed by the second universal joint to move in accordance with the plate.

7. The sun tracking mechanism of claim **5**, further comprising a third universal joint disposed between the linear actuator and the base, the third universal joint comprising:

a fifth socket fixed to the second end of the linear actuator and having two openings;

a sixth socket fixed to the base and having two openings; and

a cross shaft having four shaft ends, two opposing ones of which are disposed in the openings of the fifth socket to allow the third universal joint to rotate around the fourth axial direction through a relative motion between the cross shaft and the fifth socket, and the others of which are disposed in the openings of the sixth socket to allow the third universal joint to rotate around the fifth axial direction through a relative motion between the cross shaft and the sixth socket.

8. The sun tracking mechanism of claim **1**, wherein the power unit is a servo motor, a stepping motor or a linear motor, and the first universal joint or the second universal joint is a ball joint.

9. The sun tracking mechanism of claim **1**, wherein the power unit has a first gear disposed thereon, the first universal joint has a second gear disposed thereon, and the first gear and the second gear are engaged to transmit the transmission force of the power unit to the first universal joint, for providing a force needed by the first universal joint to rotate around the first axial direction.

10. The sun tracking mechanism of claim **1**, wherein the first universal joint is pivotally connected to a central point of the first surface of the plate.

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