Abstract: The load-bearing and positioning equipment (1) for the set of the solar panels (2) enables the movement of this set on a trajectory following the movement of the Sun. The load-bearing frame (7) with panels rotates around two mutually perpendicular axes, namely around the first axis (6) of rotation of the platform (3) and, at the same time, around the second axis (10) of rotation of the angular adapter (8). The second axis (10) makes, along with the first axis (6), angle (α) located within the range from 0° to 80°, and the normal line (11) of the surface of the solar panels (2) on the load-bearing frame (7) makes, along with the second axis (10), angle (β) located within the range from 10° to 80°, when the values of both angles (α, β) are mutually complementary so that their sum is within the range from 20° to 90°.
Load-bearing and positioning equipment for the set of solar panels

Background and summary of the invention

The invention concerns load-bearing and positioning equipment for the set of solar panels, especially photovoltaic, which enables the movement of the frame with the solar panels on a trajectory following the movement of the Sun, and it is equipped with the applicable swivelling and tilting equipment to achieve this purpose.

Solar panels are usually located in bigger quantities on the load-bearing frame to ensure sufficient thermal or electric output of the equipment and the load-bearing frame moves by means of the swivelling and tilting equipment during the day so that the panels would be continually in optimum position with respect to the Sun, i.e. if possible vertically to the direction of incidence of the sunshine.

To follow the movement of the Sun, one group of known solutions utilizes the structure of a vertical platform, usually a column, which can be attached to a base. On the platform, there is a head with the swivelling equipment, which enables the rotation of the load-bearing frame with panels around the vertical axis of the platform. The load-bearing frame is attached to the head so that it could be simultaneously tilted around the horizontal axis against the Sun. Such solution is known e.g. from the Czech Utility Model No. 18 355, where the tilting is realized by means of a screw brace, or from the Czech Utility Model No. 15 559, where the swivelling equipment includes a system of toothed wheels with inserted rotor, or from the German published patent application DE 10 2005 042 478. Also from the German patent application DE 44 19 244, the vertical platform is known that consists of the external cylinder, in which the inner cylinder is rotating. A tie rod is connected to the load-bearing frame with the solar panels in a way that does not hinder the rotating movement of the inner cylinder. This tie rod controls tilting of the load-bearing frame around the horizontal axis. The European patent application EP 1867 935 also describes a similar solution, where there are springs in the horizontal axis of the load-
bearing frame and tilting around the horizontal axis is limited by pulling ropes on the bottom edge of the load-bearing frame.

Another group of known solutions also uses the combination of movement with tilting around the so-called "hour axis" for the movement of the load-bearing frame, by which we understand the axis of symmetry of the load-bearing frame, which is located in the vertical plane also including the vertical axis of the platform. The hour axis is (with the exception of the location on the equator at high noon) continually inclined towards the Earth surface. Tilting of the load-bearing frame around this axis follows the hourly movement of the Sun on the sky, i.e. the movement from the east to the west. The solution described in the published patent application WO 2008/000867 includes the rotating movement of the load-bearing frame around vertical axis of the platform and, at the same time, a combined movement formed by compounding the tilting around the horizontal axis and the tilting around the hour axis. The tilting is ensured with the inclined telescopic tie rod located asymmetrically on the reverse side of the load-bearing frame from the Sun.

The French patent FR 83 057 65 then describes the solution, when the vertical platform is ended with the inclined arm, the angle of which is fixed and corresponds to the particular geographical latitude of location. The inclined arm bears the head that tilts around the hour axis, which is in parallel with the axis of the Earth, and the load-bearing frame with the solar panels is located on the head with the possibility of further tilting movement around the horizontal axis. Tilting around the hour axis is realized automatically by means of the electro drive; tilting around the horizontal axis is adjusted manually with the screw tie rod according to the season of the year and position of the Sun.

From the German published patent application DE 101 44 601, we can know the equipment, when the tilting around the horizontal axis is solved with bend guide way, on which the mobile part moves; it is connected with the load-bearing frame and the load-bearing frame tilts around the hour axis. The resulting movement is a
combination of both these movements, the platform is fixed and consists of the frame trapezoidal structure, on the top traverse of which, two-wing solar panels rotate for 360° per 24 hours. The bend guide way ensures season tilting of the axis of rotation according to the season of the year.

Another group of known solutions includes simple single-axis equipment. For example the German Utility Model DE 20 2005 001 195 describes the load bearing structure with the inclined load-bearing frame, which has a revolving central pin in the middle and travel equipment on the sides for the rotation along a circular trajectory. From the Czech patent file 283818 we can know the equipment for tilting of the load-bearing frame around the firmly located hour axis. A cylindrical case rotates around the fixed axis; it is driven with a reversible electromotor with self-locking gearing.

From another German Utility Model DE 2004 001 642, we can know the equipment, which carries the hour axis of the load-bearing frame on two adjustable braces of different height. A similar solution is also known from the Utility Model CZ 16891 as well as from the published German patent application DE 2006 022 982.

The disadvantage of the currently known solutions of the load-bearing and positioning equipment consists in the fact that if it concerns simple, usually single-axis equipment, then it is generally possible neither to achieve optimum adjustment of the solar panels of such equipment vertically against the Sun within the whole time and geographic range, nor the safety adjustment (tilting down) of the solar panels in case of a wind above the critical level from various angles. Such pieces of equipment have small efficiency and are not designed for bearing a bigger number of solar panels. If they are compiled to bigger ground units, the units are complex and their ground projection occupies an extensive area.

If it concerns more complex multi-axis pieces of equipment, they enable adequate optimization of the position and set-up, but their disadvantage consists in the fact that the structural design of such equipment is complex; they include a big number of
parts stressed with movement, which results in their higher price, higher failure rate, higher demands for installation, operation and maintenance.

The task of the invention is to create the equipment, which would eliminate the aforesaid shortcomings and, therefore, enable both the optimum adjustment of the position against the Sun and against the wind exceeding the critical level and, at the same time, it would concern the equipment with the minimum number of moving parts with simple production and installation.

This task is solved with the load-bearing and positioning equipment, which consists, in a known way, of the platform that can be attached to the base and provided with the first rotating instrument.

The nature of the invention consists in the fact that between the load-bearing frame and the first rotating instrument, there is an angular adapter provided with the second rotating instrument with the possibility of the rotating movement around the second axis of rotation. This second axis makes, along with the first axis, angle ($\alpha$) located within the range from $10^\circ$ to $80^\circ$. Then the load-bearing frame is attached to the second rotating instrument so that the normal line of the surface of the solar panels on the load-bearing frame makes, along with the second axis, angle ($\beta$) located within the range from $10^\circ$ to $80^\circ$. Nevertheless, it shall apply that the values of angles ($\alpha$, $\beta$) are mutually complementary so that their sum is within the range from $20^\circ$ to $90^\circ$. This design enables tilting and swivelling of the surface of the solar panels to all required directions following the trajectory of the Sun, with the application of the minimum number of rotating (mobile) parts. In the advantageous design of the invention, the first axis of rotation is vertical, so that it ensures the rotation of the angular adapter around the platform in the same position. It is advantageous especially with respect to the possibility of tilting of the surface of the solar panels against the wind at any angle of rotation if the wind force exceeds the critical level.
It is also advantageous when the value of angle (α) is situated from 15° to 35° and the value of angle (β) is from 40° to 60°, which are the values for optimum swivelling and tilting in the Central European geographical latitudes, and, at the same time, they enable tilting of the panels to a safe position. From this standpoint, it is also advantageous when the load-bearing frame with the solar panels has essentially an elliptical shape, which enables swivelling the surface at an angle to the ground against the wind with the longitudinal axis of the ellipse, whereby the bottom edge of the panels gets very close to the base, so that the air current slides upwards along it.

In another advantageous design of the invention, the first rotating instrument and/or the second rotating instrument consist of a flange circular rotating ring with an electro drive. This equipment is very reliable; it does not include any external mobile parts and is protected against dust and damage.

Finally it is advantageous when the flange circular rotating ring is provided with a toothed wheel, which is engaged with the worm on the shaft of the electro drive. This design enables very accurate swivelling and, at the same time, it is self-locking so that an undesired change of the position cannot occur, e.g. as a result of wind.

The advantages of the load-bearing and positioning equipment for the set of the solar panels according to the invention consist especially in the fact that it includes the minimum amount of mobile rotating parts; no rotating parts are exposed to climatic conditions, and it concerns the equipment with very simple production and especially installation and with reliable operation. The kinematical principle of rotation around two mutually non-perpendicular axes enables the adjustment of the optimum position of the solar panels against the Sun at any time of the day and year and, at the same time, it enables very efficient tilting of the surface against the wind from any direction down to the safety position in case of strong gust wind.
Brief description of the Drawings

The invention will be explained in detail on drawings, where fig. 1 shows the side view of the equipment in the morning operation position, with the identification of the safety position of the load-bearing frame in case of strong gust wind, fig. 2 front view of the equipment with the elliptical load-bearing frame in the horizontal position, fig. 3 front view of the equipment with the elliptical load-bearing frame in the vertical position, fig. 4 vertical section of the equipment.

Detailed description of the preferred embodiments

It shall be understood that the specific examples of realization of the invention described and illustrated hereinbelow are presented for illustration and not as a limitation of examples of design of the invention to the provided examples. The experts familiar with the state of the art will find or will be able to identify a higher or smaller amount of equivalents during the application of routine experimenting for specific realizations of the invention, which are described herein specially. Such equivalents shall also be included into the range of the claims.

Fig. 1 to fig. 4 illustrate the example of design of the load-bearing and positioning equipment 1, which is formed on the platform 3, consisting of a vertical steel column fixed vertically to the base 4, so that the first axis 6 of rotation is equal with the vertical axis of the platform 3. The equipment 1 can also be realized, in other examples of design, which are not illustrated, with the platform 3 connected to the base 4 in other than vertical position or, as the case may be, with the platform 3 consisting of a frame, tripod etc. The top part of the platform 3 carries the first rotating instrument 5 for the rotation around the first axis 6 of rotation. It can be arranged in the horizontal plane, as illustrated in fig. 1 to fig. 4, or it can be inclined against the horizontal line at an acute angle. The structure of the first rotating instrument 5 can be realized by various experts in known ways, but it is formed with an advantage with a flange circular rotating ring with an inner toothed wheel 13.
located on the bearing, which is driven with tangentially arranged electro drive 12
with a worm 14 engaged with the toothed wheel 13, as illustrated in fig. 1 to fig. 4.
One flange of the rotating ring is connected with the platform 3 and the angular
adapter 8, consisting also of the steel tube, which is terminated with the second
rotating instrument 9, is attached to the other flange. It can also consist of various
means known to the experts, but it is formed with an advantage with the same flange
rotating ring as the first rotating instrument 5.

The second rotating instrument 9 enables the rotating movement around the second
axis 10 of rotation, which makes, along with the first axis 6 of rotation, an acute angle
g, located within the range from 10° to 80°. In fig. 1 to fig. 4, which illustrate the
equipment 1 in the example of design with the vertical first axis 6, the second axis 10
makes, along with the first axis 6, angle g = 19°. One flange of the second rotating
instrument 9 is connected with the angular adapter 8 and the load-bearing frame 7 of
the elliptical shape bearing the symmetrically placed set of the photovoltaic solar
panels 2 is attached to the second flange. The shape of the load-bearing frame 7
with the set of panels 2 can be discretionary in substance, but the elliptical design is
the most advantageous for achieving the optimum safety position 15 in case of
strong gust wind.

For the correct function of the equipment 1 and adjustment of the optimum position
within the whole range, it is important that the load-bearing frame 7 is attached to the
second rotating instrument 9 so that the normal line of the surface of the solar
panels 2 on the load-bearing frame 7 makes, along with the second axis 10 of
rotation angle 8 located within the range from 10° to 80°. It is achieved by the
attachment of the load-bearing frame 7 by means of the inclined seating face 16,
which is not in parallel with the plane of the load-bearing frame 7 or, as the case may
be, the solar panels 2. At the same time, it shall apply that the values of angles g, 8
are mutually complementary so that their sum is always within the range from 20° to
90°. In the example of design illustrated in fig. 1 to fig. 4, the value g = 19° and 3 = 53°.
so that $\alpha + \beta = 72^\circ$. It is also the angle made by the surface of the solar panels 2 with the base 4 in the morning operation position, i.e. during the sunrise.

The electro drives 12 driving the first rotating instrument 5 and the second rotating instrument 9 are controlled with the electronic programmable control unit, which is not illustrated, and the rotation around the first axis 6 and the second axis 10 occurs simultaneously as follows: the surface of the solar panels 2 on the load-bearing frame 7 is continually inclined vertically to the direction of incidence of sunshine in the optimum way at any time of the day and year, so that high efficiency of the equipment 1 is achieved with the minimum number of the rotating parts. On the basis of a signal of the applicable sensors in case of a strong gust wind (above the critical level), the equipment 1 can be tilted automatically down to the safety position 15 with the bottom edge of the load-bearing frame 7 very closely above the base 4, at any angular range exactly against the direction of the wind, so that the air current can flow around the whole equipment 1 along the surface of the solar panels 2 without any risk of damaging it.

The load-bearing and positioning equipment pursuant to the invention can be used for bearing the set of solar panels, especially photovoltaic, which are located on the load-bearing frame, which moves automatically on a trajectory following the movement of the Sun.
Overview of the positions used in the drawings

1. Load-bearing and positioning equipment
2. Solar panels
3. Platform
4. Base
5. First rotating instrument (circular ring)
6. First axis of rotation
7. Load-bearing frame
8. Angular adapter
9. Second rotating instrument (circular ring)
10. Second axis of rotation
α. Angle between the vertical axis and the inclined axis
β. Angle between the inclined axis and the normal line of the load-bearing frame
11. Normal line of the surface of the solar panels on the load-bearing frame
12. Electro drive of the circular ring
13. Toothed wheel
14. Worm
15. Safety position in case of strong gust wind
16. Inclined seating face of the load-bearing frame
α. Angle made by the first axis of rotation and the second axis of rotation
β. Angle made by the second axis of rotation and the normal line of the surface of the solar panels on the load-bearing frame
CLAIDS

1. The load-bearing and positioning equipment (1) for the set of the solar panels (2), especially photovoltaic, with the possibility of its movement on a trajectory following the movement of the Sun, consisting of the platform (3), which can be attached to the base (4), and provided with the first rotating instrument (5) with the possibility of rotating movement around the first axis (6) of rotation, and of the load-bearing frame (7) bearing the solar panels (2) and connected with the first rotating instrument (5), characterized by that between the load-bearing frame (7) and the first rotating instrument (5), there is the angular adapter (8) provided with the second rotating instrument (9) with the possibility of the rotating movement around the second axis (10) of rotation, which makes, together with the first axis (6), angle ($\alpha$) located within the range from 10° to 80°, and the load-bearing frame (7) is connected to the second rotating instrument (9) so that the normal line (11) of the surface of the solar panels (2) on the load-bearing frame (7) makes, along with the second axis (10), angle ($\beta$) located within the range from 10° to 80°, when it applies that the values of angles ($\alpha$, $\beta$) are mutually complementary so that their sum is within the range from 20° to 90°.

2. The load-bearing and positioning equipment according to Claim 1, characterized by that the first axis (6) is the vertical axis.

3. The load-bearing and positioning equipment according to Claim 1 or 2, characterized by that the value of angle ($\alpha$) is within the range from 15° to 35° and the value of angle ($\beta$) is within the range from 40° to 60°.

4. The load-bearing and positioning equipment according to at least one of the Claims 1 to 3, characterized by that the load-bearing frame (7) with the solar panels (2) has essentially an elliptical shape.
5. Load-bearing and positioning equipment according to at least one of the Claims 1 to 4, characterized by that the first rotating instrument (5) and/or the second rotating instrument (9) consists of the flange circular rotating ring with the electro drive (12).

6. The load-bearing and positioning equipment according to Claim 5, characterized by that the flange circular rotating ring is provided with the toothed wheel (13), which is engaged with the worm (14) on the shaft of the electro drive (12).
According to International Patent Classification (IPC) or to both national classification and IPC.

**A. CLASSIFICATION OF SUBJECT MATTER**

INV. F24J2/54 H01L31/042

Minimum documentation searched (classification system followed by classification symbols)

F24J HOIL

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal , WPI Data

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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Further documents are listed in the continuation of Box C

Date of the actual completion of the international search

16 September 2009

Date of mailing of the international search report

25/09/2009

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk

Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016-

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