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(54) **Title:** PHOTOVOLTAIC SYSTEM FOR AN AGRI VOLTAIC FARM, COMPRISING A PROTECTIVE COVER

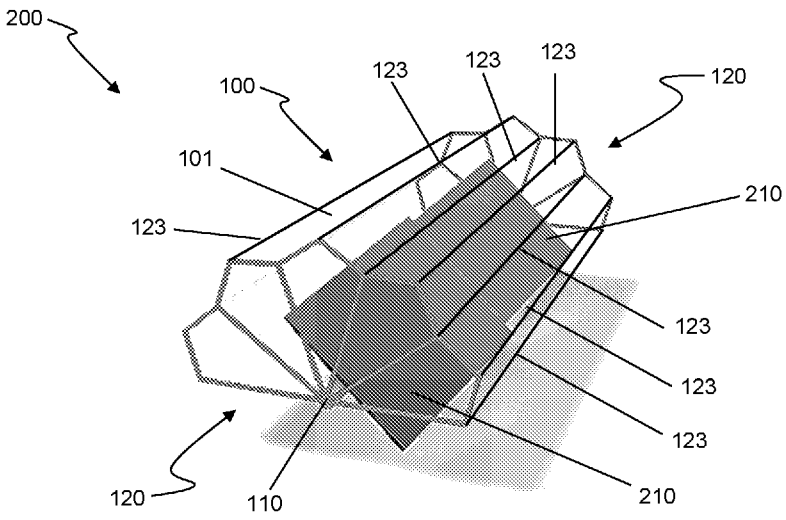

FIG. 1

(57) **Abstract:** Described herein is a photovoltaic system for an agrivoltaic farm, comprising : a plurality of photovoltaic panels; a protective cover comprising : a rotation shaft and two foldable supporting structures; a plurality of supporting rods, each supporting rod being engaged, at its ends, with a respective supporting structure; the protective cover further comprising a protective sheet supported by the plurality of supporting rods; wherein the plurality of photovoltaic panels are mechanically engaged with said support shaft; said protective cover being driveable, by means of a motori zed system acting upon the supporting structures, between : a first configuration, in which the protective sheet is open and the surface of at least one photovoltaic panel is, in a plan view, under the surface of the protective sheet; a second configuration, in which the protective sheet is, in a plan view, folded on one side of the photovoltaic panel.

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"Photovoltaic system for an agrivoltaic farm, comprising a protective cover"

DESCRIPTION

Field of the invention

The present invention relates, in general, to the field of renewable energy. In particular, the present invention relates to an agrivoltaic farm. In particular, the present invention relates to an agrivoltaic farm comprising a photovoltaic system equipped with a protective cover, preferably an automated one.

Description of the prior art

As is known, photovoltaic systems and agricultural production land can be mutually integrated. In particular, those systems which integrate photovoltaic systems and agricultural land are known as agrivoltaic farms.

The agrivoltaic farms currently known in the art require the installation of photovoltaic panels at such a height from the ground as to permit cultivating the land underneath (e.g. vineyard) as desired. Such a solution has proven to be very effective, since the photovoltaic panels, while producing electric energy, do non hinder proper solar radiation, temperature and humidity conditions that promote plant growth, while also protecting the plants from severe weather events.

The Applicant noticed that, although they offer several advantages, the known agrivoltaic farms rely on the ability of photovoltaic panels to physically shield the plants against weather events, e.g. events induced by climate changes. Disadvantageously, however, solar panels may get damaged as a consequence of such

events.

Document CN 209 170 291 U describes a protection device for photovoltaic solar panels.

Document CN 213 027 910 U describes a windproof adjustable solar photovoltaic power generation panel.

Document CN 109 217 788 A describes a distributed photovoltaic power generation device and a solar thin film used for the power generation device.

Document CN 110 635 760 A describes a photovoltaic panel capable of being quickly stored.

Document CN 212 464 253 U describes a solar folding rain-shielding greenhouse.

Document CN 112 821 855 A describes a photovoltaic greenhouse shutter solar panel.

Document US 2016/173025 A1 describes a solar power plant.

Document KR 102 212 091 B1 describes a farming type solar generating apparatus capable of tilt angle adjustment and module movement.

Document HUANG KAI ET AL: "Photovoltaic Agricultural Internet of Things Towards Realizing the Next Generation of Smart Farming", IEEE ACCESS, IEEE, USA, vol. 8, 20 April 2020 (2020-04-20), pages 76300-76312, DOI: 10.1109/ACCESS.2020.2988663, introduces an Internet of Things concept into the photovoltaic farming sphere.

Document DHONDE MAHESH ET AL: "The application of solar-driven technologies for the sustainable development of agriculture farming: a comprehensive review", REVIEWS IN ENVIRONMENTAL SCIENCE AND BIO-TECHNOLOGY, KLUWER, DORDRECHT, NL, vol. 21, no. 1, 20 January 2022 (2022-01-20), pages 139-167, ISSN: 1569-1705, DOI: 10.1007/S11157-022-09611-6, provides a focused review of key strategies for saving energy in agricultural activities.

Document KR 2019 0045695 A describes a maritime photovoltaic power generation apparatus.

Brief description of the invention

It is the object of the present invention to provide an agrivoltaic farm equipped with a protection system against severe weather events, such as, for example: hail; heavy rain; strong wind. Such protection system being suitable for protecting both the photovoltaic panels and the crops.

In particular, the protection system according to the present invention achieves a dual goal of preserving the crops and extending the service life of the photovoltaic panels.

According to a first aspect, the present invention provides a photovoltaic system for an agrivoltaic farm, comprising:

- a rotation shaft and two foldable supporting structures;
- a plurality of photovoltaic panels mechanically engaged with the rotation shaft;
- a protective cover comprising a plurality of supporting rods. Each supporting rod being engaged, at its ends, with a respective supporting structure.

The protective cover further comprising a protective sheet supported by the plurality of supporting rods. Such protective cover being driveable, by means of a motorized system acting upon the supporting structures, between:

- a first configuration, in which the protective cover is open and the surface of at least one photovoltaic panel is, in a plan view, under the surface of the protective sheet;
- a second configuration, in which the protective cover is closed and, in a plan view, the protective sheet is folded on one side of a photovoltaic panel.

Advantageously, the protective cover makes it possible to protect the photovoltaic panels from weather conditions that might damage them and/or reduce their efficiency.

Preferably, each supporting structure comprises:

- a plurality of spokes; and
- a plurality of connecting arms;

wherein adjacent connecting arms and adjacent spokes are mutually engaged to form an articulated parallelogram.

Preferably, said rotation shaft comprises:

- a fixed supporting shaft having a longitudinal axis of development;
- a first shaft coaxial to the supporting shaft and having a length of longitudinal development which is shorter than the length of the supporting shaft;

wherein the first shaft is mechanically coupled to at least one supporting structure;

wherein the first shaft is free to rotate relative to the supporting shaft about the axis of longitudinal development;

wherein the motorized system is mechanically coupled to the first shaft.

Preferably, said rotation shaft further comprises a second shaft, coaxial to the first shaft and to the supporting shaft; each photovoltaic panel being engaged with the second shaft.

Preferably, the second shaft is free to rotate about the axis of longitudinal development, independently of the rotating motion of the first shaft. The motorized system is mechanically coupled to the second shaft and allows the photovoltaic panels to be rotated about the axis of longitudinal development.

Advantageously, said second shaft, which can rotate freely about the axis of longitudinal development, permits obtaining a better

angle of incidence of the solar radiation on the photovoltaic panels, resulting in higher efficiency of the photovoltaic system.

Preferably, the motorized system comprises a selective coupling system that selectively couples a motor to either the first shaft or the second shaft.

Preferably, the selective coupling system comprises:

- a first toothed wheel, fixed to the first shaft;
- a second toothed wheel, fixed to the second shaft;
- a toothed drive wheel, movable and selectively coupled to either the first toothed wheel or the second toothed wheel by means of an actuator; the toothed drive wheel being actuated by means of the motorized system.

Advantageously, the protection system can be opened automatically by means of the motorized system. As described above, said motorized system can be used for opening/closing the protection system and also for orienting the photovoltaic panels (when every photovoltaic panel is engaged with the second shaft).

According to a further aspect, the present invention provides an agrivoltaic farm comprising at least one photovoltaic system in accordance with the present invention.

Preferably, said agrivoltaic farm comprises:

at least four elevation members parallel to one another;

at least two bracings parallel to each other and engaged with the upper ends of two respective elevation members.

Each rotation shaft is engaged, at a first end thereof, with a first bracing and, at a second end thereof, with a second bracing.

Preferably, each elevation member has the same length of longitudinal development, said length being greater than or equal to 2 metres. Even more preferably, said length is greater than or equal to 2.4 metres, so as to allow a person to stand underneath the

photovoltaic system. Alternatively, when agricultural machines need to be used, said length is greater than or equal to approximately 5 metres.

Preferably, said agrivoltaic farm comprises a plurality of photovoltaic systems in accordance with the present invention.

Preferably, a minimum distance between the protective sheets of adjacent protection structures, when the protection structures are open, is greater than or equal to 2 cm, even more preferably 5 cm.

Alternatively, the minimum distance between the protective sheets of adjacent protection structures is greater than or equal to the length of a connection member, e.g. 30 cm or 40 cm, so as to avoid any collision in the event that, due to some problem, either one of the two protection structures cannot be closed.

Advantageously, the protective sheets of adjacent protection structures form a semicircular covering, and create adjacent vaults to protect any plants underneath the photovoltaic system and the photovoltaic panels against extreme weather events.

Advantageously, the protective cover can be used for insulating the underlying soil and limiting the effect of night frost.

Advantageously, the supporting structure coupled to the motorized system makes it possible to obtain a protective cover that can be fully automated, e.g. by remote control, for covering the plantation when hail, heavy rain or strong winds are expected.

Advantageously, the protective cover prevents crops deterioration while extending the life of the panels and reducing their maintenance needs.

Advantageously, the protective cover can be used for shading the plants in case of excessive solar radiation and/or when the plants get beneficial effects from reduced exposure to solar radiation (for example, fruit trees like apple, pear or cherry

trees).

Brief description of the drawings

The invention will become more apparent in light of the following detailed description, provided herein merely by way of non-limiting example, wherein reference will be made to the annexed drawings, wherein:

- Figure 1 is a perspective view of a protective cover in a substantially open first configuration, according to the present invention;
- Figure 2 is a perspective view of the cover of Figure 1 in a substantially closed second configuration;
- Figures 3a, 3b, 4a, 4b and 5 are side views of a supporting structure of the protective cover according to the present invention;
- Figure 6 shows a control system adapted to drive the protective cover;
- Figure 7 is a schematic sectional view of a rotation system in a first configuration suitable for rotating photovoltaic panels;
- Figure 8 is a schematic sectional view of the rotation system in a second configuration suitable for opening/closing the protective cover;
- Figure 9 is a perspective view of an agrivoltaic farm according to the present invention;
- Figure 10 is a side view of the agrivoltaic farm of Figure 9.

The drawings are not in scale.

Detailed description of some preferred embodiments

With reference to Figures 1 and 2, the invention consists of a protective cover 100, semicylindrical in shape, which can be unfolded as necessary over the photovoltaic panels 210 and/or the crops.

According to the present invention, a photovoltaic system 200 for an agrivoltaic farm 1000 comprises a plurality of photovoltaic panels 210 (Figure 9).

The plurality of photovoltaic panels 210 are engaged with a shaft 110. The photovoltaic panels 210 may be either fixed or movable, e.g. movable about the shaft 110 in a time-dependent manner, thus creating a solar tracking system that will be described in further detail hereinafter.

As aforementioned, the photovoltaic panels 210 are associated with a protective cover 100.

The protective cover 100 comprises:

- a rotation shaft 110 (coinciding with the shaft 110);
- two foldable support structures 120 coupled to the rotation shaft 110;
- a plurality of supporting rods 123, preferably parallel to one another. Each supporting rod 123 is engaged, at its ends, with a respective supporting structure 120. In other words, each supporting rod 123 extends from a first supporting structure 120 to a second supporting structure 120;
- a protective sheet 101 supported by the plurality of supporting rods 123.

As shown in Figure 6, the protective cover 100 can be driven by means of a motorized system 300 which, co-operating with the rotation shaft 110, acts upon the supporting structures 120.

In particular, the protective cover 100 can be driven between:

- a first configuration, in which the protective cover 100 is open and the surface of at least one photovoltaic panel 210

is, in a plan view, under the surface of the protective sheet 101;

- a second configuration, in which the protective cover 100 is closed and, in a plan view, the protective sheet 101 is folded on one side of a photovoltaic panel 210.

Preferably, as shown in Figure 8, the rotation shaft 110 comprises:

- a fixed supporting shaft 113 having a longitudinal axis of development X-X;
- a first shaft 111 concentric to the supporting shaft 113 and having a length of longitudinal development which is shorter than the length of the supporting shaft 113.

The first shaft 111 is mechanically coupled to at least one supporting structure 120 and is free to rotate relative to the supporting shaft 113 about the axis of longitudinal development (X-X).

The motorized system 300 is mechanically coupled to the first shaft 111 for driving the protective cover 100 between the first and second configurations.

Preferably, each photovoltaic panel 210 is associated with one protective cover 100.

For example, as shown in Figures 1 and 2, two or more supporting structures 120 are engaged with the ends of the rotation shaft 110, and supporting rods 123 extend from the first supporting structure 120 to the second supporting structure 120, parallel to the axis of rotation 110. Two photovoltaic panels 210 are engaged at the axis of rotation 110. In the first configuration, both photovoltaic panels 210 are, in a plan view, under the surface of the protective cover 101 (Figure 1); in the second configuration, the protective sheet

101 is, in a plan view, folded on one side of the two photovoltaic panels 210.

With reference to Figures 3a, 3b, 4a, 4b and 5, each supporting structure 120 comprises a plurality of articulated parallelograms P. Each articulated parallelogram is pivoted to the rotation shaft 110.

In particular, each articulated parallelogram P comprises:

- a first and a second spoke 121a, 121b mutually hinged at a first end thereof; and
- a first and a second connecting arm 122a, 122b mutually hinged at a first end thereof;

each spoke 121 is hinged to a connecting arm 122 at the second end thereof.

The connections between two connecting arms 122 and between the spokes 121 and the connecting arms 122 are provided by means of pins allowing the connected elements (connecting arms 122 and/or spoke 121) to rotate. The pins are preferably made of steel.

The articulated parallelograms P are arranged in succession. This means that two adjacent articulated parallelograms P are formed by means of three successive spokes 121a, 121b, 121c, the two parallelograms sharing a respective intermediate spoke 121b.

Preferably, each spoke 121 has a longitudinal extension which is greater than the longitudinal extension of a connecting arm 122. Alternatively, the spokes 121 and the connecting arms 122 have the same length.

Preferably, the spokes 121 have all the same length.

Preferably, the connecting arms 122 have all the same length.

Preferably, the rotation shaft 110 and/or the supporting structures 120 and/or the plurality of supporting rods 123 are made of aluminium. The use of aluminium is recommended because of the low density of this material, which makes for a very light structure,

combined with its excellent resistance to corrosion (especially when alloyed with magnesium (5000 series) or with magnesium and silicon (6000 series), or when anodized), its good weldability, its full recyclability, as well as the possibility, with anodized aluminium, to obtain hues having a lower impact on the landscape.

As an alternative, the rotation shaft 110 and/or the supporting structures 120 and/or the plurality of supporting rods 123 are made of steel. Steel ensures stability even with relatively thin sections, despite the resulting structure being heavier. Considering the typical use of phytosanitary products in agriculture, in order to ensure sufficient resistance to corrosion it is preferable to resort to galvanized, weathering or stainless steel.

The protective sheet 101 is, for example, an anti-hail net. The protective sheet 101 may be made from HDPE (i.e. high-density polyethylene). As is known, this material offers remarkable advantages in terms of protection, especially when charged with antioxidizing additives providing UV radiation stability, which is a critical aspect for most polymers when long-term exposure to solar radiation is expected. As is known, a net comprising suitably woven filaments of polyethylene cannot be undone, i.e. the meshes of such a net will neither stretch nor become deformed. Alternatively, the protective sheet 101 may be made from PLA (polylactic acid or polylactide), but durability will be shorter than can be ensured by HDPE.

As aforementioned, the photovoltaic panels 210 can be rotated.

With reference to Figures 7 and 8, the rotation shaft 110 further comprises a second shaft 112, whose length of longitudinal development is shorter than the length of longitudinal development of the first shaft 111. The second shaft 112 is concentric to the first shaft 111 and to the supporting shaft 113. Each photovoltaic

panel 210 is mechanically and rigidly engaged with the second shaft 112.

The second shaft 112 is free to rotate about the axis of longitudinal development X-X, independently of the rotating motion of the first shaft 111. The motorized system 300 is mechanically coupled to the second shaft 112 and allows the photovoltaic panels 210 to be rotated about the axis of longitudinal development X-X.

According to a preferred embodiment, the motorized system 300 comprises a selective coupling system 320 that selectively couples a motor 301 to either the first shaft 111 or the second shaft 112.

The selective coupling system 320 comprises:

- a first toothed wheel 111', fixed to the first shaft 111;
- a second toothed wheel 112', fixed to the second shaft 112;
- a toothed drive wheel 321, movable and selectively coupled to either the first toothed wheel 111' or the second toothed wheel 112' by means of an actuator 322.

The toothed drive wheel 321 is actuated by means of the motor 301.

The present invention also provides an agrivoltaic farm 1000 comprising at least one photovoltaic system as described above.

The agrivoltaic farm 1000 comprises:

- at least four elevation members 1001 parallel to one another;
- at least two bracings 1002 parallel to each other and engaged with the upper ends of two respective elevation members 1001.

The rotation shaft 110 of a respective photovoltaic system 100 is engaged, at a first end thereof, with a first bracing 1002 and, at a second end thereof, with a second bracing 1002.

Preferably, every elevation member 1001 has the same length of longitudinal development, said length being greater than or equal to 2 metres. Even more preferably, said length is greater than or

equal to 2.4 metres, so as to allow a person to stand underneath a photovoltaic system 200. Alternatively, when agricultural machines need to be used, said length is greater than or equal to approximately 5 metres.

Preferably, the agrivoltaic farm 1000 comprises a plurality of photovoltaic systems 200. In particular, each photovoltaic system is installed in a manner such that a minimum distance D between the protective sheets 101 of adjacent protection structures 100 is greater than or equal to 2 cm, even more preferably 5 cm, when the protection structures 100 are in the first, i.e. open, configuration.

Alternatively, the minimum distance D between the protective sheets 101 of adjacent protection structures 200a, 200b is greater than or equal to the length of a connection member 122, e.g. 30 cm or 40 cm, so as to avoid any collision in the event that, due to some problem, either one of the two adjacent protection structures 200a, 200b cannot be closed.

With reference to Figure 6, each photovoltaic system 200 can be driven by means of the motorized system 300 and a control system 400.

In particular, the control system 400 comprises a processor 401 and at least one weather sensor 402. The weather sensor 402 may be a sensor adapted to detect weather events such as rain, hail, temperature.

The processor 401 is connected to the motorized system 300. For example, the processor 401 is connected to both the motor 301 and the selective coupling system 320 (if present).

The processor 401 is configured for:

- receiving weather information from the at least one weather sensor 402;

- driving the protective cover 100 between the above-described first configuration and second configuration.

Preferably, the processor is further configured for:

- actuating the selective coupling system 320 in order to selectively couple the motor 301 to either the first shaft 111 or the second shaft 112;
- adjusting the position of the photovoltaic panels 210, if the photovoltaic panels 210 are engaged with the second shaft 112.

Preferably, the photovoltaic panels 210 are connected to an inverter 360. The inverter 360 is connected to:

- the external power network R, in order to supply thereto the electric current generated by the photovoltaic panels; and/or
- the control system 400 and the motorized system 300, in order to supply thereto the necessary power.

In an auxiliary embodiment, each supporting structure 120 of the photovoltaic system 200 does not necessarily need to comprise a plurality of articulated parallelograms P, pivoted to the rotation shaft and arranged in succession. In this auxiliary embodiment, the rotation shaft 110 comprises:

- a fixed supporting shaft 113 having a longitudinal axis of development X-X;
- a first shaft 111 concentric to the supporting shaft 113 and having a length of longitudinal development which is shorter than the length of the supporting shaft 113.

In this auxiliary embodiment, the first shaft 111 is mechanically coupled to at least one supporting structure 120; the first shaft 111 is free to rotate relative to the supporting shaft 113 about the axis of longitudinal development X-X; the motorized

system 300 is mechanically coupled to the first shaft 111 to drive the protective cover 100 between the first and second configurations.

Therefore, in summary, this auxiliary embodiment of the invention concerns a photovoltaic system (200) for an agrivoltaic farm (1000) which comprises:

- a plurality of photovoltaic panels (210);
- a protective cover (100) comprising:
  - a rotation shaft (110) and two foldable supporting structures (120) coupled to the rotation shaft (110);
  - a plurality of supporting rods (123), each supporting rod (123) being engaged, at its ends, with a respective supporting structure (120);
  - a protective sheet (101) supported by the plurality of supporting rods (123);

wherein the plurality of photovoltaic panels (210) are mechanically engaged with said rotation shaft (110);

wherein said protective cover (100) can be driven by means of a motorized system (300) which, co-operating with the rotation shaft, acts upon the supporting structures (120);

wherein the protective cover (100) can be driven between:

- a first configuration, in which the protective cover (100) is open and the surface of at least one photovoltaic panel (210) is, in a plan view, under the surface of the protective sheet (101);
- a second configuration, in which the protective cover (100) is closed and, in a plan view, the protective sheet (101) is folded on one side of a photovoltaic panel (210),

wherein said rotation shaft (110) comprises:

- a fixed supporting shaft (113) having a longitudinal axis of development (X-X);

- a first shaft (111) concentric to the supporting shaft (113) and having a length of longitudinal development which is shorter than the length of the supporting shaft (113);

the first shaft (111) being mechanically coupled to at least one supporting structure (120);

wherein the first shaft (111) is free to rotate relative to the supporting shaft (113) about the axis of longitudinal development (X-X);

wherein the motorized system (300) is mechanically coupled to the first shaft (111) for driving the protective cover (100) between the first and the second configuration.

In this auxiliary embodiment, preferably, each supporting structure (120) comprises a plurality of articulated parallelograms (P), pivoted to said rotation shaft and arranged in succession.

In this auxiliary embodiment, preferably, each articulated parallelogram (P) comprises:

- a first and a second spoke (121a, 121b) mutually hinged at a first end thereof; and
- a first and a second connecting arm (122a, 122b) mutually hinged at a first end thereof;

wherein each spoke (121) is hinged to a connecting arm (122) at the second end thereof.

In this auxiliary embodiment, preferably, said rotation shaft (110) further comprises:

- a second shaft (112) having a length of longitudinal development which is shorter than the length of longitudinal development of the first shaft (111),

the second shaft (112) being concentric to the first shaft (111) and to the supporting shaft (113),

wherein each photovoltaic panel (210) is engaged with the second shaft (112);

wherein the second shaft (112) is free to rotate about the axis of longitudinal development (X-X) independently of the rotating motion of the first shaft (111);

wherein the motorized system (300) is mechanically coupled to the second shaft (112) and allows the photovoltaic panels (210) to be rotated about the axis of longitudinal development (X-X).

In this auxiliary embodiment, preferably, the motorized system (300) comprises a selective coupling system (320) that selectively couples a motor (301) to either the first shaft (111) or the second shaft (112).

In this auxiliary embodiment, preferably, the selective coupling system (320) comprises:

- a first toothed wheel (111'), fixed to the first shaft (111);
- a second toothed wheel (112'), fixed to the second shaft (112);
- a toothed drive wheel (321), movable and selectively coupled to either the first toothed wheel (111') or the second toothed wheel (112') by means of an actuator (322);

wherein the toothed drive wheel (321) is actuated by means of the motorized system (300).

It is envisaged that an agrivoltaic farm (1000) comprises at least one photovoltaic system according to this auxiliary embodiment.

Preferably, said agrivoltaic farm (1000) comprises:

- at least four elevation members (1001) parallel to one another;
- at least two bracings (1002) parallel to each other and engaged with the upper ends of two elevation members (1001);

wherein each rotation shaft (110) is engaged, at a first end thereof, with a first bracing (1002) and, at a second end thereof, with a second bracing (1002).

Preferably, in such an agrivoltaic farm (1000), every elevation member (1001) has the same length of longitudinal development, said length being greater than or equal to 2 metres.

Preferably, said agrivoltaic farm (1000) comprises a plurality of photovoltaic systems (200) in accordance with the above-described auxiliary embodiment of the invention; a distance (D) between the protective sheets (101) of adjacent protection structures (100) is greater than or equal to 5 cm when the respective protection structures (100) are both in the first, i.e. open, configuration.

CLAIMS

1. A photovoltaic system (200) for an agrivoltaic farm (1000), comprising:

– a plurality of photovoltaic panels (210);

– a protective cover (100) comprising:

– a rotation shaft (110) and two foldable supporting structures (120) coupled to the rotation shaft (110);
a plurality of supporting rods (123), each supporting rod (123) being engaged, at its ends, with a respective supporting structure (120);

– a protective sheet (101) supported by the plurality of supporting rods (123);

wherein the plurality of photovoltaic panels (210) are mechanically engaged with said rotation shaft (110);

wherein said protective cover (100) can be driven by means of a motorized system (300) which, co-operating with the rotation shaft, acts upon the supporting structures (120);

wherein the protective cover (100) can be driven between:

– a first configuration, in which the protective cover (100) is open and the surface of at least one photovoltaic panel (210) is, in a plan view, under the surface of the protective sheet (101);

– a second configuration, in which the protective cover (100) is closed and, in a plan view, the protective sheet (101) is folded on one side of a photovoltaic panel (210),

wherein each supporting structure (120) comprises:

– a plurality of articulated parallelograms (P), pivoted to said rotation shaft and arranged in succession.

2. Photovoltaic system (200) according to the preceding claim, wherein each articulated parallelogram (P) comprises:
   - a first and a second spoke (121a, 121b) mutually hinged at a first end thereof; and
   - a first and a second connecting arm (122a, 122b) mutually hinged at a first end thereof;

   wherein each spoke (121) is hinged to a connecting arm (122) at the second end thereof.

3. Photovoltaic system (200) according to any one of the preceding claims, wherein said rotation shaft (110) comprises:
   - a fixed supporting shaft (113) having a longitudinal axis of development (X-X);
   - a first shaft (111) concentric to the supporting shaft (113) and having a length of longitudinal development which is shorter than the length of the supporting shaft (113);

   the first shaft (111) being mechanically coupled to at least one supporting structure (120);
   wherein the first shaft (111) is free to rotate relative to the supporting shaft (113) about the axis of longitudinal development (X-X);
   wherein the motorized system (300) is mechanically coupled to the first shaft (111) for driving the protective cover (100) between the first and the second configuration.

4. Photovoltaic system (200) according to the preceding claim, wherein said rotation shaft (110) further comprises:
   - a second shaft (112) having a length of longitudinal development which is shorter than the length of longitudinal development of the first shaft (111),

the second shaft (112) being concentric to the first shaft (111) and to the supporting shaft (113),

wherein each photovoltaic panel (210) is engaged with the second shaft (112);

wherein the second shaft (112) is free to rotate about the axis of longitudinal development (X-X) independently of the rotating motion of the first shaft (111);

wherein the motorized system (300) is mechanically coupled to the second shaft (112) and allows the photovoltaic panels (210) to be rotated about the axis of longitudinal development (X-X).

5. Photovoltaic system (200) according to the preceding claim, wherein the motorized system (300) comprises a selective coupling system (320) that selectively couples a motor (301) to either the first shaft (111) or the second shaft (112).

6. Photovoltaic system (200) according to the preceding claim, wherein the selective coupling system (320) comprises:

- a first toothed wheel (111'), fixed to the first shaft (111);
- a second toothed wheel (112'), fixed to the second shaft (112);
- a toothed drive wheel (321), movable and selectively coupled to either the first toothed wheel (111') or the second toothed wheel (112') by means of an actuator (322);

wherein the toothed drive wheel (321) is actuated by means of the motorized system (300).

7. An agrivoltaic farm (1000) comprising at least one photovoltaic system according to any one of the preceding claims.

8. Agrivoltaic farm (1000) according to the preceding claim, wherein said agrivoltaic farm (1000) comprises:
- at least four elevation members (1001) parallel to one another;
- at least two bracings (1002) parallel to each other and engaged with the upper ends of two elevation members (1001);

wherein each rotation shaft (110) is engaged, at a first end thereof, with a first bracing (1002) and, at a second end thereof, with a second bracing (1002);

9. Agrivoltaic farm (1000) according to the preceding claim, wherein every elevation member (1001) has the same length of longitudinal development, said length being greater than or equal to 2 metres.

10. Agrivoltaic farm (1000) according to any one of claims 7-9, wherein said agrivoltaic farm (1000) comprises a plurality of photovoltaic systems (200) according to any one of claims 1 to 6;

wherein a distance (D) between the protective sheets (101) of adjacent protection structures (100) is greater than or equal to 5 cm when the respective protection structures (100) are both in the first, i.e. open, configuration.

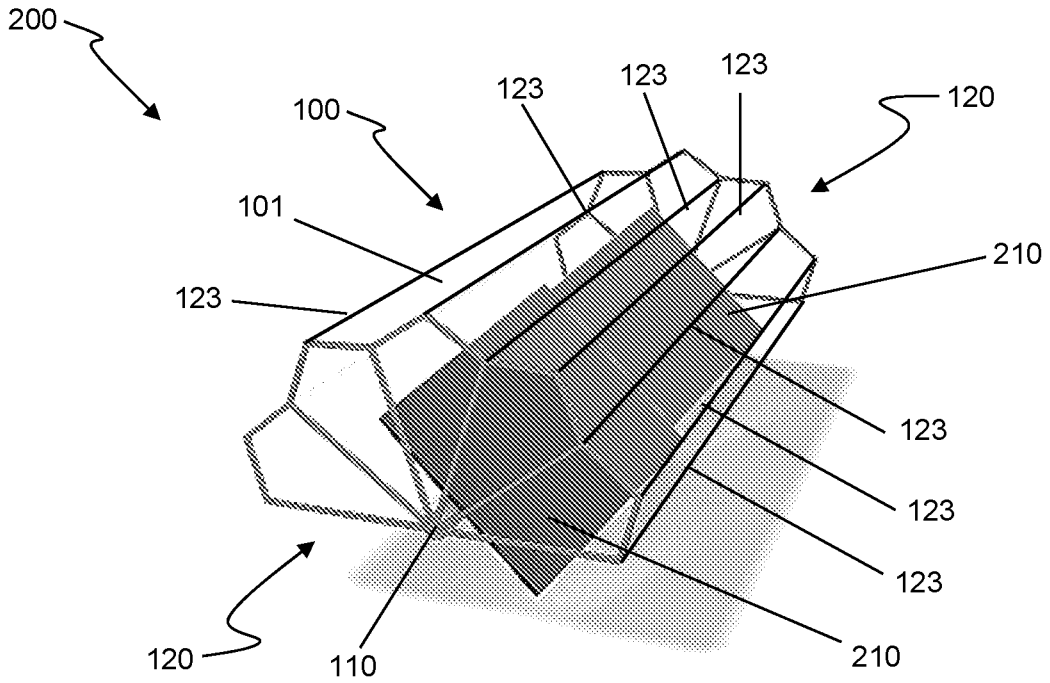
200
100
123
123
123
120
101
210
123
123
123
120
110
210

FIG. 1

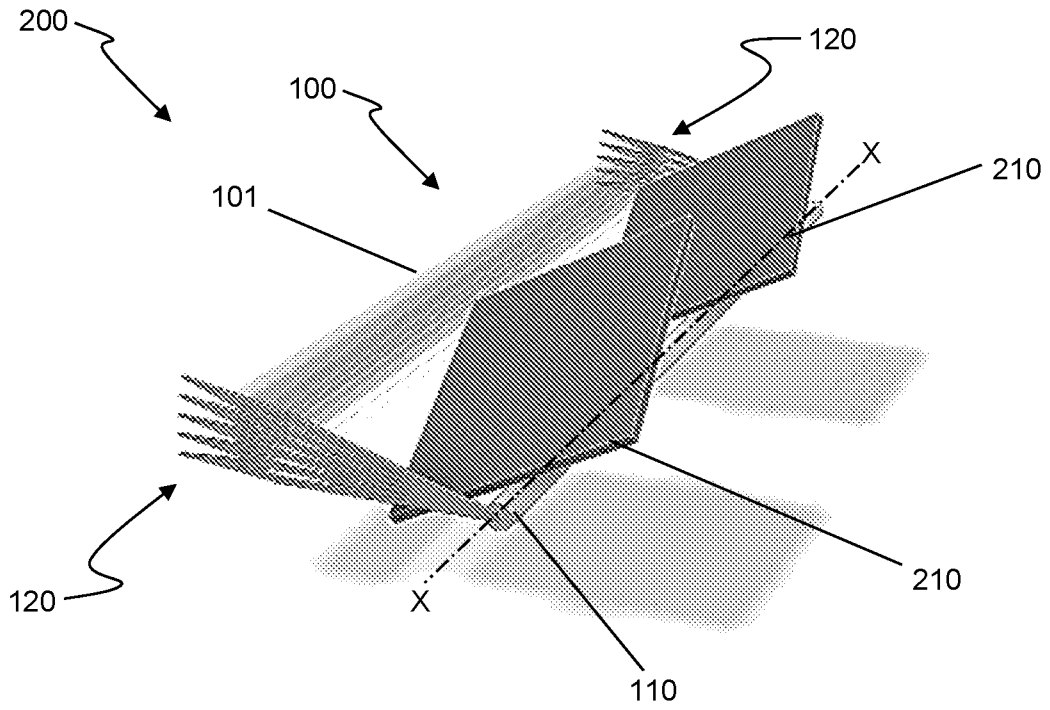
200
120
100
X
210
101
210
120
X
110

FIG. 2

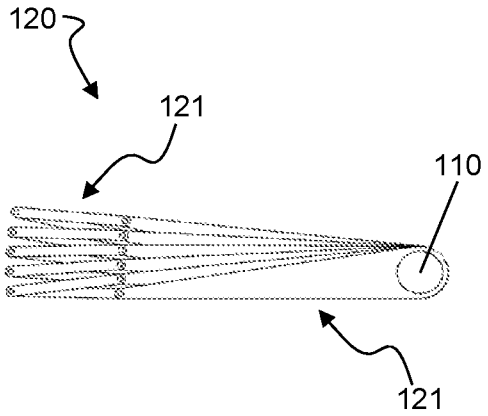

FIG. 3a

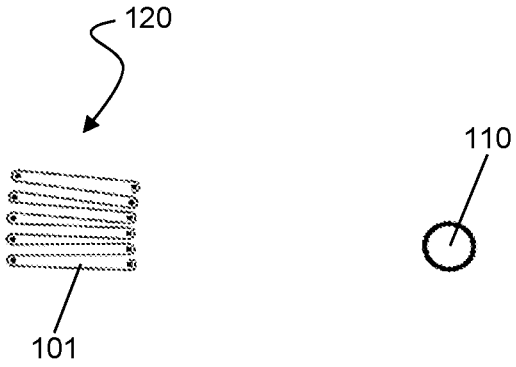

FIG. 3b

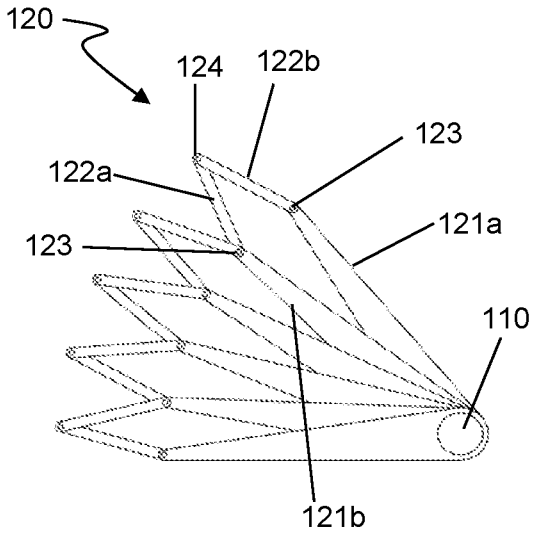

FIG. 4a

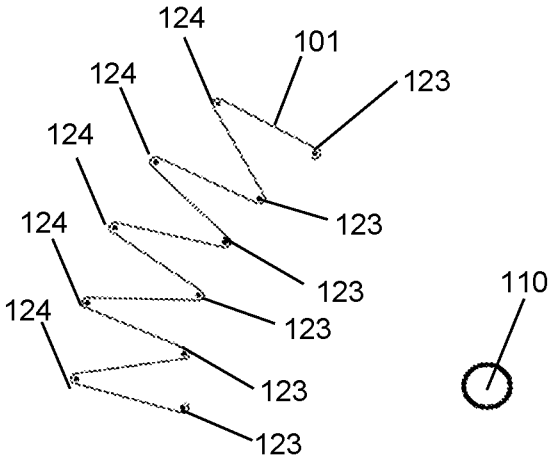

FIG. 4b

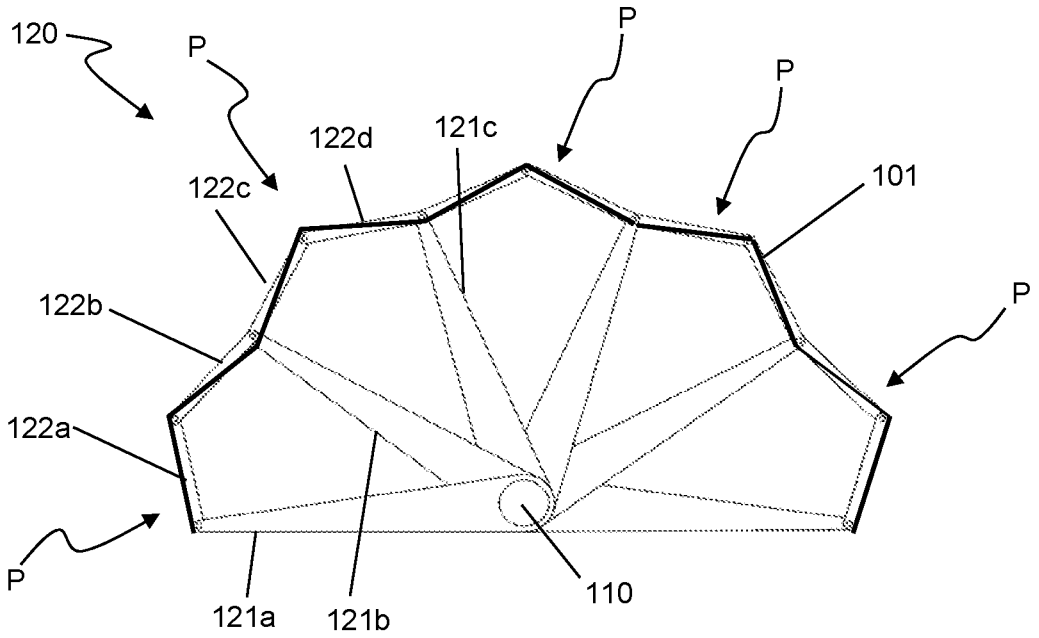
120
P
P
P
P
122d
121c
122c
101
122b
P
122a
P
121a
121b
110

FIG. 5

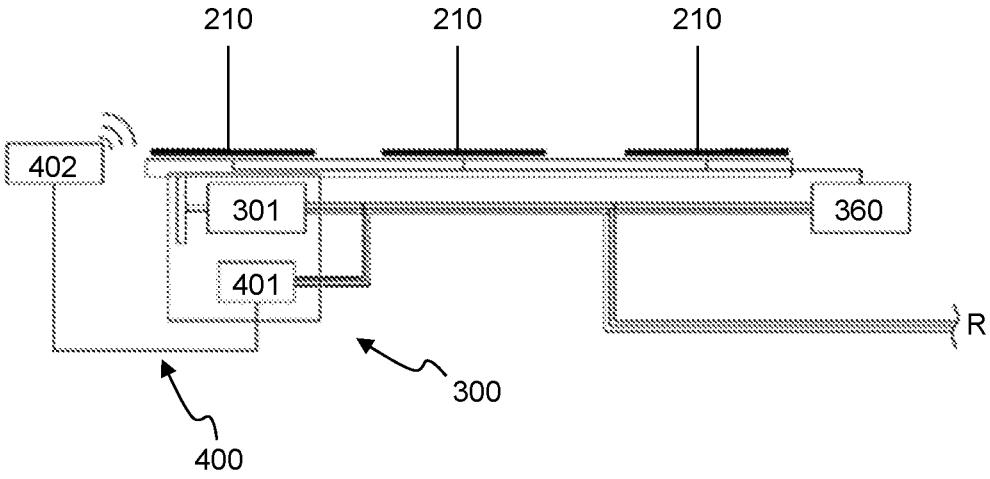
210
210
210
402
301
360
401
R
300
400

FIG. 6

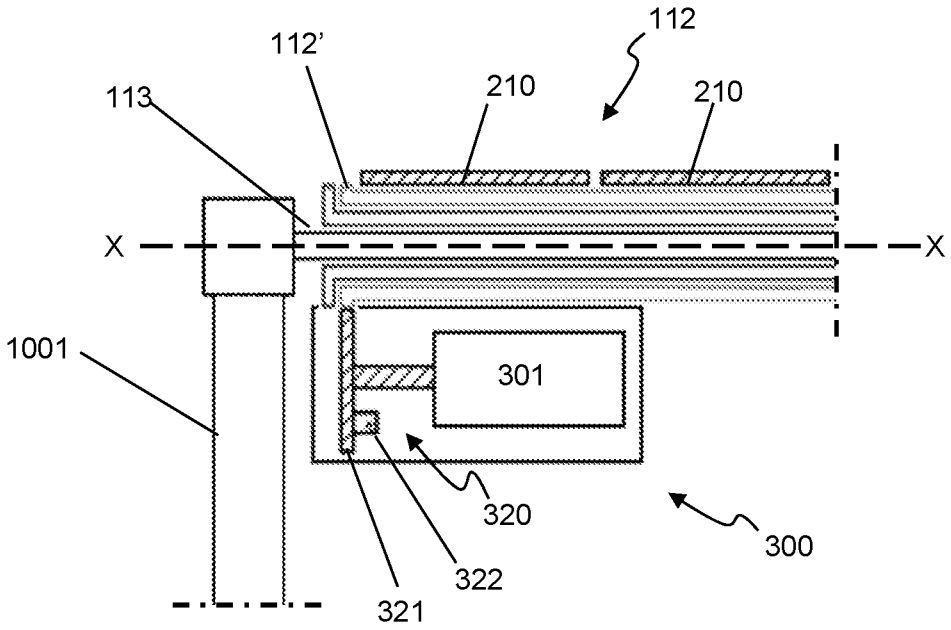
112
112'
210
210
113
X
X
1001
301
320
300
322
321

FIG. 7

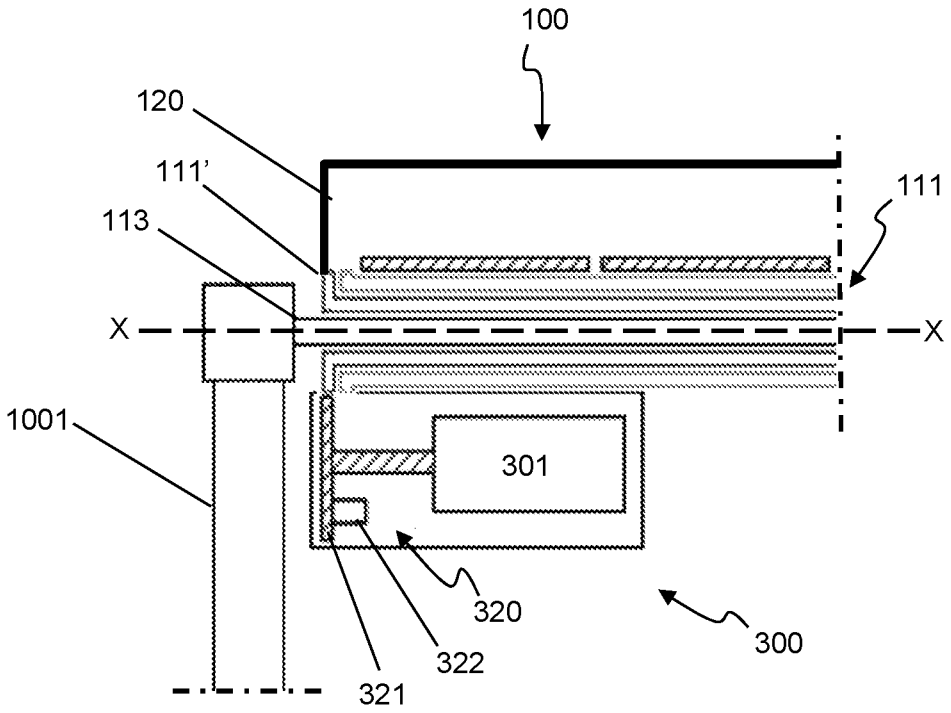
100
120
111'
111
113
X
X
1001
301
320
300
322
321

FIG. 8

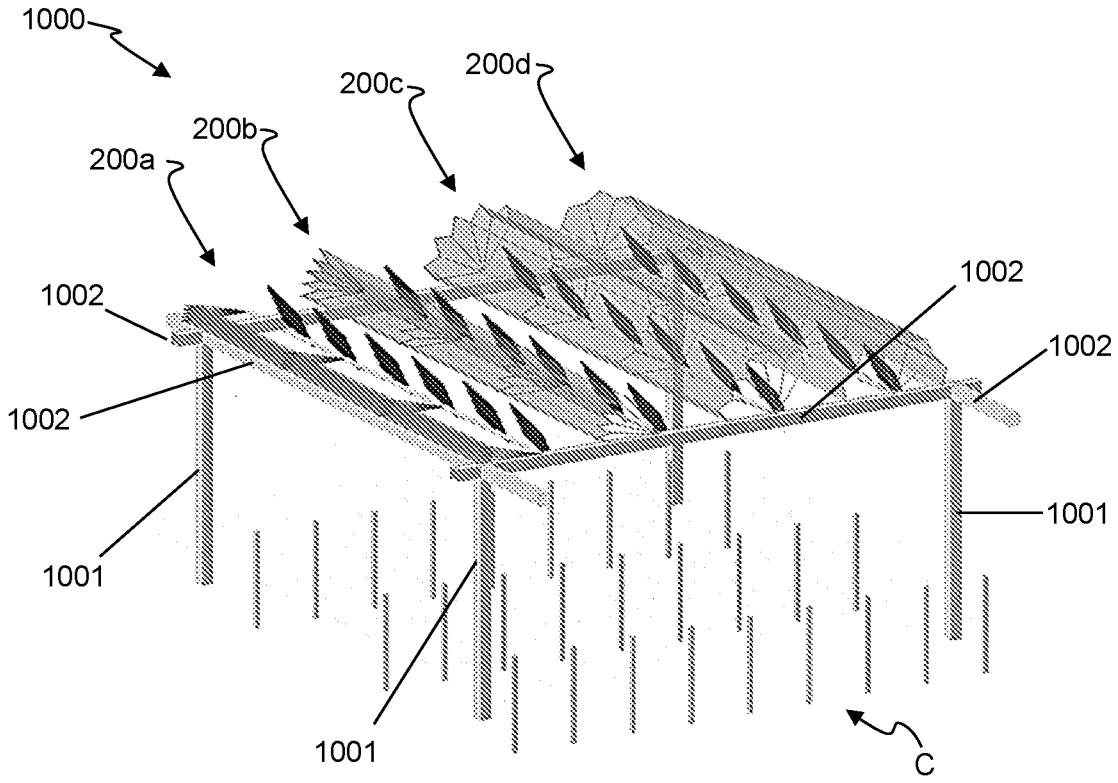
1000
200c
200d
200b
200a
1002
1002
1002
1002
1001
1001
1001
C

FIG. 9

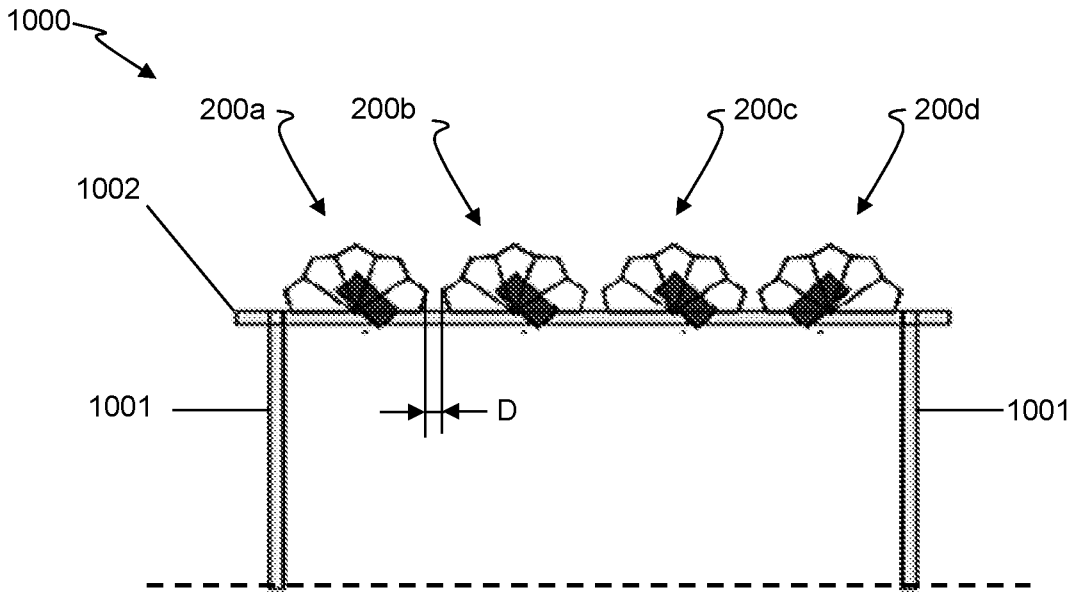
1000
200a
200b
200c
200d
1002
1001
D
1001

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2023/055372

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02S40/00 H02S10/00 H02S20/10 H02S20/23 H02S20/32
A01G9/24 G06Q50/02
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
H02S A01G G06Q

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 practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 209 170 291 U (MIANYANG HUANSHI TECH CO LTD) 26 July 2019 (2019-07-26) cited in the application abstract; figures 1,2,3 paragraphs [0001], [0002] - [0003], [0004] - [0019], [0021] - [0024], [0029] - [0030], [0032], [0034], [0036]	1-6
A	CN 213 027 910 U (JIUZHOU SQUARE GARDEN NEW ENERGY CO LTD) 20 April 2021 (2021-04-20) cited in the application abstract; figures 1,2,3,4,5 paragraphs [0025] - [0034]	1-6

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[x] Further documents are listed in the continuation of Box C.
[x] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 July 2023	21/07/2023

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Sagol, Bülent Erol

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 109 217 788 A (HEFEI XIAOFO NEW ENERGY CO LTD) 15 January 2019 (2019-01-15) cited in the application abstract; figures 1,2,3,4,5 paragraphs [0027] - [0029]	1-6
A	CN 110 635 760 A (UNIV SHAOXING) 31 December 2019 (2019-12-31) cited in the application abstract; figures 1,2,4 paragraphs [0025] - [0038]	1-6
A	CN 212 464 253 U (WULAN WUSU AGROMETEOROLOGICAL TESTING STATION) 5 February 2021 (2021-02-05) cited in the application the whole document	1-6
A	CN 112 821 855 A (QINGDAO HARBOUR VOCATIONAL AND TECHNICAL COLLEGE) 18 May 2021 (2021-05-18) cited in the application the whole document	1-6
A	US 2016/173025 A1 (BAUMGARTNER FRANZ [DE] ET AL) 16 June 2016 (2016-06-16) cited in the application the whole document	1-10
A	KR 102 212 091 B1 (JIKEOJUNG [KR]) 4 February 2021 (2021-02-04) cited in the application the whole document	1-10
A	HUANG KAI ET AL: "Photovoltaic Agricultural Internet of Things Towards Realizing the Next Generation of Smart Farming", IEEE ACCESS, IEEE, USA, vol. 8, 20 April 2020 (2020-04-20), pages 76300-76312, XP011786371, DOI: 10.1109/ACCESS.2020.2988663 cited in the application the whole document	1-10

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2023/055372

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DHONDE MAHESH ET AL: "The application of solar-driven technologies for the sustainable development of agriculture farming: a comprehensive review", REVIEWS IN ENVIRONMENTAL SCIENCE AND BIO-TECHNOLOGY, KLUWER, DORDRECHT, NL, vol. 21, no. 1, 20 January 2022 (2022-01-20), pages 139-167, XP037689596, ISSN: 1569-1705, DOI: 10.1007/S11157-022-09611-6 [retrieved on 2022-01-20] cited in the application the whole document -----	1-10
A	KR 2019 0045695 A (LEE JONG YONG [KR]) 3 May 2019 (2019-05-03) cited in the application the whole document -----	1-6

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2023/055372

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		US 2016173025 A1	16-06-2016
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KR 20190045695 A	03-05-2019	NONE	