(19) NL Octrooicentrum

(11) **2011096**

(12) A **OCTROOIAANVRAAG**

(21) Aanvraagnummer: **2011096**

(22) Aanvraag ingediend: **04.07.2013**

(51) Int.Cl.:
H01L 31/042 (2006.01)

(30) Voorrang:
05.07.2012 NL 2009127

(41) Aanvraag ingeschreven:
07.01.2014

(43) Aanvraag gepubliceerd:
15.01.2014

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(54) **Energy management system for conversion of solar energy and method of establishing the system in a greenhouse.**

(57) The present invention relates to an energy management system for conversion of solar energy for use in and near greenhouses. The system comprises a number of parallel arranged solar cell lamellae with associated holding elements for controlling the lamellae on inclined positions towards the sun and has associated functional plates scattering or converting the fraction of transmitted light between the lamellae. The functional plates comprise materials such as, surface roughened plates, diffuser plates, pigmented plates, translucent plates, for generating transmitted light that approach an optimum performance, in particular for a plant culture.

NL A 2011096

Deze publicatie komt overeen met de oorspronkelijk ingediende stukken.

ENERGY MANAGEMENT SYSTEM FOR CONVERSION OF SOLAR ENERGY AND METHOD OF ESTABLISHING THE SYSTEM IN A GREENHOUSE

The present invention relates to an energy management system for conversion of solar energy for use in and near greenhouses. The system comprises a number of parallel arranged solar cell lamellae with associated holding elements for controlling the lamellae on inclined positions towards the sun. The parallel lamellae are facing south on the northern hemisphere and with an inclination normally adjusted such that the average sunlight on the lamellae will be a maximum. In greenhouses also the plants need sunlight for growth and a competition between the solar cell lamellae and the plants is anticipated.

It is an object of the invention to provide an energy management system for conversion of solar energy for use in and on greenhouses both to promote plant growth and to harvest electricity from the solar cell lamellae.

According to the invention the energy management system for conversion of solar energy, comprises a number of parallel arranged solar cell lamellae, and is characterized in that the solar cells have associated holding elements for controlling the lamellae on inclined positions and have associated functional plates scattering or converting the transmitted light between the lamellae. With preference the functional plates have also holding elements associated with the solar cell lamellae. The plates can be as thin as a foil, for example with a thickness of 100 micrometer, but can also be thicker up to thickness of a few millimeter,

The division of the sunlight for the solar cell lamellae and for the plants can be optimized: by controlling the fraction of transmitted light passing between the lamellae with a functional plate herewith realizing sufficient and abundant plant growth.

For plant growth a sufficient and sometimes high transmittance of sunlight is needed. Especially the Photosynthetically Active Radiation (PAR) range of the sunlight contributes and has a wavelength range from 300 nm to 800 nm. Other light spectrum sensitivities can differ from one plant culture to another or even from one plant to another. With preference the functional plates are able therefore to scatter the incoming

light preventing herewith the formation of shadow area's in the greenhouse that inhibit plant growth. In growing experiments it has also unexpectedly be found that indirect (diffuse/scattered) light favors plant growth more than direct sunlight at a given solar energy input. According to the invention the functional plates comprise materials such as, surface roughened plates, diffuser plates, pigmented plates, translucent plates, all capable in generating transmitted light that approach an optimum performance for a given plant culture. The word translucent refers to the partial light permeability of a body in combination with scattering. One can describe translucence as permeability to light, and transparency as permeability to visibility for images and view.

Altering the amount of pigments determines the fraction of diffused transmitted light and can be tuned for the particular plant culture. Microtextures in the surface of the functional plates give also excellent translucent permeability. Functional plates able to scatter light with a scattering angle between 5° and 20° are preferred. Transmitted light through a microtextured polycarbonate plate with a scattering angle of 5° to 10° is about 5% or higher than light transmitted through a flat polycarbonate plate.

Within the PAR range the yellow-orange light between 550 nm and 650 nm is very efficient for plant growth. According to the invention the solar cell lamellae may comprise solar elements having a considerable (=10-30%) reflectance in the PAR range of 550-650 nm. The reflected light from the lamellae will pass the functional plates herewith inducing plant growth. With preference the solar cell lamellae comprise thin film solar elements, in particular of amorphous silicon type. Single and specific tandem junction amorphous silicon cells only partly use the 550-650 nm range for photovoltaic conversion, making these good candidate solar cells for use within the greenhouse. The advantage of thin solar film elements is that they are much less sensitive for shadow spots, diminishing severely the total electric output, than for example normal solar panels based on crystalline silicon.

The energy management system may further comprise a LED light system, particular in the range of 550-650 nm, in an electrical feeding connection with the solar cell lamellae. Herewith crop growth can be induced directly near the solar cell lamellae without the direct need of long dissipative electrical wires or a dc/ac voltage conversion of the solar energy.

Another preferred energy management system according to the invention is the provision of heat pipes in thermal connection with the lamellae. A heat pipe can efficiently manage the transfer of heat generated by sunlight from the solar cell lamellae via the associated holding elements and tubing towards a large heat sink, such as a water well under-ground for later use in summer or winter. The heat pipes can be gravity or capillary driven with a mixture of compounds such as water, ammonia and/or methanol.

Figure 1 depicts a closed (1A) and an open (1B) energy management system for conversion of solar energy (1), comprising a number of parallel arranged solar cell lamellae (2) having associated holding elements (3,4) for controlling the lamellae on inclined positions.

Figure 2 depicts an energy management system with associated functional plates (5) influencing the fraction of transmitted light between the lamellae. With preference the functional plates have also holding elements (4) associated with the solar cell lamellae. (2A) and (2B) refer to different inclined positions of the lamellae towards the sun.

CONCLUSIES

1. Een energie systeem voor het omzetten van zonne-energie, omvattende een aantal evenwijdige zonnecel lamellen, met het kenmerk, dat de zonnecellen een aantal hiermee verbonden vasthoudelementen omvatten voor het verstellen van de lamellen in een schuine stand, en daarnaast ook functionele platen omvatten die het doorgelaten licht tussen de lamellen converteren of verstrooien.

2. Een energie systeem volgens conclusie 1, met het kenmerk, dat de functionele platen vasthoudelementen omvatten verbonden met de zonnecel lamellen.

3. Een energie systeem volgens conclusie 1 en 2, met het kenmerk, dat de functionele platen materialen omvatten zoals, oppervlak bewerkte platen, diffusor platen, gepigmenteerde platen, doorschijnende platen voor het genereren van doorvallend licht met een optimale werking, in het bijzonder voor een plant cultuur.

4. Een energie systeem volgens 1,2 of 3, met het kenmerk, dat de functionele plaat licht verstooid met een verstrooiing hoek tussen 5° tot 20°.

5. Een energie systeem volgens conclusie 1,2,3 of 4, met het kenmerk, dat de zonnecel lamellen dunne film elementen omvatten, in het bijzonder van het amorfe silicium type.

6. Een energie systeem volgens 1,2,3,4 of 5, met het kenmerk, dat de zonnecel lamellen warmtepijpen omvatten in thermische verbinding met de lamellen.

7. Een energie systeem volgens 1,2,3,4,5 of 6, met het kenmerk, dat het systeem LED lampen omvat, met name in het bereik van 550 tot 650 nm in een elektrische verbinding met de zonnecel lamellen.

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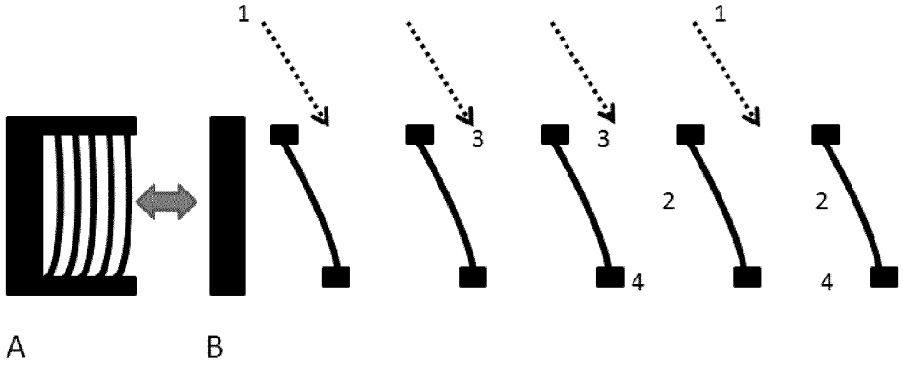

FIG.1

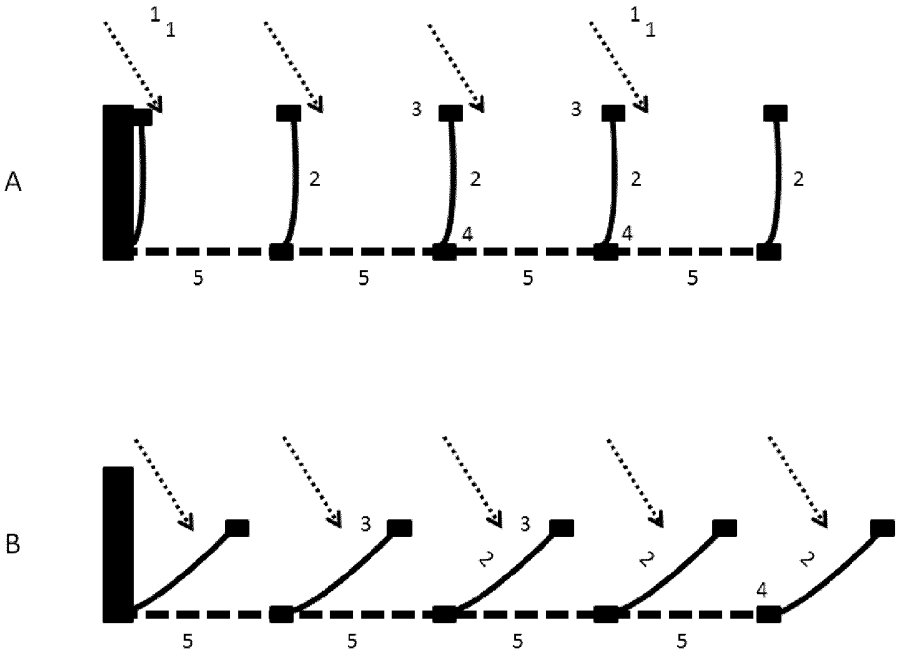

FIG.2