

PLANT RADIATION ARRANGEMENT

FIELD OF THE INVENTION

The invention relates to a plant radiation arrangement and to a plant radiation system comprising such arrangement. Further, the invention also provides a method for treating a plant, wherein such plant radiation arrangement or plant radiation system is applied, especially for hydroponic horticulture purposes.

BACKGROUND OF THE INVENTION

The use of reflectors in photosynthetic growth processes is known in the art. For instance, WO2010132955 describes a photosynthetic growth apparatus including at least one solar collector configured to collect solar radiation, at least one growth area configured for photosynthetic material to perform photosynthesis using radiation having at least one selected wavelength, a wavelength converter configured to convert at least a portion of the collected solar radiation having at least one wavelength different from the at least one selected wavelength to radiation with the at least one selected wavelength for the photosynthetic material, and a light modulator configured to control irradiation of the photosynthetic material by the radiation with the at least one selected wavelength to at least substantially reduce photoinhibition of the photosynthesis. The irradiation of the photosynthetic material uses light arising from the solar radiation. The light modulator includes a distributor configured to distribute the collected radiation and the converted radiation between a plurality of different portions of the photosynthetic material in the at least one growth area. The distributor includes a moving distributor configured to selectively and sequentially direct the collected radiation and the converted radiation to the plurality of different portions of the photosynthetic material. The moving distributor is a rotating distributor including a rotating reflector.

SUMMARY OF THE INVENTION

For certain crops there is a trend to using soilless cultivation for a number of reasons: e.g. for reducing the waste of nutrients (and hence reduce pollution because of nitrogen emission), for better controlling the environment and for guaranteeing the

cleanliness of the crop (no soil dirt particles). Also there is a wish to stretch the period that crops can be produced locally, reducing the need for importing of the crops. Local fabrication of crops also allows for control points and local value adding, and may also provide a much more controlled (food safety) food production. Such wishes are till now often accomplished by growing crops in greenhouses with artificial climate conditions and artificial light. It is clear that such measures may pose very high demands on energy consumption and initial investment.

Hence, it is an aspect of the invention to provide an alternative plant arrangement, which preferably further at least partly obviates one or more of above-described drawbacks. It is further an aspect of the invention to provide an alternative method for treating plants, which preferably further at least partly obviates one or more of above-described drawbacks.

Amongst others, it is a desire to allow certain of the advantages which also exist in open air growth and/or to especially use a passive system (not requiring energy).

Herein, amongst others a concept for increasing light intensity, and optionally tuning the light spectrum, as originating from natural solar radiation, for use in e.g. open ground horticulture, such as hydroponics / soilless cultivation, is proposed. Amongst others, the concept may in embodiments be based on passive elements only, making use of at least two optical elements (especially two reflectors) with optionally (one or both) having wavelength selectivity. The proposed arrangement may have as one or more purposes to provide e.g. one or more of (i) higher levels of solar irradiation, by solar radiation concentration, (ii) modified solar spectrum, e.g. for correcting spectrum as related to solar radiation zones or time of year, by spectrum selectivity (absorption of specific non-equilibrated wavelengths), (iii) a solution for maintaining the option to grow culture/region-preferred crops despite changing environmental conditions (e.g. shifting climate zones), and (iv) accumulate solar heat in water or a massive element, to radiate to the plant after daytime.

Hence, in a first aspect a plant radiation arrangement is provided. Especially, the plant radiation arrangement (which may also be indicated as “collector arrangement” or “arrangement” or “plant arrangement” or “plant radiation arrangement”) comprises a first collecting reflector (may also indicated as “first reflector” or “first collector”; or when in use may also be indicated as “bottom reflector”) having a first reflective surface having a first reflective area, especially defined by a first reflective area edge, and a second collecting reflector (may also indicated as “second reflector” or “second collector”; or when in use may also be indicated as “top reflector”) having a second reflective surface having a second

reflective area, especially defined by a second reflective area edge; wherein (i) the first reflective area is larger than the second reflective area, (ii) the first collecting reflector and the second collecting reflector are separate, different collecting reflectors and arranged to define a concentrator cavity between the collecting reflectors (“cavity”), accessibly by light from external of the concentrator cavity, with a cavity opening between at least part of said first reflective area edge and said second reflective area edge, and (iii) the plant radiation arrangement is configured to concentrate within said concentrator cavity with one or more of said first collecting reflector and said second collecting reflector at least part of the light from external of the concentrator cavity reaching (via the cavity opening) one or more of the first reflective surface and second reflective surface. Especially, in embodiments the cavity is suitable for hosting a plant support for a plant (and for hosting also such plant). In embodiments the plant radiation arrangement may comprise the plant support for hosting a plant.

With the present arrangement the plant may receive direct solar radiation (and/or other radiation) via the cavity opening between the first collector and the second collector. Further, solar radiation (and/or other radiation) may be received by one of the collectors and be concentrated, such that the plant and/or a support therefore receive concentrated (solar) light. Hence, amongst others the plant configured within the collector arrangement may receive concentrated radiation. In this way, the plant may grow more efficient and solar light or other radiation may be used more efficiently. When using movable or otherwise configurable collectors, the collection may stay (relatively) optimized due to adaptations of the collector arrangement to the movement of the sun. Hence, a passive (solar) radiation reflector arrangement is provided.

As indicated above, the plant radiation arrangement comprises a first collecting reflector having a first reflective surface having a first reflective area, especially defined by a first reflective area edge, and a second collecting reflector having a second reflective surface having a second reflective area, especially defined by a second reflective area edge. Herein, the term “collecting reflector” is used to indicate a reflector that is configured such that light is not only reflected but also concentrated. Such reflector will in general be curved and/or have facets and have a reflector cavity. Examples of such collecting reflector are e.g. parabolic reflectors, trough-shaped reflectors, sphere-segment shaped reflectors, etc.. Such collecting reflector especially has a focal point or a plurality of focal points, such as a focal line like may be in the case of a trough-shaped reflector. The phrase “configured to concentrateat least part of the light” and similar phrases may indicated that

part of the light that reaches one of the reflectors is concentrated within the cavity, whereas also some part may enter the cavity under such angles, that such radiation may also be reflected again out of the cavity. Further this phrase may optionally also indicated that part of the light is absorbed or converted (see also below).

5 The collecting reflector may have a curved reflecting face or a faceted reflecting face, or a combination thereof. Especially, a non-planar reflective surface may allow concentration of light. The non-planar surface may (thus) also define a reflector cavity (which may provide part of the concentrator cavity. Further, the collecting reflector is not necessarily fully optimized to e.g. a single focal point or a single focal line. Especially
10 however, the focal volume of a collecting reflector is less than the volume of the concentrator cavity, such as less than 20% of the volume of the cavity. In embodiments, the collecting reflector is concave. As indicated above, instead of the term “collecting reflector” also the term “collector” or “reflector” may be used. Herein, the term “cavity” is in general used to indicate the concentrator cavity. The term “reflector cavity” may refer to a cavity defined by
15 the (non-planar) reflective surface that is configured to concentrate radiation.

 The arrangement comprises two reflectors, a first collecting reflector and a second collecting reflector. The arrangement may comprise more than two collecting reflectors, but this does not change the principles described herein. In general, however, there will be one first collecting reflector, though there may be more than one first collecting
20 reflectors, and one or more second collecting reflectors, such as up to eight, like up to four, such as two, especially only one second collecting reflector. However, the number of second collecting reflectors may be limited or they are configured as a single second reflector. Thus, in specific embodiments the arrangement comprises a (single) first collecting reflector and a (single) second collecting reflector. Hence, the cavity may amongst others be defined by the
25 (one or more) first collecting reflector(s) and the (one or more second collecting reflector(s).

 Hence, the term “first collecting reflector” may in embodiments also refer to a plurality of first collecting reflectors (together providing the first collecting reflector). Likewise, the term “second collecting reflector” may in embodiments also refer to a plurality of second collecting reflectors (together providing the second collecting reflector).

30 The term “first collecting reflector” may in embodiments also refer to a plurality of (first) reflectors that together provide the first collecting reflector. Likewise, the term “second collecting reflector” may in embodiments also refer to a plurality of (second) reflectors that together provide the second collecting reflector.

Hence, the term “arrangement” refers to the arrangement of the first collecting reflector and the second collecting reflector, which are configured as a set (of collecting reflectors) and which can provide the herein described functions. Of course, the arrangement may also include a plurality of such sets (in use associated with a plurality of plants, respectively). Here below, the arrangement is further defined in relation to such set but the person skilled in the art will understand that the arrangement (or system) may include a plurality of such sets.

Especially, in embodiments the first reflective area (A1) of the first collecting reflector is larger than the second reflective area (A2) of the second collecting reflector. In this way, an arrangement can be provided wherein the larger collecting reflector is arranged below a plant and the smaller collecting reflector is arranged at a higher position, especially above the plant. In this way, the second collecting reflector obstructs less possible direct solar light but may still be useable to redirect light that was collected and redirected by the first collecting reflector towards the second collecting reflector. The reflective areas may have area ratios of the first reflective area to the second reflective area ($A1/A2$) selected from the range of 1.05-20, such as 1.2-10, like at least 1.4. Would more than one second collecting reflector be used (for a set) then the second reflective area refers to the sum of the reflective areas of the more than one second collecting reflector. Likewise, would more than one first collecting reflector be used (for a set) then the first reflective area refers to the sum of the reflective areas of the more than one firstcollection reflector.

In general, the first reflective area and the second reflective area do not touch each other anywhere. Especially, the first reflective area and the second reflective area are arranged at a distance from each other (i.e. are arranged at a non-zero distance from each other). As will be indicated below, in some embodiments the distances may be variable, as the position of one or more collecting reflectors may be variable. There may be a shortest distance (sd) between the reflective surfaces and a largest distance (ld) between the reflective surfaces. The shortest distance (sd) may be in the range of about 1-200 cm. The longest distance (ld) may be in the range of about 10-250 cm.

The first collecting reflector and the second collecting reflector define a concentrator cavity. This cavity may be formed by the reflective surfaces of the collecting reflectors and a virtual surface connecting the reflective area edges of the collecting reflectors. Solely for the purpose of understanding: would the two reflectors have identical round concave shapes, the cavity would have the shape of a cylinder with convex ends (i.e. the reflector cavities). Assuming two collecting reflectors, the shape of the cavity may have

the shape of a truncated cone, with a base and a top that are convex, assuming two reflectors having round concave reflective areas (but the first reflective area being larger than the second). Would e.g. the second collecting reflector (temporarily) be tilted, a distorted truncated cone may (temporarily) be obtained.

5 Especially, a substantial part of the space between the reflective areas is not occupied to allow light entering the cavity. For instance, at least 50%, such as at least 80%, like 90% or more, of the virtual surface connecting the reflective area edges is not intercepted by an element (i.e. a solid element, such as a part of the arrangement, like a part of the plant support, etc.), allowing substantial access of solar light to the cavity. Hence, there is a cavity
10 opening between at least part of said first reflective area edge and said second reflective area edge, and the cavity is accessibly by light from external of the cavity through such cavity opening. Here, the term “cavity opening” may also refer to a plurality of (different) cavity openings. Further, a substantial part of the cavity, such as at least 50% of the cavity, may be unoccupied. Instead of the term “cavity opening” also the term “concentrator cavity opening”
15 may be used.

Radiation, such as UV radiation, visible light, and IR radiation, for instance provided by the sun, may enter the cavity. At least part of such radiation may be concentrated by one or both collecting reflectors. Hence, the plant radiation arrangement is configured to concentrate within said cavity, using one or more of said first collecting reflector and said
20 second collecting reflector, at least part of the light from external of the cavity reaching one or more of the first reflective surface and second reflective surface.

The arrangement can be used for several applications. Especially, however, the cavity is suitable for hosting a plant support for a plant. The term “plant” may also refer to a plurality of (different) plants.

25 Even more especially, the concentrator cavity is suitable for hosting a hydroponic based system, yet even more especially an essentially water based horticulture system. For instance, the plant support may contain water and part of the plant.

Hence, in specific embodiments at least part of the plant support may be transmissive for said light. Herein, the term “light” is especially used for visible light
30 (essentially in the range of 380-780 nm). However, the arrangement and system may also employ UV and/or IR radiation. In embodiments, the reflectors may reflect at least part of the UV and/or also part of the IR. For instance, the reflectors may have a good reflection in the range of 250-2500 nm, such as especially at least in the range of 250-900 nm, like even more especially at least in the range of 400-700 nm. For instance, averaged over the (respective)

wavelength range the reflection may be at least 20%, such as at least 40%, like at least 60%, such as especially at least 80%, like at least 90%.

Above, some examples were given with round concave reflectors, like shells, with – in operation – the larger shell arranged lower than the smaller shell, and the latter configured upside down relative to the former, thereby defining the cavity. However, also other embodiments may be possible, such as trough-like collecting reflectors. In such embodiments the collecting reflector(s) may include a plurality of focal points configured in a line. Hence, in embodiments the first collecting reflector has one or more first focal points, the second collecting reflector has one or more second focal points.

As indicated above, the focal points of (both) the collecting reflectors are not necessarily chosen within the cavity. Hence, in specific embodiments one or more of the (one or more) first focal points are configured outside the cavity, or one or more of the (one or more) second focal points are configured outside the cavity, or one or more of the (one or more) first focal points and one or more of the (one or more) second focal points are configured outside the cavity.

However, when the focal point(s) are chosen within the cavity the largest concentration may be obtained. Hence, in specific embodiments one or more of the (one or more) first focal points are configured within the cavity, or one or more of the (one or more) second focal points are configured within the cavity, or one or more of the (one or more) first focal points and one or more of the (one or more) second focal points are configured within the cavity. Of course, focal points of the first and second collecting reflector may be chosen to coincide e.g. in a specific configuration. Hence, in embodiments one or more of the (one or more) first focal points and one or more of the (one or more) second focal points coincide at one or more mutual focal points.

If desired, the optical properties of the reflected light may be tuned by using an optical filter on and/or may be comprised by the reflective surface of one or more of the collecting reflectors. This may allow a tuning of the spectral distribution of the (solar) light such that a spectral distribution is obtained that may better fit the specific plant and/or the specific plant stadium (plant growth, building leaf, flowering, bearing fruit, preparation for post-harvest status, etc..) needs. Therefore, in specific embodiments one or more of the first reflective surface and the second reflective surface may comprise an optical filter configured to change the spectral distribution of light redirected by said one or more of the first reflective surface and the second reflective surface by one or more of (i) absorbing at least

part of the light and (ii) converting at least part of the light into light having another spectral distribution.

Here, the term “absorbing” especially refers to a process without conversion. For such absorption, a color filter may be used. The term “converting” especially refers to a process wherein radiation is absorbed but then converted in radiation of another wavelength. For such conversion a luminescent material may be used.

The optical filter may be comprised by the reflector, for example essentially inseparably combined therewith. However, in other embodiments the optical filter may (e.g.) be a foil that is configured removably from the reflector. This will allow using the filter when appropriate (see examples above and below). In such embodiments, the reflector may additionally be used as a support for the optical filter.

The reflector may comprise a reflective element, optionally also having an optical filter functionality, that may be detachable. As indicated above, this may allow a tuning of the spectral distribution of the (solar) light reflected such that a spectral distribution is obtained that may better fit the specific plant and/or the specific plant stadium (flowering, bearing fruit, etc..) needs. Hence, in embodiments one or more of the first collecting reflector and the second collecting reflector may comprise a reflector support configured to support a reflective element, wherein the reflective element provides the respective reflective surface, and wherein the reflective element is detachably associated with said reflector support.

In specific embodiments, the reflective element comprises a reflective foil. In further specific embodiments, the reflective element comprises a reflective foil having an integrated optical filter function.

In yet other embodiments, the first collecting reflector comprises a reflective foil. Alternatively or additionally, in embodiments the second collecting reflector comprises a reflective foil. Hence, a reflective foil may be used to provide a first collecting reflector functionality or a second collecting reflector functionality; also both functionalities may be provided by reflective foils.

A reflective foil may e.g. be a metal foil or a polymeric foil having a reflective coating.

The plant radiation arrangement may further optionally comprise one or more other elements, such as e.g. one or more (other) optical elements, but also one or more heating elements, one or more cooling elements, one or more irrigation elements, one or more gas providing elements (e.g. to provide CO₂, etc.), one or more sensor elements (see also below), etc..

The one or more (other) optical elements may e.g. include one or more optical filters which may not be part of the collector(s), but which may be arranged physically distinct thereof, e.g. between a reflective element and the plant. Optionally, such one or more (other) optical elements may also be movable associated with the plant radiation

5 arrangement. Hence, in embodiment an optical filter, such as a filter foil, may be applied that is arranged at a certain distance from the first reflector. Likewise, an optical filter, such as a filter foil, may be applied that is arranged at a certain distance from the second reflector.

When using optical filters (in embodiments) it may also be possible to provide different types of radiation at different positions within the cavity. Hence, in embodiments
10 radiation with different spectral distributions may be provided in different parts of the cavity. For instance, in this way roots or a lower part of the plant may receive different radiation than a higher part of the plant.

As indicated above, in embodiments the arrangement may e.g. comprise a plurality of first collecting reflectors or a plurality of second collecting reflectors. Further, as
15 indicated above in (other or further) embodiments the arrangement may include a plurality of sets of one or more first collecting reflectors and one or more second collecting reflectors. When a plurality of first collecting reflectors are used, a single reflective foil may be applied to provide this plurality of first collecting reflectors. Likewise, when a plurality of second collecting reflectors is applied, a single reflective foil may be applied.

20 Note that the term “reflective foil” may refer to a foil having at least one surface that is entirely reflective but may also refer to a foil having one or more reflective areas and one or more other areas (not necessarily especially configured for reflection).

The configuration of the collecting reflectors may essentially be static. Hence, in such embodiments the arrangement has a fixed configuration that is essentially not
25 changeable (unless reconstructing and/or disintegrating part of the arrangement). In other embodiments however, the plant arrangement may be configured to allow different configurations of the collecting reflectors.

In embodiments, one or more of the collecting reflectors may be configurably (such as one or more of movable and bendable) associated with the arrangement. For
30 instance, one or more of the reflectors may be rotatable or tiltable. Allowing such functionality, provides the possibility to for example track the solar position in such a way that the arrangement optimizes the collected light across the day. Therefore, in specific embodiments one or more of the first collecting reflector and the second collecting reflector are arranged configurable, such as movable, allowing a plurality of different configurations.

Alternatively or additionally, one or more of the collecting reflectors may be deformable, allowing a plurality of alternative or additional collecting reflector configurations. In this way, e.g. the focal point of a reflector may be chosen as function of the arrangement configuration. A reflector may be deformable by means of for example a deformable reflective foil or by means of a plurality of facets that may be configured in different configurations.

Hence, one or more of the collecting reflectors may be configurable in two or more configurations, especially by bending the reflective element or entire reflector and/or by changing configurations of reflective facets of the collecting reflector. A reflective foil may e.g. be deformable by changing a position of a pivot point about which two parts of the reflective foil may be pivotably arranged. Hence, in embodiments a change of configuration may be realized by a mechanical deformation of the collecting reflector or reflective element (e.g. a metal sheet) or by hinging/bending around a pivot location associated with the collecting reflector or reflective element (e.g. a metal sheet).

Hence, in specific embodiments one or more of the collecting reflectors may be arranged to be configurable.

Therefore, in embodiments the arrangement allows at least one configuration of the collecting reflectors, and in further embodiments a plurality of different configurations. Especially, the position of the second collecting reflector may be controllable.

The change from one configuration into another configuration may be done manually, but may also be executed by one or more actuators. Hence, the arrangement may also include one or more actuators to control the configuration of one or more of the collecting reflectors in the arrangement.

In specific embodiments, the plant radiation arrangement may further comprising a control system, especially configured to control the configuration of one of the first collecting reflector and the second collecting reflector as a function of one or more of a light sensor signal of a light sensor and a time schedule. The control system may control a plurality of arrangements or a single arrangement.

The control system might also be functionally coupled with one or more sensors, e.g. for tracking solar position, sensing light intensity level, sensing solar spectrum as received, sensing temperature, sensing humidity, sensing air flow, etc.. Further, the control system may control a plurality of arrangements or the configuration of these arrangements (also) as function of their position e.g. their position within a space, such as a greenhouse.

The arrangement may further be used to locally control humidity and/or temperature in the cavity.

For instance, one or more of the first collecting reflector and the second collecting reflector may comprise a thermal energy storage element. Especially, in
5 embodiments the first collecting reflector may comprise such thermal energy storage element. In embodiments, the thermal energy storage element may include a metal body, such as steel, which heats up when receiving (solar) light (like in examples during the day) and may release heat when receipt of light is low or absent (like in examples during at least part of the night).

10 Alternatively or additionally, the thermal energy storage element may comprise a phase-change material (PCM). This is especially a substance with a high heat of fusion which, melting and solidifying at a certain temperature, is capable of storing and releasing large amounts of energy. Heat is absorbed or released when the material changes from solid to liquid and vice versa. Hence, phase-change materials may be classified as latent
15 heat storage (LHS) unit. Therefore, in embodiments the thermal energy storage element comprise latent heat storage unit. In embodiments, the arrangement may further include elements to facilitate e.g. the phase-change to a state wherein heat can be stored or wherein heat can be released, as known in the art.

20 Alternatively or additionally, the collecting reflector(s) may also be used for heating by incorporating an active heating element, such as based on electricity and/or hot water. Hence, in embodiments the plant radiation arrangement may further comprise a temperature control element configured to control the temperature of at least part of the first collecting reflector and/or at least part of the second collecting reflector, especially at least part of the first collecting reflector. The temperature control element may be controlled by a
25 control system which may be the same control system as the control system controlling the configuration of the one or more collecting reflectors or may be another control system. The ability to control the temperature of at least part of the first collecting reflector may also be used to control local humidity. When the first collector for example (temporarily) hosts water, a heating of at least part of the collector may create a (more) humid (local)
30 environment. This feature may simply be made available and especially be useful in combination with a water supply system configured to provide water to the plants hosted in the cavity (see further below).

A control system may control a feature, such as a configuration of a collecting reflector, as function of a time scheme and a sensor signal, etc.. Hence, the control system

may for example control humidity, temperature etc. as function of the intensity of solar light (see further also below).

As indicated above, the second collecting reflector might potentially also block part of the direct (solar) light. Likewise, also the first collecting reflector may potentially also block part of the light. Therefore, in embodiments the second collecting reflector has reflection and transmission properties, wherein the second collecting reflector is further configured to transmit at least part of the external light via the second collecting reflector into the cavity. Alternatively or additionally, in embodiments the first collecting reflector has reflection and transmission properties, wherein the first collecting reflector is further configured to transmit at least part of the external light via the first collecting reflector into the cavity.

The arrangement as indicated above may be used in e.g. greenhouses, like solar greenhouses, or in open ground agriculture, etc.. In such industrial applications, a plurality of arrangements may be applied.

In yet a further aspect there is provided a plant system (or “plant radiation system”) comprising the plant radiation arrangement as defined herein, wherein the second collecting reflector is configured at a higher position than the first collecting reflector. Hence, the larger collecting reflector is configured lower than the smaller collecting reflector. As indicated above, such plant system may comprise a plurality of plant radiation arrangement. A plurality of arrangements may be configured in a 2D array. However, also 3D arrangements may be possible with rows of arrangements next to each other and on top and/or crossing each other. Hence, the plant system may comprise a plurality of sets of one or more first collecting reflectors and one or more second collecting reflectors.

The plant system described herein, is especially configured for operation (with the second collecting reflector being configured at a higher position than the first collecting reflector). The phrase “configured for operation” does not necessarily imply that also a plant is actually configured within the cavity, but that a plant can be configured within the cavity. Hence, herein also a passive (solar) radiation reflector system is provided.

In use, the arrangement may include a plant support with a plant, or a plant support with a seed, or a plant support with a seedling, etc.. Hence, in use the system (comprising the arrangement) may include a plant support with a plant, or a plant support with a seed, or a plant support with a seedling, etc..

Herein, the term “plant” is used for essentially all stages. The term “plant part” may refer to root, stem, leaf, fruit (if any), etc.. The term “horticulture” relates to (intensive)

plant cultivation for human use and is very diverse in its activities, incorporating plants for food (fruits, vegetables, mushrooms, culinary herbs) and non-food crops (flowers, trees and shrubs, turf-grass, hops, grapes, medicinal herbs). Horticulture is the branch of agriculture that deals with the art, science, technology, and business of growing plants. It may include the cultivation of medicinal plants, fruits, vegetables, nuts, seeds, herbs, sprouts, mushrooms, algae, flowers, seaweeds and non-food crops such as grass and ornamental trees and plants. Here, the term “plant” is used to refer essentially any species selected from medicinal plants, vegetables, herbs, sprouts, mushrooms, plants bearing nuts, plants bearing seeds, plants bearing flowers, plants bearing fruits, non-food crops such as grass and ornamental trees, etc.. Even more especially, the term “plant” is used to refer essentially any species selected from medicinal plants, vegetables, herbs, sprouts, plants bearing nuts, plants bearing seeds, plants bearing flowers, plants bearing fruits, non-food crops.

The term "crop" is used herein to indicate the horticulture plant that is grown or was grown. Plants of the same kind grown on a large scale for food, clothing, etc., may be called crops. A crop is a non-animal species or variety that is grown to be harvested as e.g. food, livestock fodder, fuel, or for any other economic purpose. The term "crop" may also relate to a plurality of crops. Horticulture crops may especially refer to food crops (tomatoes, peppers, cucumbers and lettuce), as well as to plants (potentially) bearing such crops, such as a tomato plant, a pepper plant, a cucumber plant, etc. Horticulture may herein in general relate to e.g. crop and non-crop plants. Examples of crop plants are Rice, Wheat, Barley, Oats, Chickpea, Pea, Cowpea, Lentil, Green gram, Black gram, Soybean, Common bean, Moth bean, Linseed, Sesame, Khesari, Sunhemp, Chillies, Brinjal, Tomato, Cucumber, Okra, Peanut, Potato, Corn, Pearl millet, Rye, Alfalfa, Radish, Cabbage, Lettuce, Pepper, Sunflower, Sugarbeet, Castor, Red clover, White clover, Safflower, Spinach, Onion, Garlic, Turnip, Squash, Muskmelon, Watermelon, Cucumber, Pumpkin, Kenaf, Oilpalm, Carrot, Coconut, Papaya, Sugarcane, Coffee, Cocoa, Tea, Apple, Pears, Peaches, Cherries, Grapes, Almond, Strawberries, Pine apple, Banana, Cashew, Irish, Cassava, Taro, Rubber, Sorghum, Cotton, Triticale, Pigeonpea, and Tobacco. Especial of interest are tomato, cucumber, pepper, lettuce, water melon, papaya, apple, pear, peach, cherry, grape, and strawberry.

The term “plant” herein may especially refer to Archaeplastida. The Archaeplastida are a major group of eukaryotes, comprising the red algae (Rhodophyta), the green algae, and the land plants, together with a small group of freshwater unicellular algae called glaucophytes. Hence, in embodiments the term “plant” may refer to land plants. In

embodiments the term “plant” may (also) refer to algae (such as one or more of green algae and red algae and unicellular algae called glaucophytes).

The plant support is especially configured somewhere between the first collecting reflector and the second collecting reflector, and will in general not touch one of these. Hence, especially the plant support is configured at non-zero shortest distances from the collecting reflectors.

Further, as indicated above the arrangement may especially be used for essentially water-based horticulture, i.e. part of the plant is arranged in water, and essentially no soil or other substrate, like clay pellets, is used. The plant system (especially the plant radiation arrangement) may (further) comprise a plant support for a plant, wherein at least part of the plant support is transmissive for light. The plant support may include a container, such as a tray or a pot, etc.. For instance, a glass pot or a (light transmissive) polycarbonate pot may be used. However, the invention is not limited to the application of essentially water-based horticulture, and may e.g. also be used for airoponics.

The plant support may also include a cell or tube, such as from glass or transmissive polymeric material. Such support may in embodiments be configured in a flow-through configuration. Such embodiments may e.g. be of interest for the growth of algae.

As indicated above, the arrangement and/or system may also be used for locally controlling temperature and/or humidity. To this end, the system may further include a water supply system. Hence, in yet further embodiments the plant system further comprises a control system and a temperature control element controlled by the control system, especially configured to control the temperature of at least part of the first collecting reflector, wherein the plant system may further comprise a water supply system configured to provide water to the cavity, and wherein the control system is configured to control a local humidity in the cavity by controlling the temperature of at least part of the first collecting reflector. The water supply system may comprise an irrigation system, which may provide water into the cavity and/or may include an water supply system with an outlet in the first collecting reflector. In embodiments, the arrangement may further include a humidity sensor to measure humidity in the cavity and/or a water sensor to measure the presence of water in the first collecting reflector. The term “local humidity in the cavity” especially indicates the humidity in the cavity.

As also indicated above, the first collecting reflector or the second collecting reflector, especially the latter, may be configured movable. For instance, one of the collecting reflectors, especially the second collecting reflector may be configured in the

arrangement with an arm that may allow at least one degree of freedom, even more especially at least two degrees of freedom. Alternatively or additionally, the first collecting reflector or the second collecting reflector, especially the latter, may be configured deformable (such as especially bendable). One or more actuators may control the configuration of the collecting reflector(s). A control system may control the actuators.

Hence, in embodiments of the plant system one of the first collecting reflector and the second collecting reflector are arranged configurable, such as movable and/or bendable (deformable), allowing a plurality of different configurations, wherein the plant radiation arrangement further comprises a control system configured to control the configuration of one of the first collecting reflector and the second collecting reflector, especially as function of one or more of a light sensor signal of a light sensor and a time schedule.

In yet a further aspect, also a method of treating a plant is provided. Especially, the method comprises allowing light entering a cavity from external to the cavity of the plant arrangement or the plant system as defined herein, wherein said plant is arranged within the cavity, at least partially in a plant support. Especially, the method may comprise providing one or more plant growth conditions within the cavity of the plant arrangement or the plant system as defined herein, the method comprising providing a plant in a plant support in the cavity and allowing light to enter the cavity. Providing one or more plant growth conditions may include providing water, (other) nutrients, and light. Further, CO₂ and/or heat may be provided, etc.. The phrase “one or more plant growth conditions” may especially refer to providing light to the plant (especially at least with the aid of the arrangement). Hence, the method may especially include providing light to the plant by allowing light to enter the cavity. The light that enters the cavity may be provided by one or more of the sun, i.e. solar light, and an artificial light source, i.e. artificial light. Such sources of light are configured external to the cavity.

Further, an additional light source may also be configured within the cavity, such as a solid state light source. Hence, in some embodiments the arrangement may include a light source configured within the cavity and in other embodiments, the arrangement does not include a light source configured within the cavity. An additional light source may especially be configured to enrich the light in the cavity with specific types of light, such as one or more of UV, blue, green, red, infrared, especially only one or two of these at the same time. The herein indicated control system may also control such light source.

In yet further embodiments, the method may include controlling the configuration of the arrangement to optimize light conditions within the cavity.

In embodiments the method comprises a hydroponic based plant growing method, wherein the plant support contains water and part of the plant, wherein at least part of the plant support is transmissive for said light, wherein one of the first collecting reflector and the second collecting reflector are arranged configurable, such as movable, allowing a plurality of different configurations, wherein the method especially further comprises controlling the configuration of one of the first collecting reflector and the second collecting reflector as function of one or more of a light sensor signal of a light sensor and a time schedule.

The term “controlling” and similar terms especially refer at least to determining the behavior or supervising the running of an element. Hence, herein “controlling” and similar terms may e.g. refer to imposing behavior to the element (determining the behavior or supervising the running of an element), etc., such as e.g. measuring, displaying, actuating, opening, shifting, changing temperature, etc.. Beyond that, the term “controlling” and similar terms may additionally include monitoring. Hence, the term “controlling” and similar terms may include imposing behavior on an element and also imposing behavior on an element and monitoring the element.

Hence, herein amongst others a passive solar radiation reflector system, e.g. for hydroponics or soilless horticulture is provided.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying schematic drawings in which corresponding reference symbols indicate corresponding parts, and in which:

Fig. 1 schematically depicts a plant radiation arrangement and a horticulture system comprising such arrangement;

Figs. 2a-2c schematically depict some aspects and variants;

Figs. 3a-3b schematically depict some variants including an optical element;

and

Figs. 4a-4b schematically depict some variants including features that may allow imposing an effect on the temperature (in the cavity and/or of the respective collecting reflector).

The schematic drawings are not necessarily on scale.

DETAILED DESCRIPTION OF THE EMBODIMENTS

In embodiments two reflectors are applied, especially in such way and with such geometries that a solar light concentration is achieved.

5 In embodiments the bottom reflector and top reflector have essentially the same optical reflectivity characteristics and reflect at maximum (a substantial part of) the solar radiation spectrum.

The purpose of the combination of reflectors is to provide a solar radiation concentration (due to the focusing beam pattern) and distribute the light over the plant, including to top side of the plant. Infrared heat is absorbed by the (hydroponic) system, or an additional heat accumulator below the hydroponic system.

The reflectors can be solid elements, or might be compositions of a solid carrier structure combined with a foil-like reflector element.

15 Fig. 1 schematically depicts an embodiment of the plant arrangement 1 and the plant system 2.

Here, the plant radiation arrangement 1 comprises a first collecting reflector 100 having a first reflective surface 110 having a first reflective area A1, defined by a first reflective area edge 101, and a second collecting reflector 200 having a second reflective surface 210 having a second reflective area A2, defined by a second reflective area edge 201. 20 The first reflective area A1 is larger than the second reflective area A2. Both collecting reflectors 100,200 have – in this schematically depicted embodiment - round concave shapes. Fig. 1 schematically depicts a set of the first collective reflector 100 and the second collective reflector 200.

The first collecting reflector 100 and the second collecting reflector 200 define 25 a concentrator cavity 150, accessibly by light 11 from external of the cavity 150, such as solar light. This light 11 can enter the cavity 150 via a cavity opening 151 between at least part of said first reflective area edge 101 and said second reflective area edge 201. Hence, the set of the collecting reflectors 100,200 essentially define the cavity 150 (with cavity opening 151). As can be derived from Fig. 1, at least about 50%, or even (much) more) such as at 30 least 80%, like 90% or more of the virtual plane between the reflective area edges is not intercepted by an element.

In alternative embodiments, as first collecting reflector 100, also a plurality of (collecting) reflectors may be applied. Likewise, as second collecting reflector 200, also a plurality of (collecting) reflectors may be applied.

The collecting reflectors are used to concentrate within said cavity 150 with one or more of said first collecting reflector 100 and said second collecting reflector 200 at least part of the light 11 from external of the cavity 150 reaching one or more of the first reflective surface 110 and second reflective surface 210

5 The second collecting reflector 200 is configured at a higher position than the first collecting reflector 100. A frame, or one or more other elements may be used to provide the configuration of the first collecting reflector 100 and second collecting reflector 200. The structure providing this arrangement or configuration is herein indicated with reference 360 and may include e.g. steel elements but alternatively or additionally also other elements, like
10 polymeric elements.

As shown in the schematic drawing, the cavity 150 is suitable for hosting a plant support 310 for a plant 5. Also the plant support 310 may comprise steel elements or polymeric elements, etc.. The plant support 310 may especially comprise a pot or other element to allow roots and optionally part of the plant be hosted. Here, by way of example a
15 hydroponic system, more especially a water-based system is schematically displayed. Reference 313 indicates water. The presently proposed arrangement 1 and system 2 may also be used for airoponics. A substantial part of the cavity, such as at least 50% of the cavity, may be unoccupied.

Here, by way of example plant 5 is a land plant with roots. However, as
20 indicated above the term plant may also refer to algae. In such embodiments, the support may provide a closed environment, such as a flow-through container, for the algae for flow-through applications, though this is not necessarily the case.

In specific embodiments at least part of the plant support 310 is transmissive for light 11. For instance, a container, such as pot 312 of polycarbonate (PC) or poly methyl
25 methacrylate (PMMA) or glass may be applied. The container may thus also be a flow-through container in embodiments wherein the container may e.g. be used for airoponics, hydroponics, or e.g. algae applications.

As schematically shown in Fig. 1, the plant support 310 is configured at non-zero shortest distances d_1, d_2 from the first collecting reflector 100 and the second collecting
30 reflector 200, respectively.

Here, by way of example the plant 5 is a plant that may grow upwards. However, the plant may also be a hanging plant, etc.. For all these types of plants the radiation may be concentrated for optimized conditions for the plant

In a variant, the arrangement may further include one or more temperature control elements 350, configured to control the temperature of one or both of the first collecting reflector 100 and the second collecting reflector 200. In embodiments, the temperature control element(s) 350 may be able to cool. In other embodiments, the temperature control element(s) 350 may be able to heat. Especially, the temperature control element(s) 350 may be able to heat.

Here, by way of example the temperature control elements 350 are configured to control the temperature of the first collecting reflector 100, though alternatively or additionally, temperature control elements may be configured to control the temperature of the second collecting reflector 200.

The arrangement 1 or the system 2 may further comprise a control system to control e.g. the configuration (if applicable) or e.g. above-mentioned optional temperature control element(s) 350. The control system is schematically indicated with reference 340.

Hence, here a variant (of the arrangement 1 or the system 2) is schematically depicted further comprising a control system, indicated with reference 340, and especially further also comprising a temperature control element 350 controlled by the control system 340, configured to control the temperature of at least part of the first collecting reflector 100.

Further, a variant is schematically depicted wherein the arrangement 1 or plant system 2 further comprises a water supply system 380 configured to provide water 381 to the cavity 150. With the temperature control element 350 and the control system 340 a local humidity in the cavity 150 can be controlled (by controlling the temperature of at least part of the first collecting reflector 100).

Optionally, the control element 350 may choose an action in dependence of a sensor (and/or time schedule). Here, by way of example a sensor 341 is schematically depicted. The term “sensor” may also refer to a plurality of (different) sensors. The sensor 341 may e.g. be configured to sense one or more of temperature, radiation conditions (such as radiation intensity), humidity, etc.. As indicated above, the term “radiation” may refer to one or more of UV, visible and IR, especially at least visible light.

The first collecting reflector 100 has one or more first focal points 121. Here, a single focal point 121, by way of example, outside the cavity 150 is depicted.

The second collecting reflector 100 has one or more second focal points 221. Here, a single focal point 221 within the cavity 150 is schematically depicted.

However, both focal points may be configured within or outside the cavity 150. The same may apply when one or more of the collecting reflectors have a plurality of focal points.

One of the first collecting reflector 100 and the second collecting reflector 200 may be configured movable allowing a plurality of different configurations. Here, the first collecting reflector 100 is schematically depicted as configured fixed, whereas the second collecting reflector 200 is schematically depicted configurable in different positions. For instance, the arrangement may include an element 61, such as an arm, with one or more movable elements 62, such as one or more telescope elements and/or one or more pivot elements. Here, by way of example pivot elements are schematically depicted.

Hence, the top and/or bottom reflectors are provided with a means to change the orientation of the reflectors, independently for top and bottom reflector. This can be done by pivot points on the reflectors. This is graphically represented in Fig. 1 (for the second collecting reflector 200). By adding to the top and/or bottom reflector a pivot point, the reflector(s) can individually or in conjunction be directed towards the sun. For that scale marks might be provided. The purpose of the adjustment can be to provide optimal setting e.g. depending on latitude/longitude of the location.

The position (or more general the configuration) of the collecting reflector(s) may be adapted as function of the (solar) light, but e.g. also as function of the type of plant or the growth stadium of the plant, etc..

The control system 340 may be used to control the configuration of one of the first collecting reflector 100 and the second collecting reflector 200, for instance (also) as function of one or more of a light sensor signal of sensor 341, such as a light sensor 341, and/or of a time schedule.

Figs. 2a-2c schematically depict some aspects and variants.

Fig. 2a schematically depicts a collecting reflector which has the shape of shell. Such collecting reflector may have a single focal point (reference 121 when representing an embodiment of the first collecting reflector or reference 221 when representing an embodiment of the second collecting reflector). Other shapes, including parabolic reflectors, may also be possible. As the information provided in Fig. 2a may relate to both reflectors 100,200, the reference numbers are also related to both reflectors 100,200. Here, a single focal point 121 or 221 is depicted. The concave reflector provides a concave reflector cavity.

Fig. 2b schematically depicts a trough-like collecting reflector. In such embodiment, there will be a plurality of focal points 121 or 221 (such as a focal line), for the respective collecting reflectors 100,200. The drawing of Fig. 1 may include simplified cross-section representations. In variants, the reflectors may extend lengthy in the direction of a group of plants. So such system can be super-imposed on a line of crops (see e.g. Fig. 2b). The elongated concave reflector provides an elongated concave reflector cavity. Here, by way of example the trough-like collector has a concave shape. In specific other embodiments, the trough-like collector may have a V-shape.

Fig. 2c schematically depicts the arrangement with the first collecting reflector 100 and second collecting reflector 200. There is a shortest distance s_d between the reflective surfaces 110,210 and a largest distance l_d between the reflective surfaces 110,210. The shortest distance s_d may be in the range of about 1-200 cm. The longest distance l_d may be in the range of about 10-250 cm. Reference VP indicates the virtual (curved) (circumferential) plane between the first reflector edge 101 and the second reflector edge 201. Here, the cavity 150 has the shape of a truncated cone, with a base and a top that are convex (assuming both collecting reflectors 100,200 being round (see e.g. Fig. 2a) and thus defining respective reflector cavities). Note that this shape may vary when one or both reflectors are configured movable (in the arrangement 1). Fig. 2c also schematically depicts a variant wherein one or more of the first focal points 121 and one or more of the second focal points 221 coincide at one or more mutual focal points 152. Coincidence might be lost when one of the reflectors 100,200 is moved or deformed. Note that in this schematically depicted (cross-section) embodiment the virtual plane is defined by the cavity opening 151.

In Fig. 2c by way of example a variant is also included wherein the first collecting reflector 100 (or at least a reflective element) may be part of a larger system, such as a reflective foil (see the dashed lines at the right and left side of the first collecting reflector 100).

Using e.g. pivot points, indicated with reference 17, the configuration of the collecting reflector(s) may be provided. When the pivot points 17 are configurable in different positions, the collecting reflector(s) may be configured in different configurations. In this way, the position of the focal point(s) may be controlled. Hence, the collecting reflector may be bendable (deformable) in this way.

Referring for instance to Figs 1 and 2c, one or more of the collecting reflectors may in themselves configurable (like deformable, such as bendable). Further, referring for instance to Figs 1 and 2c, the absolute or relative position of one or more of the collecting

reflectors may be configurable. In embodiments, one or more of the collecting reflectors may be configurable in one or more of size, focal point, and curvature. Especially, the curvature and/or position may be configurable. Allowing an optimization of the concentration of the light, dependent on e.g. the lighting conditions (period of the year), type of plant, stage of plant, part of plant, etc. etc..

Figs. 3a-3b schematically depict some variants, such as including an optical element. Fig. 3a schematically depicts a variant wherein one or more of the first reflective surface 110 and the second reflective surface 210 comprise an optical filter 320 configured to change the spectral distribution of light 11 redirected by said one or more of the first reflective surface 110 and the second reflective surface 210. The optical filter may absorb and/or convert at least part of the light 11 into reflected light having another spectral distribution. In embodiments, a color filter may essentially have no influence on the reflection angles, whereas a converter, such as a luminescent material, may redistribute the light 11b.

In embodiments, such as schematically depicted in Fig. 3b, one or more of the first collecting reflector 100 and the second collecting reflector 200 comprises a reflector support 330 configured to support a reflective element 331, wherein the reflective element provides the respective reflective surface 110,210. Especially, the reflective element 331 is detachably associated with said reflective support 330. This allows providing the desired optical properties which may depend on e.g. the type of plant, the growth stage of the plant, the time of the year solar positions, etc.. Especially, the reflective element 331 may comprise a reflective foil. As indicated above, the entire collecting reflector may essentially consist of a reflective foil.

When applying optical foils with wavelength selection (e.g. dichroic or alike) one can create different radiation spectra for the top side and the bottom side of the plant (as the parts of the plant, leaves, stems, fruits, can have different light requirements or might benefit from such different spectra). For instance, the light exposure to the bottom side of strawberry plants, where the fruits hang, can be optimized for enhancing the ripening process. Another quite relevant wavelength selective purpose is to modify the spectrum such that there is a more evenly spectrum provided to the plants, e.g. for Nordic regions where the natural component UV-A is partly lacking in the natural radiation. Selectively favoring the UV-A in the reflected spectrum towards the plants can solve this problem. There are a number of optional methods to modify the natural radiation spectrum, for further optimization of these spectra:

- the optical foils could be such that long wavelength IR radiation (IR-B and IR-C) are selectively removed, as to reduce the heating of the crops
- opposite, the IR radiation might be optimized for using the radiation as temperature micro-climate element for optimization
- 5 • optical foils with (partly) color conversion (phosphor) might be implemented as well. Another word for phosphor is luminescent material.

The optical foil can be comprised by the collecting reflector or can be a separate element on at least part of the collecting reflector, or can also be configured at some distance of the collecting reflector. Of course, also a plurality of different optical foils may be
10 used, also at different positions within the cavity.

In embodiments the reflectors can be foils that are combined and hold in position by mechanical carriers, and can be characterized by the fact that these reflector foils are segmented in zones for each plant and overlapping, and that these foils could be unwrapped and new overlays be made such as to change spectrum without replacing the
15 whole foil. This would be useful for e.g. changing from 'growth-enhancing foil' towards 'ripening foil', which allow addressing different growth stages of the plant.

Figs. 4a-4b schematically depict some variants including features that may allow imposing an effect on the temperature (in the cavity and/or of the respective collecting reflector).

20 One or more of the first collecting reflector 100 and the second collecting reflector 200 may comprise a thermal energy storage element 370, such as schematically depicted in Fig. 4a. This thermal energy storage element 370 may in embodiments comprise a metal block, such as a steel block.

Fig. 4b schematically depicts another variant including a water supply system
25 380 configured to provide water 381 to the cavity 150. With the temperature control element 350 and the control system 340 a local humidity in the cavity 150 can be controlled (by controlling the temperature of at least part of the first collecting reflector 100). Hence, the bottom reflector element might also be used to influence e.g. the local humidity around the plant (micro-climate) by providing an additional water filling of that element meant for
30 evaporation, combined with radiative heating by the reflector.

The top reflector obviously can also serve the purpose of protection to rain fall. If that is wanted and/or preferred, than the geometry can be selected such that maximum rain protection is provided while the radiation optimization is still guaranteed.

The top reflector might be semi-transparent, such that part of the natural light proceeds to the canopy of the plant, either as-is or in a modified spectrum.

A reflector method can be provided that also allows for (day-time) micro-climate optimizations (e.g. temperature, humidity (drying), etc.), based on pivoting the mechanical elements multiple times during the day (such pivoting being effectuated either manually or automated).

The reflectors might be bendable/deformable as to further optimize reflected beam patterns. This might e.g. be done at the instalment of the installation (as a kind of fine-tuning) or intermediately be changed for optimization.

Optionally, some active light sources, in the form of LEDs, e.g. for adding the contribution of a specific wavelength to the overall spectrum, might be comprised by the arrangement, such as configured in the cavity.

For applications where crops are cultivated on ground level the use of only one of the two reflectors (top or bottom) might also be implemented and can show to be valuable.

The term “substantially” herein, such as in “substantially all light” or in “substantially consists”, will be understood by the person skilled in the art. The term “substantially” may also include embodiments with “entirely”, “completely”, “all”, etc. Hence, in embodiments the adjective substantially may also be removed. Where applicable, the term “substantially” may also relate to 90% or higher, such as 95% or higher, especially 99% or higher, even more especially 99.5% or higher, including 100%. The term “comprise” includes also embodiments wherein the term “comprises” means “consists of”. The term “and/or” especially relates to one or more of the items mentioned before and after “and/or”. For instance, a phrase “item 1 and/or item 2” and similar phrases may relate to one or more of item 1 and item 2. The term “comprising” may in an embodiment refer to “consisting of” but may in another embodiment also refer to “containing at least the defined species and optionally one or more other species”.

Furthermore, the terms first, second, third and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein.

The devices herein are amongst others described during operation. As will be clear to the person skilled in the art, the invention is not limited to methods of operation or devices in operation.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. Use of the verb "to comprise" and its conjugations does not exclude the presence of elements or steps other than those stated in a claim. Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising", and the like are to be construed in an inclusive sense as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to". The article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention may be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In the device claim enumerating several means, several of these means may be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

The invention further applies to a device comprising one or more of the characterizing features described in the description and/or shown in the attached drawings. The invention further pertains to a method or process comprising one or more of the characterizing features described in the description and/or shown in the attached drawings.

The various aspects discussed in this patent can be combined in order to provide additional advantages. Further, the person skilled in the art will understand that embodiments can be combined, and that also more than two embodiments can be combined. Furthermore, some of the features can form the basis for one or more divisional applications.

CLAIMS:

1. A plant radiation arrangement (1) comprising a first collecting reflector (100) having a first reflective surface (110) having a first reflective area (A1) defined by a first reflective area edge (101), and a second collecting reflector (200) having a second reflective surface (210) having a second reflective area (A2) defined by a second reflective area edge (201); wherein:

- the first reflective area (A1) is larger than the second reflective area (A2);
- the first collecting reflector (100) and the second collecting reflector (200) are arranged at a distance from each other and define a concentrator cavity (150), accessibly by light (11) from external of the cavity (150), with a cavity opening (151) between at least part of said first reflective area edge (101) and said second reflective area edge (201);
- the plant radiation arrangement (1) is configured to concentrate within said cavity (150) with one or more of said first collecting reflector (100) and said second collecting reflector (200) at least part of the light (11) from external of the cavity (150) reaching one or more of said first reflective surface (110) and said second reflective surface (210); and
- said cavity (150) is hosting a plant support (310) for a plant (5).

2. The plant radiation arrangement (1) according to claim 1, wherein the first collecting reflector (100) has one or more first focal points (121), wherein the second collecting reflector (100) has one or more second focal points (221), wherein one or more of the first focal points (121) are configured within the cavity (150), or wherein one or more of the second focal points (221) are configured within the cavity (150), or wherein one or more of the first focal points (121) and one or more of the second focal points (221) are configured within the cavity (150).

3. The plant radiation arrangement (1) according to claim 2, wherein one or more of the first focal points (121) and one or more of the second focal points (221) coincide at one or more mutual focal points (152).

4. The plant radiation arrangement (1) according to any one of the preceding claims, wherein one or more of the first reflective surface (110) and the second reflective surface (210) comprise an optical filter (320) configured to change the spectral distribution of light (11) redirected by said one or more of the first reflective surface (110) and the second reflective surface (210) by one or more of (i) absorbing at least part of the light (11) and (ii) converting at least part of the light (11) into light having another spectral distribution.

5. The plant radiation arrangement (1) according to any one of the preceding claims, wherein one or more of the first collecting reflector (100) and the second collecting reflector (200) comprise a reflector support (330) configured to support a reflective element (331), wherein the reflective element (331) provides the respective reflective surface (110,210), and wherein the reflective element (331) is detachably associated with said reflective support (330), and wherein the reflective element (331) comprises a reflective foil.

6. The plant radiation arrangement (1) according to any one of the preceding claims, wherein one or more of the first collecting reflector (100) and the second collecting reflector (200) are configurable allowing a plurality of different configurations.

7. The plant radiation arrangement (1) according to claim 6, further comprising a control system (340) configured to control the configuration of one of the first collecting reflector (100) and the second collecting reflector (200) as function of one or more of a light sensor signal of a light sensor (341) and a time schedule.

8. The plant radiation arrangement (1) according to any one of the claims 1 to 6, further comprising a temperature control element (350) for controlling the temperature of at least part of the first collecting reflector (100) and/or at least part of the second collecting reflector or further comprising a thermal energy storage element (370) in one or more of the first collecting reflector (100) and the second collecting reflector (200).

9. The plant radiation arrangement (1) according to any one of the preceding claims, wherein the second collecting reflector (200) has reflection and transmission properties, wherein the second collecting reflector (200) is further configured to transmit at least part of the light (11) from external of the cavity via the second collecting reflector (200) into the cavity (150).

10. A plant system (2) comprising the plant radiation arrangement (1) according to any one of the preceding claims 1-9, wherein during operation of the plant system (2) the second collecting reflector (200) is configured at a higher position than the first collecting reflector (100).

11. The plant system (2) according to claim 10, further comprising a plant support (310) for a plant (5), wherein at least part of the plant support (310) is transmissive for light (11), and wherein the plant support (310) is configured at a distance from the collecting reflectors (100,200).

12. The plant system (2) according to any one of the preceding claims 10-11, further comprising a water supply system (380) configured to provide water (381) to the cavity (150) and, when dependent on claim 8, the temperature control element (350) is configured to control a local humidity in the cavity (150) by controlling the temperature of at least part of the first collecting reflector (100).

13. A method of treating a plant (5), the method comprising:

- allowing light (11) entering a cavity (150) of the plant arrangement (1)

according to any one of the preceding claims 1-9 or the plant system (2) according to any one of the preceding claims 11-13, wherein said plant (5) is configured within the cavity (150).

14. The method according to claim 13, wherein the method is a hydroponic based plant growing method, wherein the plant support (6) contains water and part of the plant (5) and wherein at least part of the plant support (6) is transmissive for said light (11).

15. The method according to any one of the claims 13 or 14, wherein one of the first collecting reflector (100) and the second collecting reflector (200) are configured movable allowing a plurality of different configurations and wherein the method further comprises controlling the configuration of one of the first collecting reflector (100) and the second collecting reflector (200) as function of one or more of a light sensor signal of a light sensor (341) and a time schedule.

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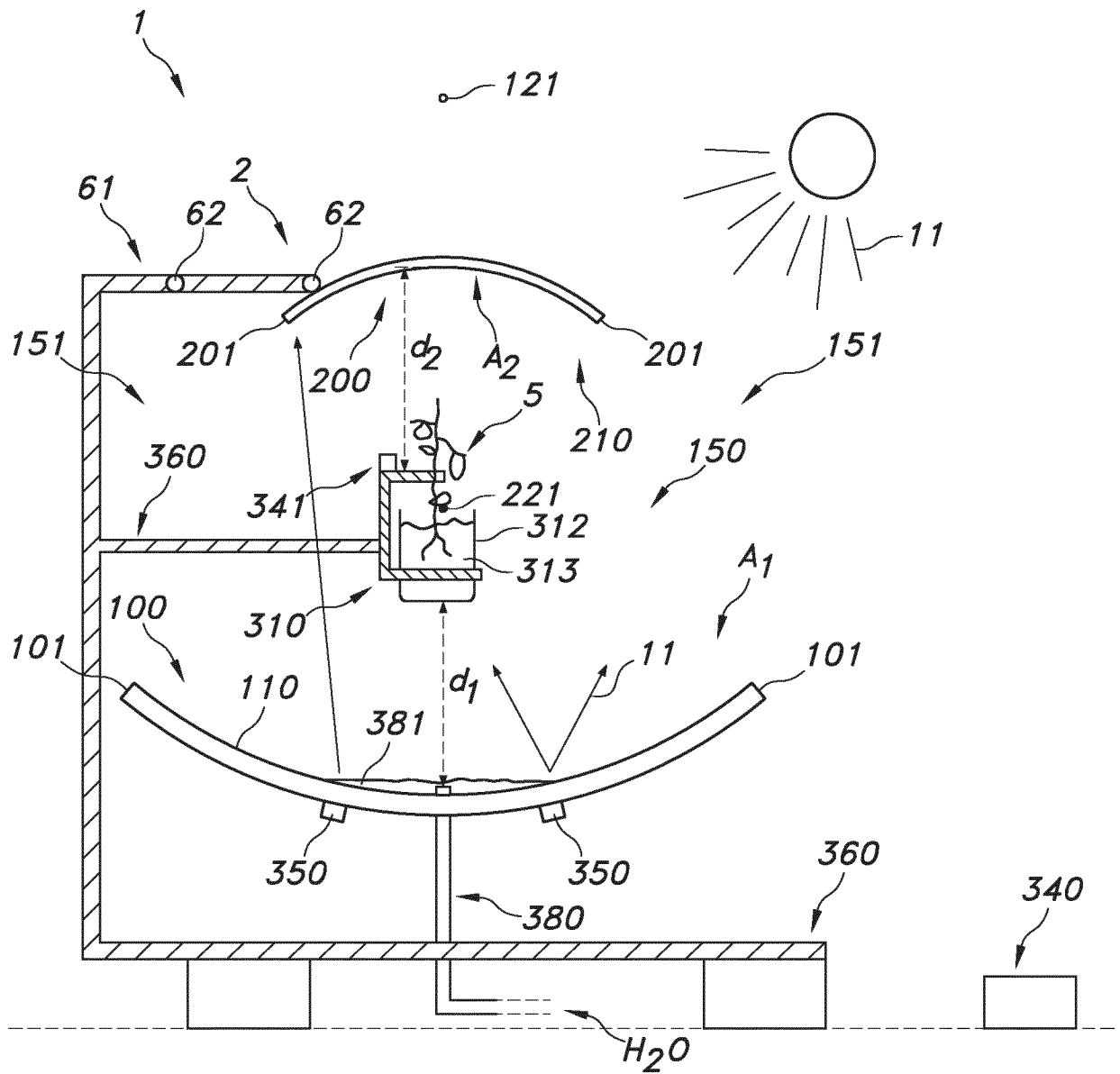


FIG. 1

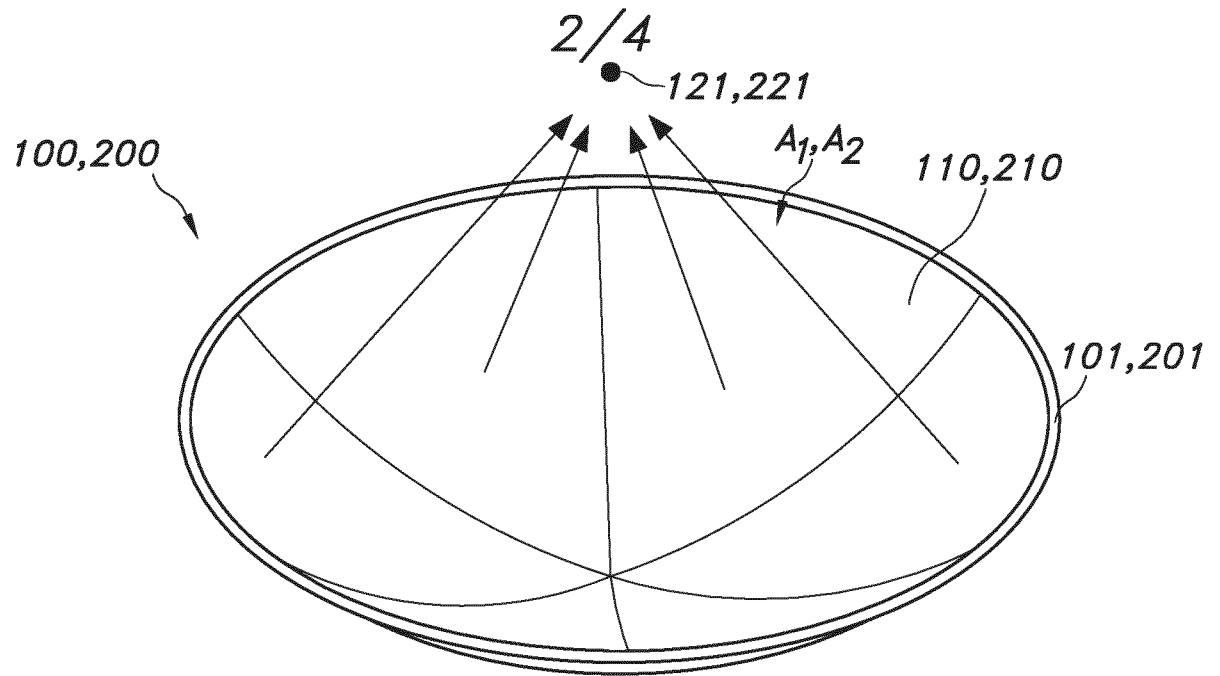


FIG. 2A

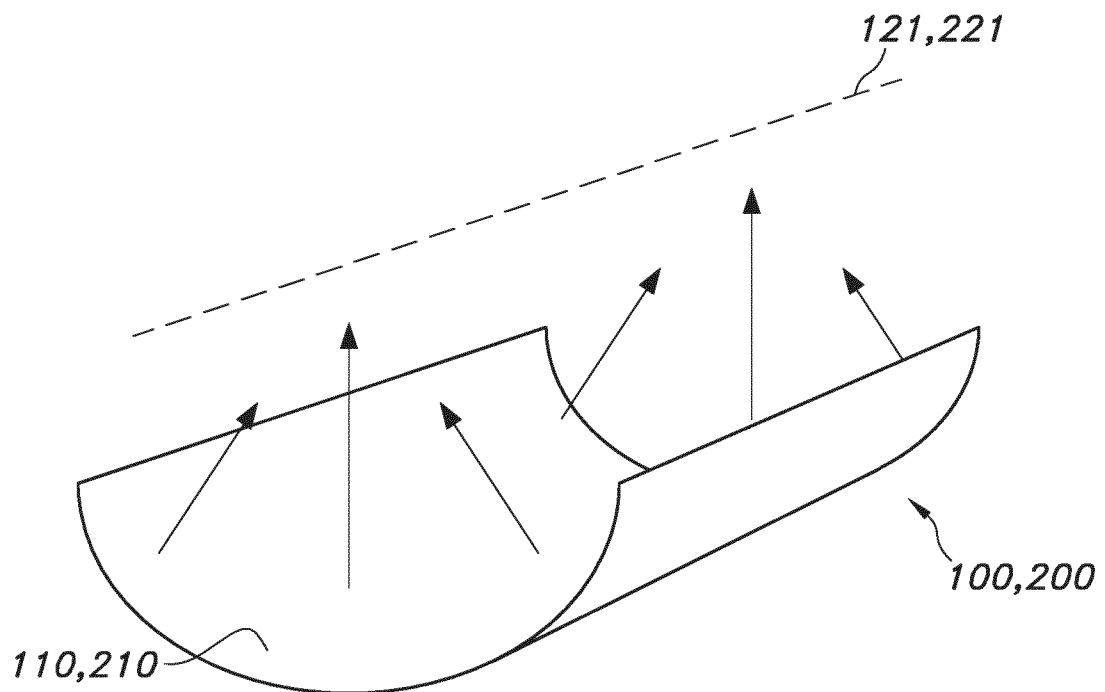


FIG. 2B

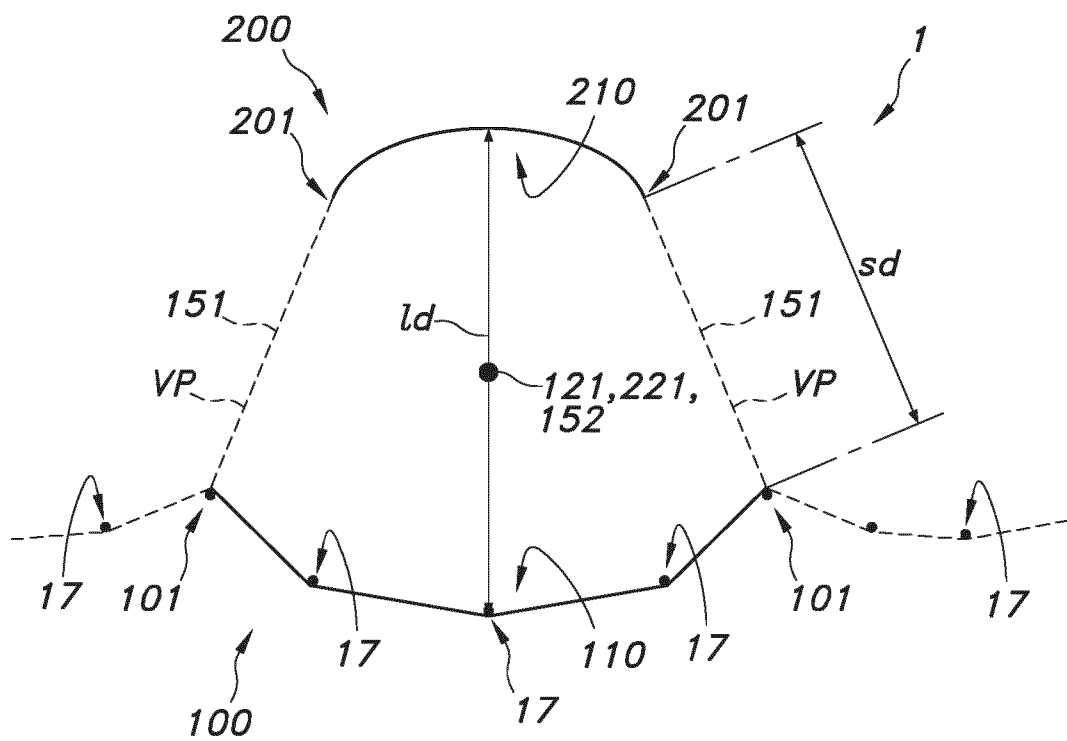
$$3/4$$


FIG. 2C

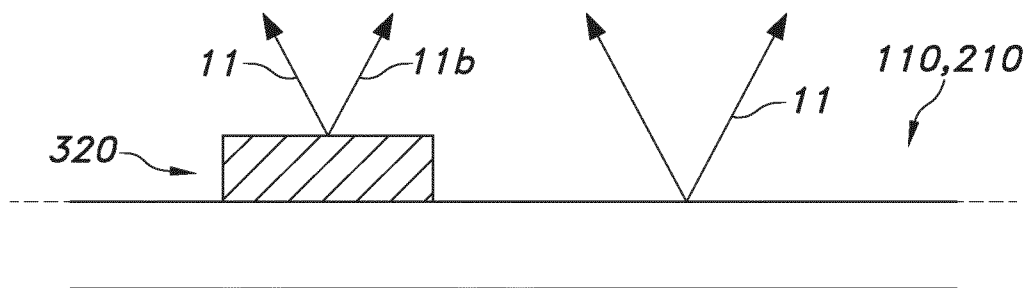
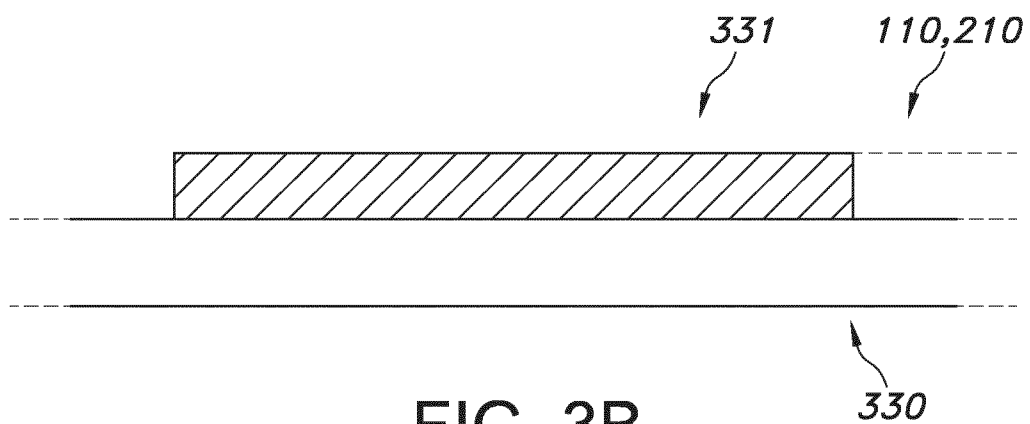


FIG. 3A



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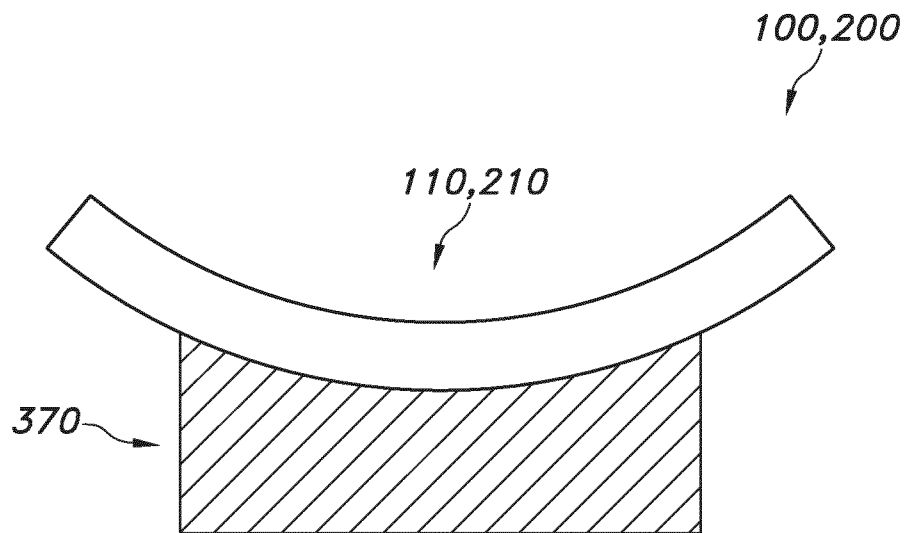


FIG. 4A

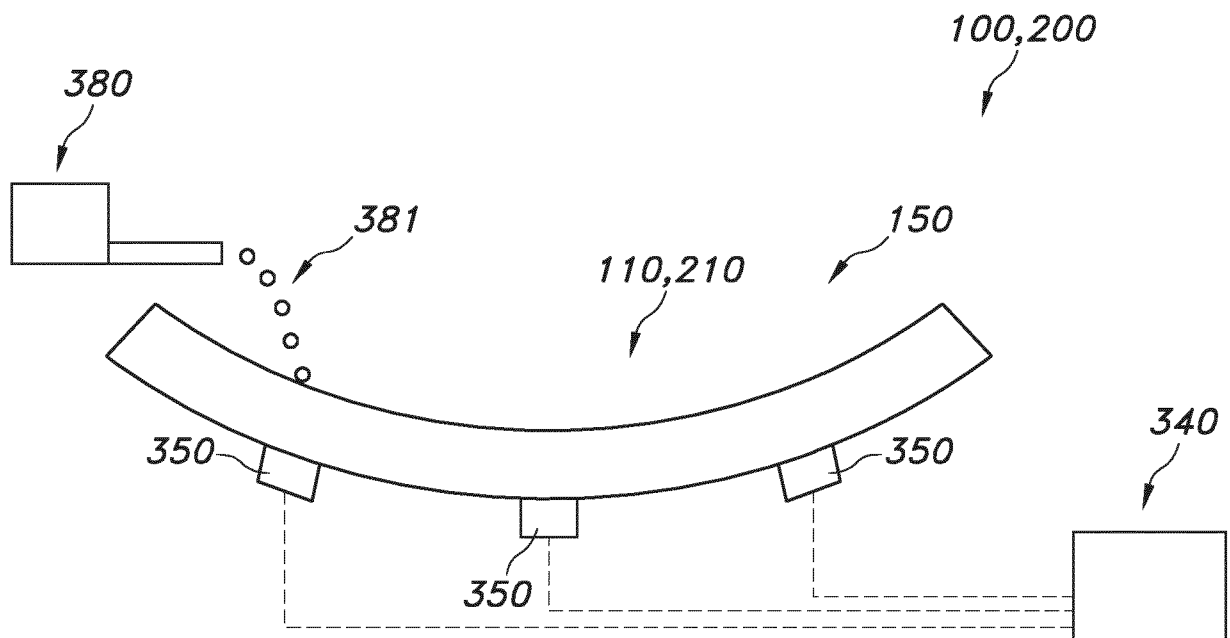


FIG. 4B

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/079855

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24J2/18 A01G9/24
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)
F24J A01G

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.
X	DE 196 03 742 A1 (POETZSCHER CAROLA [DE]) 7 August 1997 (1997-08-07)	1-3,5-12
Y	figure 1 column 2, line 45 - line 50 -----	4
X	CA 2 261 777 A1 (MUTSCHLER FRIEDOLF [DE]) 29 January 1998 (1998-01-29)	13-15
Y	figure 10 page 6, paragraph 2 -----	4
X	DE 10 2010 011374 A1 (SCHMIDT TOBIAS [DE]) 15 September 2011 (2011-09-15) the whole document -----	1,6,10
A	US 2008/222949 A1 (BISSONNETTE W MICHAEL [US] ET AL) 18 September 2008 (2008-09-18) the whole document ----- -/-	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search

12 December 2017

Date of mailing of the international search report

19/12/2017

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2017/079855

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 198 953 A (POWER DEAN V [US]) 22 April 1980 (1980-04-22) the whole document -----	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/079855

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		DE 19629670	A1 29-01-1998
		EP 0917422	A1 26-05-1999
		WO 9803054	A1 29-01-1998

DE 102010011374	A1	15-09-2011	NONE

US 2008222949	A1	18-09-2008	US 2008222949 A1 18-09-2008
		US 2008282610	A1 20-11-2008

US 4198953	A	22-04-1980	NONE
