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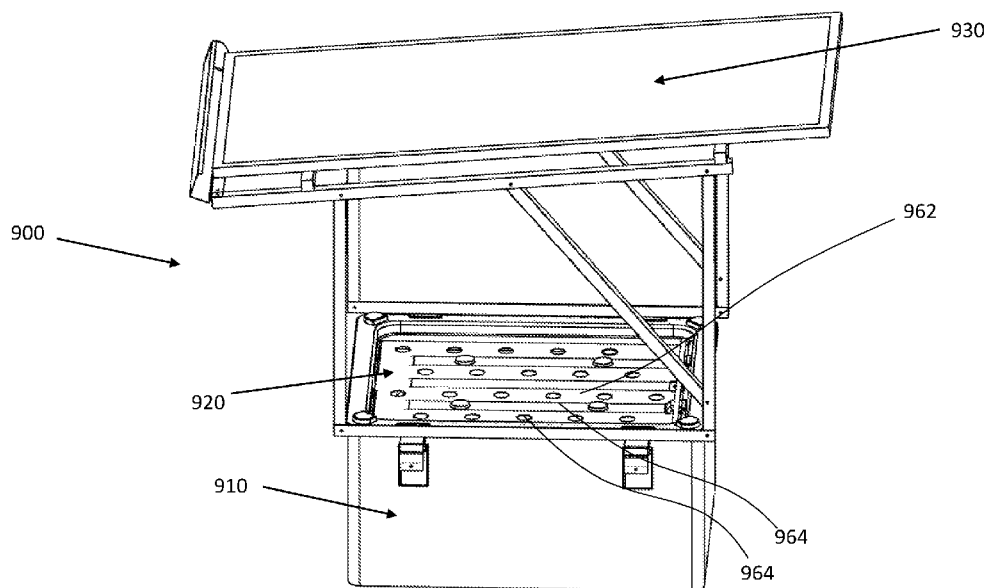


Fig. 9A

(57) Abstract: The presently disclosed subject matter refers to agro-photovoltaic modules (at times also referred to as agri voltaic modules) designed to increase the productivity use of available area. The agro-photovoltaic module can enable agricultural growth and the production of energy, e.g. by using photovoltaic cell(s), while using the same area (land space, lake, rooftop, etc.), therefore the agro-photovoltaic module can offer a good solution for this issue. This may help overcome legislations/rules in different countries, for example, where land can not be used solely for solar energy cultivation and must be integrated with agricultural purposes. The produced photovoltaic energy is either being used by components of the module or directed to an external electric power system.



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AGRO-PHOTOVOLTAIC MODULE

TECHNOLOGICAL FIELD

The presently disclosed subject matter relates in general to the field of agro-
5 photovoltaic modules, and more particularly to the field of units enabling the growth of plants and the production of photovoltaic energy.

BACKGROUND

Available land space is becoming a scarce commodity, in the countryside as well as in large cities. Recently, people have started noticing the value of organic agricultural
10 products and are therefore looking for ways to grow their own vegetables. Therefore, people in many of the cities around the world have started to grow vegetables and/or groom a small garden on their rooftops. In order for the rooftop garden to flourish, the agricultural growth need to receive sunlight, water and of course a proper growing bed. Accordingly, personal small units allegedly provide these conditions to enable an
15 individual growing unit on rooftops. Additionally, farmers worldwide are always seeking ways to increase their yield, and therefore have started to incorporate different types of plants to maximize available land space. In the energy sector it is common to see photovoltaic cells over water reservoirs for exploiting these areas for the production of energy, while not taking up space in other places.

20 Since the use of available land is becoming a scarce commodity there is the need to use it wisely. Both energy and agricultural products are of great importance for people worldwide and therefore the “battle” between the use of available land for agricultural purposes or for the production of photovoltaic energy can be seen in many places.

For example, US patent application 2015/082697 discloses a low-maintenance
25 and water-conserving container-gardening system used indoors or outdoors to grow plants, vegetables, herbs, fruits, and flowers. This system uses one or more gardening containers each having water-elevating structure causing slow and consistent upward flow of nutrient/fluid into the soil, and nutrient/fluid drainage-facilitating structure that directs surplus nutrient/fluid away from plant roots when the pump stops. The system
30 uses solar panels to supply energy to the pump.

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CN 209861787 utility model discloses a cultivation device for vegetable seedling raising. A water tank is arranged at the bottom of the box body; a plant light supplementing lamp and a telescopic device are arranged at the top in the box body; a humidity sensor is arranged at the bottom in the seedling tray. A solar cell panel is arranged at the upper end of the supporting rod, providing energy locally, e.g. to the light, which is positioned within the box, sensor and motor.

Acknowledgement of the above references herein is not to be inferred as meaning that these are in any way relevant to the patentability of the presently disclosed subject matter.

10 GENERAL DESCRIPTION

The presently disclosed subject matter refers to agro-photovoltaic modules (at times also referred to as agrivoltaic modules) designed to increase the productivity use of available area. The agro-photovoltaic module can enable agricultural growth and the production of energy, e.g. by using photovoltaic cell(s), while using the same area (land space, lake, rooftop, etc.), therefore the agro-photovoltaic module can offer a good solution for this issue. This may help overcome legislations/rules in different countries, for example, where land can not be used solely for solar energy cultivation and must be integrated with agricultural purposes.

In some embodiments, the agro-photovoltaic module is mobile, at least when empty, and it can be easily shipped around the world and relocated at any desired location. The mobile agro-photovoltaic module can be easily moved according to farmers needs or the unique landscape of any location or it can be positioned on rooftops and/or water reservoirs, etc.

Accordingly, the present subject matter discloses an agro-photovoltaic module comprising: a growing tray having a bottom surface and circumferential side walls, configured to facilitate a growing bed for enabling the growth of one of plants or animals; and a photovoltaic cell positionable over said growing tray, configured to produce photovoltaic energy.

The produced photovoltaic energy is either being used by components of the module or directed to an external electric power system. In some embodiments, a majority of said produced photovoltaic energy is directed to an external electric power system. In

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some embodiments all of the produced photovoltaic energy is directed to an external electric power system.

The agro-photovoltaic module according to the presently disclosed subject matter has a number of unique features and/or elements identified below in different aspects of the presently disclosed subject matter, each of which contributes in its way to the ability of the module to operate under different conditions and/or to enable production of photovoltaic energy such that, optionally, a majority of which is directed for use of an external electric power system along with the growth of different agricultural products which may require different growing beds, such as solid/semi-solid/semi-liquid/ or even hydroponic and/or aquaponic growth. The features of the module according to different aspects identified below and also other features described in Detailed Description of Embodiments can be combined with each other in any combination in accordance with further aspects of the presently disclosed subject matter.

The two basic elements that the agro-photovoltaic module comprise are the growing tray and the photovoltaic cell. The growing tray can be configured for facilitating a growing bed, such as soil, manure, tuff, perlite, peat or alike, which may enable agricultural growth, such as of plants, e.g. vegetables, flowers, shrubs, vines, climbing plants, poultry, bees or alike. The growing tray can have a bottom surface and circumferential side walls which can define a basin capable of facilitating the growing bed therein. The photovoltaic cell can be positioned over the growing tray, thereby increasing the direct line of sight with sunlight or artificial lighting. Being positioned above the growing tray, can also enable the photovoltaic cell to shelter the plants growing in the growing tray. For example, reduce the exposure of the plants to direct sunlight, e.g. particularly during mid-day, i.e. the hottest hours of the day. Additionally, the photovoltaic cell may also shelter the plant, e.g. during heavy rains, which may be harmful to delicate plants such as flower or herbs.

The photovoltaic cell is configured to produce photovoltaic energy, with at least a majority of the produced photovoltaic energy directed to an external electric power system, which can be external with respect to the elements comprising the agro-photovoltaic module, e.g., an external power grid, a battery, an end user any combination thereof and/or any other electrical energy transporting, consuming and/or storing devices. Accordingly, the photovoltaic cell can produce more energy than required and/or consumed by the agro-photovoltaic module, thereby at least the majority of the produced

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photovoltaic energy may not be intended for powering energy related elements of the module, such as internal lighting, motors, pumps etc.

The agro-photovoltaic module can further comprise a water collecting tank, which can be configured to hold liquid therein, such as water and/or liquid fertilizers. The water
5 collecting tank can have circumferential side walls, such that the growing tray can be contained therebetween or nested therein. The water collecting tank can be positioned under the growing tray, thereby enabling water to drain from the growing tray to the water tank. Additionally, excess rainwater or irrigation water can also be collected in the water tank. Water stored in the water tank may, for example, be used to water the agricultural
10 products growing within the growing tray of the module and/or neighboring modules or other agricultural products, thereby preserving water usage.

The water collecting tank, when filled with water, can affect the ambient environment conditions of the module. The passive heating and cooling of the water collecting tank maintain balanced temperatures in the proximity surrounding of the
15 module.

According to an aspect of the presently disclosed subject matter, the growing tray can be configured for stackable nesting into like growing trays. The water collecting tank can be configured for stackable nesting into like water collecting tanks or wherein the growing tray can be configured for stackable nesting into the water collecting tank, or
20 vise versa.

A stackable nesting arrangement of the agro-photovoltaic module requires a small footprint, e.g. when stored as one module or upon storing multiple modules together, thereby reduce storage and shipping costs.

According to an aspect of the presently disclosed subject matter, the photovoltaic
25 cell can be detachably attachable to the growing tray and/or the water collecting tank. When attached, the growing tray and the water tank can comprise a bottom unit which can be detachably attachable to the photovoltaic cell. Detaching the photovoltaic cell, or other elements, from the module may enable stackable nesting the elements into like elements of like modules, such as the growing trays or water collecting tanks, which may
30 then, be stacked together.

According to an aspect of the presently disclosed subject matter, the agro-photovoltaic module as a whole, or as part of a system comprising at least two agro-photovoltaic modules can float on water, such as a water reservoir, e.g. lakes, fish ponds,

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treated or rain collecting water reservoirs or like reservoirs. This can be achieved due to the design of the module or parts thereof, e.g. by having a floating design, the material used during production, such as floatable material or by using a floating arrangement which may be connected and/or be part of the agro-photovoltaic module as a whole or to
5 any part thereof. Alternately, the agro-photovoltaic module can be positioned over a support system within the water.

According to a particular embodiment, the growing tray can be configured to float on the stored water in the water collecting tank. This can enable the growing tray to be easily rotated with respect to the water collecting tank, i.e. since the friction factor is
10 reduced by the stored water. In some embodiments, e.g. when the agro-photovoltaic module may not float properly (or at all), a system, comprising at least two agro-photovoltaic modules can be designed to float on water. For example, as a system, the agro-photovoltaic modules can form a floating design i.e. have the structural characteristics of a floating structure.

15 According to yet an aspect of the presently disclosed subject matter the photovoltaic cell can be connectable to the external electric power system. For example, the photovoltaic cell can be connected to the external electric power system directly or the photovoltaic cell can be connectable to like photovoltaic cells to form a series circuit, a parallel circuit or series of any combination thereof which may then be connected to the
20 external electric power system as a circuit.

The growing bed can be any growing bed which suitable for growth of plants, such as soil, manure, tuff, perlite, peat or alike. The growing bed can be semi-liquid, moist or liquid which can enable hydroponic or aeroponic growth of plants or aquaponic growth of fish.

25 The growing tray can further comprise a side door for enabling easy access to the plants or growing bed. The door can be opened to facilitate a side entrance, thereby enabling a user an additional point of access to the plants or growing bed. The growing tray can have two doors or more, wherein the doors can be posited along the same side wall, or at different side walls, thereby enabling multiple access points to the plants and/or
30 growing bed.

The agro-photovoltaic module as a whole, or any part thereof, can be mobile by hand, at least when empty. For example, the agro-photovoltaic module can be moved by a user without additional machinery-based assistance, such as a tractor and/or a forklift.

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The agro-photovoltaic can be secured to the ground, e.g. by stakes, wedges and/or ropes, to prevent it from unintentional movement, at least until it may be filled with the growing bed or water.

Positioning of the agro-photovoltaic can be done, for example, based on
5 environmental conditions of each area. For example, upon positioning of the agro-photovoltaic module or part thereof at a desired location, the user can take into consideration the amount of sheltering required for the plants growing within the growing tray and/or the amount of direct sunlight desired for the photovoltaic cell. Accordingly, the user may choose to position the agro-photovoltaic such that the photovoltaic cell may
10 shelter the growing tray as much as possible, or vice versa. In some embodiments, an optimization program may recommend the desired angle the photovoltaic cell should be positioned, so that as much as direct sunlight will reach the photovoltaic cell while sheltering the plants as much as required.

The module or any part thereof can be mobile, even when full of water and/or
15 growing bed, by a forklift, a tractor or any other agricultural or industrial machinery. In most cases after the agro-photovoltaic has been filled with the growing bed or water, or when plants have started to grow, its total weight may prevent unintentional movement. Nonetheless, when necessary to reposition the agro-photovoltaic, e.g. due to change of weather or the scenery (such as shading of a new tree or building), or when the farmer
20 wants to change the system location due to changes in the fields layout, or any other reason, agricultural or industrial machinery, such as forklifts, tractors, trucks or cranes may be of such an assistance.

The growing tray, the solar panel or both, can be rotatable with respect to the water tank. For example, after positioning the agro-photovoltaic module at its location,
25 any one or both of the growing tray and the solar panel can be pivoted according to the movement of the sun through the day. For example, to increase production of the photovoltaic cell, which may be detachably attachable to the growing tray, and/or to increase the plants exposure to the sun, e.g. during winter. This “following the sun” function may be done manually or by a mechanical apparatus such as a motor or a piston,
30 etc., according to a predetermined program, such as a computer program/algorithm or other predefined algorithm, configured to optimize the production of energy and/or agricultural growth. The rotation and/or pivoting of the growing tray with respect to the water tank may be done by a motor and/or manually. As detailed hereinabove the growing

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tray can float on the liquid stored within the water tank (e.g. water, liquid fertilizers, etc.), when doing so the friction between the growing tray and the water tank may be reduced, thereby enabling the rotation and/or pivoting to be completed by using less force than otherwise required.

5 According to an aspect of the presently disclosed subject matter there is provided a system comprising at least two agro-photovoltaic modules as described hereinabove, wherein the photovoltaic cell of each of the modules can be connectable to the external electric power system. It should be noted that when forming a system of agro-photovoltaic modules. In some embodiments, the photovoltaic cells are connected to form a series
10 circuit, a parallel circuit or series of any combination thereof which may then be connected to the external electric power system thereby increasing the voltage or current produced by the system, e.g. according to the requirements of the external electric power system.

Any one or more of the following features, designs and configurations can be
15 applied to the agro-photovoltaic module by its own or as part of a system according to any aspect of the present disclosure, separately or in various combinations thereof:

- All of the produced energy in the agro-photovoltaic module is directed for use of an external power system;
- The photovoltaic cell of the agro-photovoltaic module is positioned over
20 the growing tray by poles, rods, stacks or any other element which may secure the photovoltaic cell above the growing tray;
- The agro-photovoltaic module or any part thereof is made out of plastic (polymeric material), or any other manipulated material;
- The agro-photovoltaic module or any part thereof is made of plastic
25 (polymeric material), or any other material that is configured to float on water;
- The growing tray is divided into multiple individual growing units;
- The growing tray and/or each individual growing unit have holes enabling excess of water from the water tank when submerged into the water tank,
30 to enable hydroponic growth;
- The growing tray and/or the water collecting tank is formed by using a Rotation Molding technique;

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- The growing tray and/or the water collecting tank may be formed by using a direct injection technique with or without the use of vacuum;
- The photovoltaic cell of the agro-photovoltaic module is used to produce DC or AC currents;
- 5 • The water tank has at least one water port, such that it is able to receive water directly from a water line via one of the water ports and to enable water flow to like water tanks or to the next module via a second water port;
- 10 • The water tank comprises a lifting lever along an external side of the water tank to enable easy lifting of the agro-photovoltaic module, bottom unit and/or water tank;
- 15 • The bottom surface of the growing tray is inclined towards a drainage port to enable drainage of excess water from the growing tray to the water collecting tank;
- 20 • The drainage port comprises a filter, such as gravel filter, sand filter, carbon filter, membraned filter or any other sort of water filter, that insures that at least a majority of the growing bed does not enter the water tank;
- 25 • The agro-photovoltaic module assumes any polygonal (such as a hexagon, symmetric or not), or round, or hybrid shape;
- 30 • The module has a general shape of a rectangular or a hexagon. When a single agro-photovoltaic module is generally shaped as a hexagon, a system comprising multiple modules may have a general shape of a hive.
- The module comprises one or more water ports for allowing flow of water between the water collecting tank and at least one of like water collecting tanks, growing trays, a water feeding line and/or a big collection water tank. The flow of water is either (i) unidirectional, namely that the flow occurs only from the collecting tank or only into the collecting tank, or (ii) bi-directional, such that water can flow from and into the collecting tank;
- The module is connectable to like photovoltaic cells to form a series circuit, a parallel circuit or series of any combination thereof;
- The module is connectable to a like agro-photovoltaic module either through liquid communication by one or more water ports or through an

electrical connectivity in series or parallel, or through a combination of the two connection types.

- 5 • The module or a system that comprises a plurality of connected modules is connectable via a first port to a first water source including biological matter, e.g. a water source for fish growing, and via a second port to a second water source to discharge processed water after passing through the growing trays and some of the biological matter is being absorbed by the growing plants. In some embodiments, the module or the plurality of modules in the system comprise one or more pumps for circulating water from the water collecting tank to the growing tray.
- 10 • The growing tray is configured to provide a growing bed for animals, such as poultry and bees. The biological matter produced by the animals is discharged to the water below the growing tray, in which fish can be grown and use the discharged biological matter.
- 15 • The photovoltaic cell of the module is two-sided photovoltaic cell. In other words, the photovoltaic cell is configured to receive electromagnetic radiation from two faces and transform it to electric power.
- 20 • The module further comprises one or more sensors for sensing at least one of: temperature, humidity, water level in the collecting tank and state of the photovoltaic cell. The module further comprises a processing circuitry for controlling at least one of: water inflow/outflow of the system, water properties such as: temperature, EC, pH etc., climate conditions and photovoltaic cell state in response to the measurement received by said one or more sensors.
- 25 • The photovoltaic cell is inclined to define a bottom part of the photovoltaic cell. The bottom part of the photovoltaic cell comprises a water draining element for draining the water flowing over the photovoltaic cell and direct them to either the water collecting tank or the growing tray.
- 30 • The water is used to clean the photovoltaic cell and circulated to the water collecting tank or the growing tray.
- The module further comprises a perforated cover mounted on the growing tray. The perforations of the cover are configured for fitting over the plants in the growing tray to allow them to be exposed to the environment, e.g.

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- to sunlight. The cover is used to prevent evaporation of water from the water collecting tank below the growing tray. In some embodiments, the perforated cover comprises a photovoltaic facing face that comprises or coated by a reflecting material that is configured to reflect a selected range of electromagnetic radiation. The reflected radiation can be received by the plants abutting from the perforations or by the photovoltaic cell, when it is configured as a two-sided photovoltaic cell.
- Wherein a majority of said produced photovoltaic energy is directed to an external electric power system.
 - Wherein said majority of produced photovoltaic energy is not intended for powering energy related elements of said module.
 - Wherein said external electric power system is an external power grid.
 - Wherein said external electric power system is a battery or any other electrical energy storing device.
 - The photovoltaic cell is detachably attachable to said module or any part thereof.
 - The growing tray further comprises watering tunnels for providing constant water supply to plants growing thereon, wherein the watering tunnels define growing spots for the plants.
 - The growing tray further comprises watering tunnels for providing constant water supply to plants growing thereon and the perforations of the perforated cover are arranged along the watering tunnels to define growing spots for plants.
 - The water collecting tank can be configured for growing of fish therein, namely contain essential environmental conditions for growing fish.
 - The agro-photovoltaic module is mobile.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to better understand the subject matter that is disclosed herein and to exemplify how it may be carried out in practice, embodiments will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1A is a schematic illustration of an agro-photovoltaic module having a general rectangular shape, according to an example of the disclosure;

Fig. 1B is a schematic exploded illustration of the agro-photovoltaic module illustrated in Fig. 1A, according to an example of the disclosure;

5 **Fig. 1C** is a schematic illustration of construction of a bottom unit of the agro-photovoltaic module illustrated in Figs. 1A and 1B, according to an example of the disclosure;

Fig. 2A is a schematic cross section illustration of a bottom unit of the agro-photovoltaic module, according to an example of the disclosure;

10 **Fig. 2B** is a schematic cross section illustration of a hydroponic growing tray and a water collecting tank where the plant roots grow, of an agro-photovoltaic module, according to an example of the disclosure;

Fig. 3 is a schematic cross section illustration of stackably nesting two bottom units of the agro-photovoltaic module illustrated in Figs. 1A to 1C, according to an
15 example of the disclosure;

Fig. 4A is a schematic illustration of an agro-photovoltaic module having a general hexagon shape, according to an example of the disclosure;

Fig. 4B is a schematic exploded illustration of the agro-photovoltaic module illustrated in Fig. 4A, according to an example of the disclosure;

20 **Fig. 5A** is a schematic illustration to a water collecting tank of the agro-photovoltaic module illustrated in Figs. 4A and 4B, according to an example of the disclosure;

Fig. 5B is a schematic illustration of a growing tray divided into multiple individual growing units, of the agro-photovoltaic module illustrated in Figs. 4A and 4B,
25 according to an example of the disclosure;

Fig. 6A is a schematic illustration of an agro-photovoltaic module having a pivotable bottom unit, according to an example of the disclosure;

Fig. 6B is a schematic exploded illustration of the agro-photovoltaic module illustrated in Fig. 6A, according to an example of the disclosure;

30 **Fig. 6C** is a top front view of the schematic exploded illustration of Fig. 6B, according to an example of the disclosure;

Fig. 7 is a schematic illustration of a system of the agro-photovoltaic modules illustrated in Figs. 1A and 1B disposed in a field, according to an example of the disclosure;

Fig. 8 is a schematic illustration of a system of the agro-photovoltaic modules illustrated in Figs. 4A and 4B positioned on top of a roof of a building, according to an example of the disclosure; and

Figs. 9A-9C are schematic illustrations of different views of a non-limiting example of the agro-photovoltaic module according to an aspect of the present disclosure. **Fig. 9A** is a perspective view; **Fig. 9B** is a side view; and **Fig. 9C** is a longitudinal cross-sectional view.

DETAILED DESCRIPTION OF EMBODIMENTS

Reference is now made to Figs. 1A to 1C which schematically illustrate an agro-photovoltaic module generally designated **100** having a general rectangular shape, according to an example of the disclosure. In the illustrated example the agro-photovoltaic module **100** is rectangular, this being a mere example, whereas the agro-photovoltaic module can assume any polygonal (such as a hexagon illustrated in Figs. 4A to 5B, symmetric or not), or round, or hybrid shapes (as illustrated with respect to Figs. 6A to 6B). Likewise, other elements of the agro-photovoltaic module have a corresponding rectangular shape, as a result of present examples employing a rectangular agro-photovoltaic module.

The agro-photovoltaic module **100** comprises a growing tray **120** having a bottom surface **122** and circumferential side walls **124** defining a basin, configured to facilitate a growing bed therein (not illustrated) for enabling the growth of plants, a photovoltaic cell **130** is positionable over the growing tray **120**, e.g. by rods **132**, configured to produce photovoltaic energy, such that a majority of the produced photovoltaic energy is directed to an external electric power system (not illustrated), and a water collecting tank **110** positioned beneath the growing tray **120** configured to store water therein. The stored water in the water tank **110** can be used to water the agricultural products growing within the growing tray **120** or other agricultural products, thereby preserving water usage. The water tank **110** has circumferential side walls **114**, such that the growing tray **120** is supported by side walls **114** e.g. when nesting within water tank **110**. It should be noted that although the agro-photovoltaic module **100** comprises the water collecting tank **110**

the two basic elements of the module are the growing tray **120** and the photovoltaic cell **130**. In some embodiment all of the produced photovoltaic energy is directed to an external electric power system.

The growing bed can be introduced into the growing tray **120**, to enable
5 agricultural growth of plants, e.g. vegetables, flowers, shrubs or alike. Accordingly, the growing bed can be any solid or semi-solid growing bed, such as soil, manure, tuff, perlite, peat or alike. The growing bed is supported by the bottom surface **122** and by the side walls **124** of the growing tray **120**. The bottom surface of the growing tray **122** is inclined towards a drainage port **126** to enable drainage of excess water from the growing
10 tray **122** to the water collecting tank **110**. Excess water may result from rains, irrigation and/or use of growing bed which does not "hold" water. The drainage port **126** comprises a filter **127**, such as gravel filter, sand filter, carbon filter, membraned filter or any other sort of water filter, that insures that at least a majority of the growing bed does not enter the water tank **110**.

15 The water tank **110** can receive excess water form the growing tray **120** as detailed hereinabove or by a direct water line which can be connected to water port **116**. Whereas water port **116** is configured to receive water into the water tank **110**, e.g. via connection to a hose, an additional water port **116** (not illustrated) can be configured to enable flow of water to like water tanks, or to big water collection tank e.g. when forming a system
20 of agro-photovoltaic modules **100**, such as system **700** illustrated in Fig. 7. The water stored in the water tank **110** can be used for irrigation of the plants growing within the growing tray **120**, e.g. through irrigation port **128**. The stored water in the water tank **110** can "travel" to the irrigation port **128** by using the capillary lows, or by using a pump. It should be noted that the stored water in water tank **110** can also be used for irrigation of
25 like growing trays of other agro-photovoltaic modules, e.g. when being part of a system. Air hole **129** is configured at an upper portion of the water tank **110** thereby enabling air to enter or exit the water tank **110**. For example, upon water exiting the water tank **110**, e.g. via irrigation port **128**, to irrigate the plants in the growing tray **120**, air must enter the water tank, e.g. via air hole **129**. On the other hand, when filling up the water tank,
30 via water port **116**, air must exit the water tank **110**, e.g. via air hole **129**.

The photovoltaic cell **130** is detachably attachable to bottom unit **140** or any part thereof, e.g. the growing tray **120** and/or the water collecting tank **110**, this is best illustrated with respect to Figs. 4B and 5B. Detaching the photovoltaic cell **130** from unit

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140, enables stackable nesting elements of like modules, such as like growing trays and/or like water collecting tanks as detailed with respect to Fig. 3. The photovoltaic cell **130** is positionable over the growing tray **120**, at an upmost section of the module, to enable a direct line of sight with sunlight or artificial lighting. Additionally, by being
5 positioned above the growing tray **120**, the photovoltaic cell **130** shelters the plants growing in the growing tray **120**, which reduces their exposure to direct sunlight. Reducing exposure to direct sunlight is mainly desired during mid-day, i.e. the hottest hours of the day. For example, having the plants sheltered from direct sunlight can help reduce the water vapor by 12-34%, thereby improving water usage. Furthermore,
10 sheltering the plants can also be effective during heavy rains, hail, or hard weather which may be harmful to delicate plants, such as flower or herbs. As illustrated, the photovoltaic cell **130** is inclined towards the growing tray **120**. This inclination helps guide rain or irrigation water, e.g. when using sprinklers, falling onto the photovoltaic cell **130** to reach the plants growing within growing tray **120**, thereby ensuring that the plants receive the
15 maximal amount of water available to the land pace occupied by the agro-photovoltaic module. This inclination, may also help guide rain or irrigation water falling onto the photovoltaic cell **130** to reach the water tank **110**, e.g. for storage therein.

Furthermore, since the plants growing in the growing tray **120**, may help maintain a more moderate temperature then the surrounding area, e.g. due to vapor of water from
20 the plants, the efficiency of the photovoltaic cell **130**, positioned directly above them, may be increased as a result of the more moderate temperature, e.g. by 4-6%. Therefore, positioning the photovoltaic cell **130** over the growing tray **120** may increase both agricultural efficiency and energy production efficiency.

The positioning of the agro-photovoltaic module **100**, or at least the growing tray
25 **120** and/or the photovoltaic cell **130**, can be according to the environmental conditions. For example, upon positioning of the agro-photovoltaic module **100** at a desired location, a user may take into consideration the amount of sheltering required for the plants growing within the growing tray **120**, and/or the amount of direct sunlight desired for the photovoltaic cell **130**. In some embodiments, an optimization program may recommend
30 the desired angle at which direct sunlight reaches the photovoltaic cell **130** with respect to the amount of sheltering required for the plants, according to the global positing of the agro-photovoltaic module **100**.

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It should be noted that the photovoltaic cell **130** is configured to produce more photovoltaic energy than required by the agro-photovoltaic module **100**, e.g. when using a pump to propel the water from the collecting tank **110** to growing tray **120**, or when using artificial internal lighting to increase lighting for the plants, motors for rotating or pivoting the growing tray **120** and/or the photovoltaic cell **130** etc. Therefor, at least a majority of the produced photovoltaic energy is directed to an external electric power system, which may be external with respect to the elements comprising the agro-photovoltaic module, e.g., an external power grid, a battery, an end user any combination thereof or any other electrical energy transporting, consuming or storing device(s). The photovoltaic cell **130** can be connectable to the external electric power system directly or the photovoltaic cell **130** can be connectable to like photovoltaic cells to form a series circuit, a parallel circuit or series of any combination thereof which may then be connected to the external electric power system as a circuit.

According to another aspect of the presently disclosed subject matter the growing tray **120** the solar panel **130** or both, may be rotatable with respect to the water tank **110**. For example, after positioning the agro-photovoltaic module **100** at its location, the growing tray **120** may be pivoted according to the movement of the sun through the day, e.g. at least along a horizontal reference plane of agro-photovoltaic module **100**. For example, to increase production of the photovoltaic cell **130**, which may be rotated along with the growing tray **120**, and/or to increase the plants exposure to the sun,. This “following the sun” function may be done manually and/or by a motor, e.g. according to an optimization program, such as a computer program or other predefined algorithm, configured to optimize the production of energy and/or agricultural growth. In some embodiments, the growing tray **120** can be configured to float on the water stored within the water tank **110**, when doing so the friction between the growing tray **120** and the water tank **110** may be reduced thereby enabling the rotation and/or pivoting to be completed by using less force than otherwise required.

Although not illustrated, the growing tray **120** can comprise a side door for enabling easy access to the plants or growing bed. The door may be opened to facilitate a side entrance thereby enabling a user an additional access point to the plants or growing bed, e.g. for replacing the growing bed. In some embodiments, the growing tray **120** can have more than one side door, e.g. two doors or more. When comprising more than one side door, the doors may be posited along the same side wall **124**, e.g. at opposite ends of

the same side wall, or at different side walls **124a**, **124b**, **124c** or **124d**, thereby enabling multiple access points to the plants and/or growing bed.

According to an aspect of the presently disclosed subject matter, the agro-photovoltaic module **100**, or any part thereof, is mobile by hand, at least when empty. For example, the agro-photovoltaic module **100** can be moved by a user without additional assistance such as a forklift. Accordingly, the user may place the agro-photovoltaic module **100** in its designated location, which may be out in an open field or on top of a roof. Accordingly, when empty, or when placed at a windy location it may be advised to secure the agro-photovoltaic to the ground, e.g. by stakes, wedges and/or ropes, to prevent it from unintentional movement, at least until it may be filled with the growing bed or water or sheltered from the wind. In other embodiments, e.g. when the agro-photovoltaic module **100** as a whole may weigh over 100kg, the module may not be mobile by hand.

According to an aspect of the presently disclosed subject matter, the agro-photovoltaic module **100** or any part thereof can be mobile, even when full of water and/or growing bed, e.g. by a forklift, a tractor or any other agricultural or industrial machinery. For example, water tank **110** comprises grooves **119** disposed at its bottom section (illustrated best in Figs. 2A and 2B as grooves **219**). The grooves **119** enable forks of a forklift to easily elevate, move and/or displace/reposition the agro-photovoltaic module **100** or part thereof (such as bottom unit **140** or water tank **110**). In most cases, after the agro-photovoltaic module **100** has been filled with the growing bed, water or when plants have started to grow, its total weight may prevent unintentional movement. Nonetheless, when necessary to reposition the agro-photovoltaic, e.g. due to change of weather or the scenery (such as shading of a new tree or building), agricultural or industrial machinery, such as forklifts, tractors, truck or cranes may be of such an assistance.

Fig. 1C illustrate a construction of bottom unit **140** by detachably attaching the growing tray **120** with the water tank **110**. As illustrated the growing tray **120** is configured for being nested within the water collecting tank **110**, such that side walls **114** support at least a portion of side walls **124** and lever **118** supports at least a portion of bottom surface **122**, therefore no additional securing members are required. However, when the growing tray **120** is not nested within the water tank **110**, securing members, such as a snap fit, a locking pin and/or clip and/or other securing member which can enable quick release and activation thereof, which can be used to ensure that after attachment, growing tray **120** may not be moved with respect to water tank **110**. In this

example, when the growing tray **120** is formed separately from the water collecting tank **110**, the manufacturing of each unit, i.e. growing tray **120** and/or water tank **110**, can be done e.g. by using a variety of manufacturing technologies and combinations thereof, such as injection molding, vacuum-forming, thermo-forming, blow-molding, any
5 combination thereof, etc.

It should be noted that, when each unit, i.e. growing tray **120** and/or water tank **110**, is manufactured separately, the growing tray **120** can be configured for stackable nesting into like growing trays, such as growing tray **320** illustrated in Fig. 3. Accordingly, water collecting tank **110** can be configured for stackable nesting into like
10 water collecting tanks, such as water tank **310** illustrated in Fig. 3. These stackable nesting characteristics can reduce the total footprint of the unconstructed modules, which in turn can reduce costs, e.g. when stored and/or when shipped.

Fig. 2A illustrates a cross section of a bottom unit **240a**, which comprises growing tray **220a** and water collecting tank **210a**, unit **240a** or any part thereof is similar to unit
15 **140** or any part thereof. However, in this embodiment the growing tray **220a** and the water collecting tank **210a** are formed together into bottom unit **240a**, e.g. by using a Rotation Molding technique or any other manufacturing technique. Manufacturing bottom unit **240a** instead of manufacturing the water collecting tank **110** and the growing tray **120** separately as detailed hereinabove, may be more cost effective and can also
20 facilitate easier displacement and/or movement of the units as a whole. When formed together, i.e. as bottom unit **240a**, the water collecting tank **210a** is configured for being stackable nesting into like growing trays **320** which, in turn are configured to receive therein the water collecting tank **210a**, as illustrated in Fig. 3. This is also true for growing trays **120** or water tanks **110** which are also configured for being stackable nesting into
25 like growing trays **320** or like water tanks **310**.

Fig. 2B illustrates a cross section of a bottom unit **240b**, which comprises growing tray **220b** and water collecting tank **210b**, unit **240b** or any part thereof is similar, at least in their general functionality, to unit **140** or any part thereof. However, in this embodiment the growing tray **220b** is divided into multiple individual growing units **221**, such that
30 each individual growing unit **221** is submerged into water tank **210b** and has at least one hole which enables water to enter the individual growing unit **221**, thereby "flooding" the unit. Individual growing units **221**, are usually aimed for hydroponic growth. In this embodiment, the growing bed can be semi-liquid, moist or liquid for enabling hydroponic

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growth of plants. At least one drainage port **226b** is disposed at each individual growing unit **221b**. In most cases more than one drainage ports **226b** are disposed for each individual growing unit **221b** to enable continuous water circulation from and to the water collecting tank **210b**. Although not illustrated, in some embodiments, the bottom unit as
5 a whole can enable aquaponic growth of fish, e.g., when the growing tray is fully submerged into the water tank or by canceling growing tray and optionally extending the total size of the water tank. In this example and when forming a system comprising at least two agro-photovoltaic modules, i.e. when at least one growing tray is fully submerged into the water tank or canceled to enable aquaponic growth of fish, the
10 aquaponic bottom unit can be connected to other bottom units aimed for use with solid, semi-solid, semi-liquid or liquid growing bed to enable these bottom units to use natural fertilized water, produced by the fish.

Fig. 3 illustrates stackably nesting unit **140**, on top of like unit **340**, comprising the growing tray **120** and water tank **110**, it should be noted that other bottom units of other
15 modules can also be stackable and/or nesting in bottom unit **340** or other like bottom units. When stacking several bottom units **140** together, the water collecting tank **110** is nested within like growing tray **320**, such that at least a portion of bottom surface **112** or side walls **114** of the water collecting tank **110** is supported by like bottom surface **322** or like side walls **324** of like growing tray **320**. The stackable nesting characteristics can
20 reduce the total footprint of the unconstructed modules, which in turn can reduce costs, e.g. when stored and/or when shipped.

Figs. 4A to 5B illustrate an agro-photovoltaic module generally designated **400** having a general hexagon shape, according to an example of the disclosure. Although the agro-photovoltaic module **400** has a general hexagon shape, the module **400** and parts
25 thereof are similar in their functionality to the agro-photovoltaic module **100** and its parts thereof disclosed hereinabove. For example, water tank **410** along with side walls **414**, bottom surface **412** and water port **416**, etc., are equivalent in their functionality to water tank **110** and the elements comprising it such as side walls **114**, bottom surface **112** water port **116** etc. Additionally, photovoltaic cell **430** and rods **432** are equivalent to
30 photovoltaic cell **130** and rods **132**, and growing tray **420** is equivalent in its general functionality of holding the growing bed and growing plants therein to growing tray **120**. The hexagon shape, enables the agro-photovoltaic module **400** along with like modules to form a hive like system, as illustrated in Fig. 8, which has a better spacing efficiency

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than other shapes. Connecting elements **418**, are disposed at the bottom of most of side walls **414**. Connecting elements **418** are configured to connect the agro-photovoltaic module **400** to like modules, thereby preventing them from moving with respect to each other. In this embodiment, each connecting element **418** has a hollow elevated section
5 configured for being inserted into link hollow elevated section of like modules or vice versa.

In this example, Fig. 5B illustrates that growing tray **420** is divided into multiple individual growing units **421**, although not illustrated growing units **421** have at least two water holes that enable a "water connection" between the growing units **421** which in turn
10 enables water to flow freely from one unit **421** to the other. In some embodiments, units **421** are formed without the water holes and each unit **421** acts by its own as a small growing tray. Individual growing units **421**, are usually aimed for growing delicate plants, such as flowers, unlike growing units **221** illustrated in Fig. 2B which are mainly designed to facilitate hydroponic growth. It should be noted that although growing units **221**
15 growing unit **421** are target different growing techniques they are similar at least in their functionality.

Air hole **429** is configured at an upper portion of the water tank **410** thereby enabling air to enter or exit the water tank **410**, as detailed with respect to air hole **129**.

Fig. 5B clearly illustrates sockets **428** which are configured for detachably
20 attaching rods **432** to bottom unit **440**. Rods **432** can be easily inserted into sockets **428** and/or removed, e.g. by pulling them out, from sockets **428**, i.e. detaching photovoltaic cell **430** from bottom unit **440**. It should be noted that other forms of detachably attaching photovoltaic cell **430** to bottom unit **440**, e.g. via rods **432**, can be done, for example, screw mounting rods, metal profiles, etc.

Reference is now made to Figs. 6A to 6C, which illustrate an agro-photovoltaic
25 module, generally designated as **600** can float on water, such as a water reservoir, e.g. lakes, fish ponds, treated or rain collecting water reservoirs or like reservoirs. This may be achieved due to a fitted design of the module **600** or any part thereof, e.g. having a floating design, the material used during production, such as floatable material and/or by
30 using a floating arrangement which may be connected to the agro-photovoltaic module **600** as a whole or to any part thereof. In this example, module **600** further comprises floating arrangement **650** configured to support bottom unit **640** and to float on water, floating arrangement **650** enables positioning the agro-photovoltaic module **600** in water

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reservoirs thereby increasing their "usable areas". For example, floating arrangement **650** enables agricultural growth and the production of energy, e.g. by using growing tray **620** and photovoltaic cell **630**, on areas which were not available for agricultural use, prior to the use of module **600**. Floating arrangement **650** is generally hollowed and sealed, thereby using the air "trapped" inside for increasing floating capabilities. Additionally, the floating arrangement **650** is made of a material that floats on water, such as plastic, wood or any other floating material. The floating arrangement **650**, in general, is designed to frame bottom unit **640** by side walls **654** which form a confined basin **655** preventing bottom unit **640** from drifting away. Bottom surface **652** is designed to support bottom unit **640** so that it will not sink in the water, e.g. by providing at least one resting point **651**, configured to support the water tank's bottom surface **612**. In this example, resting point **651** is slightly elevated with respect to the rest of bottom surface **652**. Additionally, bottom surface **652** has openings **653** which enable water to enter basin **655** thereby surrounding bottom unit **640** at least from its side walls **614** and bottom surface **612**.

In this embodiment, bottom unit **640** is configured to pivot with respect to the floating arrangement **650** for example along a horizontal reference plane of module **600**, e.g. by hand or a motor. Pivoting bottom unit **640** can help increase the effective lighting that reaches the growing tray **620** and/or photovoltaic cell **630** which in turn can increase the power generated by it. For example, since photovoltaic cell is detachably attachable to bottom unit **640**, e.g. by rods, **632**, pivoting bottom unit **640** pivots in turn photovoltaic cell **630**, which enables the growing tray **620** and the photovoltaic cell **630** to "follow the sun". This "following the sun" ability may be done manually or by a motor, e.g. according to a predetermined optimization program, such as a computer program/algorithm or other predefined algorithm, configured to optimize the production of energy and/or agricultural growth.

When water enters basin **655**, they help to reduce the friction between the bottom unit **640** and floating arrangement **650**, which in turn also reduces the power required to pivot bottom unit **640** with respect to the floating arrangement **650**. Reducing the power required for pivoting, e.g. by a motor, results in less power required to operate the agro-photovoltaic module **600**, enabling more of the produced power to be available for external use e.g., an external power grid, a battery, an end user or any combination thereof or any other electrical energy transporting, consuming or storing device.

Since bottom unit **640** nests within basin **655** and they are two separate elements, bottom unit **640** is also pivotable with respect to the like modules or like bottom units attached to module **600**, e.g., via floating arrangement **650**, e.g., when forming a floating system which comprises multiple modules **600**. It should be noted that the agro-
5 photovoltaic module **600** can also be used on a "hard" surface such as ground or rooftops. Thereby, when being part of a system, each photovoltaic cell **630** and growing tray **620** can be pivoted individually, with respect to the rest of the bottom units in the system. In other embodiments bottom unit **640** or water tank **610** may not be pivoted with respect to the floating arrangement **650**, e.g. when the water tank **610** and the floating arrangement
10 **650** are formed as one unit.

In this example, the agro-photovoltaic module **600** comprises a pivoting element **634**, which enables photovoltaic cell **630** to be pivoted at an angle with respect to bottom unit **640**, i.e. along the vertical plain of the agro-photovoltaic module **600**. Pivoting element **634**, enables further adjustment of the photovoltaic cell **630**, e.g. to better "follow
15 the sun" as detailed hereinabove and/or to increase and/or decrease the shelter provided to the plants growing in growing tray **620** by photovoltaic cell **630**.

In some embodiments, e.g. when the water tank **610** is formed along with floating arrangement **650**, bottom unit **640** may not pivot with respect to floating arrangement **650**. When growing tray **620** and accordingly photovoltaic cell **630** can not pivot with
20 respect to the floating arrangement **650** there may not be any additional adjustments of the photovoltaic cell **630**, such as "following the sun" function detailed hereinabove.

Although in this embodiment growing tray **620** is illustrated as having individual growing units similar to growing units **421** and/or **221** it may also be similar to growing tray **120**, all the detailed hereinabove embodiments may comprise an air hole **629** is
25 disposed at an upper portion of the water tank **610** thereby enabling air to enter or exit the water tank **610**, as detailed with respect to air hole **129**.

Although not illustrated, in some embodiments, e.g. when used for hydroponic growth, the agro-photovoltaic module **600** may not comprise a water tank at all. Accordingly, bottom surface **652** can therefore be designed to support growing tray **620**
30 so that it will not sink in the water, e.g. by providing at least one resting point **651**, configured to support the growing tray's bottom surface. In this embodiment, the plants growing in the growing tray **620** can receive there water directly from the water reservoir, e.g. by having their roots submerged or at least touch the water within the water reservoir.

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Figs. 7 and 8 illustrate systems **700** and **800** respectively, each system comprises multiple agro-photovoltaic modules as described hereinabove. It should be notated that although in this examples system **700** is comprised solely of multiple agro-photovoltaic modules **100** and system **800** is comprised solely of multiple agro-photovoltaic modules **400**, a system comprising of at least two agro-photovoltaic modules, can be comprised of any combination of agro-photovoltaic modules **100**, agro-photovoltaic modules **400** or like agro-photovoltaic modules. Each system enables the photovoltaic cells, such as **130**, **430** and/or like, of each of the modules **100**, **400** and/or like to be connectable by there own and/or as part of the system **700**, **800** and/or like to the external electric power system, such that at least a majority of the energy produced by the photovoltaic units in the system is directed to an external use, with respect to the elements comprising the system. It should be noted that when forming a system of agro-photovoltaic modules **100**, **400** and/or like, it is preferable that the photovoltaic cells are connected to form a series circuit, a parallel circuit or series of any combination thereof which can then be connected to the external electric power system thereby increasing the voltage and/or current produced by the system **700**, **800** and/or like, e.g. according to the requirements of the external electric power system.

Fig.7 illustrates a plantation that integrates system **700**, which comprise multiple agro-photovoltaic modules **100** distributed, e.g. by a tractor, between the trees. By integrating system **700** into the plantation, the effective use of the available land space is increased, e.g. in an agricultural manner (use of growing trays **120** to grow plants) and energy wise.

In some embodiments agro-photovoltaic modules **100** of system **700** may not contain growing tray **120** but solely photovoltaic cell **130** and water tank **110**. For example, to collect rainwater that would be collected in water tanks **110**, which will be used to water the trees in the plantation. It should be noted that the agro-photovoltaic modules of system **700** can be connected to each other and/or to an external water collecting tank (not illustrated), e.g. via water port **116**. When system **700** is connected to the external water tank, the water stored water in each agro-photovoltaic module can be collected, e.g. via a pump, to the external water tank. Additionally, when system **700** is connected to the external water tank, water stored within the external water tank can be distributed to each agro-photovoltaic module in system **700** when needed.

Fig. 8 illustrates positioning system **800** on top of a roof of a building, e.g. by positioning multiple agro-photovoltaic modules **400** adjacent to each other. Since agro-photovoltaic modules **400** have a general hexagon shape, system **800** has a general hive shape. Positioning system **800** on top of a roof may have several advantages on top of utilizing the space for the production of energy and/or growing plants. For example, the use of system **800** may further provide thermal and acoustic insulation for the building. Additional, since growing trays **420** and water tanks **410** also collect rainwater during rain events, the use of system **800** in the urban area can decrease the water load onto the municipal drainage system.

Thereby, using systems **700**, **800** or like systems enables to utilize any unused space, whether it is out in the open, within a plantation or on top of a roof, and may have additional benefits to the area at which they are disposed at. It should be noted that the agro-photovoltaic modules of system **700**, **800** may be positioned at a verily of locations, such as: landfills, contaminated fields, municipal areas, roadsides, young plantations and like areas which have not been used for agricultural purposes for temporary and/or permanent reasons

It should be noted that any one of the particular examples described hereinabove with respect to the agro-photovoltaic modules (**100**, **400** and/or **600**) parts thereof and/or systems **700** and **800** can be implemented, *mutandis mutatis*, in any one of the other modules, parts thereof or systems which may comprise at least two agro-photovoltaic modules, even if not specifically addressed and/or disclosed hereinabove. For example, a system, such as system **700** and/or **800** may comprise different agro-photovoltaic modules. Some modules may comprise a battery for storing the collected energy, whereas other modules may not compose a photovoltaic cell. Some modules in the system may be used for aquaponic growth while others may be used for agricultural growth by using a growing bed and/or hydroponic growth.

Reference is now being made to **Figs. 9A-9C**, which are schematic illustrations of different views of a non-limiting example of the agro-photovoltaic module according to an aspect of the present disclosure. The figures exemplify an agro-photovoltaic module **900** that comprises a water collection tank **910** for storing and collecting water. A growing tray **920** is mounted above the water collection tank **910** and is formed with watering tunnels **960** for placing plants to be grown therein to receive constant water provision in a hydroponic growing method. Each watering tunnel is designed to provide water for a

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plurality of plants. The watering tunnels **960** receives water supply from the collection tank **910**, e.g. via circulating pumps. A perforated cover **962** is fitted over the growing tray **920** such that the perforations **964** are arranged along the watering tunnels **962** to allow the plants to grow therethrough while the rest of the watering tunnels portions are covered to avoid unwanted evaporation of water. The perforated cover **962** can be coated by a reflective material to reflect light to be received by the plants growing in the growing tray **920** or by a photovoltaic cell **930** that is mounted above the growing tray **920**. The photovoltaic cell **930** is mounted on upper end of posts **932**. The bottom ends of the posts **932** are coupled directly or indirectly to the body portion of the agro-photovoltaic module **900** that constitutes the growing tray **920** and/or the water collecting tank **910**. The photovoltaic cell **930** defines a photovoltaic plane **PP** that is inclined at an angle α with respect to a growing tray plane **GTP** defined by the growing tray and is parallel to the ground. The angle α can be between 2°-30° or between 2°-10° or about 5°. Thus, water that falls on the photovoltaic cell **930** flows towards its bottom part and being collected there by a water draining element **966** that circulates the water either to the growing tray or to the water collecting tank **910**.

The term "about" should be interpreted as a deviation of $\pm 20\%$ of the nominal value. For example, if the value is about 10, thus it should be understood to be in the range of 8-12.

The photovoltaic cell **930** can be two-sided, namely that the production of photovoltaic energy is performed from two sides of the photovoltaic unit. Thus, reflections of light from the reflective material of the perforated cover **962** can be received in the bottom side of the photovoltaic cell to produce photovoltaic energy.

CLAIMS:

1. An agro-photovoltaic module comprising:
a growing tray having a bottom surface and circumferential side walls, configured
to facilitate a growing bed for enabling the growth of one of plants or animals;
5 and
a photovoltaic cell positionable over said growing tray, configured to produce
photovoltaic energy.
2. The agro-photovoltaic module of Claim 1, further comprising a water collecting
tank configured to store water therein, wherein said water collecting tank is positioned
10 beneath said growing tray to enable water to drain from said tray to said tank.
3. The agro-photovoltaic module of Claim 2 wherein, said growing tray is
configured for stackable nesting into like growing trays or said water collecting tank is
configured for stackable nesting into like water collecting tanks or wherein said growing
tray is configured for stackable nesting into said water collecting tank, or vise versa.
- 15 4. The agro-photovoltaic module of Claim 2 or 3, wherein said growing tray is
rotatable with respect to the water tank.
5. The agro-photovoltaic module of any one of Claims 2-4, wherein said water tank
has circumferential side walls, wherein said growing tray is contained within said water
tank side walls.
- 20 6. The agro-photovoltaic module of any one of Claims 2-5, comprises one or more
water ports for allowing flow of water between the water collecting tank and at least one
of like water collecting tanks, growing trays, a water feeding line and/or a big collection
water tank, the flow of water is either (i) unidirectional, or (ii) bi-directional, such that
water can flow from and into the collecting tank.
- 25 7. The agro-photovoltaic module of any one of Claims 2-6, being connectable to a
like agro-photovoltaic module either through liquid communication by one or more water
ports or through an electrical connectivity in series or parallel, or through a combination
of the two connection types.
8. The agro-photovoltaic module of any one of Claims 2-7, being connectable via a
30 first port to a first water source including biological matter, and via a second port to a
second water source to discharge processed water after passing through the growing tray.
9. The agro-photovoltaic module of Claim 8, further comprises one or more pumps
for circulating water from the water collecting tank to the growing tray.

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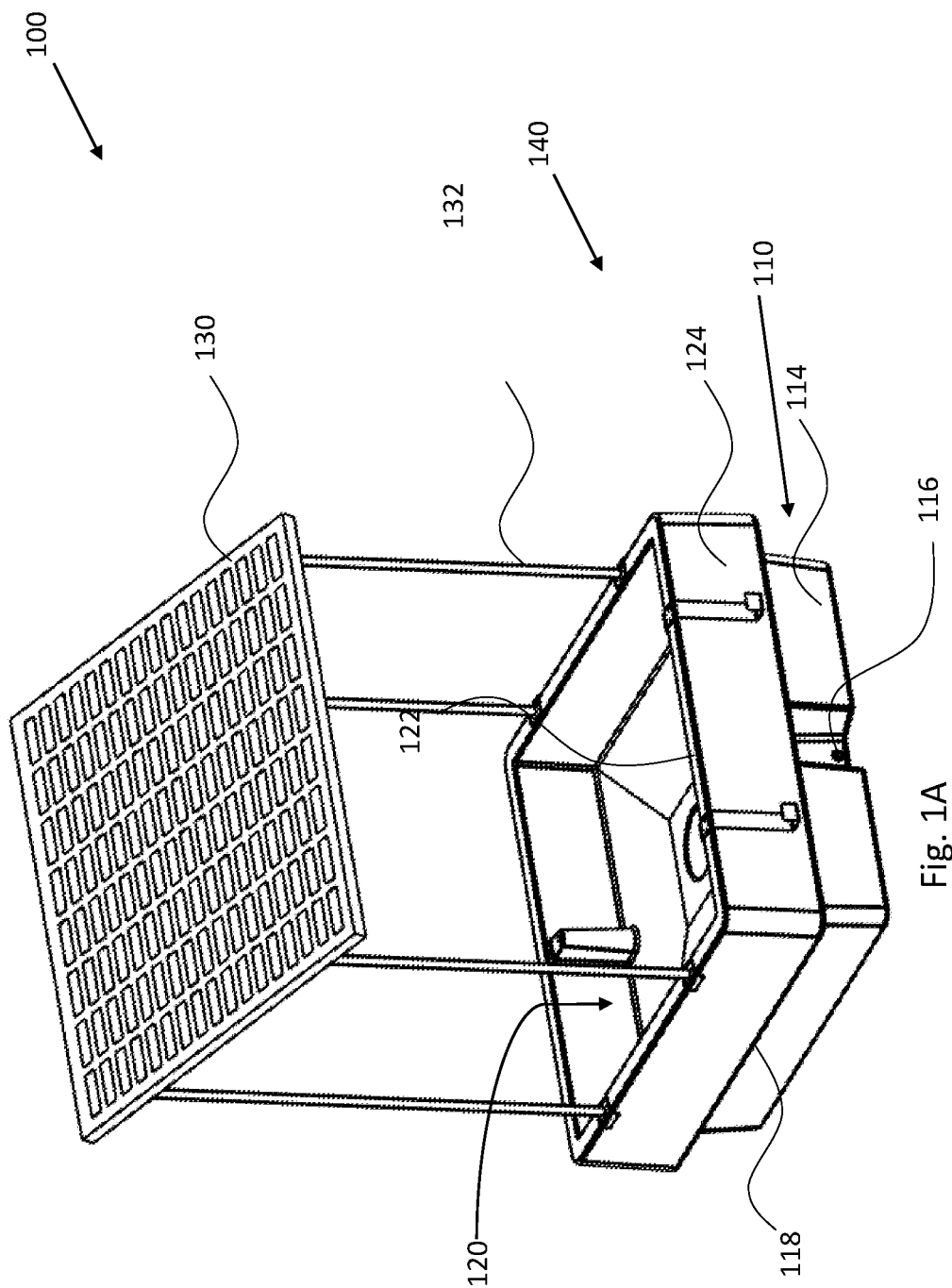
10. The agro-photovoltaic module of any one of Claims 2-9, wherein photovoltaic cell is inclined to define a bottom part of the photovoltaic cell, wherein the bottom part of the photovoltaic cell comprises a water draining element for draining the water flowing over the photovoltaic cell and direct them to either the water collecting tank or the
5 growing tray.
11. The agro-photovoltaic module of any one of Claims 1-10, wherein said agro-photovoltaic module and/or said growing tray are configured to float on water.
12. The agro-photovoltaic module of any one of Claims 1-11, wherein said photovoltaic cell is connectable to like photovoltaic cells to form a series circuit, a parallel
10 circuit or series of any combination thereof.
13. The agro-photovoltaic module of any one of Claims 1-12, wherein said growing bed, is soil, manure, tuff, perlite, peat or any other solid or semi-solid growing bed for enabling the growth of plants.
14. The agro-photovoltaic module of any one of Claims 1-13, wherein said growing
15 bed is semi-liquid, moist or liquid for enabling hydroponic or aeroponic growth of plants or aquaponic growth of fish.
15. The agro-photovoltaic module of any one of Claims 1-14, wherein said growing tray further comprises a side door for enabling easy access to the plants or growing bed.
16. The agro-photovoltaic module of any one of Claims 1-15, wherein said module
20 by its own or as a part of a system is design to float on water.
17. The agro-photovoltaic module of any one of Claims 1-16, wherein the growing tray comprises growing bed for growing animals.
18. The agro-photovoltaic module of any one of Claims 1-17, wherein the photovoltaic cell of the module is two-sided photovoltaic cell.
- 25 19. The agro-photovoltaic module of any one of Claims 1-18, further comprises a processing circuitry and one or more sensors for sensing at least one of: temperature, humidity, water level in the collecting tank and state of the photovoltaic cell, wherein the processing circuitry is configured for controlling at least one of: water inflow/outflow of the system, climate conditions and photovoltaic cell state in response to the measurement
30 received by said one or more sensors.
20. The agro-photovoltaic module of any one of Claims 1-19, wherein the growing tray further comprises watering tunnels for providing constant water supply to plants growing thereon.

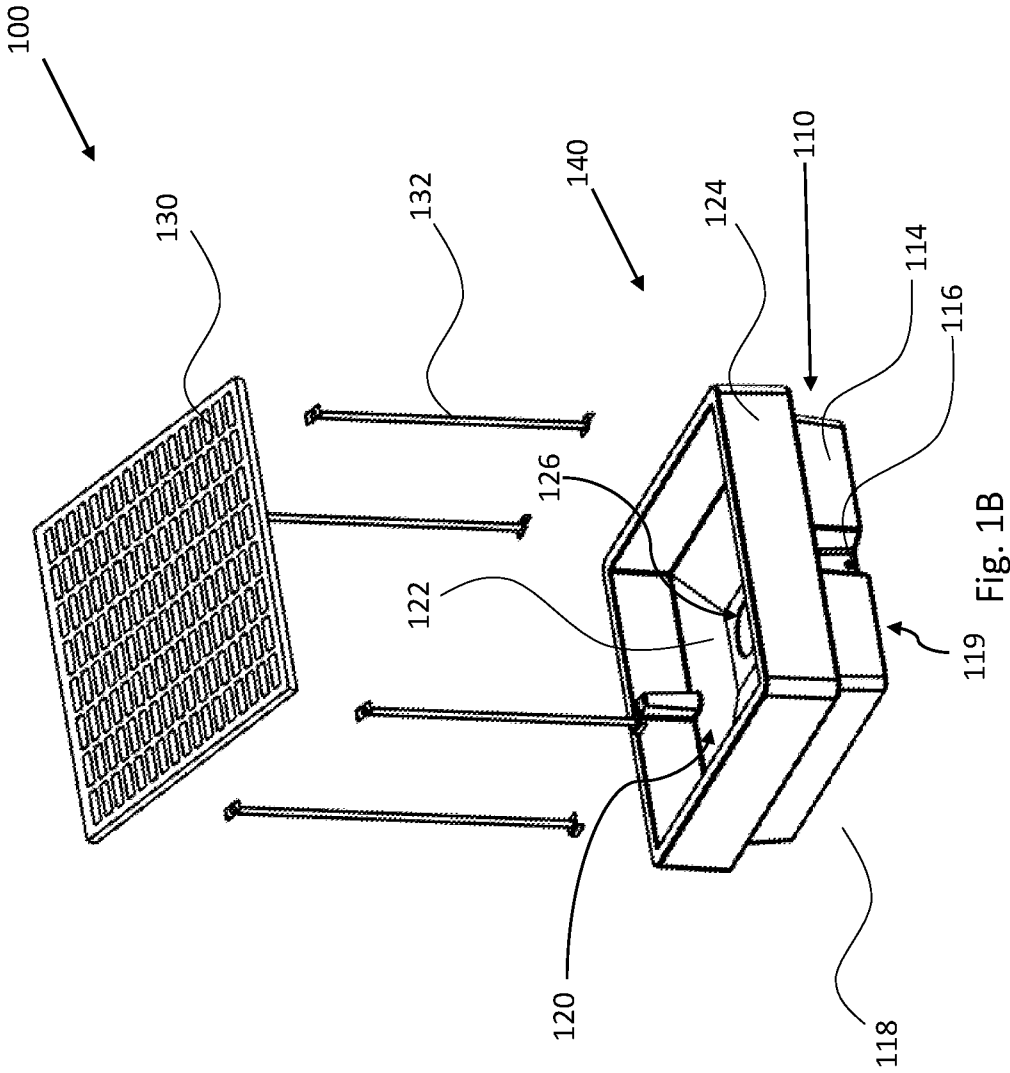
- 27 -

21. The agro-photovoltaic module of any one of Claims 1-20, further comprises a perforated cover mounted on the growing tray, the perforations of the cover are configured for fitting over the plants in the growing tray to allow them to be exposed to the environment.
- 5 22. The agro-photovoltaic module of Claim 21, the perforated cover comprises a photovoltaic facing face that comprises or coated by a reflecting material that is configured to reflect a selected range of electromagnetic radiation.
23. The agro-photovoltaic module of Claim 21 or 22, wherein the growing tray further comprises watering tunnels for providing constant water supply to plants growing thereon
10 and the perforations of the perforated cover are arranged along the watering tunnels to define growing spots for plants.
24. The agro-photovoltaic module of any one of Claims 1-23, wherein a majority of said produced photovoltaic energy is directed to an external electric power system.
25. The agro-photovoltaic module of Claim 24, wherein said photovoltaic cell is
15 connectable to said external electric power system.
26. A system comprising at least at least two agro-photovoltaic modules according to any one of Claims 1-25, wherein the photovoltaic cell of each of the modules is connectable to the electric power system.
27. The system of Claim 26, wherein the photovoltaic cells of the modules are
20 connectable to each other to form a series circuit, a parallel circuit or series of any combination thereof, and said circuit is connectable to the external electric power system.
28. The system of Claim 27, wherein each module is generally shaped as a hexagon such that said system has a general shape of a hive.
29. The system of any one of Claims 1-28, wherein said growing tray is configured
25 to facilitate a growing bed for enabling the growth of one of plants.
30. An agro-photovoltaic module comprising:
a growing tray having a bottom surface and circumferential side walls, configured to facilitate a growing bed for enabling the growth of plants;
a photovoltaic cell positionable over said growing tray, configured to produce
30 photovoltaic energy;
a water collecting tank configured to store water therein, wherein said water collecting tank is positioned beneath said growing tray to enable water to drain from said growing tray to said water collecting tank; and

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wherein the agro-photovoltaic module further characterized by at least one of: (i) comprising a water port for allowing flow of water between the water collecting tank and at least one of like water collecting tanks, growing trays, water source, and/or a big collection water tank; and/or (ii) wherein said photovoltaic cell is connectable to like
5 photovoltaic cells to form a series circuit, a parallel circuit or series of any combination thereof.





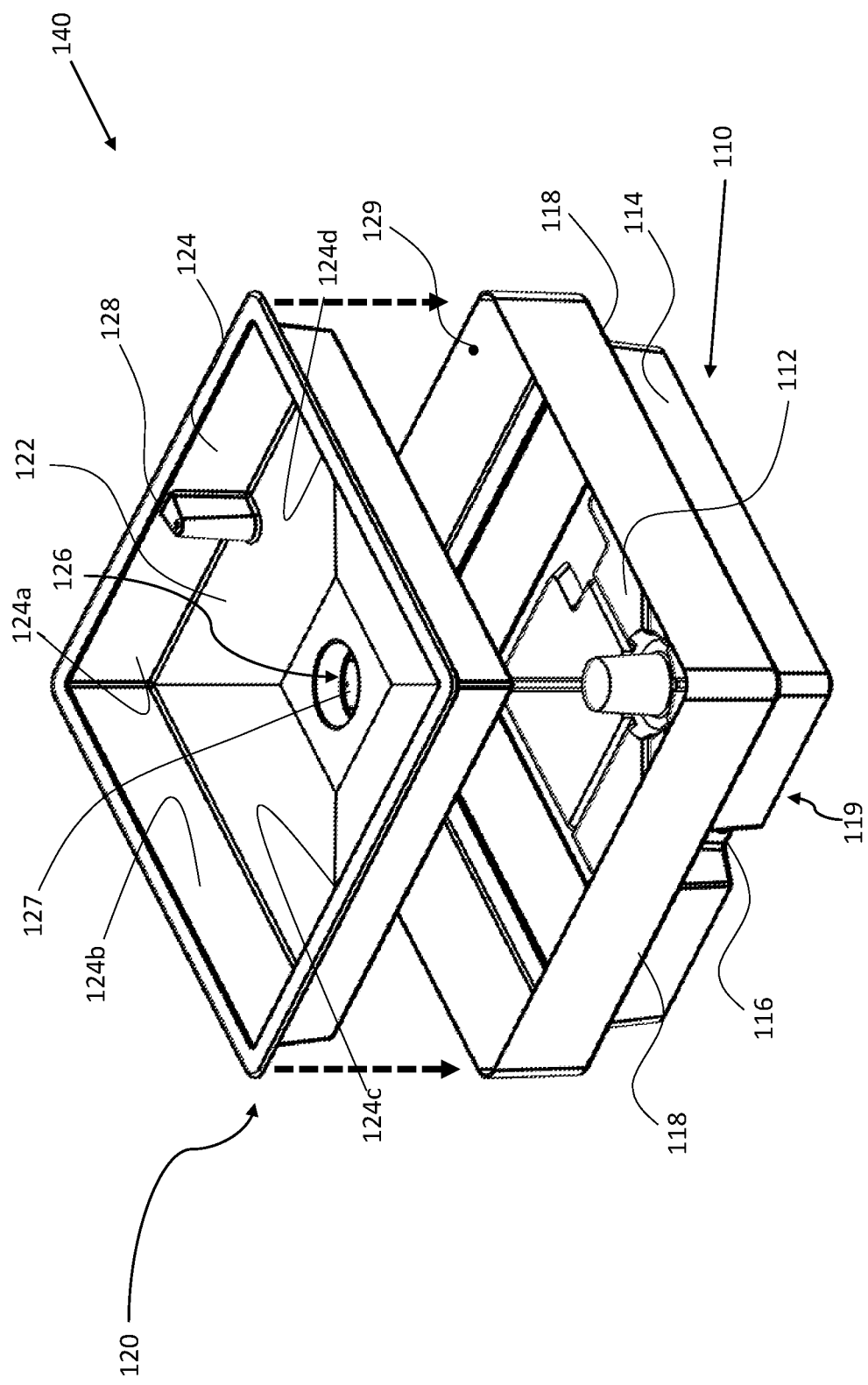


Fig. 1C

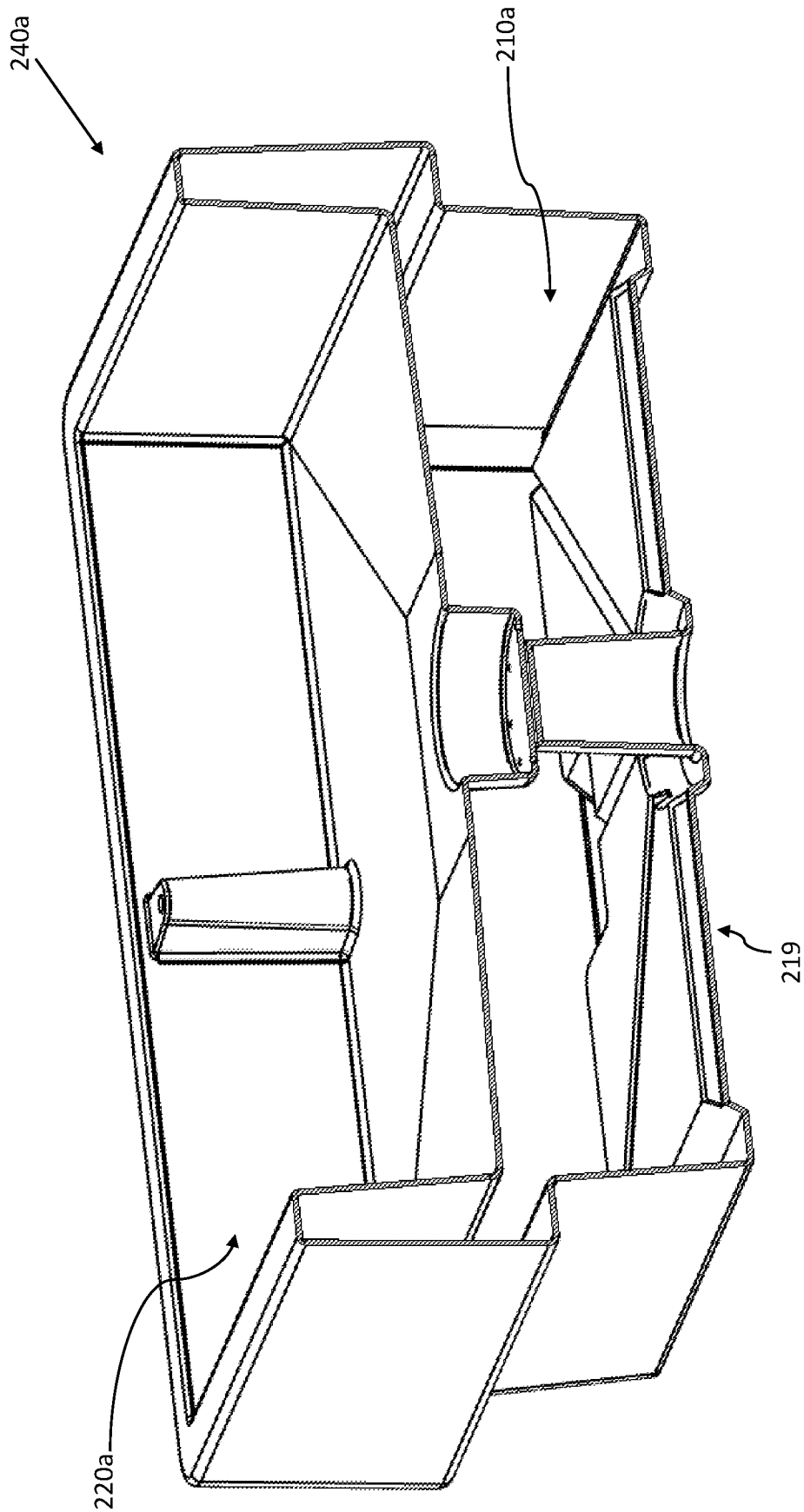


Fig. 2A

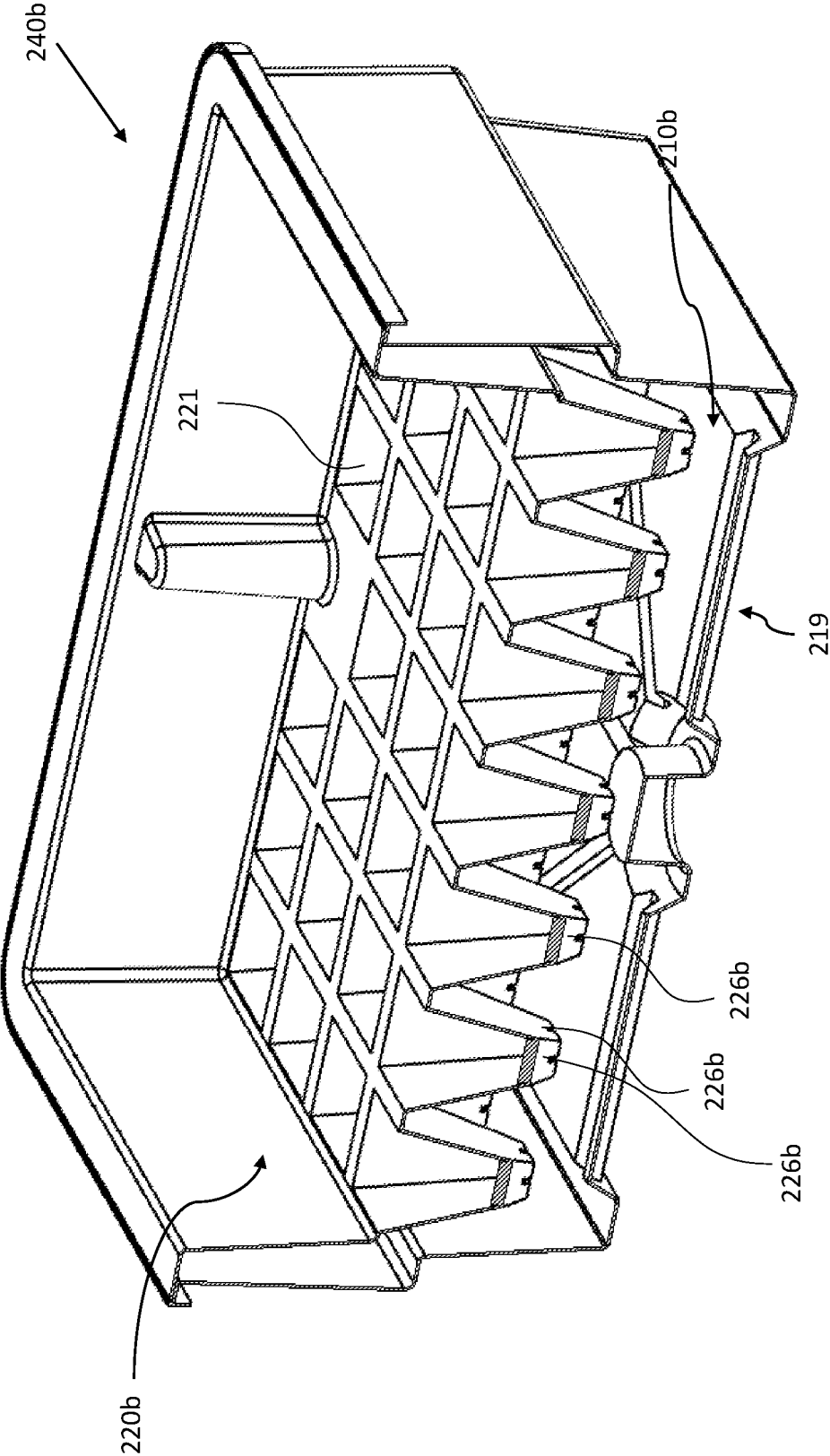


Fig. 2B

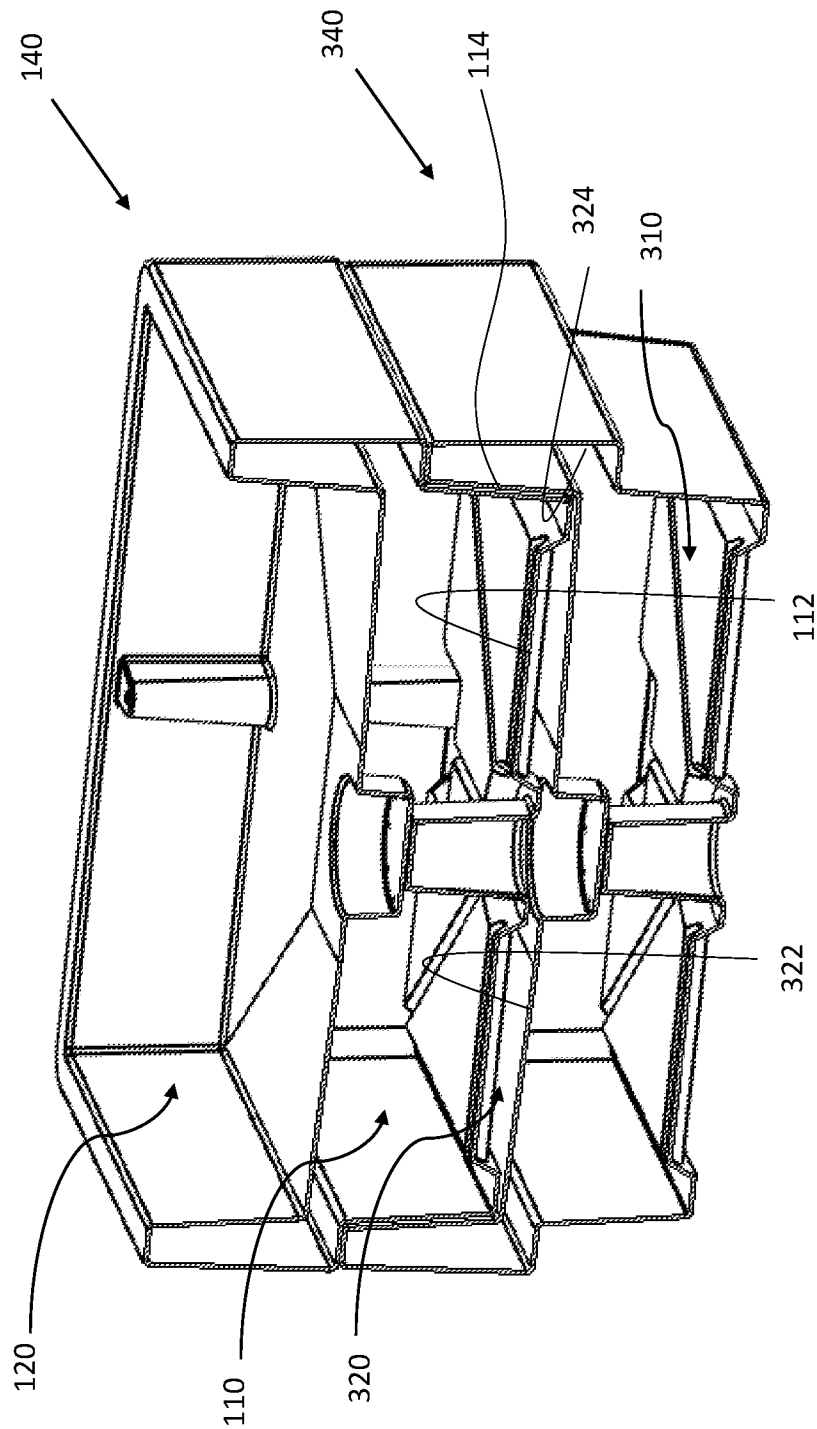


Fig. 3

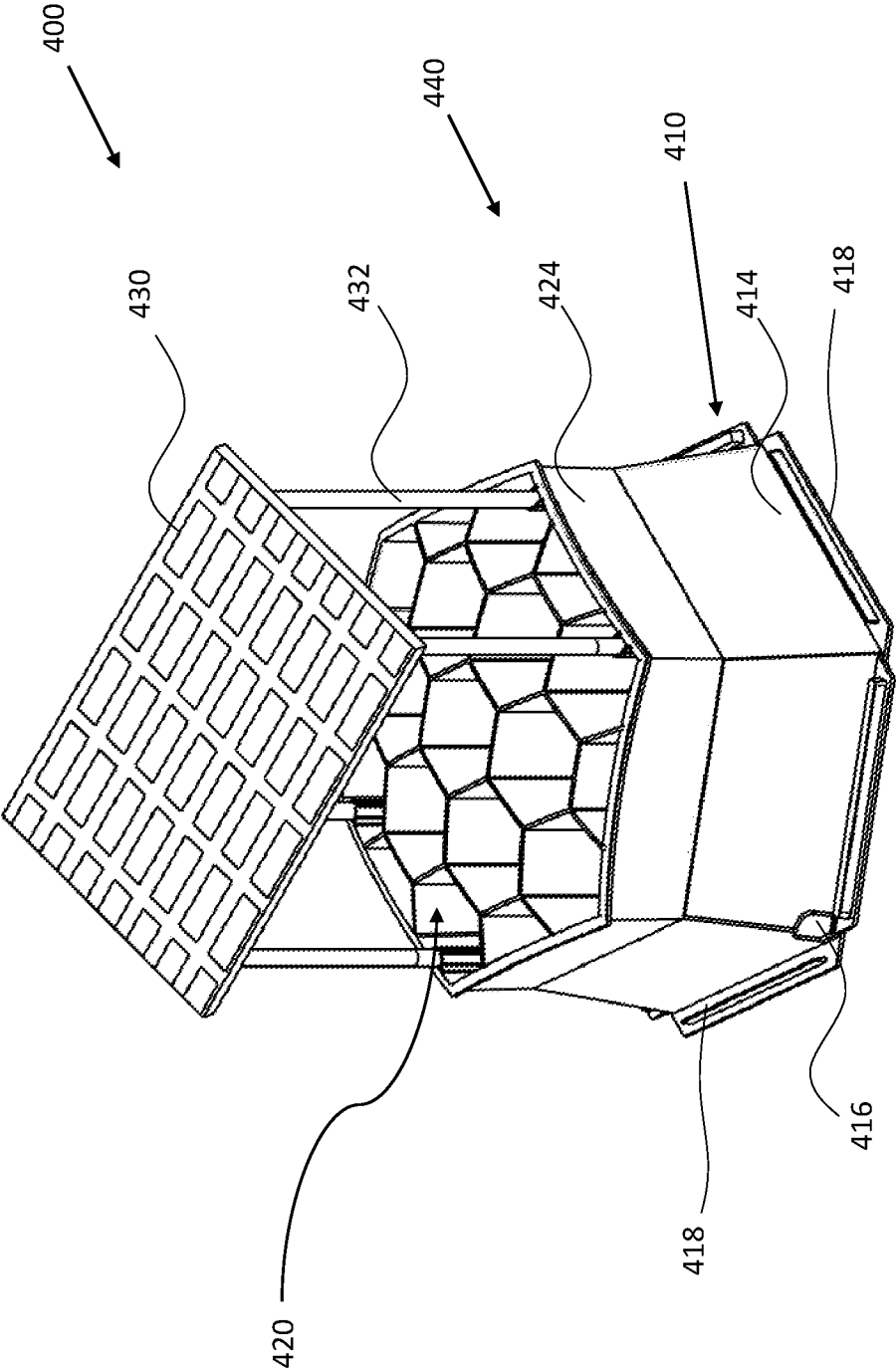


Fig. 4A

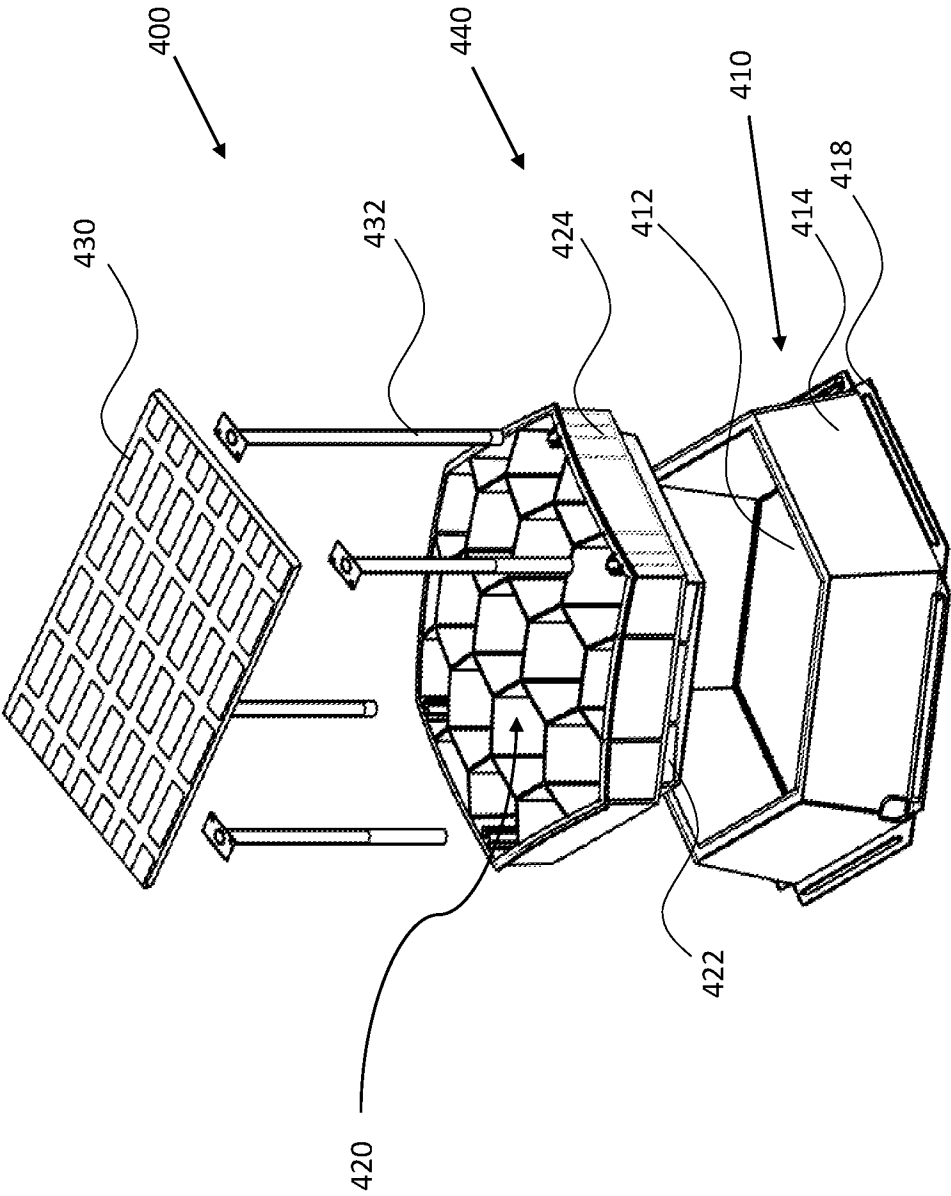


Fig. 4B

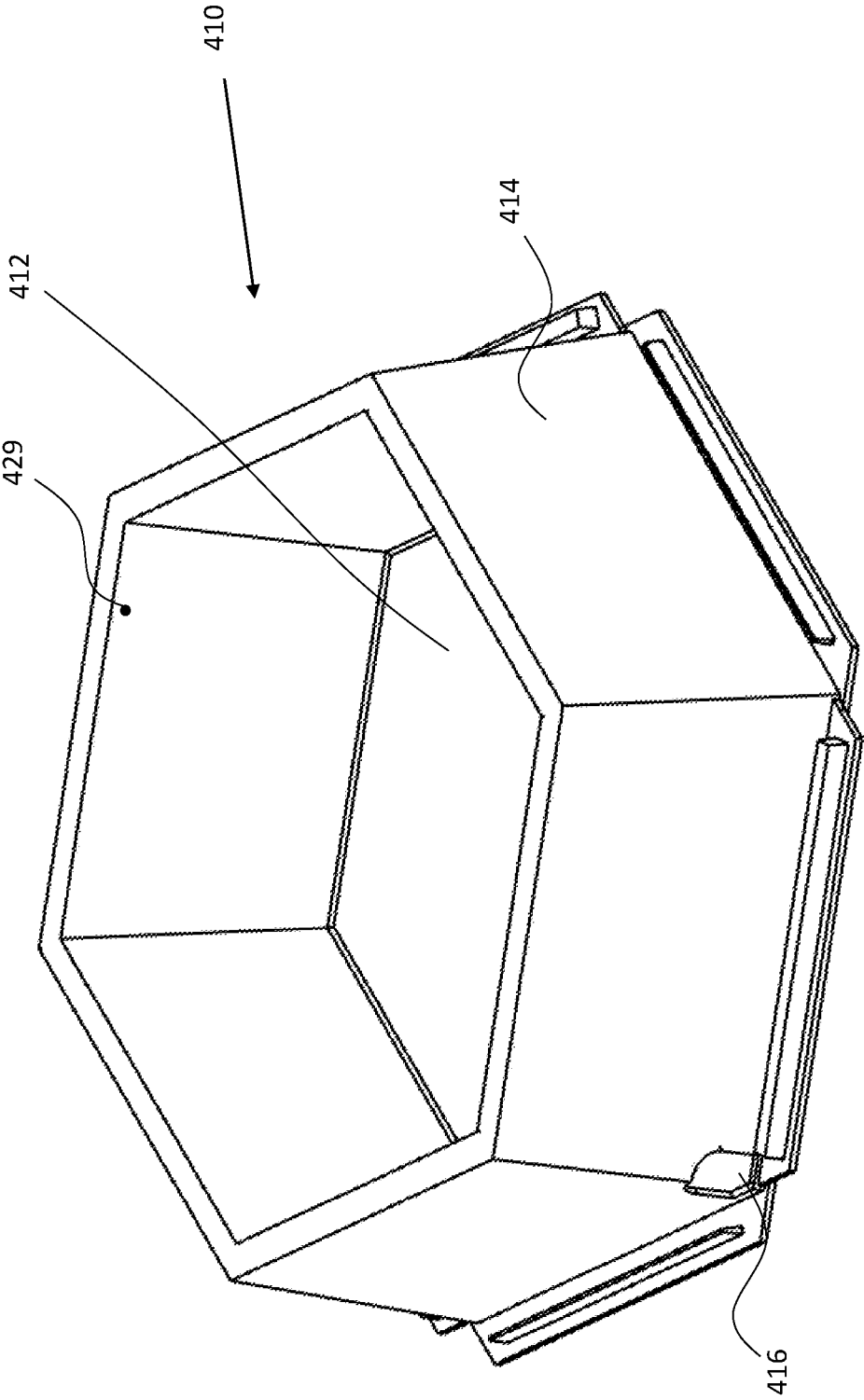


Fig. 5A

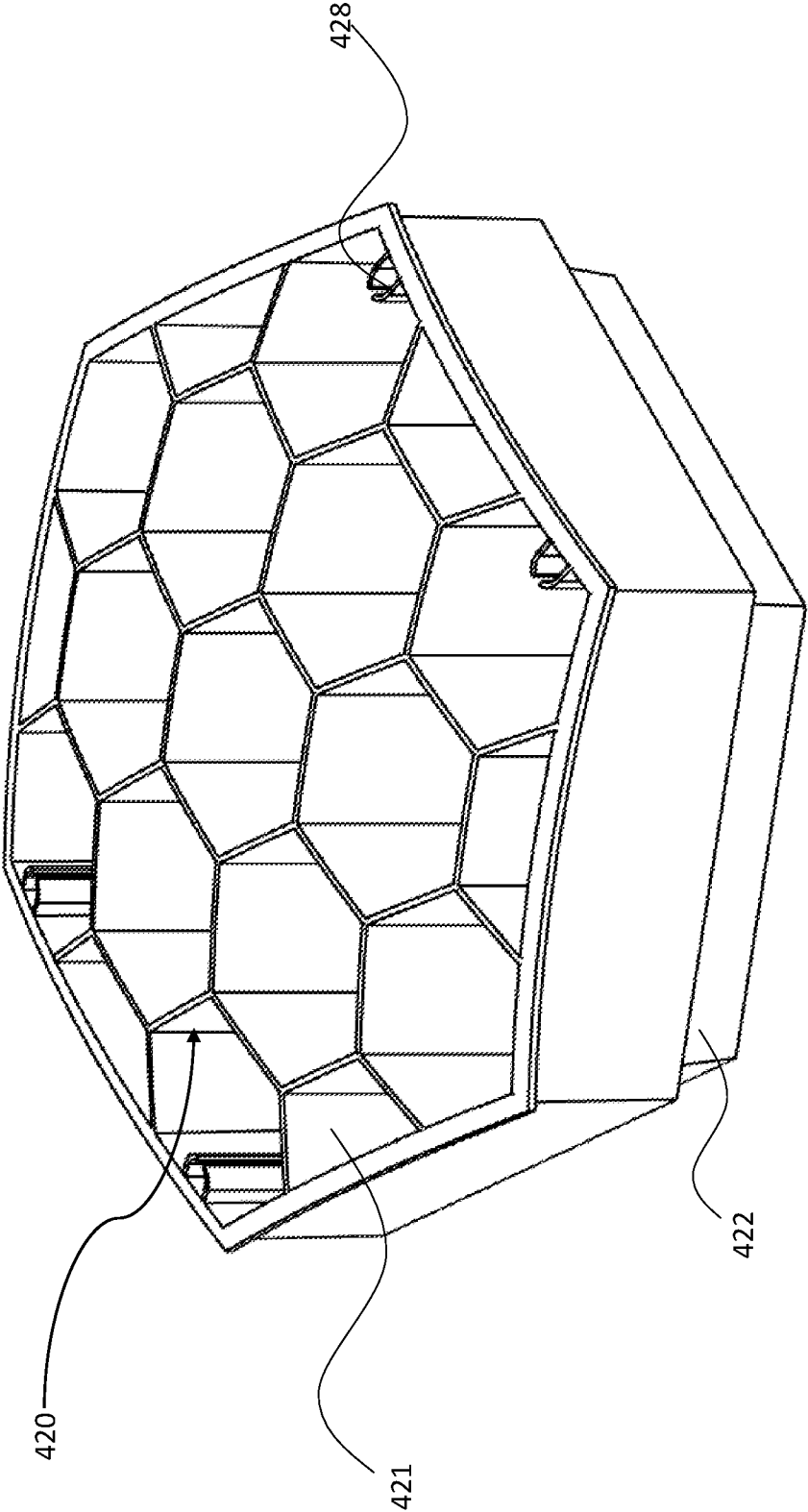


Fig. 5B

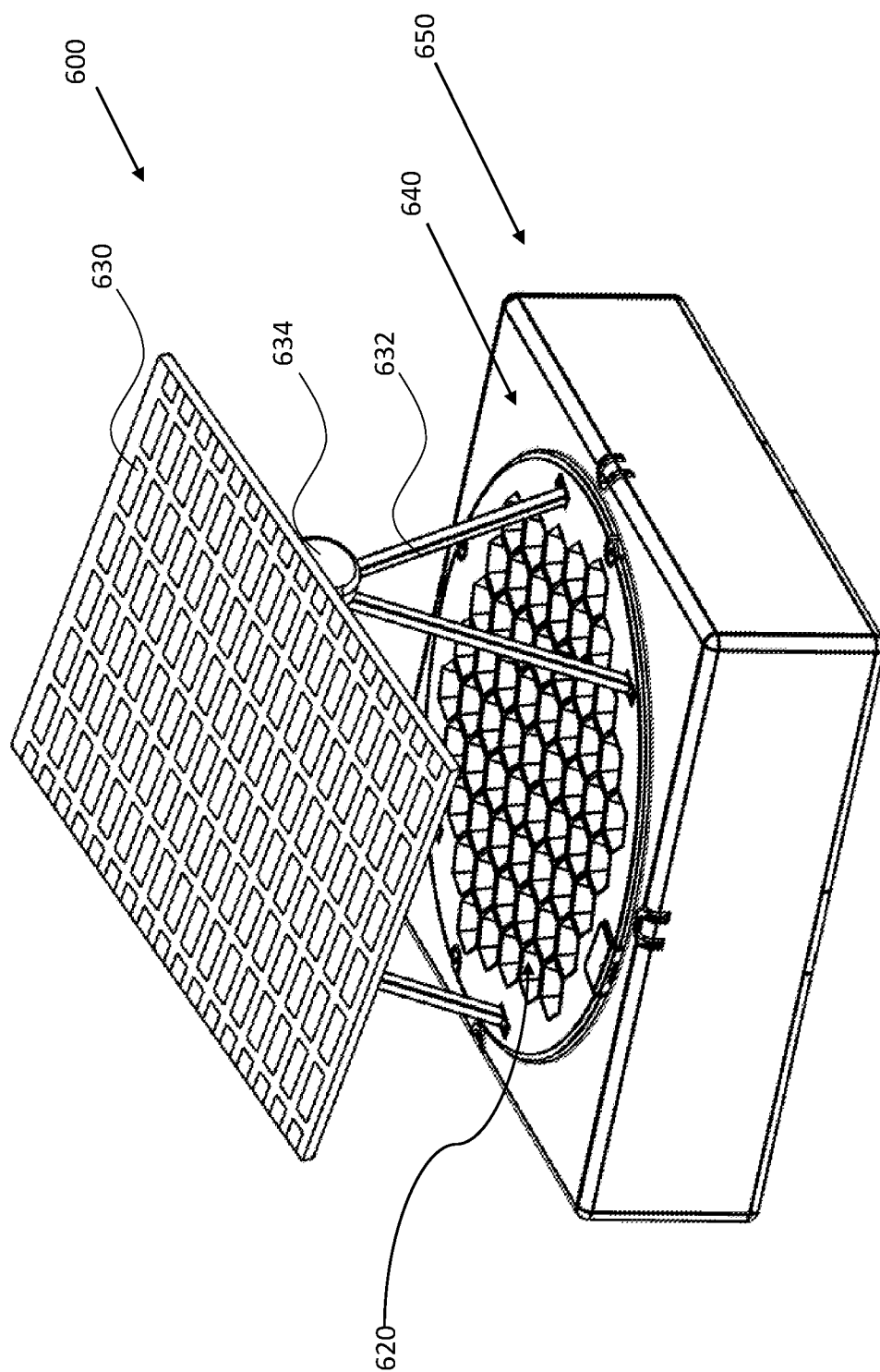


Fig. 6A

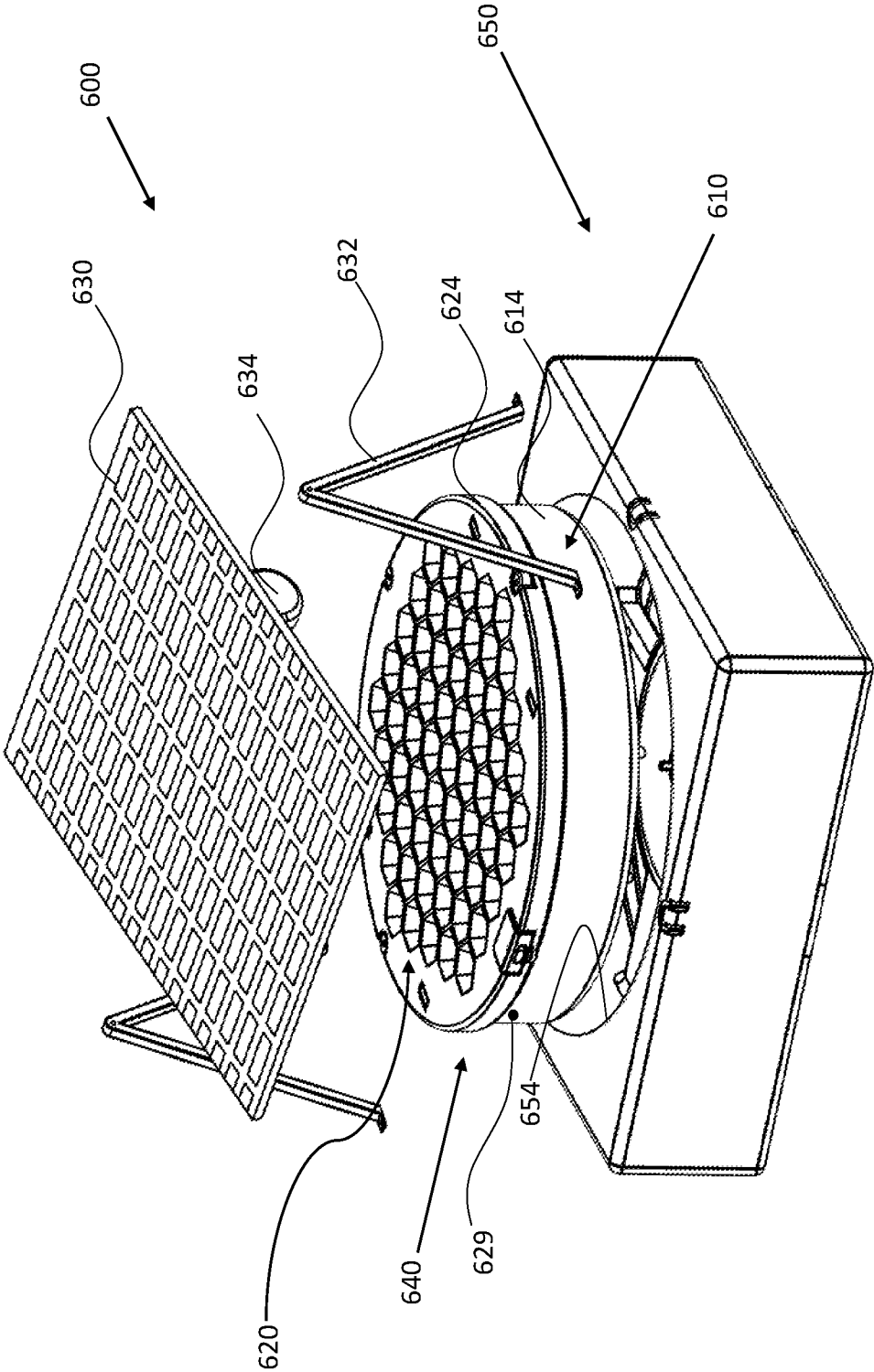


Fig. 6B

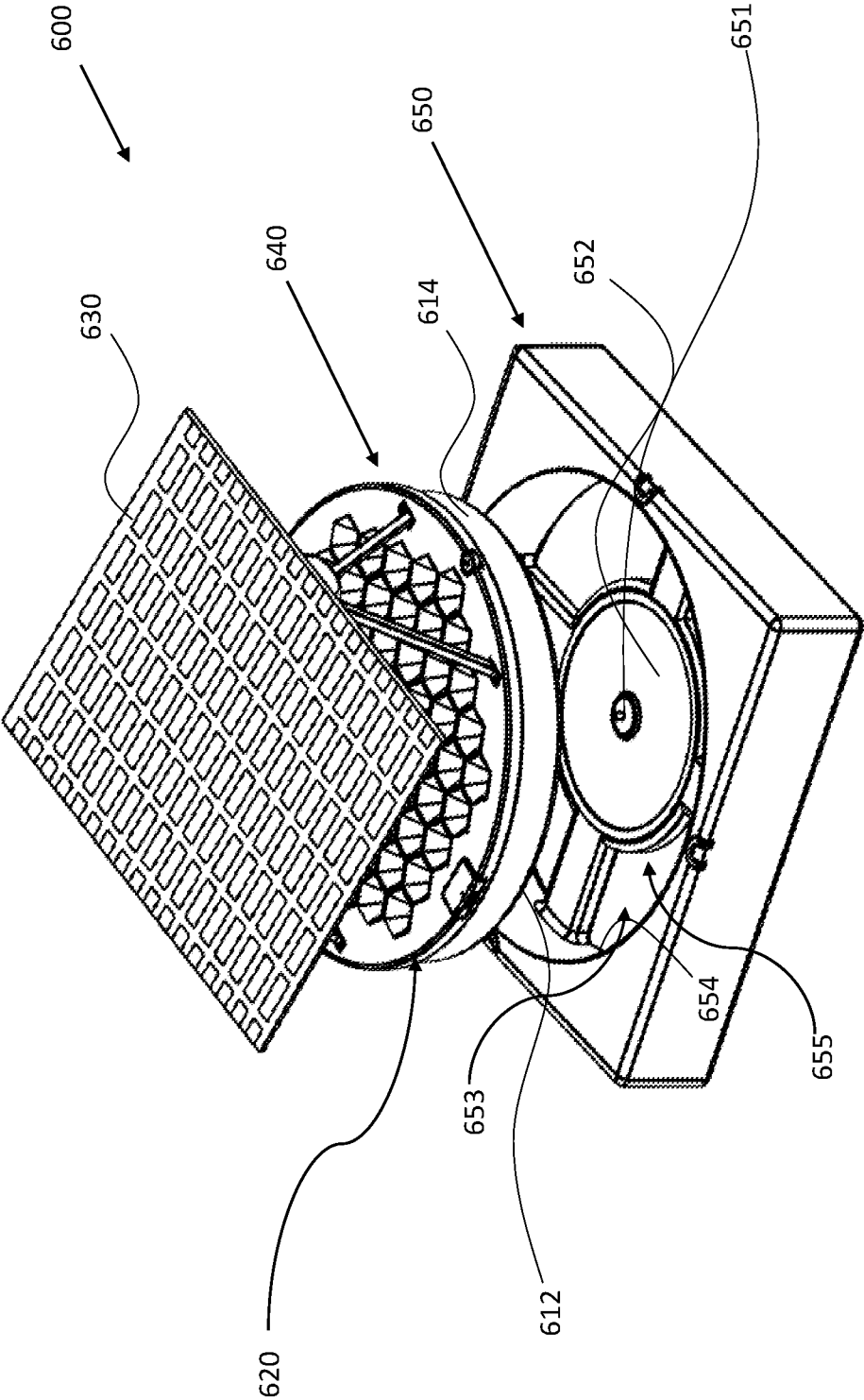


Fig. 6C

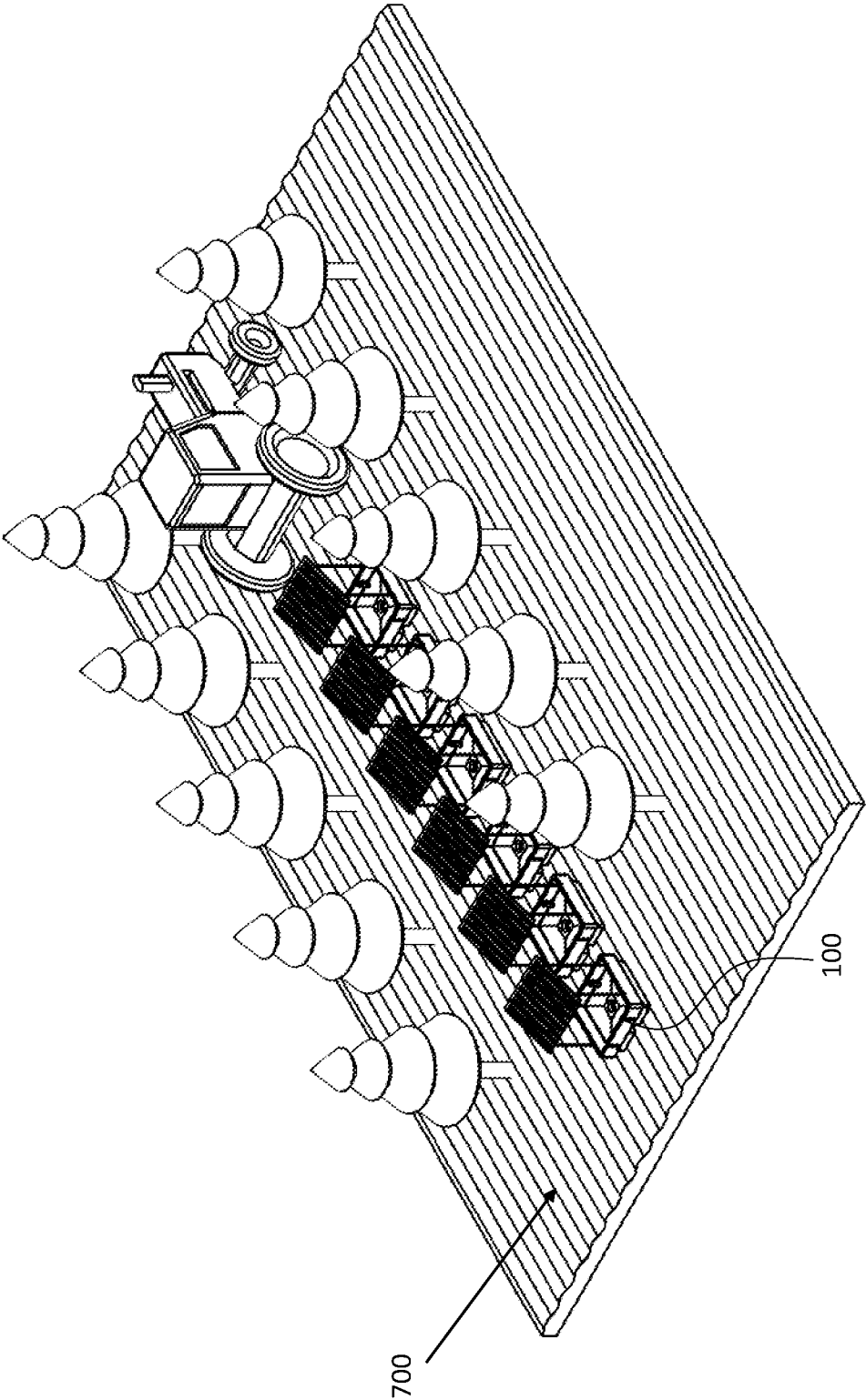


Fig. 7

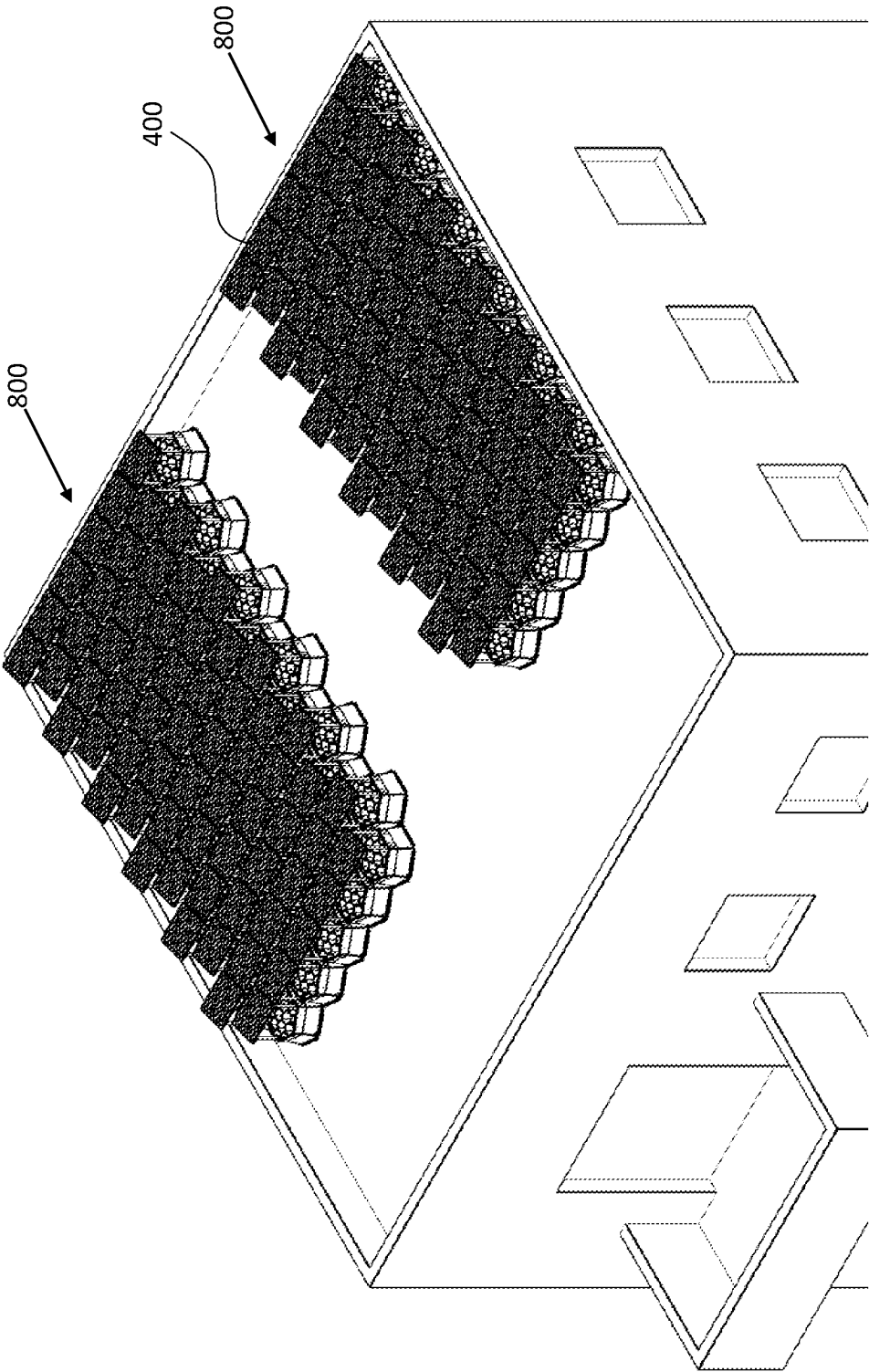


Fig. 8

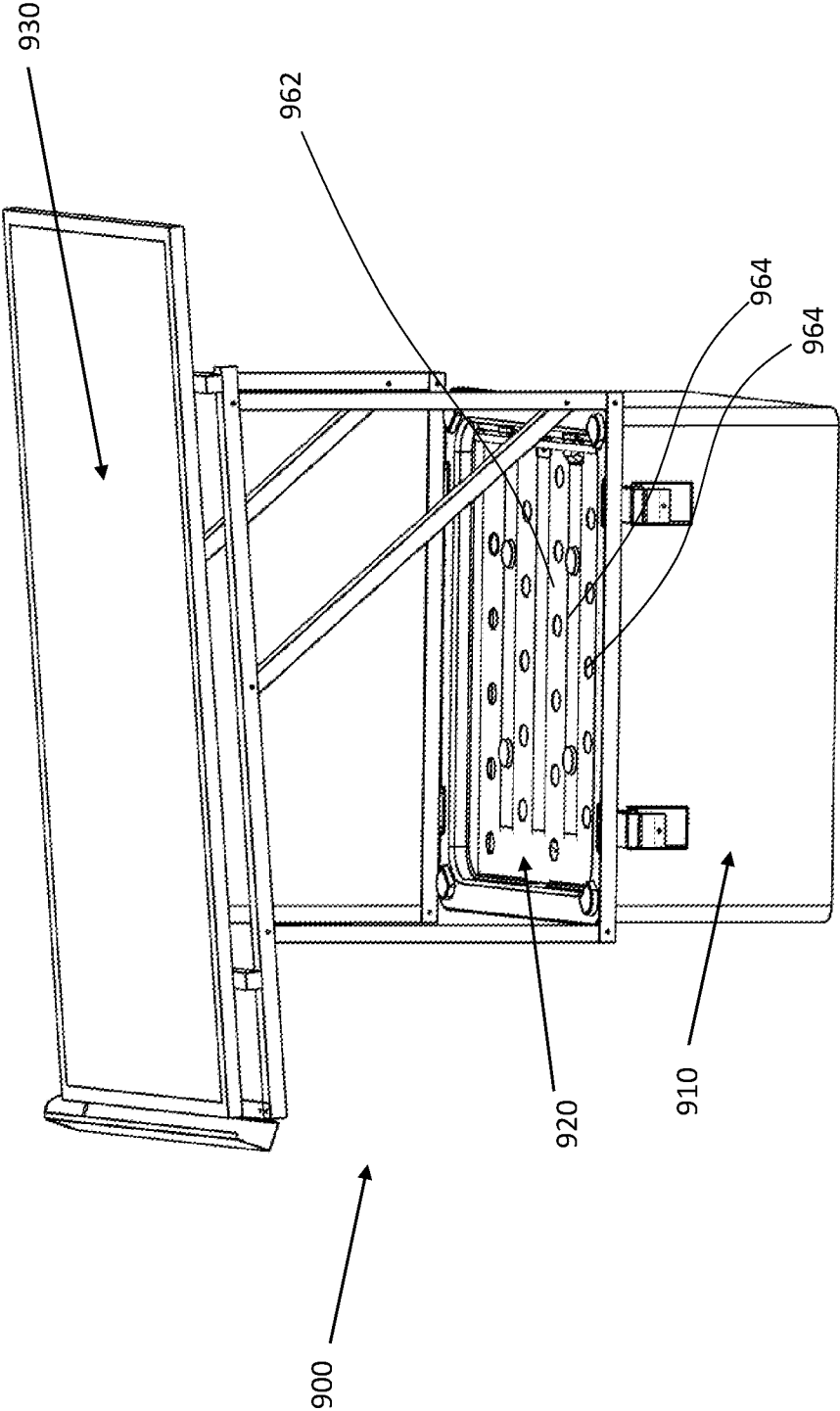


Fig. 9A

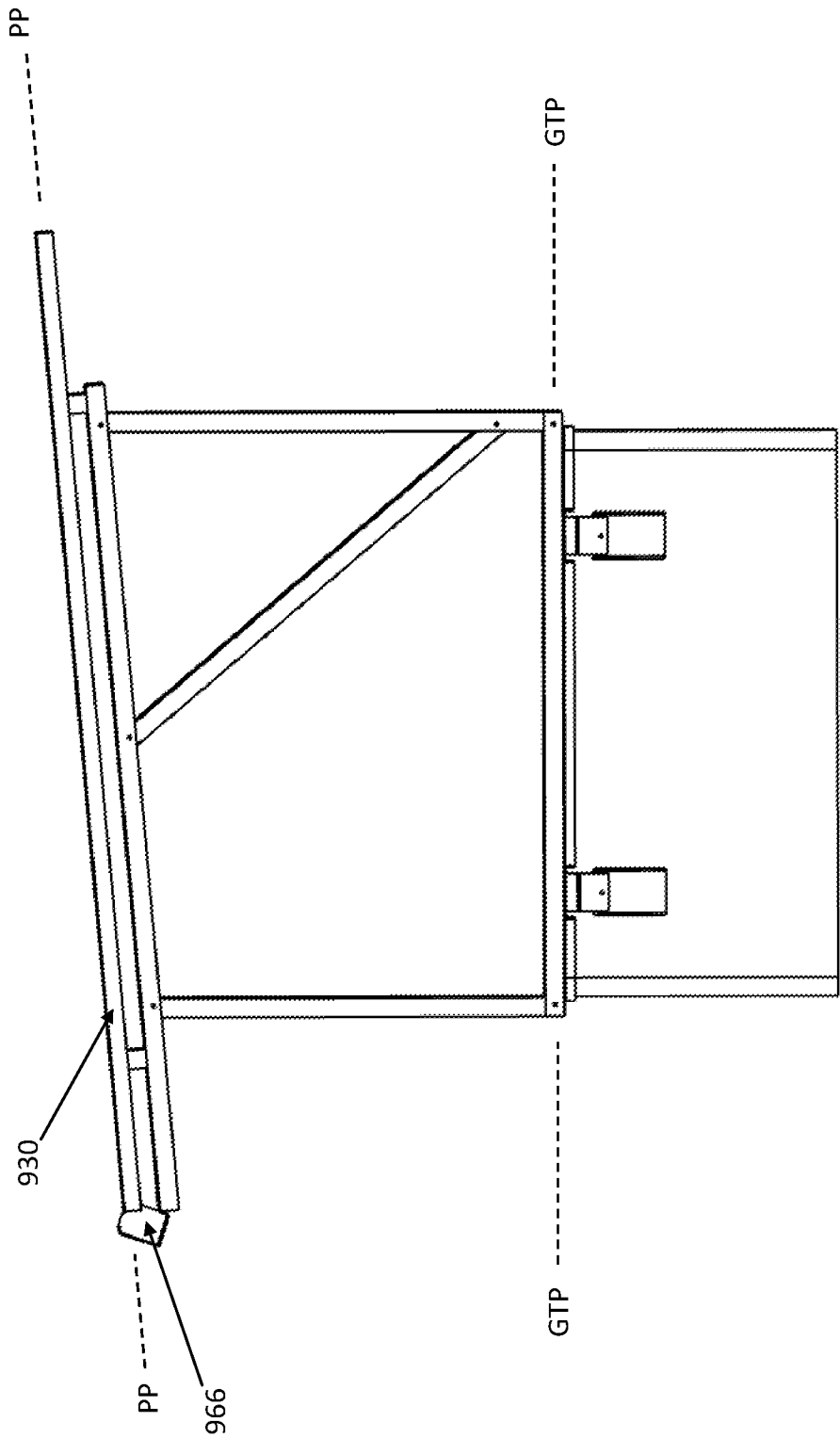


Fig. 9B

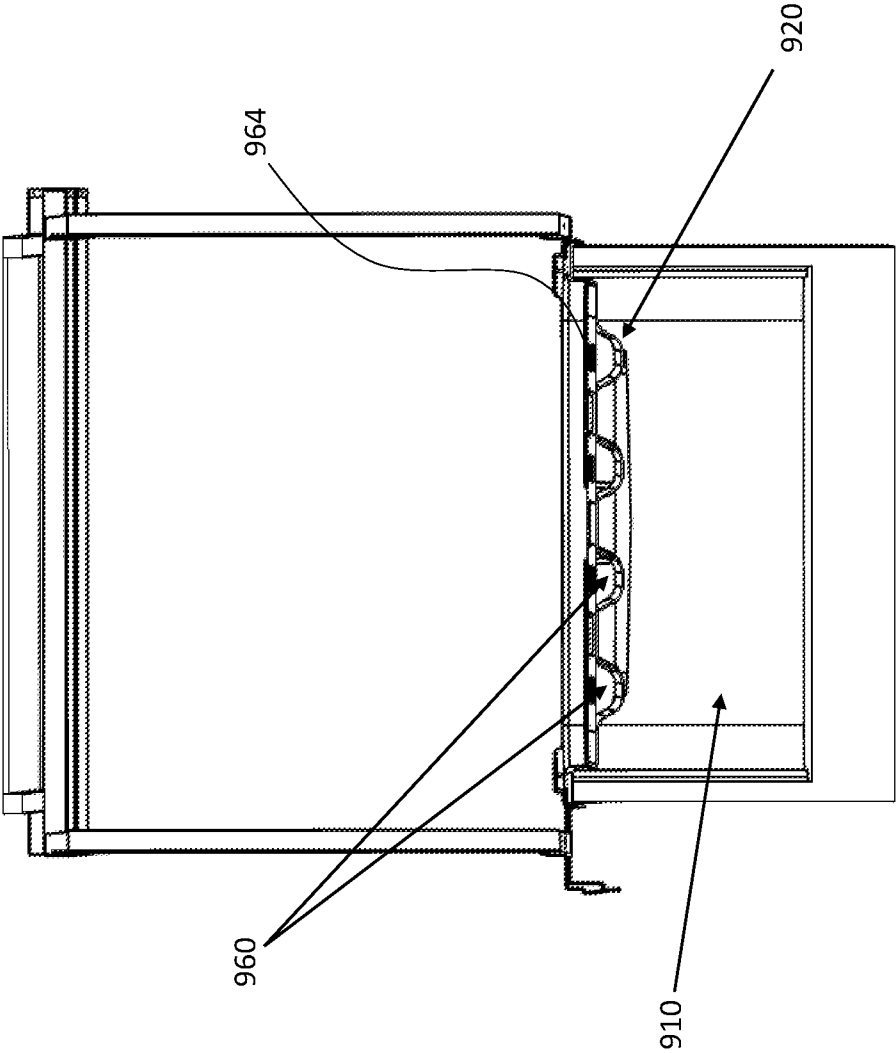


Fig. 9C

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL2021/051105

A. CLASSIFICATION OF SUBJECT MATTER

IPC (20210101) A01G 9/02, A01G 9/00, A01G 27/00, A01G 9/24, B63B 35/44

CPC (20190201) A01G 9/02, A01G 9/00, A01G 27/00, A01G 27/005, A01G 27/003, A01G 9/247, B63B 2035/4493

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)

IPC (20210101) A01G 9/02, A01G 9/00, A01G 27/00, A01G 9/24, B63B 35/44

CPC (20190201) A01G 9/02, A01G 9/00, A01G 27/00, A01G 27/005, A01G 27/003, A01G 9/247, B63B 2035/4493

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)

Databases consulted: Esp@cenet, Google Patents, Orbit, Similari (AI-based)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 106718245 A HUNAN INST SCIENCE & TECH 31 May 2017 (2017/05/31) The whole document	1-5,8,10,12-15, 17-29
Y	The whole document	6,7,9,11,16,30
X	CN 105993658 A ZHANG CAIYOU 12 Oct 2016 (2016/10/12) The whole document	1,2,5
Y	CN 105594493 A YANG ZHIHENG 25 May 2016 (2016/05/25) The whole document	6,7,9,30
Y	KR 101152068 B1 JANG, KI WOONG 15 Jun 2012 (2012/06/15) The whole document	11,16



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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“D” document cited by the applicant in the international application

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“O” document referring to an oral disclosure, use, exhibition or other means

“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

29 Nov 2021

Date of mailing of the international search report

29 Nov 2021

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Telephone No. 972-73-3927216

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/IL2021/051105

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CN 105594493 A	25 May 2016	CN 105594493 A	25 May 2016
KR 101152068 B1	15 Jun 2012	KR 101152068 B1	15 Jun 2012