



- (51) International Patent Classification:
F24J 2/52 (2006.01)
- (21) International Application Number:
PCT/EP2016/057874
- (22) International Filing Date:
11 April 2016 (11.04.2016)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
00536/15 17 April 2015 (17.04.2015) CH
- (71) Applicant: NOVATON ERNEUERBARE ENERGIE
AG [CH/CH]; Christine Maria Ledergerber Hinderling,
Sperletweg 59, 8052 Zürich (CH).
- (72) Inventors: MERESSE, Thierry; Av. de Beaulieu 1, 1004
Lausanne (CH). ELSASSER, Urs; Grundstrasse 7, 8610
Uster (CH). SHIELS, David; Schwandelstrasse 20, 8800
Thalwil (CH).
- (74) Agent: RENTSCH PARTNER AG; 2441, Fraumünster-
strasse 9, 8022 Zürich (CH).
- (81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the
claims and to be republished in the event of receipt of
amendments (Rule 48.2(h))

(54) Title: SOLAR ENERGY HARVESTING SYSTEM

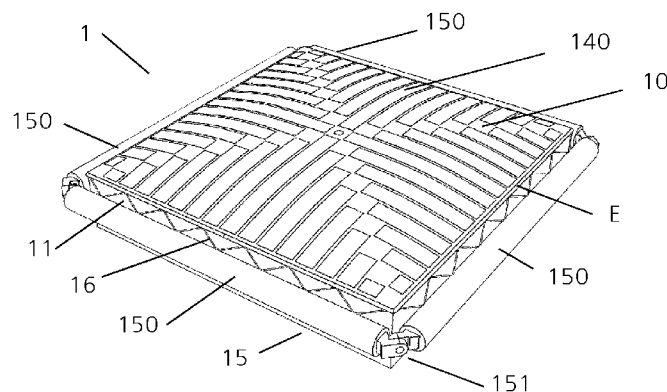


Fig. 3a

(57) Abstract: The present invention concerns a solar harvesting platform (1). The solar harvesting platform (1) is designed to float on a liquid reservoir. The solar harvesting platform (1) includes: a cover (10), the cover (10) being made from a sheet-like material; a skirt (11) projecting, in an operational state, from a bottom side of a cover periphery and immersing into the liquid of the liquid reservoir; wherein the bottom side of the cover (10), the liquid surface of the liquid reservoir and the skirt (11) serve as delimiting surfaces of a gastight enclosed volume; a solar harvesting arrangement (14), the solar harvesting arrangement (14) being arranged at a top side of the cover (10) and being fixed to the cover or being integrated into the cover. The solar harvesting platform (1) is designed to be reversibly deformed under influence of an external force. The invention further concerns a solar harvesting cluster with a plurality of solar harvesting platforms and a method of operating a solar harvesting platform.



SOLAR ENERGY HARVESTING SYSTEM

TECHNICAL FIELD

The present invention lies in the field of solar energy harvesting. Particularly, it is related
5 to solar harvesting systems, in particular solar harvesting platforms and clusters of solar
harvesting platforms, as well as methods for operating solar harvesting platforms and
clusters.

BACKGROUND

10 Harvesting of solar energy has become a technical area of considerable importance over
the last years. Harvesting of solar energy is of particular interest for local energy supply in
areas of little or generally insufficient power generation and power distribution infrastruc-
ture, as well as in the general context of an increasing necessity for renewably energy
generation with as little environmental impact as possible.

15 A variety of concepts, systems and devices for solar harvesting have accordingly been
developed, from highly miniaturized systems to huge solar power plants.

WO 2009/001225 A2 of the applicant discloses a man-made island with solar energy
collection facilities. The man-made island includes a platform and an outer ring that al-
lows the platform to float on a liquid, in particular water, typically in a ring-shaped tank
20 (channel). Under the platform, an airtight volume is defined in which overpressure is

maintained by means of a compressor, thus suspending the floating man-made island. The man-made island has a circular footprint, thus allowing alignment relative to the sun by rotating the floating island.

5 SUMMARY OF DISCLOSURE

It is an overall objective of the present invention to improve the state of solar harvesting arrangements for renewable energy generation. It is a particular object to provide arrangements that are suited for both small to medium and as well as large-scale applications in sunny areas. This overall objective is achieved by the subject matter as defined by
10 the features of the independent claims. Particular and exemplary embodiments are defined by the dependent claims as well as by the overall disclosure of the present document.

According to an aspect, the overall objective is achieved by providing a solar harvesting platform. The solar harvesting platform is designed to float on a liquid reservoir. The solar
15 harvesting platform includes a cover, the cover being made from a sheet-like material. The cover extends over a top view cover area that favourably corresponds or substantially corresponds to the top view surface area of the total solar harvesting platform. The cover being sheet-like means that its lateral dimensions are large as compared to its thickness.

In some embodiments, the Cover is made from a flexible foil or membrane, particularly
20 from a thermoplastic or coated textile foil or membrane. Flexible means that the cover may be significantly deformed and may particularly buckle under influence of an external force without being destroyed or damaged. The cover may generally be made from a

single piece of foil or membrane. Typically, however, it is made from a number of strips, with each strips having a width of, e.g. about 1.5 m. The single strips are attached to each other in a gastight way using generally known technologies such as adhesive bonding (gluing), ultrasonic welding or hot air welding. The cover is made from a gastight
5 material. In some embodiments however, the cover may also be made from the substantially rigid sheet-like material. Furthermore, the cover may be made by a combination of one or more flexible parts and one or more substantially rigid parts.

The top view geometry (footprint) of the solar harvesting platform is generally defined by and typically corresponds to the top view geometry of the cover and, in some embodi-
10 ments, an optional circumferential float structure as discussed further below.

The solar harvesting platform further includes a skirt. The skirt projects, in an operational state, from a bottom side of a cover periphery and immerses into the liquid of the liquid reservoir. The skirt is generally closed along its circumference. The skirt may generally project from the cover in a desired direction. In typical embodiments that are assumed in
15 the following, the skirt projects at least approximately vertically in an operational state. Typically, the cover and the skirt are arranged concentrically in a top view.

In operation, the bottom side of the cover, the liquid surface of the liquid reservoir and the skirt serve as delimiting surfaces of a gastight enclosed volume. In operation, the cover is above the liquid surface level, while the skirt contacts and immerses into the liquid. In
20 a top view, the cover spans the whole surface area of the gastight enclosed volume.

Any gas that is present inside the gastight enclosed volume is accordingly sandwiched between the bottom side of the platform and the liquid surface under the platform. The bottom side of the platform and the liquid surface accordingly define the vertical exten-

sion of the gastight enclosed volume. Horizontally or laterally, the enclosed volume is delimited by the skirt that is, like the cover made from a gastight material. In a top view, the skirt should form a closed curve. Since the skirt is arranged at the peripheral edge or in a peripheral region of the cover, the top view of the skirt generally corresponds to the top view or footprint of the cover.

As discussed further below in more detail, an overpressure is, in operation, maintained inside the gastight enclosed volume. Vertical forces that result from the overpressure inside the gastight enclosed volume and optionally from additional floatation that may be generated by an additional float structure allow the solar harvesting platform to float on top of the liquid reservoir. Such vertical forces exactly compensate the total weight of the solar harvesting platform. Favourably, the weight of the solar harvesting platform is substantially uniformly distributed over its surface, such that the platform is horizontally levelled.

In this document, directional terms, in particular "top", "bottom", "up", "down", "above", "below", "horizontal" and "vertical" are generally used with reference to their ordinary meaning during operation. The gravity is accordingly vertically oriented vector accordingly points downwards from top to bottom.

The enclosed volume being gastight means inside the containment is trapped and cannot exit the trapped volume unless intentionally relieved. Some leakage rate, however, is acceptable as long as function is not affected and/or an overpressure supply as discussed below is capable of replacing the escaping gas. Tightness is especially given with respect to a gas that is, in operation, present within the enclosed volume.

The solar harvesting platform further comprises a solar harvesting arrangement. The solar harvesting arrangement is arranged at a top side of the cover and is fixed to the cover or is integrated into the cover. That the solar harvesting arrangement is fixed to the cover particularly means that the weight of the solar harvesting arrangement is carried by the cover rather than some rigid frame structure. Favourably, the solar harvesting arrangement as described further below in more detail is directly mounted onto the cover and no rigid frame structure is provided to carry the solar harvesting arrangement. The solar harvesting arrangement may further be directly integrated into and formed integrally with the cover.

10 In some typical embodiments, the solar harvesting arrangement covers substantially the while surface of the cover in order to maximize the solar harvesting efficiency. As explained later on in more detail however, some areas of the cover may remain free, allowing sunlight to be provided to the liquid surface below the platform. Furthermore, predetermined free path may be provided that allow walking on the cover in an operational
15 pressurized state for maintenance, repair work, and the like.

The solar harvesting arrangement may generally operate according to any or a combination of generally known solar harvesting technologies, such as photovoltaics (PV), concentrated photovoltaics with linear concentrating parabolas, dishes or Fresnel lenses/mirrors; solar thermal; concentrated solar-thermal with linear concentrating parabolas, dishes or Fresnel lenses/mirrors as well as combinations thereof.
20

In some embodiments, the solar harvesting arrangement includes bendable photovoltaic (PV) elements. The bendable PV elements being mechanically attached, favourably directly mechanically attached, on the top side of the cover.

Bendable (thin film) PV elements are particularly suited in context of the present invention. They are comparatively lightweight and can be directly fixed to the cover by means of hook-and-loop tape, ropes, or the like. They further adopt to the (generally non-planar) surface of the cover surface and may also be directly integrated and formed integrally with the cover. A low weight of the solar harvesting arrangement results in no rigid (and heavy) frame structure being required for carrying the elements or panels of the solar harvesting arrangement. PV panels that may be used in the context of the present invention are provided, for example, by Flisom AG, Dübendorf, Switzerland. Alternatively, rigid PV panels may be used as well provided that the local curvature of the cover is sufficiently small, as it is the case for typical platform and PV panel dimensions.

The overpressure that is in an operational state present inside the gastight enclosed volume suspends the cover over substantially its total surface area. Together with the skirt and the liquid surface, the cover accordingly serves, in an operational state, as gas cushion, e.g. air cushion, that carries the weight of the solar harvesting arrangement as explained below. Therefore, the cover does not need to be very strong or sturdy. An industrial-grade foil or membrane in a range of typically 0.1mm to 5mm, more particularly 0.5mm to 3mm thickness, is generally sufficient. Suited materials are provided, e. g., by Serge Ferrari S.A.S., La Tour du Pin Cedex, France. or by Heytex Bramsche GmbH, Bramsche, Germany.

This arrangement is particularly favourable because it avoids the need for a comparatively heavy and expensive frame structure to carry and stabilize the solar harvesting arrangement. A solar harvesting platform in accordance with the present invention may therefore be designed to be particularly lightweight and therefore less expensive than arrangements according to the state of the art. Furthermore, an arrangement in accordance with

the invention is particularly ecological as less material is needed for manufacturing and ultimately for recycling at the end of the product life.

Since gas is compressible, the gas-filled volume of the gastight enclosed volume further acts as gas pressure spring and absorbs waves between the liquid surface and the platform.
5 form.

The pressurized gas inside the gastight enclosed volume accordingly fulfils the double function of generating floatation for the solar harvesting platform and suspending the cover, thereby carrying the weight of the solar harvesting arrangement. In dependence of the additional floatation that may additionally be generated by an optional float structure,
10 the overpressure that is required inside the gastight enclosed volume can be comparatively low. Typically, the overpressure does not exceed a few percent of the atmospheric pressure and may be about 1% of the atmospheric pressure or below 1% of the atmospheric pressure, such as about 0.3% of the atmospheric pressure (1% of the atmospheric pressure equals about 100 kg/m²).

15 A further advantage of a solar harvesting platform in accordance with the present invention is a generally low growth of algae. This advantage results from the comparatively small liquid-contacting surface of the platform, which is limited to the liquid-contacting portion of the skirt and, optionally, an additional float structure.

The cover material may either be transparent or opaque. If the cover is transparent and
20 the solar harvesting arrangement does not cover its whole surface area, sunlight can be provided to the liquid surface below the platform. This is especially favourable if aquatic life is present in the liquid reservoir, typically water reservoir. On the other side, the platform may be designed to be largely or partly light-absorbing. In further favourable em-

bodiments, the platform is of a reflective material, e.g. a white foil. For this type of embodiment, rays of sunlight are reflected from the platform towards the solar harvesting arrangement, thus increasing the energy harvesting efficiency.

Furthermore, the liquid under the cover is in direct contact with the gas in the enclosed
5 volume. This is particularly favourable in typical embodiments where the gas is air and aquatic life is present in the liquid reservoir. Fish etc. can accordingly still attain the surface under the cover. As will be explained further below, the gas supply can additionally be used to oxygenate the liquid, in particular water, of the liquid reservoir.

As discussed further below in more detail, solar harvesting platforms and clusters of solar
10 harvesting have the additional beneficial effect of preventing the liquid reservoir from evaporation. Solar harvesting platforms in accordance with the present invention may accordingly be used, at the same time, for the purposes of solar harvesting and evaporation prevention, while preserving aquatic life inside the liquid reservoir.

The surface of the liquid reservoir on which the solar harvesting platform floats is favour-
15 ably continuous or substantially continuous and may especially have dimensions and a footprint that is at least as large as or typically substantially larger than the footprint of the solar harvesting platform. The surface of the liquid reservoir accordingly extends at least over the whole footprint area of the at least one solar harvesting platform.

The liquid reservoir may be any suited natural or man-made liquid reservoir, in particular
20 water reservoir, such as a lake, a pond, an ocean, a man-made tank, a drinking water reservoir, an old quarry filled with water, or any other water area. The liquid may, e.g. be plain and clean sweet water, but may also be salt water or seawater or polluted water or even liquid chemicals. The liquid reservoir may accordingly also be, e.g., a sedimentation

tank or the like. The liquid reservoir may also be any otherwise unused liquid reservoir and in particular water reservoir. This is particularly favourable since in many countries, land is reserved for housing and crops and cannot be used for solar energy harvesting, resulting in rooftops remaining as essentially the only areas for installing solar harvesting equip-
5 ment on land.

Solar harvesting platforms in accordance with the present invention may have substan- tially any desired size. To be of practical economic and/or ecologic interest, the size of a single platform may typically be in a range between 10 m x 10 m to 50 m x 50 m, but smaller or larger dimensions are physically possible. As will be discussed in more detail
10 further below, individual platforms may be coupled to and arranged in clusters. Clusters may be coupled to each other and arranged in solar harvesting plants or cluster groups of substantially any required dimension.

The solar harvesting platform is further designed to be reversibly deformed under influ- ence of an external force. In some embodiments, the solar harvesting platform is particu-
15 larly designed to be reversibly twisted. A deformation of the solar harvesting platform generally means a deformation of the solar platform as a whole by bending, twisting, or the like. A deformation of the solar harvesting platform is generally associated with a change in its top view or footprint. The possibility to be reversibly deformed under the influence of an external force results in a platform to react on and thereby withstand
20 forces that generated by wind and/or waves of the liquid surface without the platform being destroyed and damaged and without requiring a rigid frame structure that is typi- cally heavy and expensive.

In some embodiments, the skirt is made from a flexible foil or membrane. The skirt may for example be made from the same material as the cover. The skirt may be attached to

the cover with the same type of technologies as for the single strips of the membrane. In order to ensure gas-tightness, the skirt is attached to the cover along its entire circumference via a closed and gapless seam.

The skirt may be arranged at the periphery of the cover as outmost as possible, e. g. at the peripheral edge of the cover. In particular if an additional float structure is present as
5 discussed further below, the skirt may also be somewhat drawn in with respect to the edge in order to prevent direct contact between skirt and float structure.

In some embodiments, the solar harvesting platform further comprises a ballast. While the solar harvesting platform floats, in an operational state, on the liquid surface, with the floatation being generated by the overpressure inside the gastight enclosed volume
10 and/or an optional float structure as discussed further below, it is favourably close to the limit of floatation. A ballast may be provided in form of one or more compact weights, e. g. concrete weights, which may be attached to the solar harvesting platform, e. g. via chains or ropes. The ballast may be attached, e.g. to the cover and/or the skirt. Alternatively or additionally, a ballast may be integrated into the skirt, for example in a circum-
15 ferential bottom section of the skirt as discussed further below in more detail. This is particularly favourable if the skirt is made from a flexible material and is designed to project from the bottom side of the cover, downwards in a vertical direction. Here, the ballast maintains the skirt vertical and tensioned even in the presence of disturbances such as wind
20 and/or waves. As also discussed further below, a ballast may be integrated into a float structure.

In some embodiments, the cover is designed to form, under influence of an overpressure inside the gastight enclosed volume, a convex surface, in particular a pyramidal or cone-shaped surface.

A convex surface is particularly favourable because sand, dust, and dirt particles in general will move in downwards direction, towards the periphery of the platform, and are accordingly removed from the solar harvesting arrangement. At the periphery, the particles can be collected and/or removed. This aspect is of particular importance, e. g. in desert environments. Similarly, liquid, such as rainwater, will flow towards the periphery of the solar harvesting platform, where it can be collected or flow off into the liquid reservoir.

It is noted that for a convex operational shape of the cover the elements of the solar harvesting arrangement, e. g. photovoltaic elements, is not oriented in an optimal angle to the sun. This drawback, however, is acceptable in areas of high solar irradiation, particularly close to the equator, and is generally outweighed under such conditions by the advantages of an arrangement in accordance with the invention.

A variety of operational geometries may be used in dependence of the platform and particularly the cover footprint. In case of a square (or rectangular) footprint, the cover may be pyramidal. In case of a circular footprint, the operational shape of the cover, may, e.g. be an approximated section of a sphere shell or be conical. A conical shape is favourable over a sphere-like shape in so far as a sphere-like surface has a substantially horizontal top region resulting from its bulge, where particle and/liquid removal is critical, while a cone surface is overall uniformly inclined. A circular footprint of the cover is further favourable in view of mechanical symmetry, resistance to the internal overpressure, and stability.

If required, further dirt and/or liquid removal arrangements may additionally be provided. In particular, a gas blower and a nozzle arrangement may be provided to remove dirt particles by blowing gas, e. g. air, over the solar harvesting arrangement continuously, periodically, and/or on demand. Similarly, a flushing arrangement may be provided to flush the solar harvesting arrangement with a cleaning liquid, e. g. with water from the liquid reservoir.

In some embodiments, the solar harvesting platform further includes a gutter, the gutter extending along the cover periphery. The gutter is arranged to collect liquid flowing on the top side of cover from the cover centre to the cover periphery. If the solar harvesting platforms cover very large areas, the total amount of (drinkable) rainwater recuperated
5 can be very significant.

Providing a gutter is particularly favourable in desert-like or generally dry environments where the availability of sweet water is an issue of concern. In such environments, a solar harvesting platform in accordance with the present invention can, in addition to the primary purpose of solar energy harvesting, be used for collecting rain water. In particularly
10 favourable embodiments, the operational geometry of the cover is convex as discussed above. The gutter is generally realized by a (typically continuous) circumferential groove that is open to the top side. The gutter is arranged such that liquid flowing in direction from the centre of the platform to the periphery is collected in the gutter. In some variants, the gutter is a dedicated groove-shaped component and made, e.g., from rigid
15 plastics or can also be a vertical extension of the skirt and made of the same thermo-plastic or coated textile material. A pump may be provided in order to pump the rainwater out of the gutter to store it in a tank on the shore or any other place. The pump to pump the rainwater can be common to more than one solar harvesting platform.

In some embodiments, such gutter is formed by a peripheral cover region and is accord-
20 ingly formed integrally with the cover. For this type of embodiment, the gutter is realized with particularly low additional material and costs. This type of embodiment will be discussed in more detail further below in the context of exemplary embodiments.

In some embodiments, the solar harvesting platform includes a float structure. Such float structure is mechanically attached to the cover along the cover periphery.

The solar harvesting platform may be designed and the overpressure inside the gastight enclosed volume may be selected such that the floatation that is caused by the pressurized gas inside the gastight enclosed volume is sufficient for the solar harvesting platform to float on the liquid surface. Mainly for reasons of mechanical stability and/or for safety reasons, however, an additional float structure may be provided.

In some embodiments with an additional float structure, the float structure is designed to generate a floatation that is sufficient for the solar harvesting platform to float on the liquid reservoir without overpressure inside the gastight enclosed volume. While the solar harvesting platform is, in operation, gas suspended as discussed before, it is favourable if the float structure provides sufficient floatation for the solar harvesting platform to float on its own. While not being essential, such design is particularly favourable for safety reasons if the overpressure in the gastight enclosed volume is partly or fully lost. It is further favourable, e.g. in view of maintenance of the overpressure supply as well as during installation. The floatation may be just at the limit of floatation in order to use as little material as possible, thus reducing costs. In alternative embodiments with a float structure, however, the float structure generates somewhat less floatation than is required for the solar harvesting platform to float, with the remaining required floatation being generated by the gas pressure inside the gastight enclosed volume.

The float structure, if present, is favourably not rigidly coupled to the platform, but is coupled in a flexible way, thus enabling relative movement between the cover and the float structure. Mechanical coupling between the platform and the float structure may be realized via tensioning ropes and turnbuckles, chains, hook-and-loop tape, etc., or any combination of such elements. In this way, the float structure may be reversibly deformed under the influence of external force, while the shape of the cover is fully or substantially maintained. The float structure generally includes one or more float element(s).

In some embodiments with a float structure, such float structure includes tubular elements, the tubular elements having longitudinal axes that extend, in an operational state, parallel to the liquid reservoir surface, i.e. the tubular elements float horizontally on the liquid surface. The tubular elements may be realized by pieces of ordinary tubing, particularly plastic tubing, as commonly used for tap water and waste water and made, e. g. from PVC, high-density polyethylene (HDPE)/ polypropylene. Instead of tubular plastic elements, hose elements may be used as float elements. In further embodiments, float elements are realized by a flexible inflatable hull which may, e.g. be made from rubber, thermoplastic material or coated textile, for example the same material as the cover.

Typically, the float elements, e.g. tubular elements, are filled with air or another gas. They may, however, fully or partly be filled with floating material, such as polystyrene foam for safety reasons. For this type of embodiment, the floatation that is generated by the float structure prevents the solar harvesting platform from sinking in case of a leakage of the gastight enclosed volume. In further embodiments, float elements are fully made of such foam material.

If a ballast is required to better compensate the vertical force of the overpressure under the cover, some or all float elements may be partly filled with ballast material, e. g. concrete, stones or any other heavy and cheap material.

In some embodiments with a float structure, at least two mutually adjacent tubular elements are operatively mechanically coupled via a hinge element. Typically, each tubular element is mechanically operatively coupled with its two adjacent neighbouring elements. Hinge elements ensure mechanical stability and integrity of the float structure and allow the float structure at the same time to deform under the influence of external forces. Suited hinge embodiments are discussed in more detail further below in the context of

exemplary embodiments. Instead of or alternatively to hinges, other types of flexible links, such as ropes or chains, may be used.

In some embodiments with a float structure, the float structure forms an at least substantially closed wall around the periphery of the cover. Here, the overpressure of the gas
5 inside the gastight enclosed volume may be employed for stiffening the float structure. In particular, the overpressure of the gas in the gastight enclosed volume does not only exert a force in vertical direction that suspends the solar harvesting platform and generates floatation, but also exerts a force in lateral direction which tensions the float structure.

Typically, the solar harvesting platform further includes or is, in an operational state, operatively fluidic coupled to a gas supply system. The gas supply system is designed to feed
10 gas into the gastight enclosed volume, thus generating and/or maintaining an overpressure inside the gastight enclosed volume. As discussed before, the overpressure inside the gastight enclosed volume both suspends the cover with the solar harvesting arrangement and generates floatation.

15 The gas supply system typically includes a pressure gas source, such as a gas pump, a blower, a compressor, one or more pressurised gas tanks, or any combination thereof. The gas is typically air. However, other stable gases, such as CO₂, or a stable gas mixture could be used as well. Typically, the gas supply system further includes a gas supply conduit or a network of gas supply conduits. Gas supply conduits are typically realized by
20 hoses, tubes, or a combination thereof.

The gas supply system further includes at least one gas supply aperture. In an operational state, the at least one gas supply aperture fluidly couples the gas supply system with the

gastight volume. The at least one gas supply aperture may be an open end of a gas supply conduit and/or comprise one or more apertures in walls of gas supply conduits.

A pressure gas source, for example a blower, may be provided as part of the solar harvesting platform and may be attached, for example, to a float element, e. g. a tubular element, of the float structure as discussed before. A gas supply conduit may cross the cover or the skirt via a gastight supply connector, such as a bushing or gland. A gas supply aperture of the gas supply conduit may open into the gastight enclosed volume. Alternatively, a gas supply conduit of the gas feeding system immerses into the liquid and crosses or penetrates below the skirt. For such embodiments, the gas is fed into the gastight enclosed volume from the bottom side, as discussed in more detail below in the context of exemplary embodiments. This type of arrangement has the particular advantage that no gastight supply connector is required.

It is noted that it is not necessarily required that a gas supply aperture may, but does not necessarily directly open into the volume of the gastight enclosed volume. In some alternative embodiments, the gas supply aperture or plurality of gas supply apertures is, are, in an operational state, arranged below the liquid surface level, favourably in an area below the platform, particularly below the cover. For this type of embodiment, the gas exits the at least one gas supply aperture as a stream of gas bubbles, e.g. air bubbles, under the platform.

For this type of embodiment, the travel path of the gas bubbles depends on the depth of the at least one gas supply aperture under the liquid surface. With increasing depth as well as with increasing potential flow speed of the liquid within the liquid reservoir, the stream of gas bubbles is widened. In case of the gas being air, the air bubbles may accordingly, in addition to suspending the solar harvesting platform, oxygenate the water.

This is favourable in case of aquatic life within the water reservoir which needs oxygen. Furthermore, anaerobes bacteria grow in non-oxygenated waters. Their growth is accordingly prevented or at least reduced by oxygenated water.

For this type of embodiment, the at least one gas supply conduit of the gas feeding system may further be arranged on the ground of the liquid reservoir. Anchors and/or weights may be attached to the at least one gas supply conduit to keep it in place.

If no oxygenation or other treatment of the liquid is required or desired, the at least one gas supply aperture may be arranged closely under the liquid surface, resulting in the distance of the bubbles to reach the surface under the cover being small. In a further variant, the gas supply conduits cuts the liquid surface under the cover and the at least one gas supply aperture directly opens into the volume of the gastight enclosed volume.

Furthermore, other types of gas than air may be used, e.g. a sterilizing and/or antibacterial gas. Such type of embodiment may be favourable e.g. in case of the liquid reservoir being a man-made drinking water reservoir.

Alternatively to arranging the pressure gas source directly at the solar harvesting platform, it may be arranged remotely from the solar harvesting platform. The pressure gas source may, for example, be arranged outside of the liquid reservoir. Alternatively, it may be arranged on a separate floating platform, a ground-fixed platform, an island or the like within the liquid reservoir. A liquid-tight gas supply pressure gas source may in principle also be arranged within the liquid reservoir, e.g. on its ground.

In some embodiments, the solar harvesting platform includes a pressure relief valve. The pressure relief valve is arranged to fluidic connect the volume inside the gastight enclosed volume with the environment if the gas pressure inside the enclosed volume exceeds a

threshold pressure and to block such connection otherwise. The threshold pressure is typically set to a value that is somewhat higher than the minimum that is required for suspending the platform and generating the required floatation.

The pressure relief valve may be a typically spring loaded mechanical valve of generally
5 known design with a design-given or adjustable threshold pressure. Alternatively, it may be a controllable valve, such as an electrically or pneumatically actuated valve in operative coupling with a pressure sensor and corresponding control circuitry. The pressure relief valve may further allow adjustment of the threshold pressure remotely, e.g. via a remote control unit in dependence of the specific environmental conditions. In a further variant,
10 the pressure relief valve is realized by a piece of fluidic conduit or tubing that extends from the inside of the gastight enclosed volume and below the liquid surface. An aperture or mouth opens into the liquid in a well-defined depth. This type of embodiment is functionally similar to a spring-loaded mechanical valve. Instead of a mechanical spring, however, the hydrostatic pressure of the water above the opening of the conduit is used to
15 define the threshold pressure. More particularly, this type of embodiment ensures that the overpressure inside the gastight enclosed volume does not exceed the hydrostatic water pressure in the depth of the mouth or aperture of the conduit or tubing.

In some embodiments, the solar harvesting platform has a footprint such that a plurality of solar harvesting platforms in a side-by-side arrangement plaster an area of the liquid
20 reservoir surface substantially without significant space remaining between the single solar harvesting platforms.

According to a further aspect, the overall objective is achieved by providing a solar harvesting cluster. Such solar harvesting cluster includes a plurality of solar harvesting platforms. The solar harvesting platforms are arranged, in an operational state, in a side-by-

side configuration on the liquid reservoir surface. Each solar harvesting platform is operatively mechanically coupled to at least one neighbouring solar harvesting platform.

When arranged as cluster in a side-by-side arrangement, such “plastering platforms” have the advantage of making efficient use of the liquid reservoir surface. The limited
5 footprint of each single solar harvesting platform, however, is favourable under aspects such as mechanical stability, transportation and on-site installation.

Additionally – and in some cases of major importance – a cluster of plastering the liquid that is covered by such a cluster of solar harvesting platforms is prevented from evaporation. In operation, the gas (typically air) in inside the gastight enclosed volume of each
10 solar harvesting platform is saturated with liquid (typically water steam). Since the enclosed volume is tightly sealed, no or very little evaporation will occur. By providing clusters of large combined footprint area, a substantially infinite liquid surface area can be prevented from evaporation. This is a particular advantage in warmer countries where water evaporation is a major issue and in some cases an urging and life-critical problem.

15 For an arrangement as solar harvesting cluster, the solar harvesting platforms may include platform couplers. The platform couplers are preferably arranged at the periphery of the at least one solar harvesting platforms. The platform couplers are designed for mechanically coupling neighbouring solar harvesting platforms. Platform couplers may be designed to operatively interact with platform link elements such as rods, bars, chains or
20 ropes. The platform link elements bridge the gap between platform couplers of neighbouring platforms to be coupled and may be provided separately from the solar harvesting platforms. Alternatively, platform link elements may be provided integrally with the solar harvesting platforms. In further embodiments, the platform couplers are designed

to directly couple neighbouring solar harvesting platforms, without intermediate link elements.

In a solar harvesting cluster, each solar harvesting platform may have its own dedicated gas supply system. In alternative embodiments, however, the solar harvesting cluster
5 includes a gas supply network. In an operational state, the gas supply network is operatively fluidic coupled to the gastight enclosed volumes of at least two solar harvesting platforms and a shared overpressure gas source.

The gas supply network is favourably designed as net, grid, or tree of gas supply conduits and has a plurality of gas supply apertures for supplying gas to the individual solar harvesting platforms of the cluster. Favorably, gas supply conduits run under the liquid surface
10 to supply gas under or into the individual gastight enclosed volumes of the individual solar harvesting platforms. Gas supply apertures may pierce the liquid surface under the covers of the solar harvesting platforms and open into the gastight enclosed volumes or may be below the liquid surface level, as explained before.

15 As will be discussed below in the context of exemplary embodiments, the solar harvesting cluster may include a pressure and/or flow control system with one or more control valves, sensors, and a control unit. Such pressure and/or flow control system is designed for controlling the gas pressure in the individual enclosed volumes and or the gas supply to the individual enclosed volumes to be substantially uniform.

20 In some embodiments of a solar harvesting cluster, the solar harvesting cluster includes at least one pressure equalization conduit, the at least one pressure equalization conduits fluidly coupling the gastight enclosed volumes of at least two solar harvesting platforms of the cluster. The pressure equalization conduit includes pressure equalization apertures

that open into the gastight enclosed volumes and above the liquid surface. Favourably, a number or all of the solar harvesting platforms of the cluster are fluidic coupled via pressure equalization conduits.

Such pressure equalization conduits are particularly favourably used in large clusters to ensure substantially identical pressure for the individual solar harvesting platforms. Without pressure equalization conduits, the gas supply may be different from platform to platform in dependence from the distance of the individual solar harvesting platform from the pressure gas source, resulting in different pressures inside the gastight containers. Additionally, the pressure could vary, for example, due to different temperatures.

Pressure equalization conduits further enable embodiments where at least some of the solar harvesting platforms do not receive the gas directly from the pressure gas supply. Instead, they may receive the gas from the enclosed volume(s) of one or more other solar harvesting platform(s). Pressure equalization circuits may be arranged above and/or below the liquid surface level.

In embodiments with at least one pressure relief valve, it is not necessary to provide pressure relief valve separately for each solar harvesting platform. Instead, a number of platforms that are fluidic coupled via pressure equalization conduits may share a common pressure relief valve. In some embodiments of solar harvesting platforms and/or solar harvesting clusters, the gas supply system is partly or fully redundant. In particular, two or more pressure gas sources and/or gas supply units and or redundant gas supply conduits and/or gas supply networks may be present. In such configurations, two or more pressure gas supplies be designed to maintain a sufficient gas supply in case of a given maximum number of e.g. one or two pressure gas supplies failing. In further embodiments, redundant components may be used as backup only and not be used during regular operation.

Solar harvesting platforms, solar harvesting clusters and/or solar harvesting plants may further be anchored or bound to the ground of the liquid reservoir, via submerged weights, anchors, steel ropes and concrete bases, or the like. Similarly, they may be anchored to the shore or generally the (lateral) borders of the liquid reservoir.

5 According to a still further aspect, the overall objective is achieved by providing a method of operating a solar harvesting platform. The method includes providing a solar harvesting platform as discussed before and/or further below. The method further includes arranging the at least one solar harvesting platform floating on a liquid reservoir. The method further includes generating and maintaining an overpressure inside the gastight
10 enclosed volume. The method is applicable to a solar harvesting cluster and/or solar harvesting plant in an analogue way.

According to a still further aspect, the present invention is directed towards the use of a solar harvesting platform, a solar harvesting cluster or a cluster group or solar harvesting plant for preventing evaporation from a liquid reservoir. In such an embodiment, the at
15 least one solar harvesting platform serves a double goal of harvesting solar energy as well as preventing evaporation.

In some embodiments, the method further includes maintaining the overpressure controlling at least one pressure gas supply to operate intermittently. Alternatively, it may also include controlling the gas supply unit to operate intermittently or continuously if
20 needed to better oxygenate the liquid, preferably water, and renew the gas, preferably air, in the gastight enclosed volume(s). The time between consecutive operations may be 1 hour or more, favourably more than 6 hours, or more than 12 hours. The gas supply may also be continuous with a small or large flow.

Since the gas inside the gastight enclosed volume(s) is trapped and accordingly stays inside the gastight enclosed volume(s), providing additional gas and accordingly operating the pressure gas supply is generally not required, once the required overpressure is established. According to a typical mode of operation, small quantities of gas, e.g. air, are supplied once or twice a day, for example in the evening or at night and/or in the morning when the air contracts with the lower temperatures. Simple visual inspection may be used optionally in the morning to check the height of the solar harvesting platforms, e.g., from an observation tower. In this way, any malfunction, potentially requiring maintenance or repair, can be identified. More sophisticated electronic arrangements, such as tele-monitoring systems may be present and connected to pressure sensors measuring overpressure within the gastight enclosed volume(s). Via corresponding control circuitry, the pressure gas supply may be actuated automatically to compensate for any pressure loss as required. Alternatively to pressure sensors, further sensors may be used for this purpose. Displacement sensors may be provided that measure the position of some measuring points of the cover. In further variants, strain gage sensors are attached to the cover.

Optionally, the pressure gas supply may be operated as required in case of temperature and/or atmospheric pressure changes that result in the gas in the gastight enclosed volume(s) to contract or expand. For this purpose, temperature sensors and corresponding control devices and/or control algorithms may be present. The pressure gas supply may further be operated manually or automatically in case of leakages and until the source of leakage is identified and fixed.

In some embodiments, the method further includes maintaining an overpressure in the gastight enclosed volume(s) of the at least one solar harvesting platform that does not

exceed 10% of the environmental pressure and does preferably not exceed 1%, for example 0.3% ... 0.5%, of the environmental pressure.

BRIEF DESCRIPTION OF DRAWINGS

- 5 Figure 1a, 1b show an exemplary arrangements in a schematic side view and top view, respectively;
- Figure 2a – 2d show further alternative arrangements in schematic side views;
- Figure 3a – 3n show further exemplary embodiments of a solar harvesting platform in a schematic three-dimensional view;
- 10 Figure 4 show further exemplary embodiments of a solar harvesting platform in a schematic side view;
- Figure 5 shows a further embodiment of a solar harvesting platform in a schematic three-dimensional view;
- 15 Figure 6a – 6e schematically shows embodiments of solar harvesting clusters in a top view;
- Figure 7 schematically shows a further embodiment of a solar harvesting cluster in a top view.

EXEMPLARY EMBODIMENTS

In the following discussion of the figures, elements that are present in the same or substantially the same way multiple times are generally referenced only once. Furthermore, identical or corresponding elements in different figures may not be explicitly referenced in
5 all of them.

In the following, reference is first made to figure 1a and figure 1b, respectively. Figure 1a shows an exemplary embodiment of a solar harvesting arrangements with a solar harvesting platform 1 and a gas supply system 2. The phrase "solar harvesting arrangement" refers to an operative arrangement of at least one solar harvesting platform and a gas
10 supply system that may be arranged at or on the solar harvesting platform or may be arranged separately and remote from the solar harvesting platform.

The solar harvesting platform 1 comprises a cover 10, a skirt 11, an optional ballast 13 and solar harvesting arrangement 14. Figure 1b shows a schematic top view of the cover
10.

15 Both the cover 10 and the skirt 11 are made from (typically identical) industrial-grade thermoplastic or coated textile membrane material. A suited material is, e. g. Precontraint by Serge Ferrari S.A.S., La Tour du Pin Cedex, France.

The skirt 11 is attached to the cover 10 along a circumferential edge E by suited bonding techniques, such as ultrasonic welding, in a gas tight way. Alternatively to the embodi-
20 ment as shown in figure 1a, the skirt 11 may be somewhat drawn in from the edge E towards the inside of the solar harvesting platform 1.

The cover 10 is made from a number of cover elements (not separately shown) to form – in an operational state as explained further below – the shape of cylindrical cone. This cone (defining the footprint of the solar harvesting platform 1) may have a diameter D in a range of, e.g., 6 m to 18 m. Other dimensions, however, are also possible in accordance with the specific circumstances of the application.

The ballast 13 is arranged and mechanically fixed at the bottom of the skirt 11. The ballast 13 may be realized by a number of concentrated weights that may, e.g., be made from concrete, steel or lead. Alternatively or additionally, the ballast 13 may be fully or partly integrated into a bottom section of the skirt 11, for example in a circumferential hem. An arrangement of the ballast 13 in the bottom region of the skirt has the particular advantage of maintaining the skirt, in operation, in a substantially vertical orientation.

For stability reasons, the height of the solar harvesting platform above the liquid surface level should be as small as possible and is selected in dependence of the amount of liquid movement/waves that is to be expected at the site of installation. It may be in a typical range of about 20 cm up to more than 1 m. Furthermore, the overall center of gravity should be as deep as possible below the liquid surface. The platform 1 of this embodiment accordingly requires the comparatively deep liquid reservoir.

The circumferential edge E and accordingly the seam where the cover 10 and the skirt 11 are joint, is favorably above but close to the liquid surface S.

At the top of the cover 10, the solar harvesting arrangement 14 is arranged. The solar harvesting arrangement 14 comprises a plurality of (not individually referenced in figure 1a) bendable or flexible PV elements of panels. The PV panels are attached to the cover 10 by suited attachment means, such as ropes and/or hook and loop elements/ Velcro.

The attachment means are sufficiently strong to securely fix the PV panels, but do not need to be particularly strong. Because the PV panels are bendable, they adopt to the non-planar shape of the cover 10 in an operational state.

The solar harvesting arrangement may cover the substantially the whole surface area of the cover 10 or may spare predefined paths that allow walking on the platform in a pressurized state.

Alternatively to arranging structurally distinct PV panels on the top side of the platform 10, PV elements of the solar harvesting arrangement 14 may be formed integrally with the cover 10. The PV panels of the solar harvesting arrangement 14 are, in an operational state, electrically functionally coupled to a power distribution net, e. g. a public power grid or an industrial plant power supply, via electric conductors, typically cables, and converter circuitry (not shown). Such converter circuitry may be arranged on the solar harvesting platform 1 and as close to the solar harvesting arrangement 14 as possible, on a separate float or island, or outside the liquid reservoir. Since the PV panels of the solar harvesting arrangement 14 have different orientations with respect to the sun irradiation, they generally produce different amounts of electrical energy and particular have different and varying terminal voltages and/or currents. To cope with this situation, a number of separate converters is typically required.

The gas supply system 2 of the shown embodiment comprises a pressure gas supply 20 in form of a blower or compressor, and a gas supply conduit 21 that is exemplarily realized as a hose. The pressure gas supply 20 of the shown embodiment is arranged separate from the solar harvesting platform 1, for example inside the liquid reservoir on a float or island (not shown), or outside of the liquid reservoir.

The gas supply conduit 21 is partly arranged inside the liquid reservoir and below the liquid surface level S. Particularly, it crosses below the skirt 11 and runs upwards and cuts the liquid surface S under the cover 10, such that a gas supply aperture 22 (open end) of the gas supply conduit 21 opens into the gastight enclosed volume V between the cover
5 10 and the liquid surface S. The overpressure inside the gastight enclosed volume V that is generated and maintained by the gas supply system 2 is favorably below 1% of the atmospheric pressure, e. g. 0.3% of the atmospheric pressure.

The floatation that is generated by the overpressure inside the gastight enclosed volume V and the total weight of the solar harvesting platform 1 (including the ballast 13) is bal-
10 anced such that the solar harvesting platform is in equilibrium.

Since the skirt 11 is a delimiting wall of the gastight enclosed volume V, it must be ensured that no gap exists between the bottom edge of the skirt and the liquid surface S in the presence of wind and/or waves, i.e., that the skirt always immerses into the liquid along its whole length. Thereby, a required minimum is given for the width w. If the width
15 w is considerably larger for stability reasons, the section of the skirt that is always below the liquid surface in an operational state is not necessarily fully closed but may have, holes, cutouts, etc.

In the following, reference is additionally made to figure 2a and figure 2b, respectively, showing further solar harvesting arrangements in accordance with the present invention.
20 For both the embodiment of figure 2a and figure 2b, the design of the solar harvesting platform is generally identical to the before-described embodiment. Some differences exist, however, with respect to the gas supply system 2.

In the embodiment of figure 2a, the gas supply conduit 21 runs under the solar harvesting platform 1 below the liquid surface S and below the bottom of the skirt 11. The length of the gas supply conduit 21 is selected such that it substantially spans the solar harvesting platform 1 along a diameter. The section of the gas supply conduit 21 that is
5 under the solar harvesting platform 1 comprises along its length a number of gas supply apertures 22. Via these gas supply apertures 22, gas exits the gas supply conduit 21 in form of bubbles B that rise to the liquid surface S and are trapped within the gastight enclosed volume V.

In the embodiment of figure 2a, the gas supply conduit 21 runs closely below the bottom
10 of the skirt 11. The gas supply conduit 21 may be attached to the skirt 11 via ropes, hook-and-loop fasteners, or the like. Alternatively, the gas supply conduit 21 may run deeper, for example the ground of the liquid reservoir and may be fixed to the ground, for example via anchors and/or ballast weights. It is noted that – like in the embodiment
15 of figure 1a, figure 1b, no attachment of the gas supply conduit 21 to the solar harvesting platform 1 is required, provided that their relative positions are sufficiently maintained.

In the embodiment of figure 2a, three gas supply apertures 22 are present. A larger or smaller number of gas supply apertures 22 may also be foreseen.

The gas supply conduit 21 does further not necessarily span the solar harvesting platform 1 along a diameter, but may follow any desired path and be, e.g., curved. Furthermore, a
20 number of gas supply conduits 21 may be present, with each of the gas supply conduits having one or more gas supply apertures 22.

In the embodiment of figure 2b, the gas supply conduit 21 does not immerse into the liquid. Instead, a gastight supply connector in form of a gland or fluidic coupler 24 is pro-

vided in the cover 10. Via the gland or fluidic coupler 24, the gas supply conduit 21 is fluidly coupled to the interior of the gas tight containment. The gland or fluidic coupler 24 may also be provided at the skirt 11 and may further be provided below the liquid surface S.

5 In the embodiment of figure 2c, the gas supply conduit crosses the cover 10 via a gastight gland or coupler (not shown) and continues within the gastight enclosed volume and further immerses into the liquid inside the gastight enclosed volume and below the cover 10. The gas supply aperture 22 is accordingly located under the liquid surface. For this type of embodiment, the liquid surrounding the gas supply aperture 22 prevents gas
10 from exiting the gastight enclosed volume and accordingly the overpressure from being lost if the pressure gas supply 20 is operated discontinuously, thereby acting as one-way valve. In embodiments where the gas supply aperture 22 does not immerse into the liquid but opens into the gastight enclosed volumes and above the liquid surface, in contrast, a dedicated (mechanical) one-way valve is generally required.

15 The embodiment of figure 2d is similar to the above-discussed embodiment of figure 2c. In figure 2d, however, a pressure relief valve is present that is realized by a piece of fluidic conduit or tubing 25 that extends from the inside of the gastight enclosed volume and below the liquid surface. An aperture or mouth 26 opens into the liquid in a well-defined depth h. Here, the hydrostatic liquid pressure corresponding to the depth h defines the
20 maximum pressure within the gastight enclosed volume, as explained above.

It is noted that the alternative gas supply arrangements of figure 1 and figure 2a – 2d are not restricted to a circular footprint of the solar harvesting platform are but are generally independent of the footprint.

In the following, reference is additionally made to figure 3a to figure 3n, showing different further embodiments of a solar harvesting platform 1 in a schematic three-dimensional view.

In the embodiment of figure 3a, the footprint of the solar harvesting platform 1 is square and the cover 10 is shaped to bulge, in an operational state, in a symmetric dome-shaped way. The solar harvesting arrangement 14 is realized by a plurality of flexible photovoltaic panels 140 that exemplarily cover substantially the hole surface area of the cover 10 for maximum utilization of its surface.

In the embodiments of figure 3a, an additional float structure 15 is further present in contrast to the above-discussed embodiments. The float structure 15 comprises four tubular elements 150, with one of the tubular elements 150 being arranged along an edge of the square cover footprint. Optionally, the single tubular elements may be divided into a number of segments.

The tubular elements 150 are made from plastic as discussed above in the general description and have a diameter of, e. g. 60 cm. The tubular elements 150 are further closed on all side and accordingly sealed. The inner volume of the tubular elements 150 is partly filled with gas, e.g. air, and partly filled with ballast, e.g. concrete. In a typical embodiment, the floatation that is provided by the float elements is sufficient to maintain floatation of the solar harvesting platform 1 alone, without relying on the overpressure inside the gastight enclosed volume.

Adjacent tubular elements 150 are mechanically coupled and linked to each other via hinge elements 151, thus providing flexibility to the float structure 15 and the overall solar harvesting platform 1. The single hinge elements 151 have a single rotational de-

gree of freedom, with the rotational axes being aligned with the diagonals of the square footprint. Via the overpressure inside the gastight enclosed volume as explained before, the circumferential structure that is formed, in combination, by the tubular elements 150 and the hinge elements 151 is tensioned and thereby stabilized, and hinge slackness is removed. Instead of the hinge elements 151, other coupling elements such as ropes and/or chains may be provided.

The cover 10 is mechanically coupled to the tubular elements 150 via a float structure coupler 16 in a flexible way. Exemplarily, the float structure coupler is realized by a rope or a number of rope segments that run(s) between the edge E of the cover 10 and the tubular elements 150 in a circumferential zigzag line. Alternatively, the float structure coupler 16 is not arranged as zigzag line. It may, for example, be realized by a number of separate pieces of rope that are arranged along the periphery in a substantially parallel way. In such an embodiment, the single pieces of rope can be individually and differently tensioned. Suited fastening elements such as hoops, loops, and/or eyelets are present at the tubular elements 150 as well as along the periphery of the cover for attachment of the float structure coupler 16. In operation, the flexible float structure coupler is tensioned by the overpressure inside the gastight enclosed volume. Additionally, the flexible float structure couplers are vertically tensioned by the upwards-directed flotation and the downwards-directed gravitational force of the tubular elements 150. Alternatively to ropes, the float structure coupler may be realized by other typically flexible coupling elements, such as one or more chains, strips of hook-and-loop tape, or the like.

In the shown embodiment of figure 3a, the circumferential skirt 11 is arranged inside the area that is delimited by the float structure 15 and along the circumferential edge E of the cover 10. Alternatively, the skirt 11 may be drawn in with respect to and somewhat distant from the edge E as discussed above. In an operational state, the skirt 11 projects

below the bottom of the float structure 15. While the ballast is, in this embodiment, largely arranged inside the tubular elements 150, some ballast is favourably also present at the bottom of the skirt 11, thus ensuring its straight vertical orientation.

The embodiment of figure 3b is in many aspects similar to the embodiment of figure 3a. In the embodiment of figure 3b, however, the cover 10 is made of exemplary four triangular cover segments 10a that are bonded along their edges E' in a gastight way, as explained before. In an operational state, the cover segments 10a form faces of a symmetric pyramid. Favourably, the PV panels 140 are arranged on the cover segments 10a without crossing the edges E'. In contrast to the embodiment of figure 3a, the embodiment of figure 3b has the advantage of a uniform slope of the cover 10 and in particular the avoidance of a substantially horizontal area, as it present in the centre 10 of the embodiment in figure 3a. Thereby, the removal of dirt, dust, water, etc. is improved.

The embodiment of figure 3c is similar to the embodiment of figure 3b. In contrast to the embodiment of figure 3b, however, the pyramid that is formed by the cover segments is asymmetric. In the embodiment of figure 3c, the cover 10 comprises a comparatively large trapezoid segment 10b of low slope, a smaller trapezoid cover segment 10c of larger slope that is arranged opposite to the cover segment 10b, and two mutually opposite triangular cover segment 10c. The cover segments 10b, 10c are connected via a horizontal apex A. In such an asymmetric embodiment, the solar harvesting platform 1 may be arranged on the liquid surface in a well-defined orientation with respect to the cardinal points such that the total solar harvesting efficiency is optimized, particularly maximized. In the example of figure 3c, the segment 10b may, for example, be oriented towards the South (in the Northern hemisphere), while the surfaces 10d may be oriented in East-West-direction in order to benefit from the sun in the morning respectively evening. While the shape that is, in an operational state, formed by the cover 10, is not symmetric

to the centre point the footprint of the solar harvesting platform, the platform footprint is square (or rectangular) like in the previously discussed embodiments.

The embodiment of Figure 3d is similar to the above-discussed embodiments of figure 3a to 3c and in particular to the embodiment of figure 3b. In contrast to the latter, however,
5 the footprint of the solar harvesting platform 1 in figure 3d is not square but hexagonal, with six triangular cover segments 10a. Consequently, the float structure 15 includes six tubular elements 150 and six hinge elements 151. The axes of rotation of the six hinge elements 151 are aligned with the edges between adjacent cover segments 10a. The hexagonal shape being closer to a circle as compared to a square shape enables a better
10 distribution of the forces resulting from the overpressure inside the gastight enclosed volume, while allowing plastering, i. e. full coverage of the liquid surface.-

In the embodiment of figure 3e, the footprint of the cover 10 is circular, like in the embodiment of figure 1a, figure 1b, respectively figures 2a – 2d. The footprint of the float structure 15, and accordingly the overall footprint of the solar harvesting platform 1, is
15 hexagonal. In view of an optimal use of the surface area, the diameter of the cover 10 is selected such that the peripheral edge E of the cover 10 touches or almost touches the tubular elements 150. In comparison to alternative shapes, a circular shape of the cover better supports the overpressure. In addition, a circular cover is easier to manufacture than most other shapes. A drawback of a circular shape is that not all the water area
20 within inside hexagonal shape of the pipes 150 is covered to prevent evaporation. This aspect is of particular importance if the solar harvesting platform 1 is installed in climate and the liquid reservoir is, e.g., a sweet water/drinking water reservoir. Because of the different footprints of the cover 10 and the float structure 15, gaps exist in this embodiment between the peripheral edge E of the cover 10 and the skirt 11 on the one hand
25 and the tubular elements 150 on the other hand. The gastight sealing of the gastight

enclosed volume under the platform 10, however, does not rely on the tubular elements 150, resulting in the gaps being uncritical.

The embodiment of figure 3f is similar to the embodiment of figure 3e. In the embodiment of figure 3f, however, the cover 10 comprises, like in the embodiment of figure 3b,
5 four cover segments 10a that are joint along their edges E'. The cone shape of the cover 10 enables a good flow of water to clean the PV panels when it rains since no surface is horizontal, in contrast to the centre of cover in the embodiment of figure 3e. The manufacture of a conical cover, however, is comparatively expensive.

The embodiment of figure 3g is similar to the embodiment of figure 3e as discussed before.
10 In contrast to the embodiment of figure 3e, the footprint of the float structure 15 and accordingly the overall footprint of the solar harvesting platform 1 is octagonal. In comparison to a hexagonal footprint, the forces are better distributed because the octagonal shape is even closer to a circle than the hexagonal shape.

In the embodiment of figure 3h, the cover 10 with the solar harvesting arrangement 14 is
15 realized in the same way as in figure 3e and 3g, respectively. In the embodiment of figure 3h, however, the footprint of the float structure 15 is circular, like the footprint of the cover 10. While the float structure 15 is shown as a single toroidal tube 150', it may also be realized by a number of adjacent tubular elements. While a solar harvesting cluster that comprises solar harvesting platforms 1 of circular footprint does not plaster the liquid
20 surface, the embodiment of figure 3h is particularly favourable with respect to mechanical symmetry and stability.

In the embodiment of figure 3i, the footprint of the cover 10 as well as the footprint of the float structure 15 is square, like in the embodiments of figure 3a to 3c. In contrast to

the latter, however, the PV panels 140' are arranged in a number of parallel rows 141. In this embodiment, the PV elements are not attached to the cover 10 directly, but via an intermediate structure between the cover 10 and the PV panels 140' (not visible). Like in the previously discussed embodiments, the weight of the PV panels 140' is carried by the cover 10 and not the float structure 15. Furthermore, the intermediate structure may not be rigid over the whole surface area of the cover 10. Instead the intermediate structure is typically divided into a number of intermediate sub-structures, e. g. one intermediate sub-structure per row 141. The intermediate sub-structures are separately attached to the cover 10 e. g. via strips of hook-and-loop tape, ropes, chains, or the like. Thereby, mechanical flexibility of the solar harvesting platform 1 is maintained, such that the solar harvesting platform 1 can be deformed. In principle, each separate PV element 140' may also be carried by the cover 10 separately. Since the PV panels 140' are distanced from the cover 10, they do not necessarily need to be flexible. In contrast to the previously discussed embodiments, all PV panels 141 further have a substantially common orientation in figure 3i, with the surface normals being substantially parallel. The PV panels 140' are accordingly oriented with respect to the sun irradiation in the same way.

In the embodiment of figure 3i – like in the subsequently discussed embodiment of figure 3j – the cover 10 may also be made from a substantially rigid sheet-like material rather than from a foil or membrane, for example from thin thermoplastic plates. Also such substantially rigid material does not need to be particularly strong or sturdy because it is suspended by the overpressure of the gastight enclosed volume. In such embodiments, also the intermediate structure may be substantially rigid. In a further alternative, no intermediate structure is present and the back side of the PV panels is directly attached to the cover 10.

The embodiment of figure 3j is similar to the embodiment of figure 3i. In Figure 3j, however, the footprint of the cover 10 as well as the overall footprint of the solar harvesting platform 1 is hexagonal.

In the embodiment of figure 3k (shown in a partial sectional view), the top surface of the cover 10 (not referenced in figure 3k) substantially corresponds to the surface section of a horizontally oriented barrel. The PV elements 140 are realized as plurality strips that are arranged on both sides of the horizontal apex A (top of the solar harvesting platform 1). The shown configuration optimizes the area that is covered by PV elements with the PV elements 140 having identical dimensions.

As compared to the above-discussed embodiments, the cover 10 is further designed in a different way. In the embodiment of figure 3k, the cover 10 comprises a flexible part 100 that is made from a foil or membrane as generally discussed before. The flexible part 100 spans the surface area of the solar harvesting platform 1 and carries the PV elements 140. Along the peripheral edge E of the flexible part 100, a rigid part 101 is attached in a gas-tight way. The rigid part 101 projects downwards from the flexible part 100 in vertical direction and is made from a substantially rigid sheet material. Around the periphery of the rigid part 101, a float structure attachment rim 102 is arranged to which the tubular elements 150 are attached as discussed above. The skirt 11 that is favorably made from a flexible material as in the above-discussed embodiments projects vertically from the rigid part 101 in downwards direction.

The embodiment of figure 3l is similar to the embodiment of figure 3k and shown in a corresponding partial sectional view. In contrast to the embodiment of figure 3k, however, the cover 10 is fully made from a flexible material. In a peripheral transition region

10a, the cover 10 is curved to form a transition between the horizontally orientated barrel-shaped section and the vertical skirt 11.

The embodiment of figure 3m is similar to the above-discussed embodiment of figure 3h and shown in a partial sectional view. In contrast to the embodiment of figure 3h, however, the float structure 15 is realized by a number of float elements that are, in this embodiment, inflatable elements 150a that are made from a flexible membrane foil-like material, for example from the same material as the cover 10. Therefore in this case, the inflatable elements 150a, the cover 10, and the skirt 11, can be a single element without the need of couplers 16 like in all other examples. The inflatable elements 150a are gas-tight and inflated with gas, for example air, to generate floatation. The single inflatable elements 150a may be fully encapsulated once they are filled with gas, or may be provided with gas via the gas supply in the same way as discussed above with respect to the gastight enclosed volume, or may also be supplied via a further gas supply. In principle, it is also possible to only provide a single circumferential float element, e. g. inflatable element, of toroidal shape. A separation or split into a number of sections, however, is favorable with respect to safety in case of single inflatable elements 150a leaking.

Further in the embodiment of figure 3m, the ballast is provided at the circumferential bottom side of the skirt 11 as discussed before. Alternatively or additionally, ballast may be provided by partly filling the inflatable elements 150a with a liquid, for example water.

The embodiment of figure 3n and is similar to the above-discussed embodiment of figure 3h. In contrast to the embodiment of figure 3n, however, no circumferentially closed float structure 15 is provided. Instead, a number of exemplarily three separate tubular elements 150 (or, alternatively, inflated elements 150a) is provided in the symmetric

arrangement around the peripheral edge E. For the cover 10 forming a section of a sphere or cylinder, a closed or substantially closed float structure is not required because a sphere or cylinder is a natural shape of a flexible membrane to be formed under overpressure.

5 In the following, reference is additionally made to figure 4. Figure 4 shows an embodiment of a solar harvesting platform 1 similar to the embodiment of figure 2a in a corresponding view. In contrast to the embodiment of figure 2a, however, a float structure 15 with tubular elements 150 as generally discussed above is additionally present. The tubular elements 150 are partly filled with ballast 152 as described above. The tubular elements 150 with the ballast 152 serve as a number of purposes: Via the arrangement at
10 the periphery of the solar harvesting platform 1, the horizontal stability of the solar harvesting platform 1 when floating on the liquid reservoir is improved. Furthermore, the float structure 15 counteracts the vertical uplift force that is generated by the overpressure inside the gastight enclosed volume, corresponding to the weight of several tons for
15 typical dimensions. Third, the floatation that is generated by the tubular elements 150 keeps the solar harvesting platform 1 at the liquid surface in case the overpressure inside the gastight enclosed volume is fully or partly lost because of a leakage. Since most of the required ballast is realized by the ballast 152 inside the tubular elements 150, the ballast 13 at the bottom of the skirt 11 is mainly dimensioned and intended to keep the skirt 11
20 straight and vertical for this type of embodiment. These different functions of the float structure 15 are present for the above-discussed embodiments of figure 3a to figure 3g in an analogue way.

The embodiment of figure 4 further comprises a gutter 17. The gutter 17 is realized by a circumferential channel all groove in a peripheral region of the cover 10. Rain water heat-

ing the cover 10 accordingly flows from the center towards the periphery of the cover 10 and into the gutter 17.

In the following, reference is additionally made to figure 5. Figure 5 shows an embodiment of a solar harvesting platform 1 similar to the above-discussed embodiment of figure 2a. The embodiment of figure 5 additionally comprises a gutter 17 that is realized by a circumferential groove along the peripheral edge E. The gutter 17 has a typical height of about 10 cm to 20 cm and a smooth transition to the cover 10 to allow water to flow from the cover 10 into the gutter 17. The gutter 17 may for example be made from the same material as the cover 10 and may also be formed integrally with the cover 10. If required, the gutter 17 may be realized by two or more layers of foil or membrane to increase its mechanical stability. Alternatively or additionally, stiffening elements or reinforcements may be provided and/or the gutter 17 may be made from a stronger and for example substantially rigid material.

In the following, reference is additionally made to figure 6a to 6e. Figure 6a to 6e show various embodiments of solar harvesting clusters in a schematic top view. Each of the solar harvesting clusters comprises a number of solar harvesting platforms 1 of a square (figure 6a), rectangular (figure 6b), hexagonal (figure 6c, 6e) or circular (figure 6d) footprint. It can be seen that solar harvesting platforms 1 of square, rectangular or hexagonal footprint can be arranged such that liquid surface is plastered substantially without gaps remaining between the single solar harvesting platforms 1. For a circular footprint, in contrast, some portion of the liquid surface generally remains uncovered.

In the following, reference is additionally made to figure 7, showing further embodiment of solar harvesting cluster, similar to the solar harvesting cluster of figure 6 a. The solar harvesting cluster of figure 7 comprises an exemplary number of 6 solar harvesting plat-

forms 1 of square foot print. It is to be understood that the square footprint is merely exemplary and other footprints may be used as well.

Exemplarily, the solar harvesting platforms 1 are arranged in rows and columns. Each solar harvesting platform 1 is mechanically coupled and thereby linked to its neighboring
5 solar harvesting platforms 1 by means of exemplarily two platform couplers 18. The platform couplers 18 may be realized, for example, by ropes, chains, or rods.

On one of the solar harvesting platforms 1 (exemplarily the solar harvesting platform in the upper left corner of the solar harvesting cluster) a pressure gas supply 20 in form of a compressor or blower is provided. The pressure gas supply 20 supplies gas into the gas-tight enclosed volume of the solar harvesting platform 1 on which it is mounted. Via the
10 gas supply conduits 21, the gastight enclosed volumes of all solar harvesting platforms 1 are fluidic coupled, resulting in a substantially equal overpressure being present in all gas-tight enclosed volumes in a steady-state. The gas supply conduits 21 are realized by tubes, hose or a combination thereof. The gas supply conduits may run above the liquid
15 surface level and couple to the gastight enclosed volumes via a gastight supply connectors as schematically shown in figure 2b. Alternatively, the gas supply conduits 21 may be arranged under the liquid surface and cross below the edges of the solar harvesting platforms 1, as schematically shown in figure 1a respectively figure 2a. Since the gastight enclosed volumes of the single solar harvesting platforms 1 are fluidic coupled, the gas
20 supply conduits 21 at the same time serve as pressure equalization conduits. At for example one of the solar harvesting platforms 1 (exemplarily the solar harvesting platform also carrying the pressure gas supply 20), an optional pressure relief valve 23 is additionally present.

It is noted that the fluidic arrangement of figure 7 is merely exemplary and various variations are possible. For example, the pressure gas supply 20 may not be provided on one of the solar harvesting platforms 1, but may be arranged separately, for example outside the liquid reservoir. Furthermore, more than one pressure gas supply 20, for example two
5 gas supplies may be present in the solar harvesting cluster. It is generally also possible to provide a pressure gas supply 20 separately on each of the solar harvesting platforms 1. In such an embodiment, additional pressure equalization conduits may or may not be present. In a comparatively large solar harvesting cluster with a plurality of solar harvesting platforms 1, the overall solar harvesting cluster may further be realized by a number
10 of sub-clusters, with each sub-cluster comprising a number of solar harvesting platforms 1 and having its own gas supply. In a further variant, the pressure gas supply 20 is arranged on the solar harvesting platform 1 that is located in the centre of the solar harvesting cluster and supplies gas to the solar harvesting platforms 1 at the periphery of the solar harvesting cluster in a star-like configuration.

Claims

1. Solar harvesting platform (1), the solar harvesting platform (1) being designed to float on a liquid reservoir, the solar harvesting platform (1) including:
- 5 a) a cover (10), the cover (10), the cover (10) being made from a sheet-like material;
- b) a skirt, the skirt (11) projecting, in an operational state, from a bottom side of a cover periphery and immersing into the liquid of the liquid reservoir; wherein the bottom side of the cover (10), the liquid surface of the liquid reservoir and the skirt (11) serve as delimiting surfaces of a gastight enclosed
- 10 volume;
- c) a solar harvesting arrangement (14), the solar harvesting arrangement (14) being arranged at a top side of the cover (10) and being fixed to the cover or being integrated into the cover;
- wherein the solar harvesting platform (1) is designed to be reversibly deformed
- 15 under influence of an external force.
2. Solar harvesting platform (1) according to either of the preceding claims, wherein the solar harvesting arrangement (14) includes bendable photovoltaic (PV) elements (140), the bendable PV elements being mechanically attached, favourably directly mechanically attached, on the top side of the cover (10).
- 20 3. Solar harvesting platform (1) according to either of the preceding claims, wherein the cover (10) is made from a flexible foil or membrane, particularly from a thermoplastic or coated textile foil or membrane.

4. Solar harvesting platform (1) according to either of the preceding claims, wherein the solar harvesting platform (1) is designed to be reversibly twisted.
5. Solar harvesting platform (1) according to either of the preceding claims, wherein the skirt (11) is made from a flexible foil or membrane.
- 5 6. Solar harvesting platform (1) according to either of the preceding claims, wherein the solar harvesting platform (1) further comprises a ballast.
7. Solar harvesting platform (1) according to either of the preceding claims, wherein the cover (10) is designed to form, under influence of an overpressure inside the gastight enclosed volume (V), convex surface, in particular a pyramidal or cone-
10 shaped surface.
8. Solar harvesting platform (1) according to either of the preceding claims, the solar harvesting platform (1) further including a gutter (17), the gutter extending along the cover periphery, the gutter (17) being arranged to collect liquid flowing on the top side of cover (10) from the cover centre to the cover periphery.
- 15 9. Solar harvesting platform (1) according to claim 8, wherein the gutter is formed by a peripheral cover region.
10. Solar harvesting platform (1) according to either of the preceding claims, wherein the solar harvesting platform (1) includes a float structure (15), the float structure (15) being mechanically attached to the cover (10) along the cover periphery.

11. Solar harvesting platform (1) according to claim 10 wherein the float structure includes tubular elements (150), the tubular elements (150) having longitudinal axes (X) that extend, in an operational state, parallel to the liquid reservoir surface.
12. Solar harvesting platform according to claim 11 wherein at least two mutually adjacent tubular elements (150) are operatively mechanically coupled via a hinge element (151).
13. Solar harvesting platform (1) according to either of claim 10 to claim 12, wherein the float structure (15) forms an at least substantially closed wall along the periphery of the cover (10).
14. Solar harvesting platform (1) according to either of the preceding claims, the solar harvesting platform (1) further including or being, in an operational state, operatively fluidic coupled to a gas supply system (2), the gas supply system (2) being designed to feed gas into the gastight enclosed volume, thus generating and/or maintaining an overpressure inside the gastight enclosed volume (V).
15. Solar harvesting platform (1) according to either of the preceding claims, wherein the solar harvesting platform (1) has a footprint such that a plurality of solar harvesting platforms (1) in a side-by-side arrangement plaster an area of the liquid reservoir surface substantially without space remaining between the single solar harvesting platforms (1).
20. Solar harvesting cluster, the solar harvesting cluster including a plurality of solar harvesting platforms (1) according to either of the preceding claims, wherein the solar harvesting platforms (1) are arranged, in an operational state, in a side-by-

side configuration on the liquid reservoir surface, and wherein each solar harvesting platform is operatively mechanically coupled to at least one neighbouring solar harvesting platform (1).

- 5 **17.** Solar harvesting cluster according to claim 16, the solar harvesting cluster including a gas supply network, the gas supply network being, in an operational state, operatively fluidic coupled to the gastight enclosed volumes of at least two solar harvesting platforms (1) and a shared overpressure gas source.
- 18.** Method of operating a solar harvesting platform, the method including:
- 10 a) providing a solar harvesting platform (1) according to either claim 1 to 15;
b) arranging the at least one solar harvesting platform (1) floating on a liquid reservoir;
c) generating and maintaining an overpressure inside the gastight enclosed volume (V).

2/12

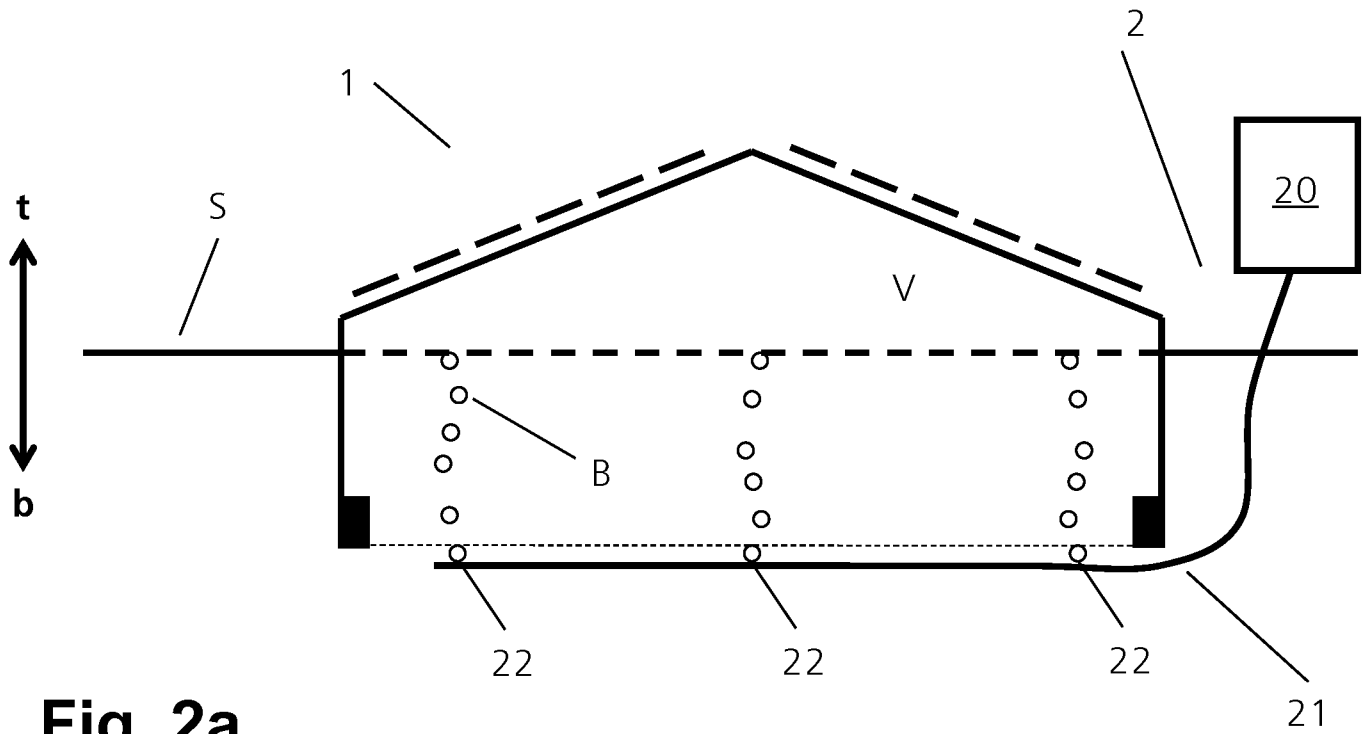


Fig. 2a

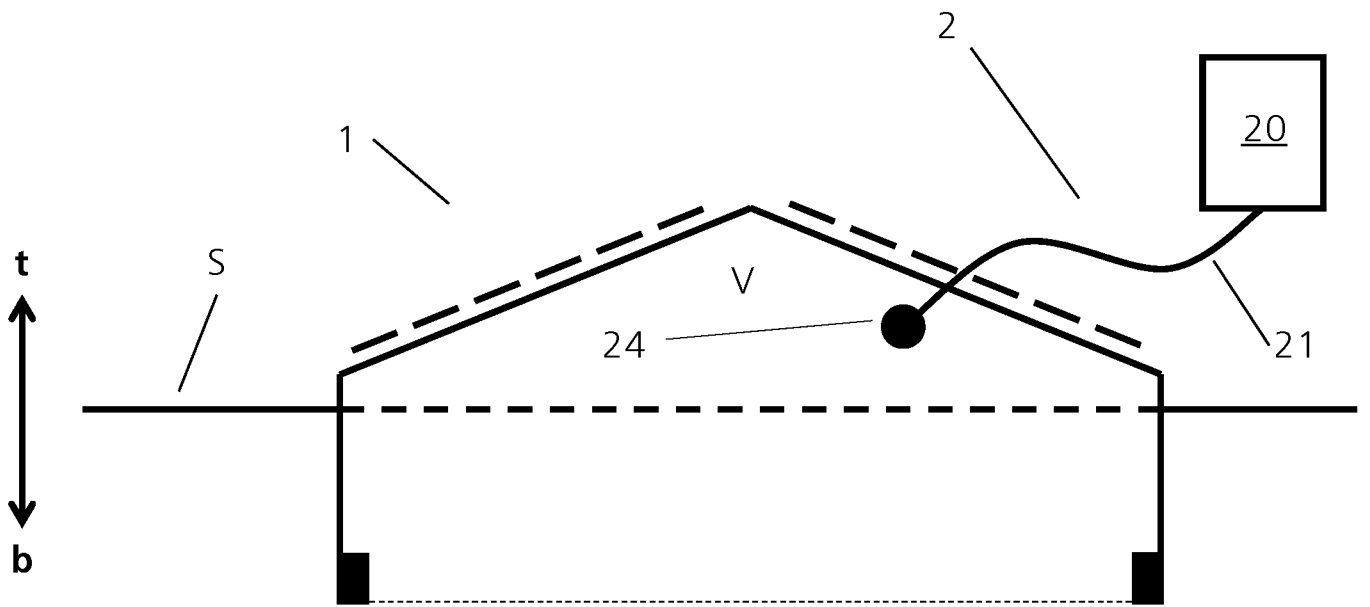


Fig. 2b

3/12

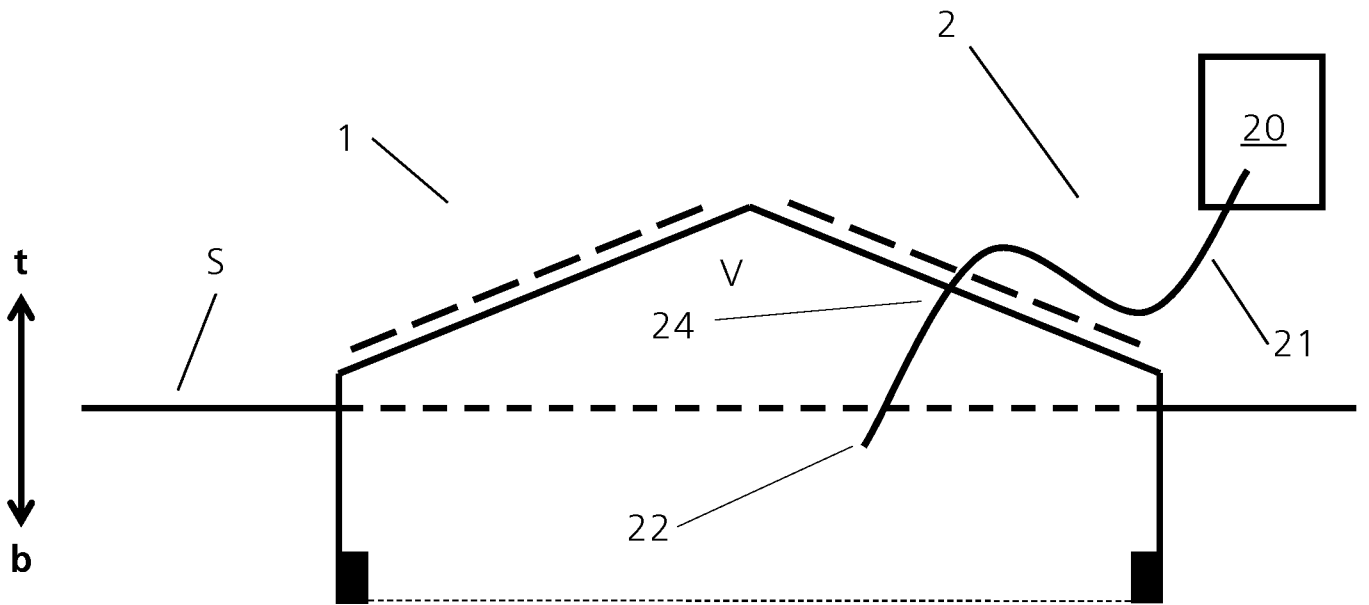


Fig. 2c

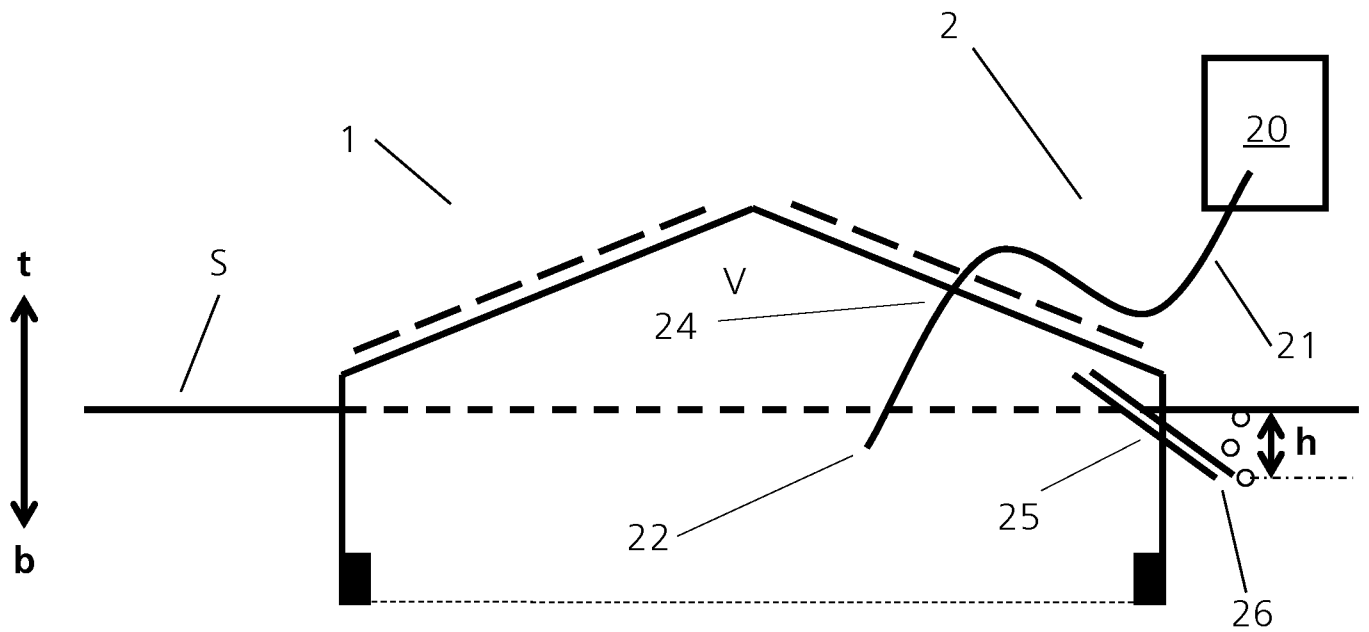


Fig. 2d

4/12

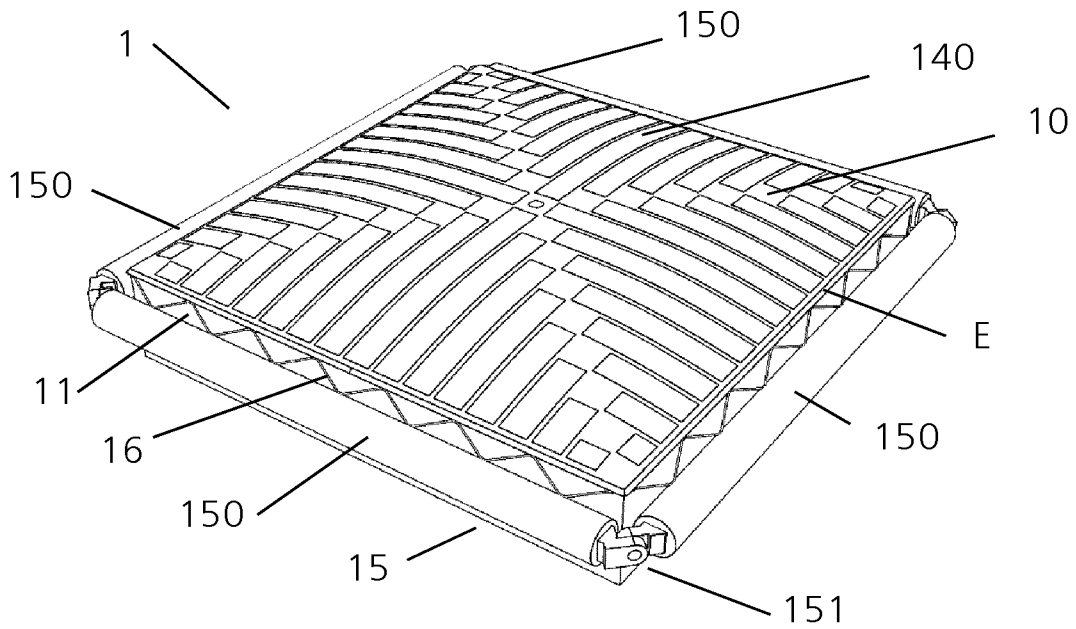


Fig. 3a

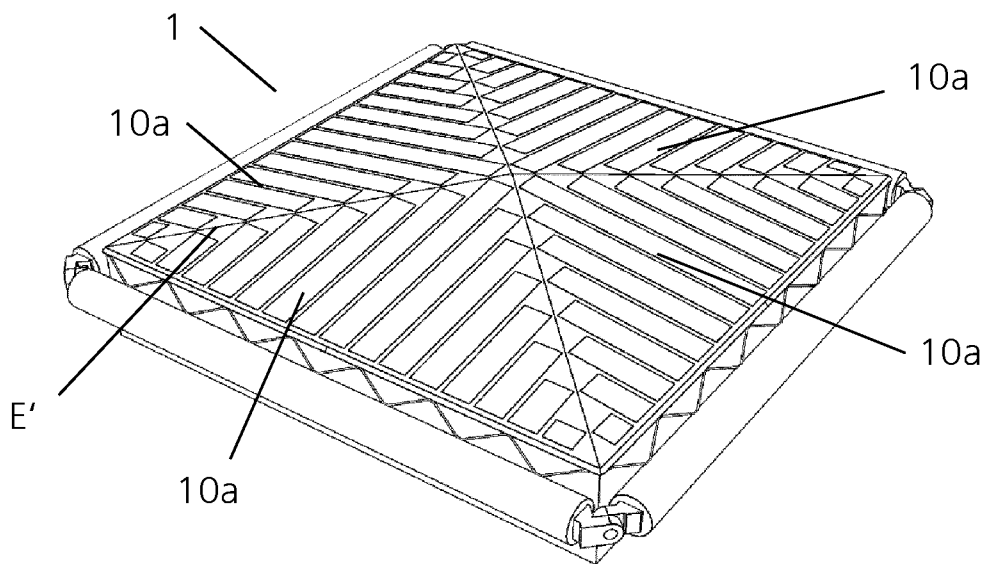


Fig. 3b

5/12

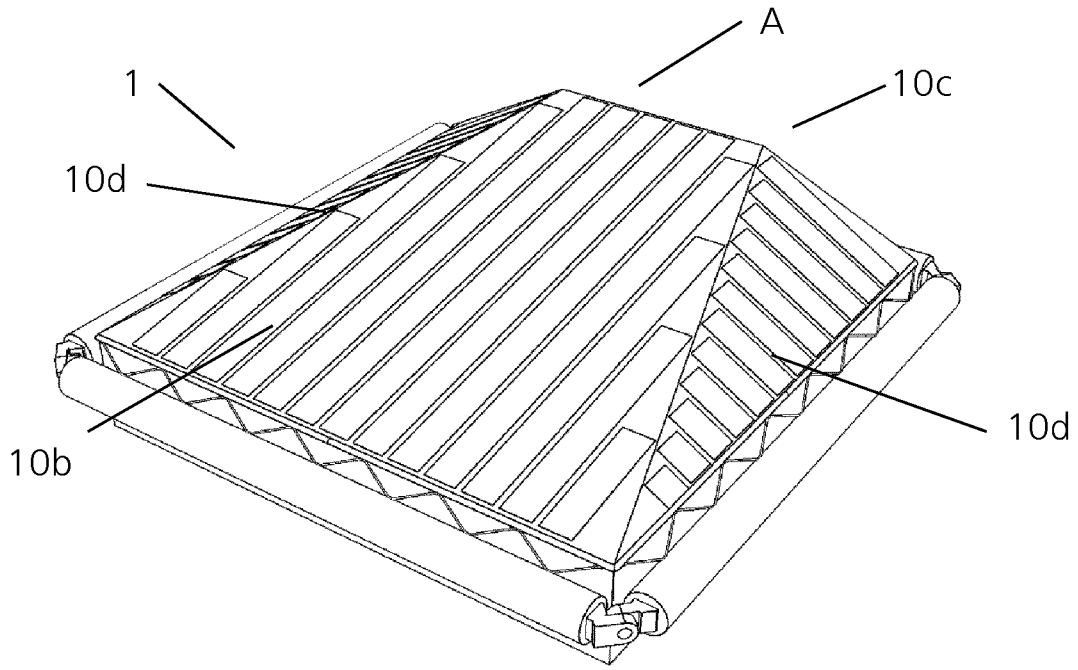


Fig. 3c

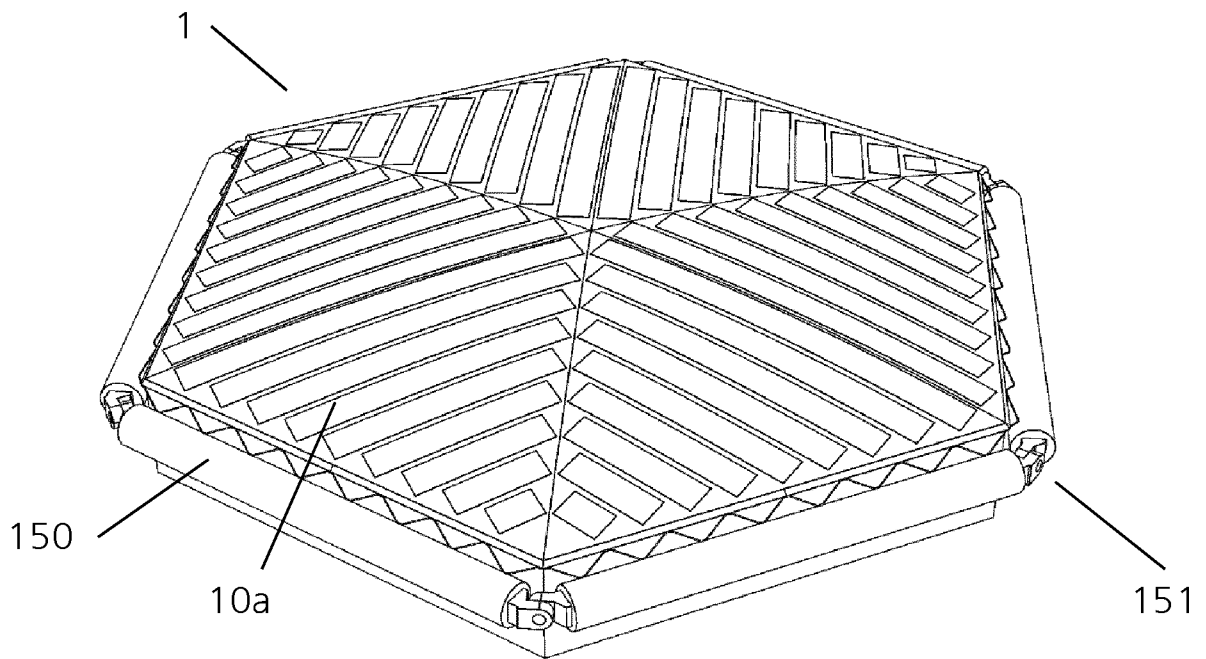


Fig. 3d

6/12

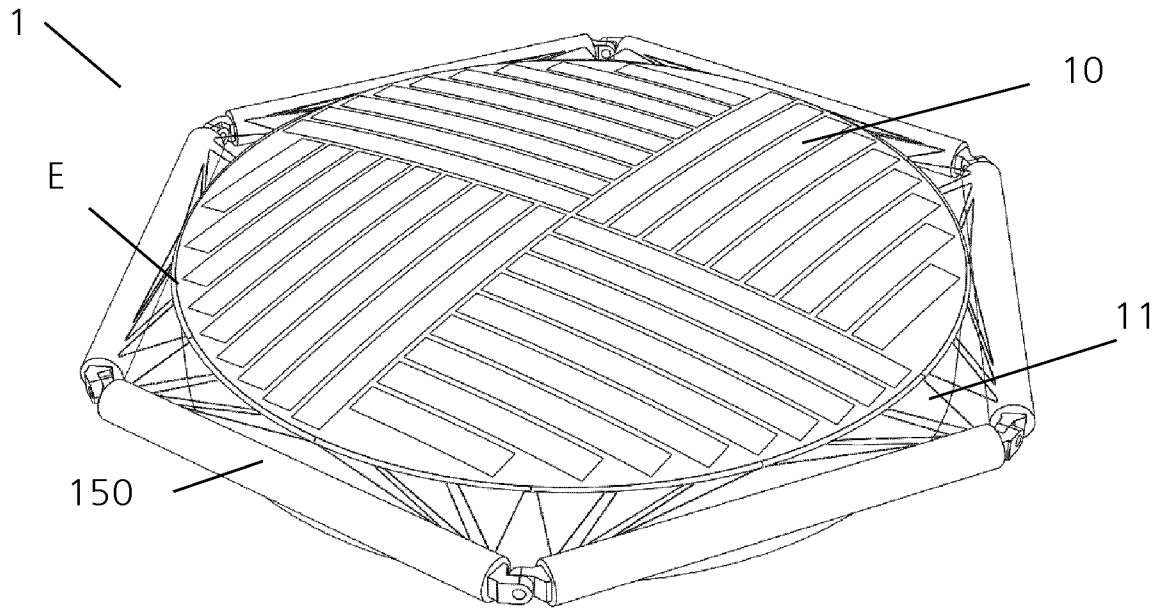


Fig. 3e

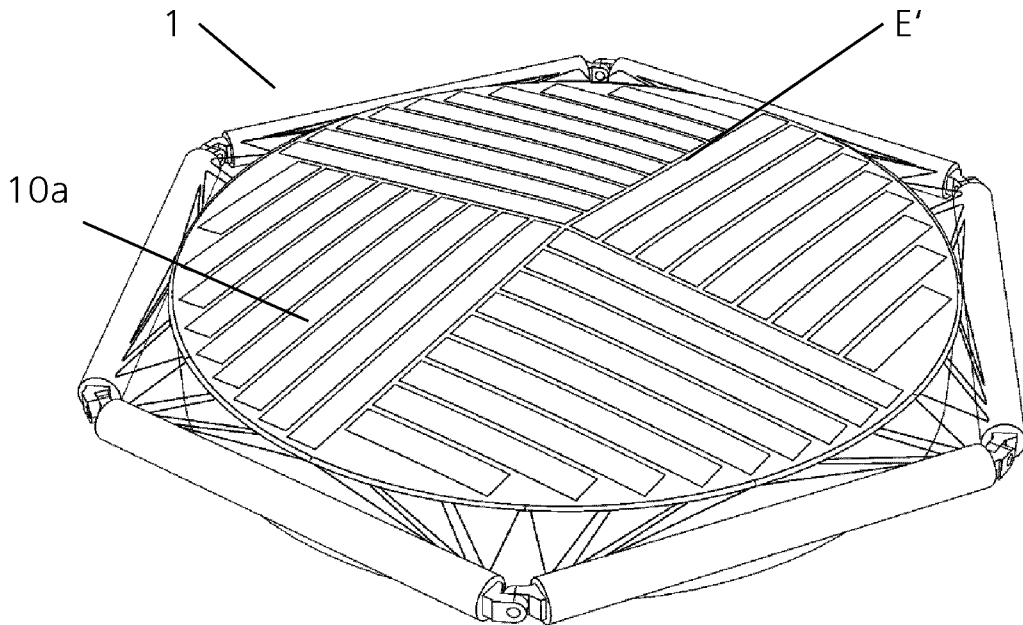


Fig. 3f

7/12

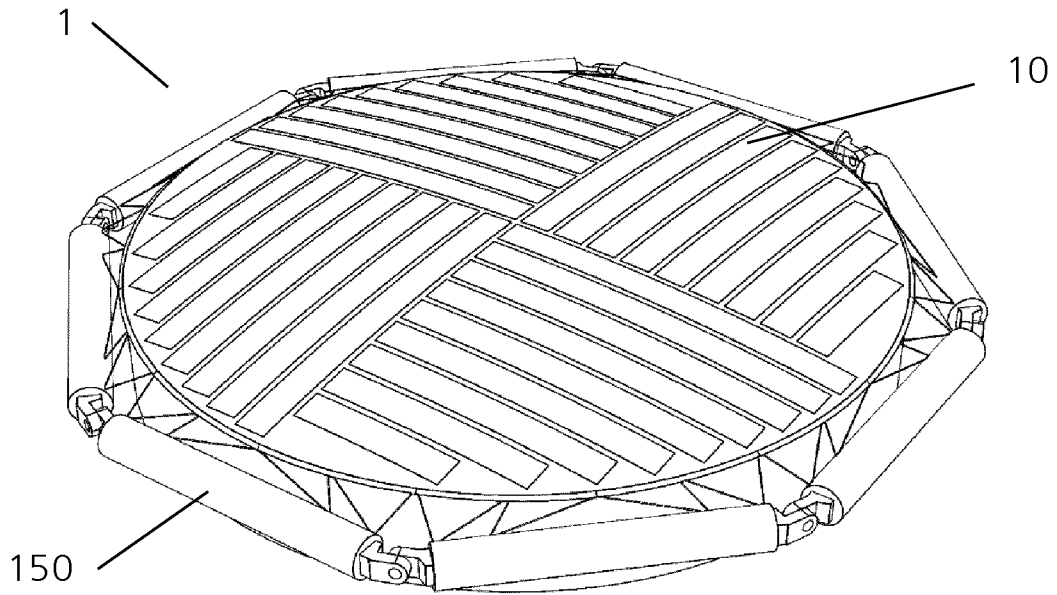


Fig. 3g

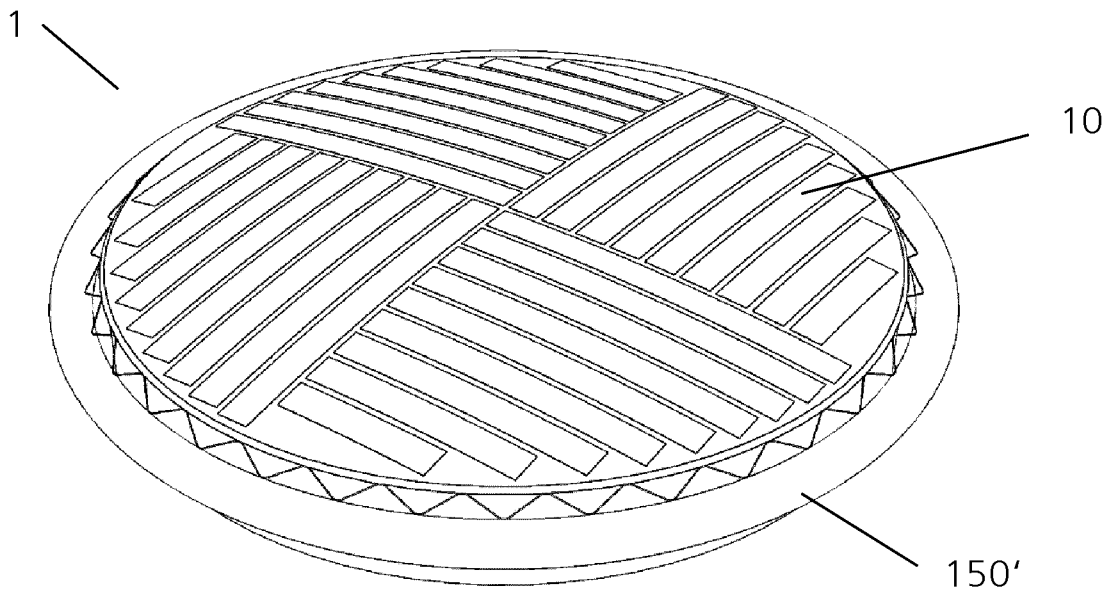


Fig. 3h

8/12

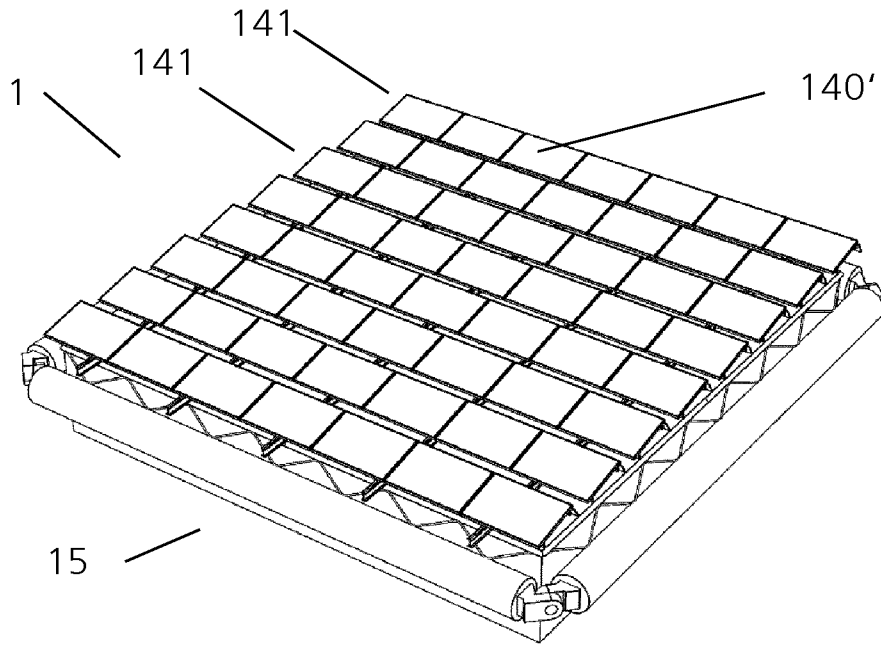


Fig. 3i

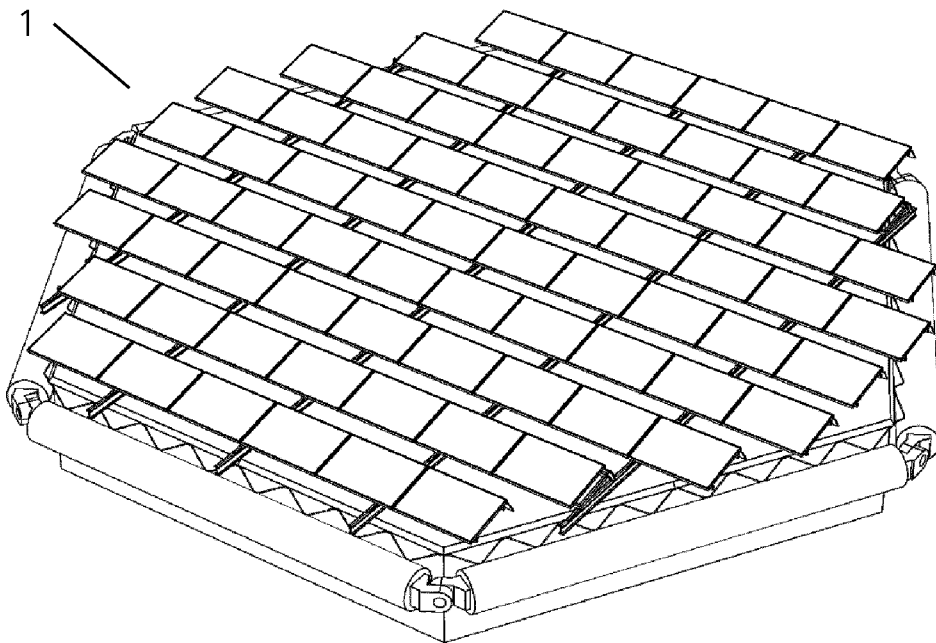


Fig. 3j

9/12

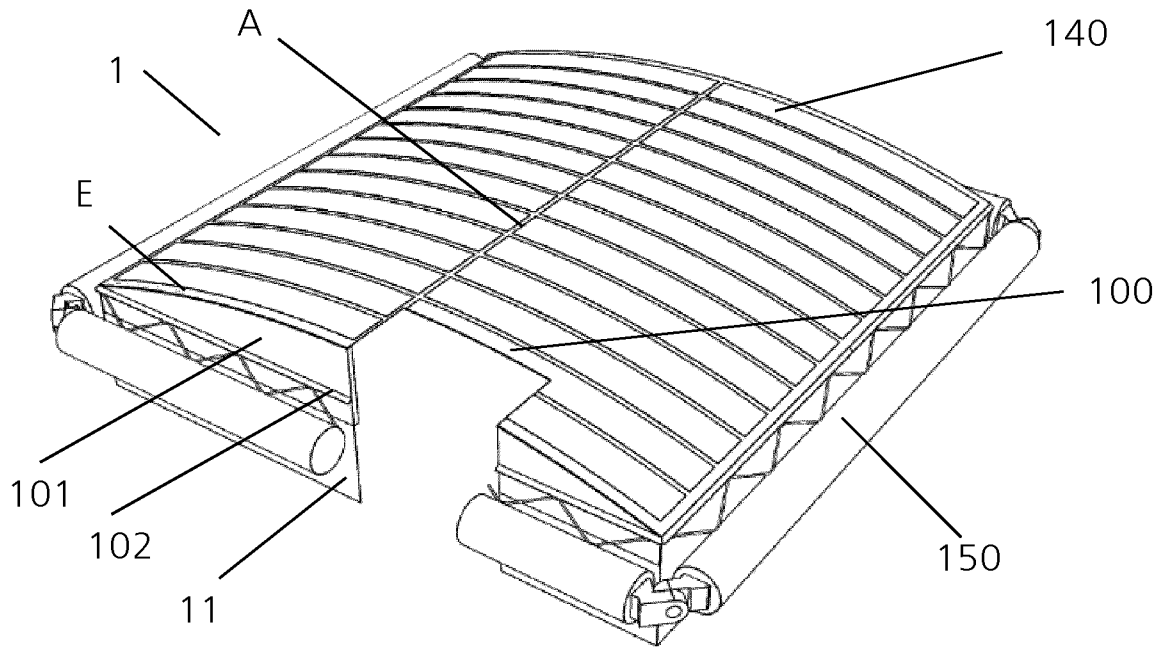


Fig. 3k

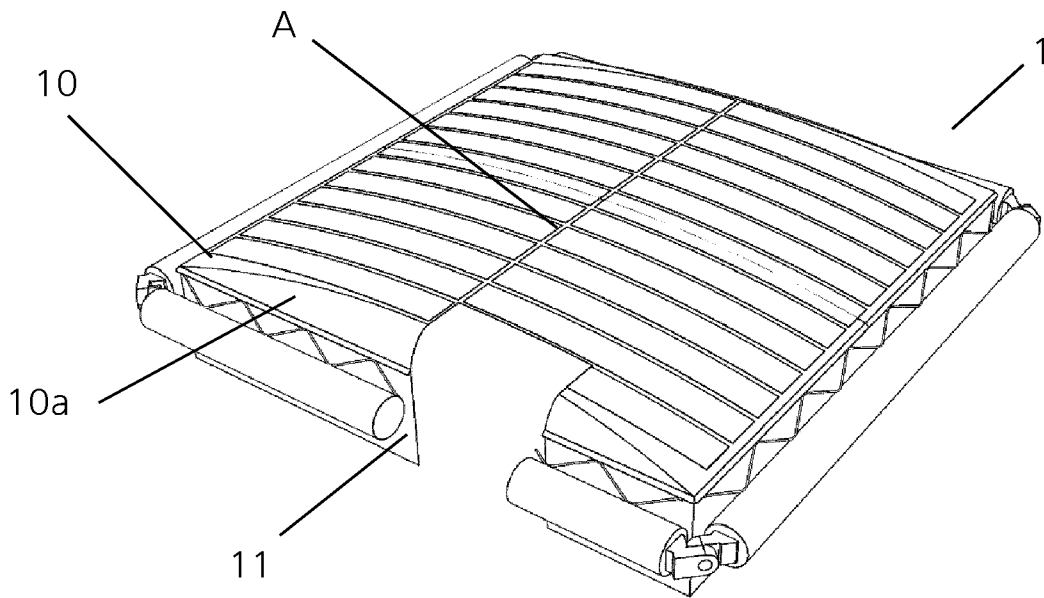


Fig. 3l

10/12

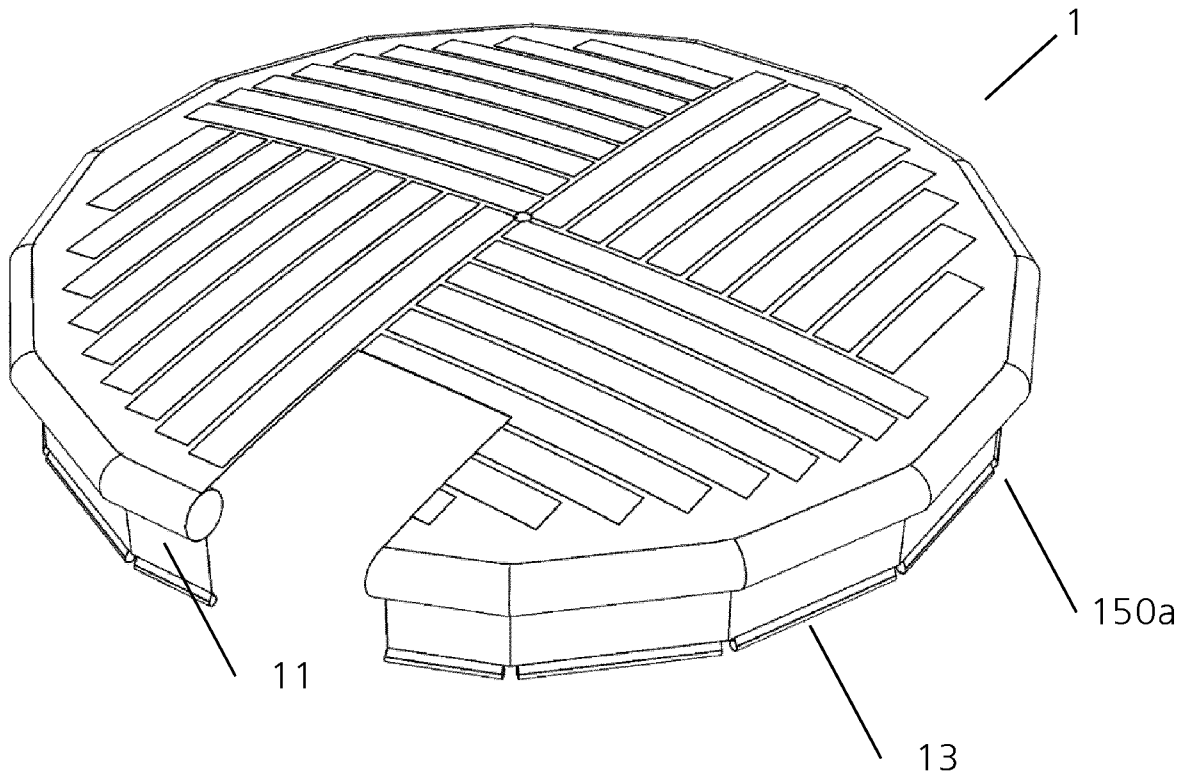


Fig. 3m

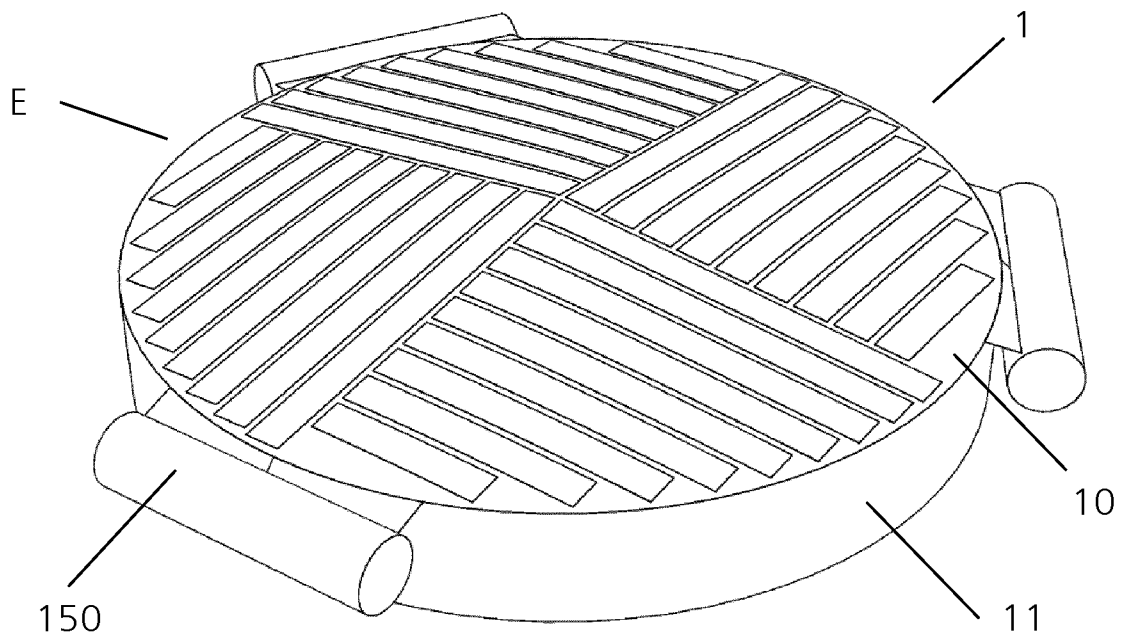


Fig. 3n

11/12

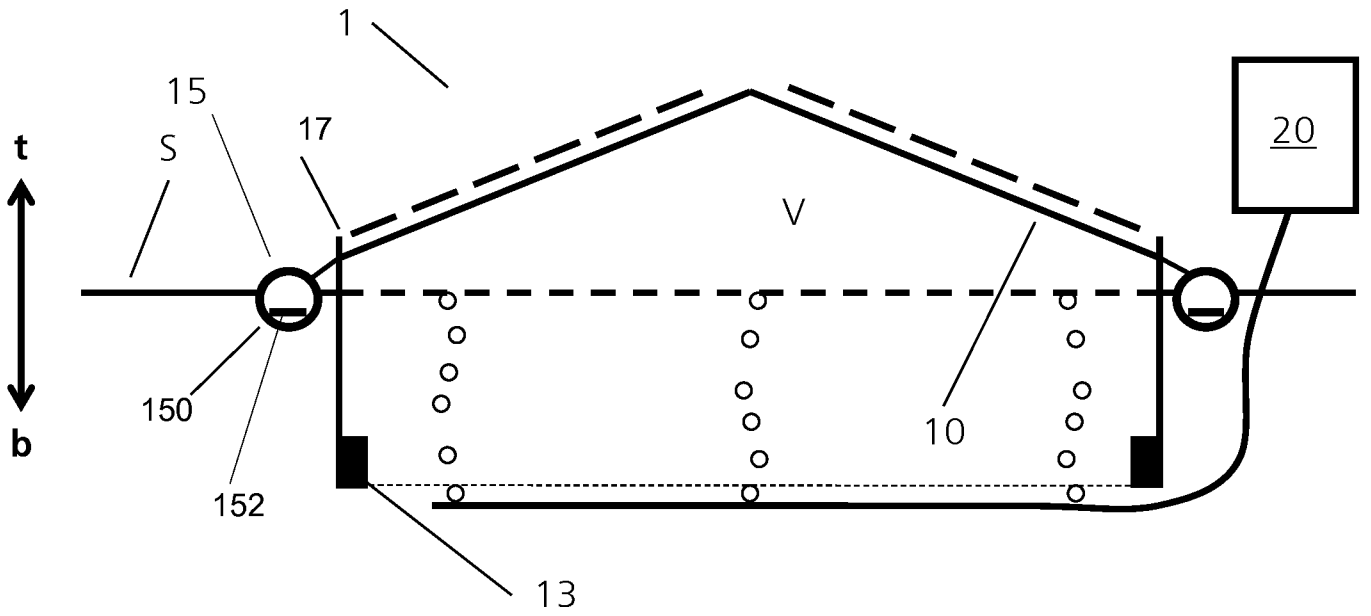


Fig. 4

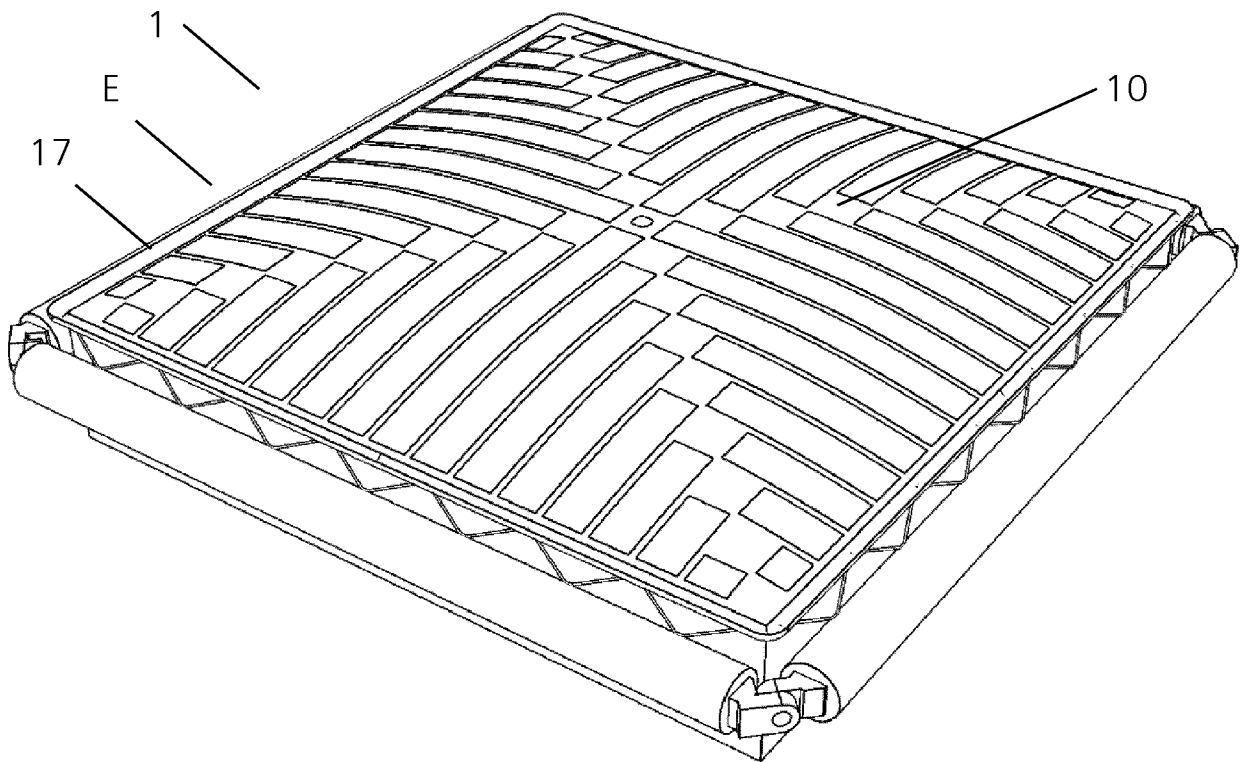


Fig. 5

12/12

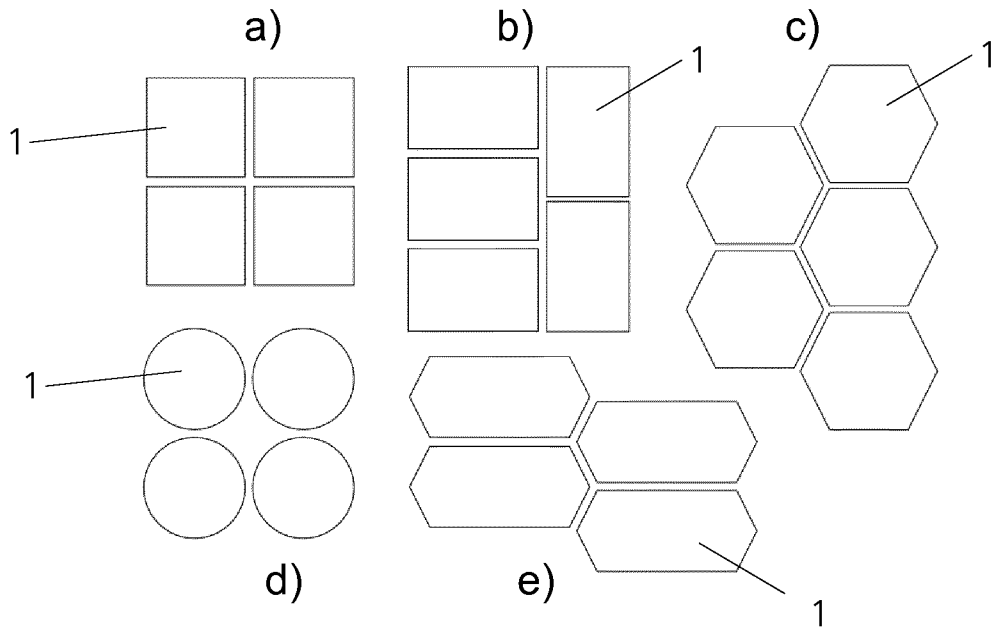


Fig. 6

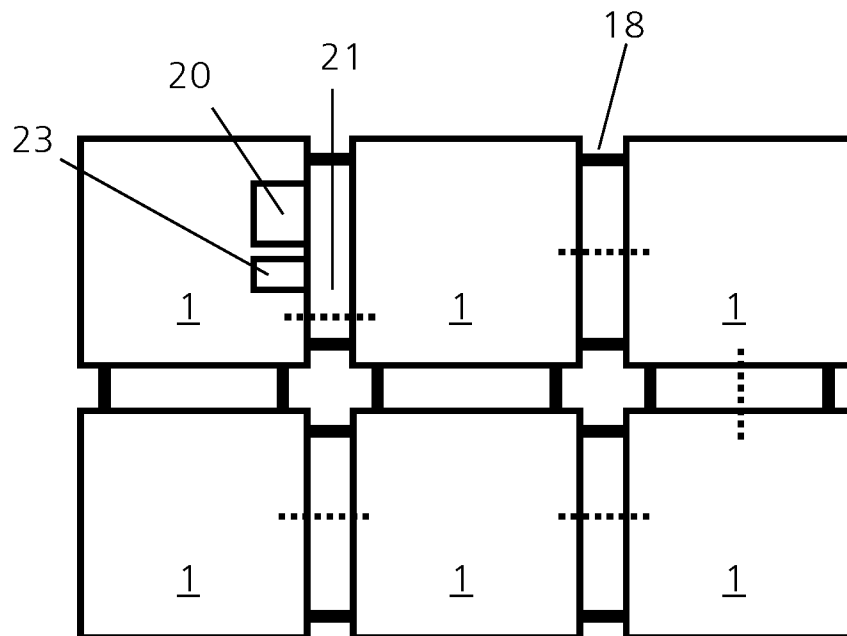


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/057874

A. CLASSIFICATION OF SUBJECT MATTER
INV. F24J2/52
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 B63B
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	US 2012/325137 A1 (HOEFLER JOHANNES [CH]) 27 December 2012 (2012-12-27)	1,2, 4-10, 13-15,18
Y	figure 1a paragraph [0009] - paragraph [0010] paragraph [0017]	2,16,17
X	US 2009/223508 A1 (HINDERLING THOMAS [CH]) 10 September 2009 (2009-09-10)	1,3,4, 7-13,15, 18
Y	paragraph [0052] figures 1, 2 paragraph [0021] paragraph [0059] paragraph [0013]	2,16,17
	----- -/--	

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "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 25 August 2016	Date of mailing of the international search report 01/09/2016
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Fernandez Ambres, A

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/057874

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CH 699 564 A2 (ARGHIRO SALVATORE [IT]) 31 March 2010 (2010-03-31) paragraph [0057] -----	2
Y	US 2007/234945 A1 (KHOURI BRUCE M [US] ET AL) 11 October 2007 (2007-10-11) paragraph [0036] -----	2
Y	DE 10 2007 029921 B3 (NOWAK PETER [DE]) 20 November 2008 (2008-11-20) figure 3 -----	16,17
A	WO 99/46543 A1 (YEOMANS ALLAN JAMES [AU]) 16 September 1999 (1999-09-16) the whole document -----	1-18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2016/057874

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012325137	A1	27-12-2012	AT 509639 A1 15-10-2011
			AU 2011223472 A1 25-10-2012
			CN 102883947 A 16-01-2013
			EG 27050 A 29-04-2015
			EP 2542467 A1 09-01-2013
			ES 2558088 T3 01-02-2016
			MA 34143 B1 03-04-2013
			US 2012325137 A1 27-12-2012
			WO 2011106810 A1 09-09-2011
US 2009223508	A1	10-09-2009	US 2009223508 A1 10-09-2009
			US 2010037887 A1 18-02-2010
			US 2010059046 A1 11-03-2010
			US 2012103322 A1 03-05-2012
CH 699564	A2	31-03-2010	NONE
US 2007234945	A1	11-10-2007	US 2007234945 A1 11-10-2007
			WO 2007062278 A2 31-05-2007
DE 102007029921	B3	20-11-2008	DE 102007029921 B3 20-11-2008
			DE 112008002304 A5 20-05-2010
			WO 2009000249 A2 31-12-2008
WO 9946543	A1	16-09-1999	AP 1255 A 03-03-2004
			AR 018584 A1 28-11-2001
			BR 9908800 A 05-12-2000
			CN 1292861 A 25-04-2001
			DZ 2734 A1 15-12-2003
			EP 1062465 A2 27-12-2000
			ES 2205779 T3 01-05-2004
			HU 0100856 A2 28-08-2001
			ID 26363 A 14-12-2000
			IL 138263 A 12-05-2004
			JO 2088 B 21-05-2000
			JP 2002506195 A 26-02-2002
			MA 24772 A1 01-10-1999
			NZ 507279 A 31-01-2003
			PE 02982000 A1 17-05-2000
			PT 1062465 E 30-01-2004
			TN SN99034 A1 03-04-2003
			TR 200002623 T2 21-12-2000
			US 6220241 B1 24-04-2001
			WO 9946543 A1 16-09-1999
			ZA 9901932 B 23-09-1999