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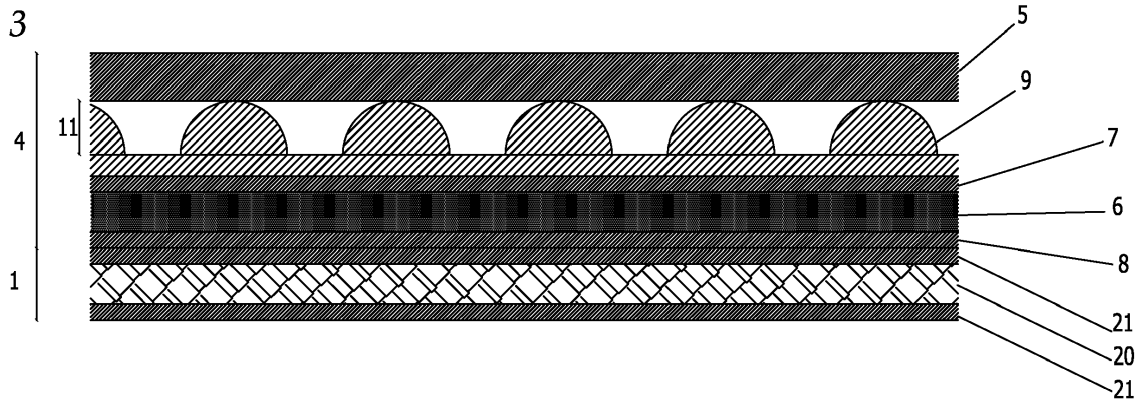
(54) **A MEMBRANE GAS HOLDER DOME WITH REDUCED HEAT LOSS**

(57) The present invention concerns the sector of equipment and components for the production of waste treatment plants.

More specifically it concerns a membrane gas holder dome (10) with reduced heat loss, adapted to be installed on a heated digester adapted to produce combustible gas, comprising:

- a first membrane (1), impermeable to gases, adapted to delimit, at least partially, a storage chamber (C1) of the combustible gas;
- a second membrane (2), impermeable to gases, adapted to delimit, at least partially, a pressurization chamber (C2) superimposed on said storage chamber (C1);
- inflation means (15, 16, 17, 18) of said pressurization chamber (C2) by means of an auxiliary gas, preferably air;
- a layer of composite material, with heat insulating function, interposed between said first membrane (1) and said second membrane (2).

Fig. 3



EP 3 276 245 A1

Description

[0001] The present invention concerns the sector of equipment and components for the production of waste treatment plants. More specifically, it concerns a membrane gas holder dome with reduced heat loss, usable in particular for the storage of biogas generated by the digestion of sludge or slurry, or for the storage of gas emitted by liquid collection tanks.

[0002] Membrane gas holder domes are designed to be positioned on a tank, in technical jargon defined as digester, inside which a waste treatment process is carried out at controlled temperature and generally comprise a first inner membrane which delimits a gas storage chamber and a second outer membrane which defines a pressurization chamber, generally air-operated, positioned over said gas storage chamber.

[0003] The storage chamber communicates directly with the tank containing the waste, generally in the form of liquids or sludge, which emits the biogas. The pressurization chamber, on the other hand, is connected to an auxiliary air fan which maintains a certain pressure inside said chamber, in collaboration with calibrated discharge valves.

[0004] The pressure exerted by the pressurization chamber on the gas storage chamber allows delivery of the gas at the desired pressure, according to the use of the gas and the stabilization of the holder dome with respect to atmospheric agents.

[0005] The membranes are flexible, generally made of polyester fibre fabric covered on both sides by a layer of plastic material, normally PVC.

[0006] In tanks acting as a heated digester in conditions of mesophily or thermophily, it is fundamental to minimize heat loss in order to maintain the temperature inside the digester at the predefined value, without consuming too much energy.

[0007] This objective is due to the fact that:

- the biology of the system does not have good tolerance to variations, even minimum, in the process temperature;
- less process heat required equates to lower energy consumption to maintain the digester at an established temperature;
- economic incentives are recognized only on the energy fed into the grid, net of the energy consumed by the plant.

[0008] Disadvantageously, recent studies have shown that in digesters, over 50% of the heat loss occurs through the plastic membranes that constitute the dome: on the walls and the bottom of the tanks it is possible to reduce the heat losses via the use of heat insulating materials whereas on the gas holder dome, it is substantially impossible to carry out similar interventions.

[0009] The membranes have a very reduced thickness which is ineffective against the transmission of heat by conduction.

[0010] Furthermore, they behave substantially like a transparent material, incapable of preventing the transmission of heat by radiation.

[0011] Said membranes are therefore not able to limit heat losses, both by conduction and convection, and above all by radiation.

[0012] From the document DE 41 20 986 A1 a membrane gas holder dome is known for positioning on a tank containing waste from which biogas is emitted. Said holder dome comprises two superimposed membranes impermeable to the gases. A first membrane delimits a storage chamber for the combustible gas; a second membrane delimits a pressurization chamber superimposed on said storage chamber. At least one of said membranes has a reflective surface, with heat insulating function, facing the tank containing the waste.

[0013] Alternative solutions to the membrane gas holder domes, for example insulated reinforced concrete slabs or bell-shaped metal containers, are not easy to implement because in the first case they have no gasometric capacity, and in the second case because they are complex to produce, and very costly in both the construction and maintenance phases.

[0014] The object of the present invention is to eliminate the drawbacks and disadvantages previously described.

[0015] The main object of the present invention is to increase the energy efficiency of combustible biogas production plants, preventing heat losses through the gas holder domes, in order to reduce the energy consumption necessary to maintain the correct operating temperatures inside the digesters.

[0016] The object of the present invention is to provide a gas holder dome with reduced heat loss which is easy and inexpensive to produce and is easy to install and maintain.

[0017] These objects are achieved by a membrane gas holder dome with reduced heat loss, adapted to be installed on a heated digester for the production of combustible gas, comprising:

- a first membrane, impermeable to the gases, adapted to delimit, at least partially, a storage chamber for the combustible gas;
- a second membrane, impermeable to the gases, adapted to delimit, at least partially, a pressurization chamber superimposed on said storage chamber;
- means for inflation of said pressurization chamber by means of an auxiliary gas, preferably air,

characterized in that it comprises a layer of composite material, with heat insulating function, interposed between said first membrane and said second membrane.

[0018] According to a first embodiment of the invention, said layer of composite material comprises:

- a membrane made of plastic material heat sealable

and impermeable to the gases;
- a reflective metal foil,

wherein said layer of composite material is oriented so that said metal foil is facing said first membrane.

[0019] In particular, said membrane in plastic material comprises a polyethylene panel, and said reflective metal foil is made of aluminium.

[0020] Advantageously, said reflective metal foil comprises an upper micro covering and a lower micro covering in polyethylene.

[0021] In particular, said lower micro covering is transparent.

[0022] In a preferred embodiment, said layer of composite material comprises a bubble polyethylene panel interposed between said membrane made of plastic material and said reflective metal foil, adapted to create an air gap between said layers.

[0023] According to a further embodiment of the invention, said gas holder dome comprises one or more panels made at least partially with said composite material, arranged above said first membrane, in contact with it.

[0024] In one possible embodiment, said panel comprises gaps which involve at least said metal foil.

[0025] Furthermore, said panels are associated with one another by means of elastic joints or bindings.

[0026] According to a preferred embodiment, said gas holder dome comprises a third membrane, impermeable to gases, made with said composite material with heat-insulating function and impermeably associated with said second membrane and adapted to delimit, in cooperation with the latter, said pressurization chamber.

[0027] Advantageously, said panels comprise projecting edges produced with said membrane made of plastic material and can be associated with one another in a manner impermeable to gases by means of heat sealing of said projecting edges, so as to produce said third membrane.

[0028] The main advantage obtained with the present invention consists in the considerable reduction in heat loss, in particular by radiation.

[0029] The metal foil of the layer of composite material intercepts the heat radiations emitted from said first membrane and reflects them, returning them to the gas storage chamber. The heat loss by radiation of the gas holder dome are thus drastically reduced.

[0030] The bubble polyethylene panel creates an air gap between the metal foil and the upper polyethylene panel: said air gap reduces heat loss by conduction as it prevents direct contact between the metal foil, conductor of the heat, and the polyethylene panel.

[0031] Advantageously, the reduction in heat loss results in a reduction in energy costs for heating the digester.

[0032] Even more advantageously, the bubble polyethylene panel provides close but discontinuous supporting points between the metal foil and the upper polyethylene panel: in this way, a uniform constant distance is maintained between foil and panel. Due to the greatly reduced thicknesses, and consequent flexibility of the materials, the metal foil and the upper panel would tend to come into contact, adhering to each other, if not correctly spaced, annulling the thickness of the air gap.

[0033] The polyethylene upper covering of the reflective metal foil favours seal-coupling to the polyethylene panel impermeable to gases or to the bubble polyethylene intermediate panel.

[0034] The polyethylene lower covering of the reflective metal foil acts as a protection of the foil against the oxidization caused by gases emitted from the waste being digested.

[0035] Furthermore, said lower covering, since it is transparent, does not absorb any heat radiation and guarantees full reflection of said radiation, with an efficiency of over 90%.

[0036] Said insulating composite layer advantageously protects said first membrane both from sources of UV light coming from the outside and from the danger of oxidization caused by the air pumped by the inflation means. This results advantageously in less wear and longer duration of said first membrane.

[0037] A plurality of panels made of composite material can be connected to one another to cover the entire surface of said first membrane.

[0038] Advantageously, the projecting edges of each panel are produced with the membrane made of plastic material and therefore they are easy to seal together to provide a stable coupling.

[0039] The production of a third membrane with said insulating composite layer constitutes a further barrier to the passage of gas from the storage chamber to the pressurization chamber. Any gas leaks from the storage chamber are confined within the space between the first membrane and the third membrane, from where they can flow to the outside, because the pressure in said space, directly in contact with the atmosphere, is considerably lower than both that of the gas and that of the air in the pressurization chamber.

[0040] These and other advantages will become clearer from the description of the invention, illustrated below with the help of the drawings which show an embodiment thereof, wherein:

- Figure 1 illustrates, in section along a vertical plane, a membrane gas holder dome with reduced heat loss according to a first variation of the invention;
- Figures 2 and 3 illustrate, in partial section axonometric view and in vertical section respectively with proportions deliberately deformed for the sake of clarity of representation, stratigraphy of a component of the gas holder dome according to a preferred variation of the invention;
- Figure 4 illustrates, in section along a vertical plane, a membrane gas holder dome with reduced heat loss according to a preferred variation of the invention;
- Figure 5 illustrates, in vertical section with propor-

tions deliberately deformed for the sake of clarity of representation, panels of heat insulating composite material according to a possible variation of the invention.

[0041] With reference to Figure 1, a membrane gas holder dome 10 with reduced heat loss is illustrated, adapted to be installed on a heated digester adapted to produce combustible gas.

[0042] Said digester consists of a tank 12 made of concrete, having circular shape, provided with a base 12' and a lateral wall 12", adapted to contain sludge or slurry L.

[0043] Said membrane gas holder dome 10 essentially comprises:

- a first membrane 1, impermeable to gases, adapted to delimit, at least partially, a storage chamber C1 of the combustible gas produced in the digester;
- a second membrane 2, impermeable to the gases, adapted to delimit, at least partially, a pressurization chamber C2 positioned over said storage chamber C1.

[0044] Said gas holder dome 10 comprises inflation means for inflating said pressurization chamber C2 by means of an auxiliary gas, preferably air.

[0045] Said inflation means generally comprise a fan or air compressor 15 and pipes 16 connected to said second membrane. Further accessory elements belonging to the known art in the sector are relief and safety valves for the air 17 and for the gas 18.

[0046] Said first membrane 1 and said second membrane 2 are anchored to the top of the lateral wall 12" of the tank 12 of the digester by flanged mechanical anchoring means of known type.

[0047] In the centre of said tank 12 a column 13 is provided adapted to support a mesh 14, anchored to the edge of said lateral wall 12", adapted to sustain said first membrane 1, preventing it from touching the free surface of the slurry L contained in the tank 12 during the intermediate phases of filling of the storage chamber C1.

[0048] On the top of the gas holder dome 10, detection means 19 for detecting the volume of the storage chamber C1 are positioned, adapted to allow measurement of the quantity of gas contained in said chamber.

[0049] Said first membrane 1 and said second membrane 2 are made of polyester fibre fabric 20 covered on both sides by a layer 21 of PVC.

[0050] In the variation of Figure 1, said gas holder dome 10 comprises a layer of composite material with heat insulating function arranged over said first membrane 1, resting on it.

[0051] With particular reference to Figures 2 and 3, a preferred stratigraphy of said layer of composite material is illustrated, prior to being positioned over said first membrane 1 and after it has been rested on it respectively.

[0052] Said layer of composite material comprises:

- a membrane made of plastic material 5, for example a polyethylene panel, impermeable to gases, with thickness of approximately 200 micron;
- a bubble polyethylene panel 9, adapted to create an air gap 11;
- a reflective metal foil 6, for example made of aluminium.

[0053] Said layer of composite material is oriented so that said metal foil 6 is facing said first membrane 1.

[0054] In particular, said reflective metal foil 6 is extremely thin to guarantee the composite material maximum flexibility, and comprises an upper micro covering 7 and a lower micro covering 8 in polyethylene, in the order of 10-50 micron.

[0055] Said micro coverings, in particular the lower one, are made of transparent polyethylene.

[0056] As can be seen from Figure 1, the heat emanated from the gases released in the digester, in addition to the convective motion generated, tends to be lost, by radiation, through the membranes 1, 2 which constitute the gas holder dome 10.

[0057] Due to the reflecting action of the metal foil 6 which belongs to the layer of composite material, a large part of this heat is returned into the digester, and only a minimum quantity is able to flow out of the second membrane 2 of the gas holder dome 10.

[0058] In the variation illustrated, said layer of heat insulating composite material is made from one single panel 4 resting on said first membrane 1 (stratigraphy detail of Figure 3).

[0059] In this case, to ensure said panel 4 the right degree of flexibility in order to adapt to the movement of said first membrane 1 due to the gas filling or emptying from said storage chamber C1, gaps are provided in the metal foil 6.

[0060] In alternative variations not illustrated, said layer of heat insulating composite material could be made of several panels 4, associated with one another by means of joints or elastic seals or by means of bindings.

[0061] With particular reference to Figure 4, said composite layer with heat insulating function creates a third membrane 3.

[0062] In particular, said third membrane 3, impermeable to gases, is impermeably associated with said second membrane 2 and is adapted to delimit, in cooperation with it, said pressurization chamber C2.

[0063] Said third membrane 3 is therefore interposed between said first membrane 1 and said second membrane 2.

[0064] Said third membrane 3 is advantageously produced so as to rest on said first membrane 1 in a gas permeable manner, to allow any gas leaks to flow out between the two membranes 1, 2 towards the edge, and then to the outside, from any point of the storage chamber.

[0065] With particular reference to Figure 5, panels 4 of appropriately shaped heat insulating composite mate-

rial are illustrated.

[0066] In said panels 4, the membrane made of plastic material 5 spills over from the layers below, to create projecting edges 4', i.e. a sort of selvage. The projecting edges 4' of adjacent panels can be sealed to each other in a gas impermeable manner, since the membrane made of plastic material 5 is heat sealable. In this way, it is possible to cover increasingly large areas, until entirely covering said first membrane 1 with a further membrane impermeable to gases.

Claims

1. A membrane gas holder dome (10) with reduced heat loss, adapted to be installed on a heated digester adapted to produce combustible gas, comprising:

   - a first membrane (1), impermeable to gases, adapted to delimit, at least partially, a storage chamber (C1) of the combustible gas;
   - a second membrane (2), impermeable to gases, adapted to delimit, at least partially, a pressurization chamber (C2) superimposed on said storage chamber (C1);
   - inflation means (15, 16, 17, 18) of said pressurization chamber (C2) by means of an auxiliary gas, preferably air,

   characterized in that it comprises a layer of composite material, with heat insulating function, interposed between said first membrane (1) and said second membrane (2).

2. A gas holder dome (10) according to claim 1, **characterized in that** said layer of composite material comprises:

   - a membrane made of plastic material (5) heat sealable and impermeable to gases;
   - a reflective metal foil (6);

   where said layer of composite material is oriented so that said metal foil (6) is facing said first membrane (1).

3. A gas holder dome (10) according to claim 2, **characterized in that** said membrane in plastic material (5) comprises a polyethylene panel.

4. A gas holder dome (10) according to claim 2, **characterized in that** said reflective metal foil (6) is made of aluminum.

5. A gas holder dome (10) according to claim 2, **characterized in that** said reflective metal foil (6) comprises an upper micro covering (7) and a lower micro covering (8) in polyethylene.

6. A gas holder dome (10) according to claim 5, **characterized in that** said lower micro covering (8) is transparent.

7. A gas holder dome (10) according to claim 2, **characterized in that** said layer of composite material comprises a bubble polyethylene panel (9) interposed between said membrane in plastic material (5) and said reflective metal foil (6), adapted to create an air gap (11) between said layers.

8. A gas holder dome (10) according to claim 1, **characterized in that** it comprises one or more panels (4) made at least partially with said composite material, arranged over said first membrane (1), in contact therewith.

9. A gas holder dome (10) according to claim 8, **characterized in that** said panel (4) comprises gaps that involve at least said metal foil (6).

10. A gas holder dome (10) according to claim 8, **characterized in that** said panels (4) are associated with one another by means of elastic joints or by means of bindings.

11. A gas holder dome (10) according to claim 1, **characterized in that** it comprises a third membrane (3), impermeable to gases, made with said composite material with heat insulating function and associated impermeably with said second membrane (2) and adapted to delimit, in cooperation therewith, said pressurization chamber (C2).

12. A gas holder dome (10) according to claims 8 and 11, **characterized in that** said panels (4) comprise projecting edges (4') produced with said membrane made of plastic material (5), and can be associated with one another in a gas impermeable manner by means of heat sealing of said projecting edges (4') so as to create said third membrane (3).

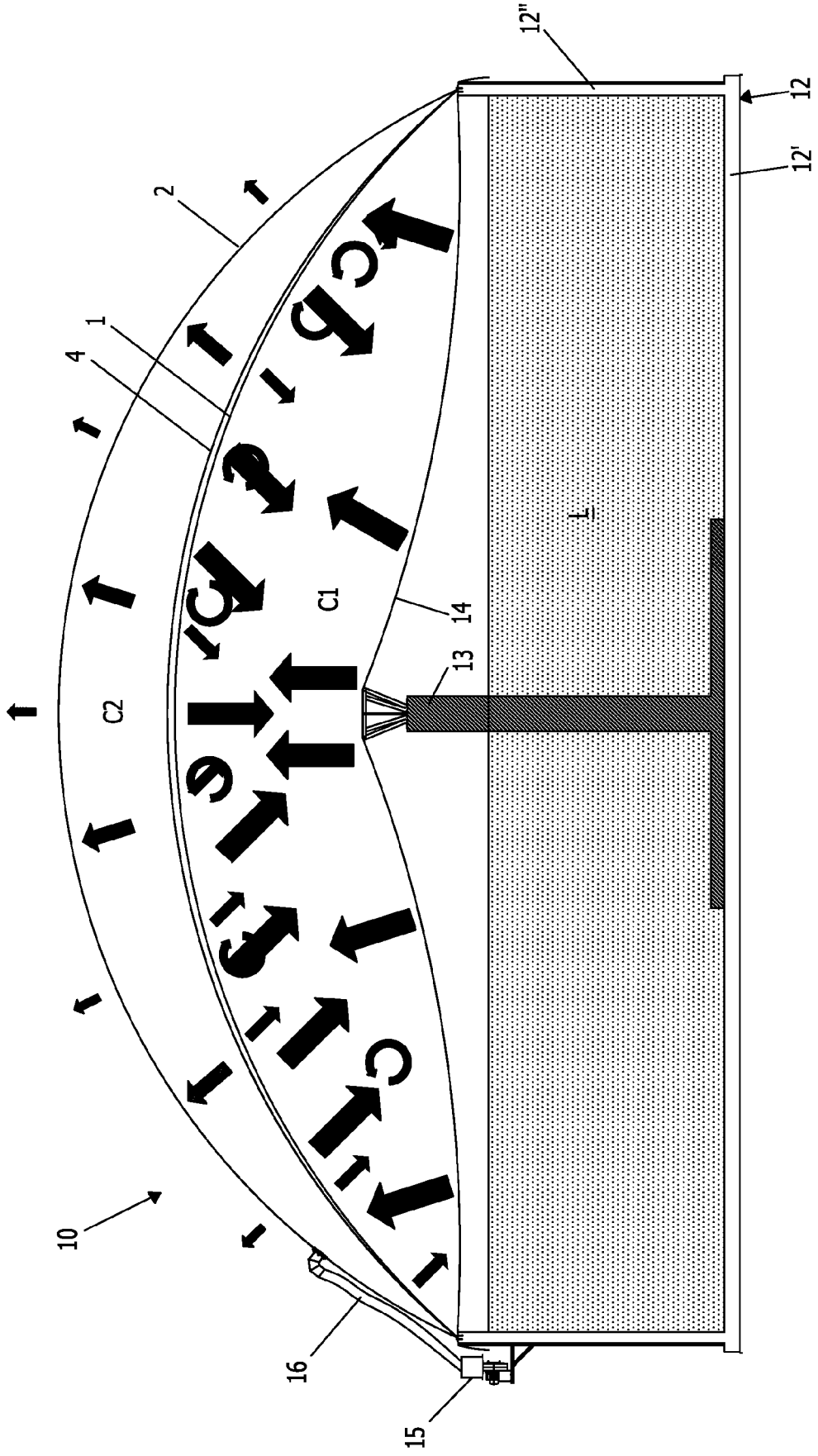


Fig. 1

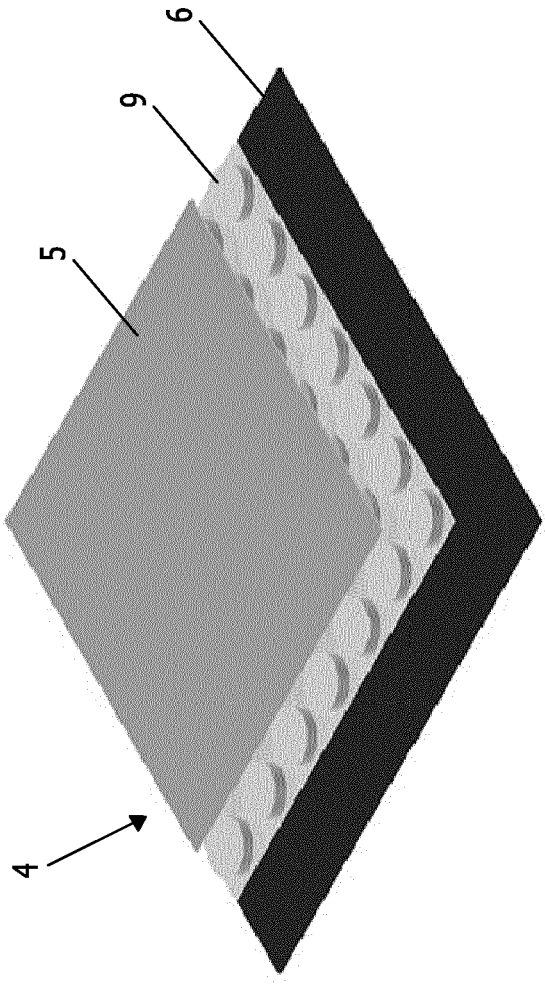


Fig. 2

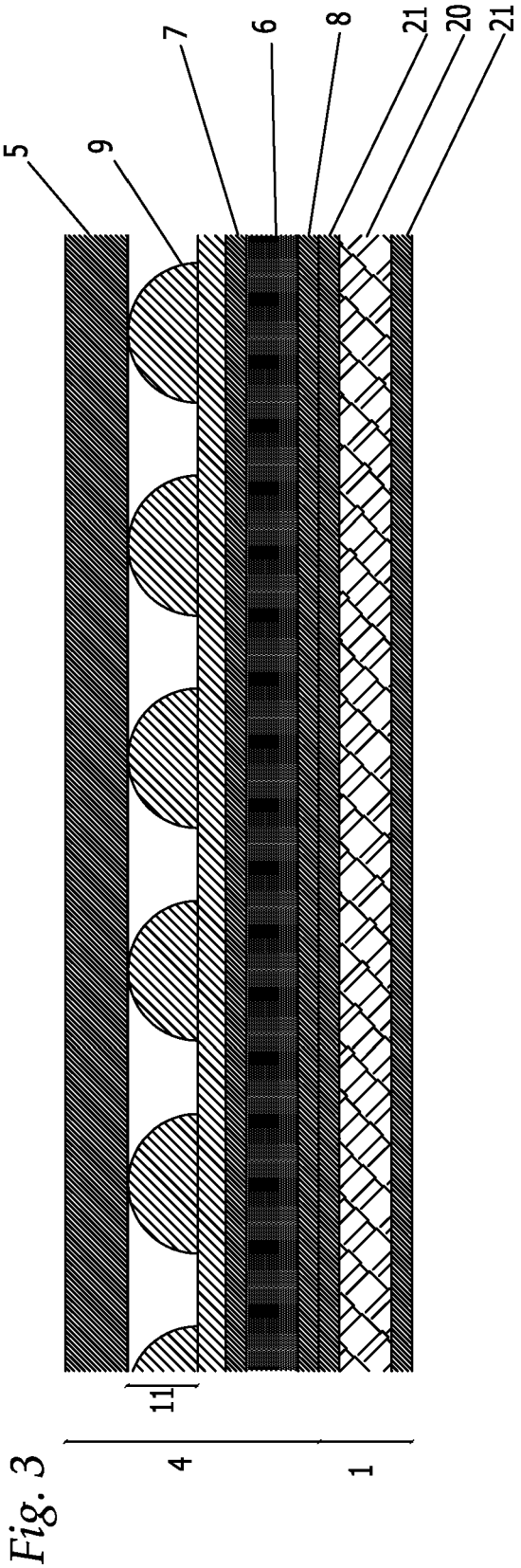


Fig. 3

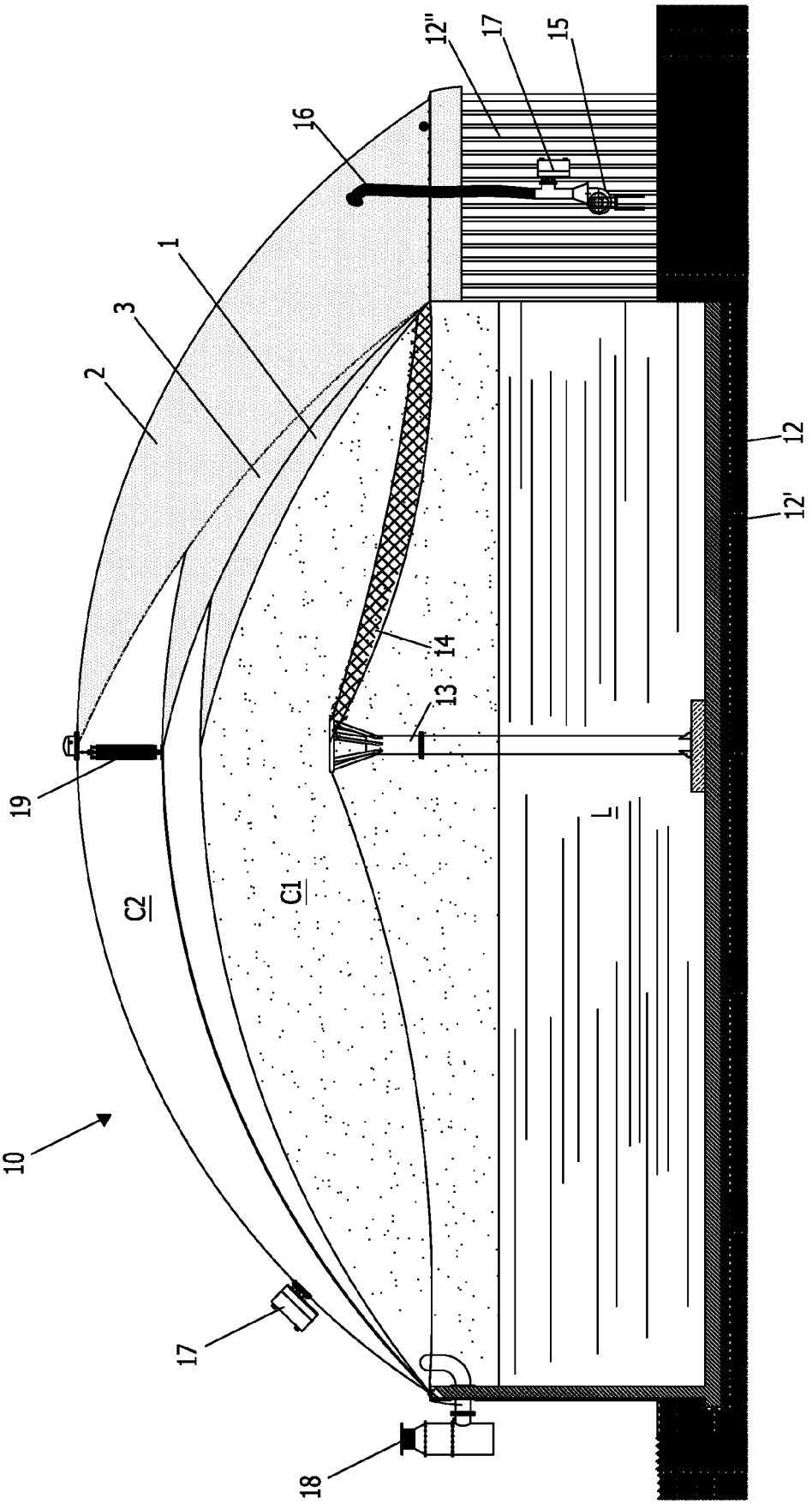


Fig. 4

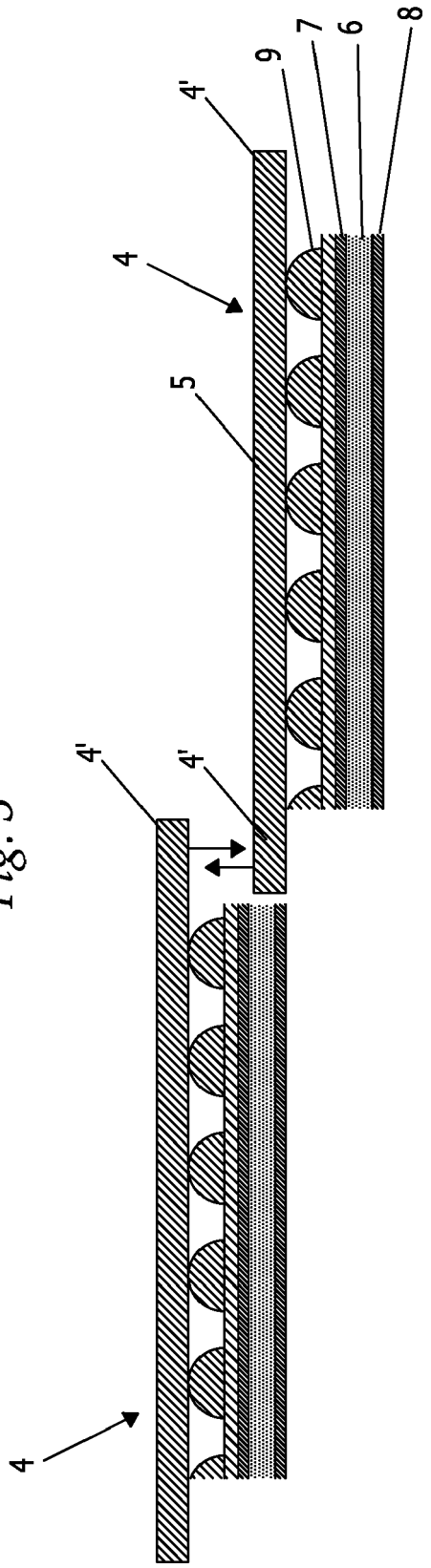


Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 17 18 2451

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	13 December 2017	Nicol, Boris

CATEGORY OF CITED DOCUMENTS

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