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(71) Applicant and

(72) Inventor: **CHRISTENSEN, Hans, Jørgen** [DK/DK];
Fauerskovvej 16, DK-8370 Hadsten (DK).

(74) Agent: **PATENTGRUPPEN APS**; Arosgaarden,
Aaboulevariden 31, DK-8000 Aarhus C (DK).

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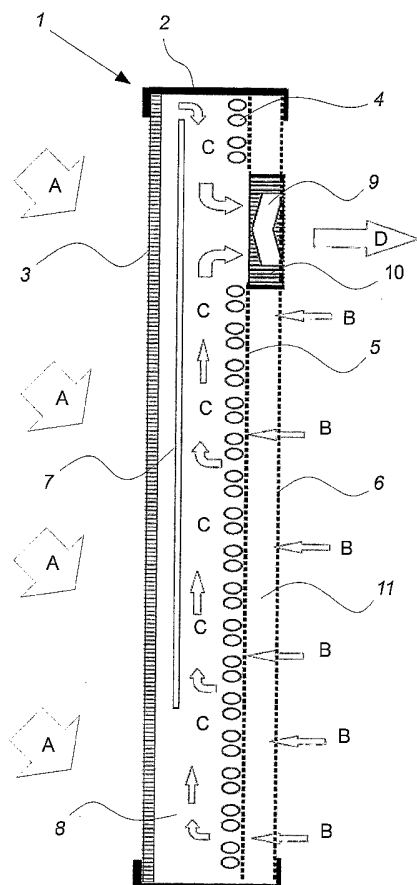
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ning of each regular issue of the PCT Gazette.

(54) Title: SOLAR COLLECTOR PANEL



(57) Abstract: A solar collector panel for collection and utilization of thermal energy obtained from the sunlight is disclosed having a transparent front panel, with at least one flow channel defined therein, an air inlet opening from the exterior to the flow channel and an air outlet opening to the interior. When the ventilator of the solar collector panel is in operation, it will drive an air flow through the flow channel and reduce the formation of dew inside the front panel. Another disclosed embodiment of a solar collector panel comprises a back panel permeable to air and open to the surroundings, an air permeable sheet extending between the front panel and said back panel, a liquid heat exchanger, and an air outlet opening extending from between the front panel and the air permeable sheet to the exterior of the solar collector panel. The air passing in through the back panel interacts with the liquid heat exchanger to be further heated or delivers heating to the liquid, depending on the mode of operation.

SOLAR COLLECTOR PANEL

The present invention relates to a solar collector panel for collection and utilization of thermal energy obtained from the sunlight.

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BACKGROUND

Solar collector panels for heating of water for domestic use or for space heating are well known in the art, but also solar collector panels for heating of air, either to be used directly for ventilation and space heating or as a medium for conveying heat to a heat exchanger is known.

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The French patent application FR 2500036 shows a typical, simple solar collector panel comprising a transparent front panel, a heat absorbing back panel which is thermally insulated at the back wall, and a passage between the front panel and the back panel, which has an inlet opening at the bottom for allowing cold air to flow into the passage and an outlet opening at the top for exit of the air heated by passing the back panel. The back wall of the back panel facing away from the front panel is thermally insulated to prevent a heat flow from the heat absorbing back panel and out of the solar collector panel.

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US patent No. US 4,054,124 discloses a more sophisticated solar collector panel, in which a perforated heat absorber panel is inserted between the transparent front panel and the thermally insulated back panel. The inlet air flows from the side of the solar collector panel into the space between the front panel and the heat absorber panel, through the perforations at which the air is heated and out from the space between the heat collector panel and the thermally insulated back panel. A much higher heat transfer coefficient between the air and the heat absorber is obtained thereby as compared to the disclosure of FR 2500036.

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In US 4,262,657 more variants of solar collector panels are disclosed, using the feature of a permeable heat absorber panel through which the air flows to be heated.

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It is a common feature of the variants that the back wall of the solar collector panels is thermally insulated to improve the thermal efficiency of the solar panel.

5 The combination of a solar collector panel for heating of air and a photovoltaic cell panel arranged behind the transparent front panel and in front of the heat collector panel is disclosed in GB 2 214 710. The heat collector plate is thermally insulated towards the exterior and a transparent panel between the photovoltaic cell panel and the heat collector panel separates airflows parallel to the panels to cool the photovoltaic cell panel and to extract heat from the heat collector panel, respectively.

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Also from WO 03/048655 by the present inventor, a solar collector panel for heating of air is disclosed, in which a photovoltaic cell is provided for producing power for a ventilator forcing air through the panel. The traditional isolating material on the back side of the panel is replaced with an air flow through the back panel against the heat gradient inside the panel.

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Solar heat panels for heating of liquid, such as water or a mixture of water and glycerol are well known from the prior art, such as from DE 10321172.

20 BRIEF DESCRIPTION OF THE INVENTION

It has been found by the present inventor that the well-known front panels for solar collectors including air-filled channels or spaces, such as double or triple layers of glass, plate of polycarbonate with elongated cavities defined therein to lower the weight thereof and improve the thermal insulation etc. may suffer from the drawback that in case such channels or spaces are to sufficiently closed off from the surroundings and are dehumidified, dew tend to form inside the front panel at certain situations, which reflects the sunlight and thereby lower the efficiency of the solar collector.

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This problem is solved by the present invention providing a solar collector panel for heating of air and liquid, comprising

5 a transparent or translucent front panel, a back panel, a ventilation outlet duct extending from the volume enclosed by the front panel and the back panel to the exterior of the solar collector panel, and a ventilator arranged to force air out through the air outlet opening,

wherein the front panel has at least one flow channel defined therein, the flow channel or channels having an air inlet opening to the exterior of the solar collector panel and an air outlet opening to the volume enclosed by the front panel and the back panel, so that the ventilator when in operation will drive an air flow through the flow channel or channels, whereby the formation of dew inside the front panel is prevented or reduced.

15 It is an advantage that the solar collector panel comprises one or more photovoltaic cell panels arranged in the volume enclosed by the front panel and the back panel, the photovoltaic cell panels being arranged to provide electric power to the ventilator.

20 Furthermore, the invention may in particular be applied to the solar collector panel disclosed in WO 03/048655, so that the solar collector panel has a back panel permeable to air and open to the surroundings over a major part of the area covered by the front panel, the solar collector panel further comprising

an air permeable sheet extending between and spaced from said front panel and said back panel defining a space there between, and

25 the ventilation outlet duct extends from the volume enclosed by the front panel and the air permeable sheet to the exterior of the solar collector panel.

30 It has been furthermore been found by the present inventor that significant advantages are achieved by combining the solar collector panel known from WO 03/048655 for heating of air with a heat exchanger for heating of a liquid, whereby the distribution of heat between the air and the liquid may be adjusted to meet

shifting demands, and the liquid heat exchanger furthermore is protected from excessive heating. This may also advantageously be combined with the above-described feature for preventing the formation of dew inside the front panel.

5 Thus, the solar collector panel according to the present invention comprises a back panel that is permeable to air and open to the surroundings over a major part of the area covered by the front panel, an air permeable sheet extending between and spaced from the front panel and said back panel, a liquid heat exchanging element with an inlet and an outlet for liquid communication to the exterior of the solar
10 collector panel, and an air outlet opening extending from between the front panel and the air permeable sheet to the exterior of the solar collector panel. Thereby, the air flows into the solar collector panel through the back panel against the temperature gradient and replaces the thermal insulating material as long as there is airflow. From there, the air flows through the air permeable sheet and passes the liquid heat
15 exchanger where the air is further heated or delivers further heating to the liquid, depending on the mode of operation of the panel, and out through the outlet opening to be used for ventilation and space heating for e.g. vacation cottages, yachts, cabins, storage containers, cellars, stables and caravans. Other advantages of the present invention and the particular preferred embodiments are disclosed in the following
20 description.

The space between the permeable back panel and the air permeable sheet serve as a thermal insulation while the solar collector panel is operating and thus replacing the thermal insulation material commonly used in the art, such as rock wool panels. The
25 substantially uniformly distributed airflow from the colder back panel to the warmer air permeable sheet has a direction opposite the temperature gradient and prevents a convection heat loss from the heat absorber. Heat loss due to radiation in the infrared spectrum from the air permeable sheet is effectively reduced by the back panel, which reflects a part of the radiation back to the air permeable sheet and absorbs the
30 remaining part as heat energy, which is returned into the solar collection panel by the cold air flowing through the permeable back panel from the surroundings.

The pressure drop of the airflow over the back panel promotes the homogeneity of the airflow distribution over the area spanned by the solar collector panel. This provides the advantage that the airflow velocities are generally low in most of the solar collector panel, with the possible exception of the area close to the outlet, even for solar collector panels spanning a large area or more solar collector panel coupled to each other, as opposed to the traditional solar collector panels having one common air inlet and a generally high velocity of the air. Low velocities means low pressure losses and low generation of noise, and the low air velocity at the intake of air into the solar collector panel, i.e. at the back side of the back panel, has the further effect that only small dust particles are carried with the air flow into the solar collector panel as larger and more heavy particles are less susceptible to be accelerated by the low air velocity. Thus, an air cleaning effect on the ventilation air exhausted from the solar collector panel is obtained as well and filtering of the ventilation air may be reduced or made redundant. The solar collector panel and in particular the permeable parts and the possible air filters will be subjected to dust to a reduced extend, thus requiring less maintenance and cleaning of the solar collector panel.

A particular advantage of the construction of a solar collector panel according to the invention is that the provision of isolation by means of the substantially uniformly distributed airflow from the colder back panel to the warmer air permeable sheet, reduces the risk of excessive heating of the liquid heat exchanger in case the airflow through the solar collector panel is stopped. When the airflow from the back panel towards the air permeable sheet stops, the thermally insulating action of the airflow is halted as well and heat may now flow from the air permeable sheet out through the back panel by natural convection and to some extend heat radiation, and the excessive heating with stagnation temperatures of more than 120°C known from solar collector panels with traditional thermal insulating material may be avoided, which may lead to a destructive boiling of the liquid inside the liquid heat exchanger, leading to damages of the tubing due to the excessive pressure developed due to the boiling. The high stagnation temperatures may also lead to weakening or destruction

of plastics materials used for the tubing, or for sealing of the tubing. The total thermal efficiency rate of the panel is increased with the combined heating of air and liquid, and the possibilities of varying the flow rates of these two heated elements allows for a wide range of possible employments of panels according to the present invention.

Thus, the present invention relates to a solar collector panel for heating of air and liquid, comprising a transparent or translucent front panel, such as a single or double glass panel or a panel of transparent plastics material, a back panel permeable to air and open to the surroundings over a major part of the area covered by the front panel, preferably at least 75%, of the area covered by the front panel, an air permeable sheet extending between and spaced from said front panel and said back panel defining a space there between, a liquid heat exchanger arranged between said space and the front panel with an inlet and an outlet for liquid communication to the exterior of the solar collector panel, and a ventilation outlet duct extending from the volume enclosed by the front panel and the air permeable sheet to the exterior of the solar collector panel.

The air permeable sheet may preferably substantially shield the back panel from the incoming light entering from the front panel.

Thereby, a solar collector is provided that can combine heating of both air and liquid.

The permeability of the air permeable sheet and of the back panel is preferably substantially homogeneous and according to one embodiment of a magnitude that allows for a convection-driven airflow through the solar collector panel due to solar radiation on the front panel.

In an embodiment, the solar collector panel has heat absorber means that comprises a substantially opaque, air permeable sheet and a liquid heat exchanger separated from each other.

In another embodiment this invention comprises a solar collector panel, wherein the liquid heat exchanging element is substantially opaque, impermeable to air and substantially shielding the air permeable sheet from incoming light.

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According to an alternative embodiment, the solar collector panel has heat absorber means that comprises a substantially opaque, air permeable sheet and a liquid heat exchanger in heat conducting contact with each other, so that heat is transferred easily between the two, the direction of heat transfer being dependent on the mode of operation.

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By the term opaque is understood substantially opaque at least to infrared light in the spectrum emitted from the sun, but it may possibly be transparent to light of other wavelengths.

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In another embodiment of the panel, the air permeable sheet is integrated with the liquid heat exchanger in one unit, being substantially opaque and permeable to air and substantially shielding the back panel from incoming light.

20 A substantially homogeneous permeability to air may e.g. be obtained with a sheet material with a homogeneously distributed perforation or with woven or non-woven fabric.

In order to optimize the efficiency of the solar collector panel, it is advantageously that the side of the air permeable sheet facing the front panel has an absorption coefficient α of the solar spectrum of radiation in the range of 0.65 to 1, preferably in the range of 0.8 to 1.

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The front panel, the air permeable sheet and the back panel are in a preferred embodiment arranged substantially parallel. The spacing between the front panel and the air permeable sheet is preferably in the range from 4 to 20 cm, largest when a

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photovoltaic cell panel is arranged in the spacing, more preferred in the range from 5 to 15 cm and the most preferred in the range from 6 to 10 cm. The spacing between the air permeable sheet and the back panel is preferably in the range from 0.5 to 5 cm, and more preferred in the range from 1 to 3 cm.

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It is advantageous to reduce the heat loss from the liquid heat absorber and the air permeable sheet due to radiation out through the front panel. The front panel may have a coating layer on the inner side facing the liquid heat absorber and the air permeable sheet that enhances the reflection of radiation in the infrared range, in particular of wavelengths in the range of 5 to 25 μm where most of the energy of the heat is radiated from the liquid heat absorber and the air permeable sheet, whereas most of the energy of the solar radiation is found at lower wavelengths.

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Another solution is to manufacture the front panel from a plastics material that is much less transparent to the long-wave infrared radiation from the air permeable sheet than to the shorter-wave solar radiation.

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Alternatively or additionally, a heat radiation trap may be applied to reduce the heat loss from the air permeable sheet by infrared radiation through the front panel. Such traps and other means for limiting the heat loss due to re-radiation of heat through the front panel is discussed and disclosed in e.g. US 4,262,657.

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The air permeable sheet may e.g. be a porous, dark or black fibrous mat, such as felt, or a woven or stamped screen, or a perforated plate material. The air permeable sheet may in particular be made from a plate material with opening defined therein of a general diameter or hydraulic diameter for the airflow through the plate, in the range from 0.7 to 3 millimetres arranged with a mutual spacing in the range of 8 to 20 millimetres. The material of the air permeable sheet may preferably be a perforated metal plate, preferably made from aluminium but also e.g. steel plates may be employed, of a thickness in the range of 0.4 to 4 millimetres, preferably of 0.7 to 3 millimetres. In the embodiments of this invention, where the liquid heat absorber

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allows the incoming solar radiation to reach the air permeable sheet, it is preferred that the side of the air permeable sheet facing the front panel and the liquid heat exchanger is dark or black and mat, so that the absorption coefficient α of the solar spectrum of radiation, i.e. the solar absorptivity α_s , is high, preferably in the range of 0.65 to 1, and most preferred in the range of 0.8 to 1. It is also preferred that the side of the heat absorber sheet facing the back panel has similar properties to absorb as much as possible of the heat radiation emission, mainly reflection, from the back panel. In the particular embodiment of this invention, where the liquid heat absorber blocks incoming solar radiation from reaching the air permeable sheet, it is preferred that the side of the air permeable sheet facing the liquid heat absorber has a reflection coefficient ρ of infrared radiation in the range of 0.65 to 1, preferably in the range of 0.8 to 1.

With respect to the back panel, it may be made from a plate material with opening defined therein of a general diameter in the range from 0.7 to 3 millimetres arranged with a mutual spacing in the range of 8 to 20 millimetres. The permeability of the back panel should be substantially homogeneous throughout its extension to promote a homogeneous distribution of the airflow. The back panel may preferably be a perforated metal plate, preferably made from aluminium e.g. of a thickness in the range of 0.4 to 4 millimetres, preferably of 0.7 to 3 millimetres, but other materials may alternatively be employed as well, such as steel, various plastics materials and plywood. The side of the back plate facing the air permeable sheet is preferably white or of a light colour and with a reflective surface, so that it has a reflection coefficient ρ of infrared radiation in the range of 0.65 to 1, preferably in the range of 0.8 to 1. The infrared radiation from the heat absorber is in particular of wavelengths in the range of 5 to 25 μm where most of the energy of the heat is radiated from the heat absorber, and the above reflection coefficient is mainly given for this range of wavelengths.

The production of the solar collector panel according to the present invention is simplified if similar plates are used for the air permeable sheet and the back panel,

e.g. perforated aluminium plates with identical perforation as discussed above. However, it is preferred that the surface properties of the two plates are different in accordance with the particulars given previously.

- 5 Instead of using a metal plate for the air permeable sheet, it is preferred to employ a fibrous mat, in particular a screen of felt that should have a dark colour or be black to absorb as much as possible of the solar radiation. Other types of fibrous mats may also be employed, such as woven or non-woven cloth or stamped cloth. A lower mass of the air permeable sheet may be obtained by using a fibrous mat as compared
10 to other materials, and the insulating effect is also advantageous for preventing heat from the spacing between the air permeable sheet and the front panel from escaping through the back panel.

- In a preferred embodiment, the solar collector panel comprises one or more
15 photovoltaic cell panels arranged between the front panel and the air permeable sheet. The one or more photovoltaic cell panels may in a further preferred embodiment of the present invention power the drive means of a ventilator that is arranged to force air out through the air outlet opening.

- 20 The present invention also relates to a solar collector panel, comprising control means for controlling flows of air and liquid through the solar collector panel.

- The solar collector panel of the present invention is preferably used for producing and heating of a flow of air for ventilation and space heating, in which air is drawn
25 into the panel from the surroundings through the back panel, is heated within the panel and is led from the ventilation outlet duct and into the space to be ventilated and heated, and for producing a flow of heated liquid, which is entered into the panel through the inlet and out from the panel through the outlet for liquid communication to the exterior.

The present invention furthermore relates to a ventilation system comprising a plurality of solar collector panels according to the above description, wherein the air outlet openings of said solar collector panels are mutually connected to a common ventilation duct with a ventilator arranged to force the airflow from said solar collector panels out through the common ventilation duct, and the liquid heat exchangers of the panels may likewise be coupled in series or in parallel.

BRIEF DESCRIPTION OF THE DRAWING

Embodiments of the present invention are shown in the enclosed drawing for illustration of how the invention may be carried out, including the following figures:

Fig. 1 shows a longitudinal section of a solar collector panel according to a first embodiment of the invention,

Fig. 2 shows a front view of a liquid heat exchanger of a solar collector panel,

Fig. 3a shows a longitudinal section of a solar collector panel according to a second embodiment of the present invention, wherein the liquid heat exchanger and the heat absorbing sheet constitute an integrated unit,

Fig. 3b shows a cross sectional view of a perforated finned tube applied in the liquid heat exchanger of fig. 3a,

Fig. 4a shows a longitudinal section of a solar collector panel according to a third embodiment of the present invention, wherein the liquid heat exchanger and the air permeable sheet are separated,

Fig. 4b shows a cross sectional view of a finned tube, and

Fig. 5 shows a longitudinal section of a solar collector panel according to a particular embodiment arranged for preventing the formation of dew inside the front panel.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE PRESENT INVENTION

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A solar collector panel 1 according to a first embodiment of the invention is shown in a longitudinal section in Fig. 1, in which an aluminium frame 2 holds a transparent front panel 3 made from a 10 millimetre plate of polycarbonate with elongated cavities defined therein to lower the weight thereof and improve the thermal insulation, a liquid heat exchanger 4 preferably made from hose or tubing, and an air permeable sheet 5 made from a screen of black felt, alternatively from a perforated aluminium sheet 0.7 millimetres of thickness, which is painted black or is anodised on both sides, and a back panel 6 made from a perforated aluminium sheet similar to the previous described that is left with a blank side facing the air permeable sheet 5.

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A photovoltaic cell panel 7 is arranged in the spacing 8 between the front panel 3 and the air permeable sheet 5. The power output from the photovoltaic cell panel 7 is connected to the motor of a ventilator 9 with a fan that is placed in the ventilation outlet duct 10, so that a combination of buoyancy forces and the ventilator 9 drives the airflow in this embodiment. However, the buoyancy force is only of a minor magnitude as compared to the effect of the ventilator 9 and is not required for the operation of solar collector panels 1 according to the embodiment. The ventilator 9 is sufficient to drive an airflow, and the ventilation outlet duct 10 may be arranged in any part of the solar collector panel, not only in the upper part of the solar collector panel 1. The airflow indicated by arrows C cools the photovoltaic cell panel 7 and prevents excessive heating thereof. The solar collector panel 1 is normally arranged with the back panel 6 in open air, so that outdoor air is entered through the back panel 6, heated and then may be used for ventilation and space heating.

30 In case the airflow is stopped or reduced, e.g. due to malfunction of the ventilator 9, contamination of the perforations of the back panel 6 or a blockage of the ventilation

duct (not shown) extending downstream of the ventilation outlet duct 10, an excessive and possibly destructive or duration-reducing heating of the photovoltaic cell panel 7 and the liquid heat exchanger 4 is prevented, to that e.g. boiling of the liquid is prevented, as the insulating effect of the spacing between the back panel 6 and the air permeable sheet 5 will be reduced or eliminated, and the heat loss through the back panel 6 will increase correspondingly.

The solar collector panel 1 is preferably arranged substantially vertically as shown, and the direction of the solar radiation is indicated with arrow A. An outlet duct 10 is arranged at the upper part of the panel 1 to form a passageway for the heated air to flow out from the panel 1 and to the place where it is utilised, e.g. for room ventilation and heating. For the liquid circuit the solar collector is equipped with an inlet and an outlet for liquid communication either to an external heat exchanger or directly e.g. to a swimming pool if chlorine resistant piping or tubing is utilized in the liquid heat exchanger 4.

The solar radiation, arrow A, is transmitted through the front panel 3 and reaches the liquid heat absorber 4 and the air permeable sheet 5, at which more than 80% of the energy of the solar radiation is absorbed and the remaining part is reflected out through the front panel 3. The absorbed energy causes the temperature of the liquid heat exchanger 4 and the air permeable sheet 5 to rise to e.g. 40° - 90°C. This will cause the liquid heat exchanger 4 and the air permeable sheet 5 to radiate heat as infrared radiation, mainly in the wavelength range of 5 to 25 µm. The blank face of the back panel 6 reflects about 70 to 75% of the radiation back to the air permeable sheet 5, whereas the remaining part is absorbed by the back panel 6. Only a minor heat loss is caused by re-radiation of heat through the front panel 3 as the type of plastics used to a large extend is opaque to the long-waved radiation from the liquid heat exchanger 4 and the air permeable sheet 5.

Air from the surroundings is, as indicated with arrows B, drawn through the perforated back panel 6, which is cooled so that absorbed heat radiation from the air

permeable sheet 5 thereby is conveyed back into the solar collector panel 1. The airflow passes the spacing 11 of approximately 2 cm width between the back panel 6 and the air permeable sheet 5 in the direction against the temperature gradient and prevents thereby effectively a convection of heat out through the back panel 6. The
5 airflow passes then, as indicated with arrows C, the air permeable sheet 5 where the air is heated, passes then the liquid heat exchanger 4 where a heat convection between the airflow and the liquid takes place, depending on the operating conditions of the panel 1, and moves mainly upward, as indicated by arrows C, in the spacing 8 of approximately 5 cm between the air permeable sheet 5 and the front panel 3,
10 towards the outlet duct 10 arranged in the upper part, preferably near or at the top end of the solar collector panel 1 and out as indicated by arrow D.

The tubing of the liquid heat exchanger 4 is simultaneously heated by the incoming solar radiation A, and this causes the temperature of the liquid in the liquid heat
15 exchanger 4 to rise. The flow rate of the air in the solar collector and of the liquid in the liquid heat exchanger, respectively, determines the distribution of the total amount of absorbed solar energy to the passing air and the liquid, and thus the temperature of the outlet air and the outlet liquid. A high flow of air and a low flow of liquid results in a high liquid outlet temperature while a low flow of air and a high
20 flow of liquid results in a high air outlet temperature.

Fig. 2 shows an embodiment of a liquid heat exchanger 4 for use in a solar collector panel according to the present invention. The heat exchanger 4 comprises an inlet 12 and an outlet 13 which via manifolds 14, 15 are connected to a plurality of parallel
25 tubes 16 extending between the two manifolds, 14, 15. The tubes are preferably made from a heat-resistant plastic, such as a heat-resistant polypropylene, or from a metal, such as a copper alloy. The liquid heat exchanger 4 of the solar collector panel may be used together with a heat absorbing air permeable sheet 5 in order to improve the efficiency of the panel and for enabling a variety of operating modes, where the
30 absorbed heat may be distributed on heated air and heated liquid as desired within a wide range of ratios between the two. Alternatively, the liquid heat exchanger may

constitute the heat absorber of the solar collector panel in itself, or the liquid heat exchanger and a heat absorbing sheet may constitute an integrated unit as shown in Fig. 3a.

5 Fig 3a shows a longitudinal section of a solar panel 1 according to a second embodiment of the present invention, in which the air permeable sheet 5 and the liquid heat exchanger 4 are combined in one integrated heat absorbing unit 17. The integrated heat absorbing unit 17 comprises a plurality of finned tubes 18, wherein the fins are perforated. The fins are preferably made from a metal, such as copper or
10 aluminium in order to have appropriate heat conduction properties. A cross sectional view of the perforated finned tubes 18 comprising two perforated heat absorbing sheets 19 and a heat absorbing tube 20 is shown in detail in fig 3b. The airflow from the spacing 11 between the back panel 6 and the integrated heat absorbing unit 17 is distributed uniformly over the area of the integrated heat absorbing unit 17. The two
15 sides of the integrated heat absorbing unit facing the front panel 3 and the back panel 6, respectively, are black so as to optimize the absorbance of heat radiation from the incoming sun light and from the back panel 6. An alternative embodiment of the integrated heat absorbing unit could be a moulded plate of polypropylene, in which a number of grooves are formed that by means of a covering plate are turned into
20 closed channels for the liquid, and wherein the moulded plate is perforated.

Fig. 4a shows a longitudinal section of a solar collector panel 1 according to a third embodiment of the present invention, in which the liquid heat exchanger 4 of the first embodiment is replaced with an opaque liquid heat absorbing unit 21 shielding the
25 air permeable sheet 5 from the incoming light. In this particular embodiment the opaque liquid heat absorbing unit 21 comprises a plurality of non-perforated finned tubes 22 covering the area of the air permeable sheet 5. A cross sectional view of the finned tubes 22 comprising two heat absorbing sheets 23 and a heat absorbing tube 20 is shown in fig 4b.

When the incoming solar radiation A reaches the opaque liquid heat absorbing unit, the temperature of the unit will rise and thus heat the liquid inside the tubes. A part of the absorbed solar energy will be transmitted through the opaque heat absorbing unit 21 into the spacing 24 between the opaque heat absorbing unit 21 and the air permeable sheet 5, and thus heat the air flowing through the air permeable sheet 5. The ventilator 9 will draw the heated air out through the ventilation outlet duct 10, where it can be utilized for space heating. In this embodiment it is preferred that the reflection coefficient of the side of the air permeable sheet 5 facing the opaque heat absorbing unit 21 is as high as possible in order to heat the air as efficient as possible.

The solar collector panels 1 according to the first embodiment as well as to the second and third embodiments may in a variant for operation in environments that are particularly polluted with particles, comprise a filter sheet releasably mounted on the outer face of the back panel 6, so that at least some of the particles in the inlet airflow, arrows B, may be captured before they enter the interior of the solar collector panel 1. The releasable filter sheet may be replaced regularly, or the filter sheet may be removed for cleaning and remounted on the solar collector panel.

The solar collector panels 1 of the present invention are employed where heated air as well as heated liquid, such as water, is requested, e.g. in a pool house having an in-door swimming pool. A control unit may be provided to manage the flow of heated liquid and heated air, respectively, from the solar collector panel or panels 1. In case the request for heated liquid has the highest priority, e.g. for heating up of the pool water after refilling the pool, the air flow through the panels 1 is reduced to a minimum, sufficient to uphold the isolating effect of the air flow from the back panel 6 and to the air permeable sheet 5, and the flow of liquid is adjusted to a maximum. When the correct temperature of the pool water is reached, the flow rate of the liquid is reduced to uphold the temperature of the pool water, and the air flow is increased to produce warm air to replace the humid air inside the pool house.

A particular solar cell panel 1 is shown in Fig. 5. The panel 1 is illustrated without a liquid heat exchanger 4 or liquid heat absorbing unit 21, but the features of the panel 1 may be employed with or without such exchanger or unit. The front panel 3 has an outer wall part 25 and an inner wall part 26 defining a flow channel there between
5 having an opening to the exterior for providing an inflow 27 of an air stream and an opening to the interior of the solar collector panel 1 in the vicinity of the air outlet opening 10, so that the ventilation 9 when operating will draw an outflow 28 from the flow channel of the front panel 3. Thus, when the ventilator is in operation, a flow of air 27 will be drawn from the exterior, through the channel inside the front
10 panel 3 and out 28 into the interior of the solar collector panel. This feature has shown in practice to prevent or at least reduce the formation of dew inside the front panel 3 and thereby increase the overall efficiency of the solar collector panel.

CLAIMS

1. A solar collector panel (1), comprising
a transparent or translucent front panel (3),
5 a back panel (6),
a ventilation outlet duct (10) extending from the volume (8) enclosed by the front panel (3) and the back panel (6) to the exterior of the solar collector panel (1),
and
a ventilator (9) arranged to force air out through the air outlet opening (10),
10 the front panel having at least one flow channel defined therein, the flow channel or channels having an air inlet opening to the exterior of the solar collector panel (1) and an air outlet opening to the volume (8) enclosed by the front panel (3) and the back panel (6), so that the ventilator (9) when in operation will drive an air flow through the flow channel or channels.
- 15 2. A solar collector panel according to claim 1, comprising one or more photovoltaic cell panels arranged in the volume (8) enclosed by the front panel (3) and the back panel (6), the photovoltaic cell panels being arranged to provide electric power to the ventilator (9).
- 20 3. A solar collector panel (1) according to claim 1 or 2, wherein the back panel (6) is permeable to air and open to the surroundings over a major part of the area covered by the front panel (3), the panel further comprising
an air permeable sheet (5) extending between and spaced from said front panel
25 (3) and said back panel (6) defining a space (11) there between, and
the ventilation outlet duct (10) extends from the volume (8) enclosed by the front panel (3) and the air permeable sheet (5) to the exterior of the solar collector panel (1).
- 30 4. A solar collector panel (1) for heating of air and liquid, comprising
a transparent or translucent front panel (3),

a back panel (6) permeable to air and open to the surroundings over a major part of the area covered by the front panel (3),

an air permeable sheet (5) extending between and spaced from said front panel (3) and said back panel (6) defining a space (11) there between,

5 a liquid heat exchanger(4) arranged between said space (11) and the front panel (3) with an inlet and an outlet for liquid communication to the exterior of the solar collector panel, and

a ventilation outlet duct (10) extending from the volume (8) enclosed by the front panel (3) and the air permeable sheet (5) to the exterior of the solar collector
10 panel (1).

5. A solar collector panel according to claim 4, wherein the air permeable sheet (5) and the liquid heat exchanging element (4) are arranged separated from each other.

15 6. A solar collector panel according to claim 5, wherein the liquid heat exchanging element (4) is substantially opaque, impermeable to air and substantially shielding the air permeable sheet (5) from incoming light.

7. A solar collector panel according to claim 4, wherein the air permeable sheet (5)
20 and the liquid heat exchanging element (4) are in heat conducting contact with each other.

8. A solar collector panel according to claim 7, wherein the air permeable sheet (5) and the liquid heat exchanging element (4) constitutes an integrated unit being
25 substantially opaque and permeable to air and substantially shielding the back panel from incoming light.

9. A solar collector panel according to any of claims 4-8, wherein the air permeable sheet (4) is substantially opaque and shielding the back panel (6) from incoming
30 light.

10. A solar collector panel according to any of claims 4-9, wherein a ventilator (9) is arranged to force air out through the air outlet opening (10)
11. A solar collector panel according to claim 10, wherein the front panel (3) has at least one flow channel defined therein, the flow channel or channels having an air inlet opening to the exterior of the solar collector panel (1) and an air outlet opening to the volume (8) enclosed by the front panel (3) and the back panel (6), so that the ventilator (9) when in operation will drive an air flow through the flow channel or channels.
12. A solar collector panel according to claim 10 or 11, comprising one or more photovoltaic cell panels arranged between the front panel and the liquid heat exchanger (4), the photovoltaic cell panels being arranged to provide electric power to the ventilator (9).
13. A solar collector panel according to any of claims 4-12, wherein the air permeable sheet (5) comprises a fibrous mat, such as a screen of felt.
14. A solar collector panel according to any of claims 4-13, comprising control means for controlling flows of air and liquid through the solar collector panel.
15. Use of a solar collector panel (1) according to any of claims 4-14, for producing and heating of a flow of air for ventilation and space heating, in which air is drawn into the panel (1) from the surroundings through the back panel (6), is heated within the panel (1) and is led from the ventilation outlet duct (10) and into the space to be ventilated and heated, and for producing a flow of heated liquid, which is entered into the panel (1) through the inlet and out from the panel (1) through the outlet for liquid communication to the exterior.
16. A system for heating of air and liquid comprising a plurality of solar collector panels (1) according to any of claims 4-14, wherein the ventilation outlet ducts (10)

of said solar collector panels (1) are mutually connected to a common ventilation duct with a ventilator arranged to force the airflow from said solar collector panels (1) out through the common ventilation duct, and the inlets (12) and outlets (13) of the liquid heat exchanging elements of said plurality of solar collector panels (1) are
5 mutually connected to common inlet and outlet conducts for the liquid to be heated.

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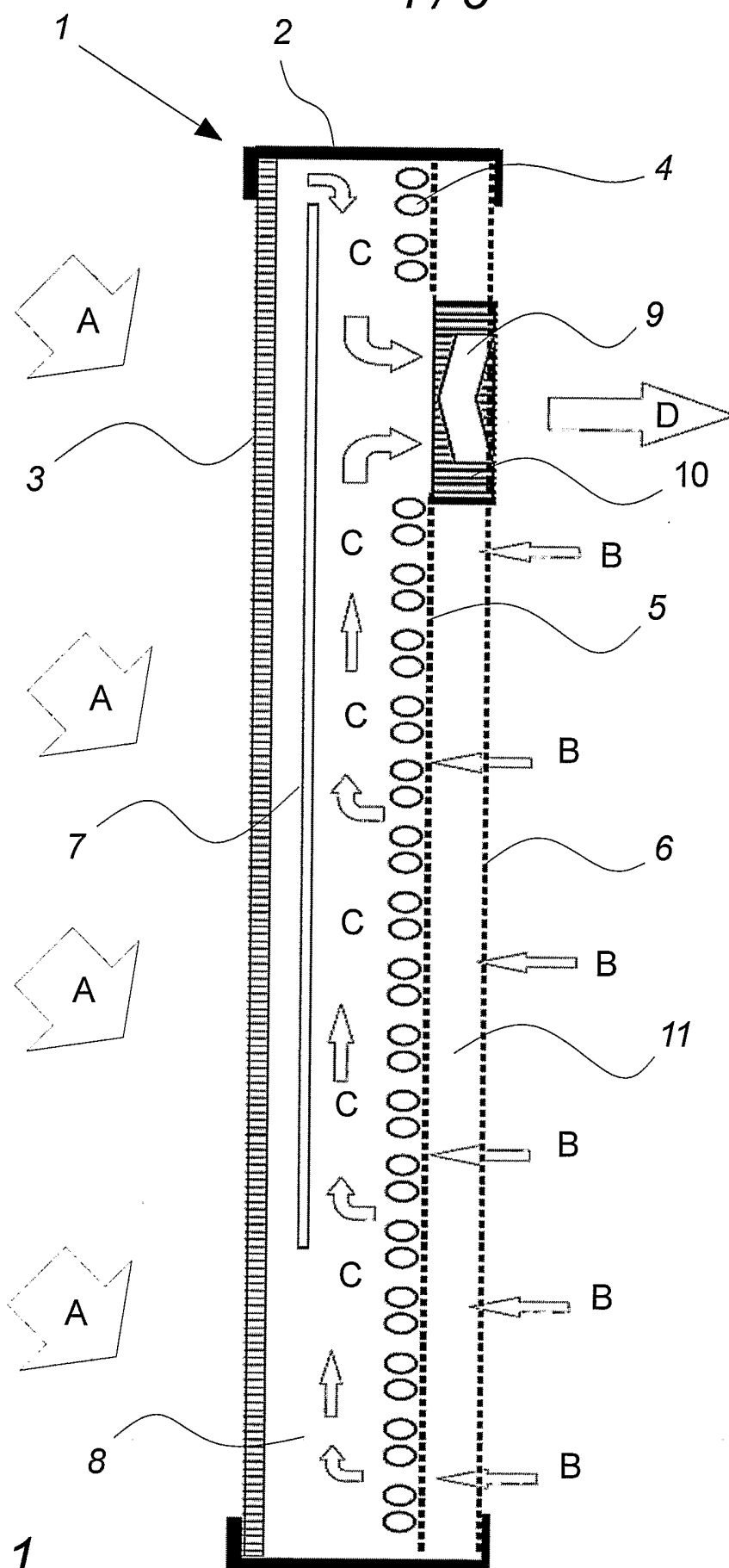


Fig. 1

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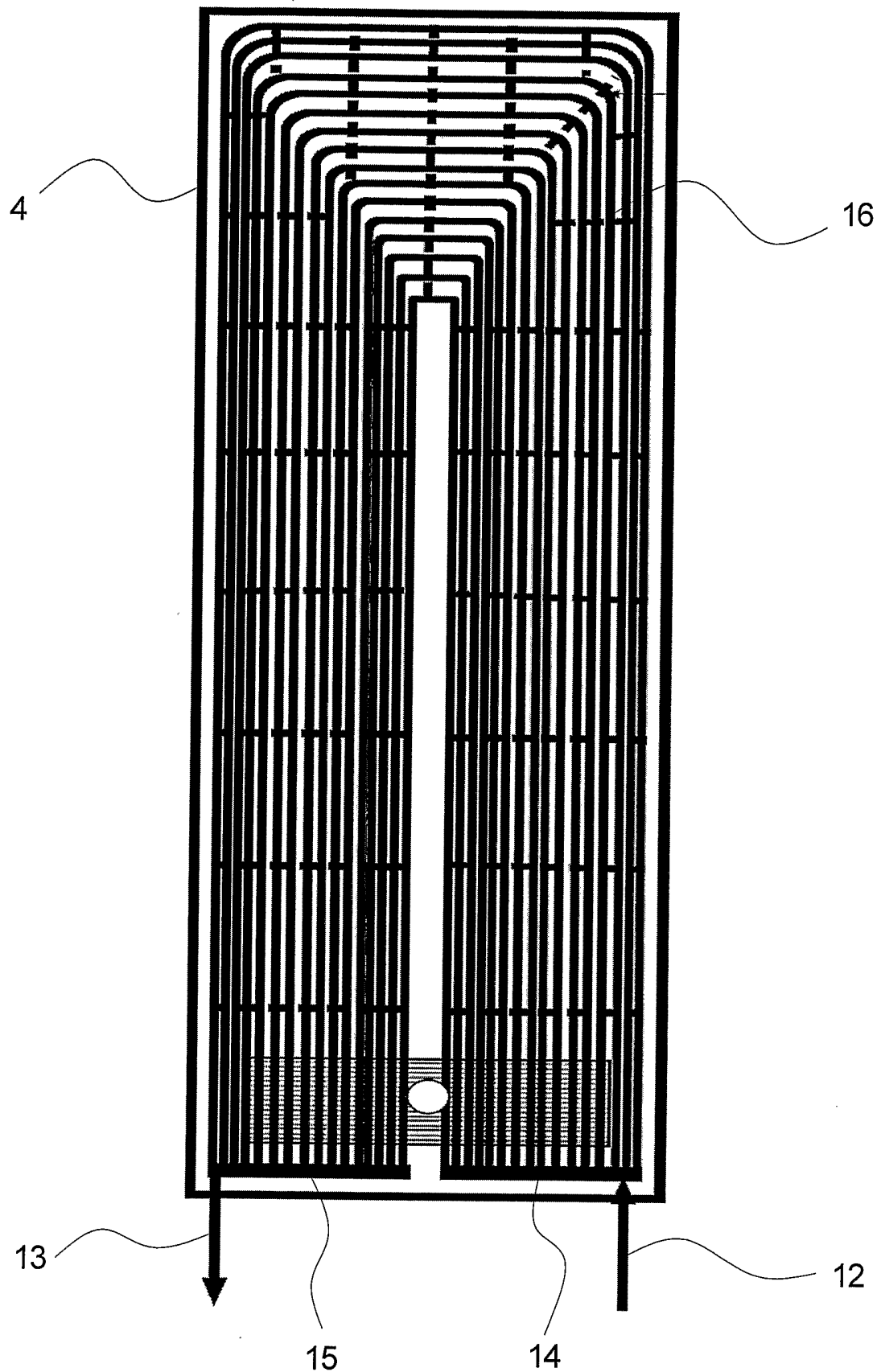


Fig. 2

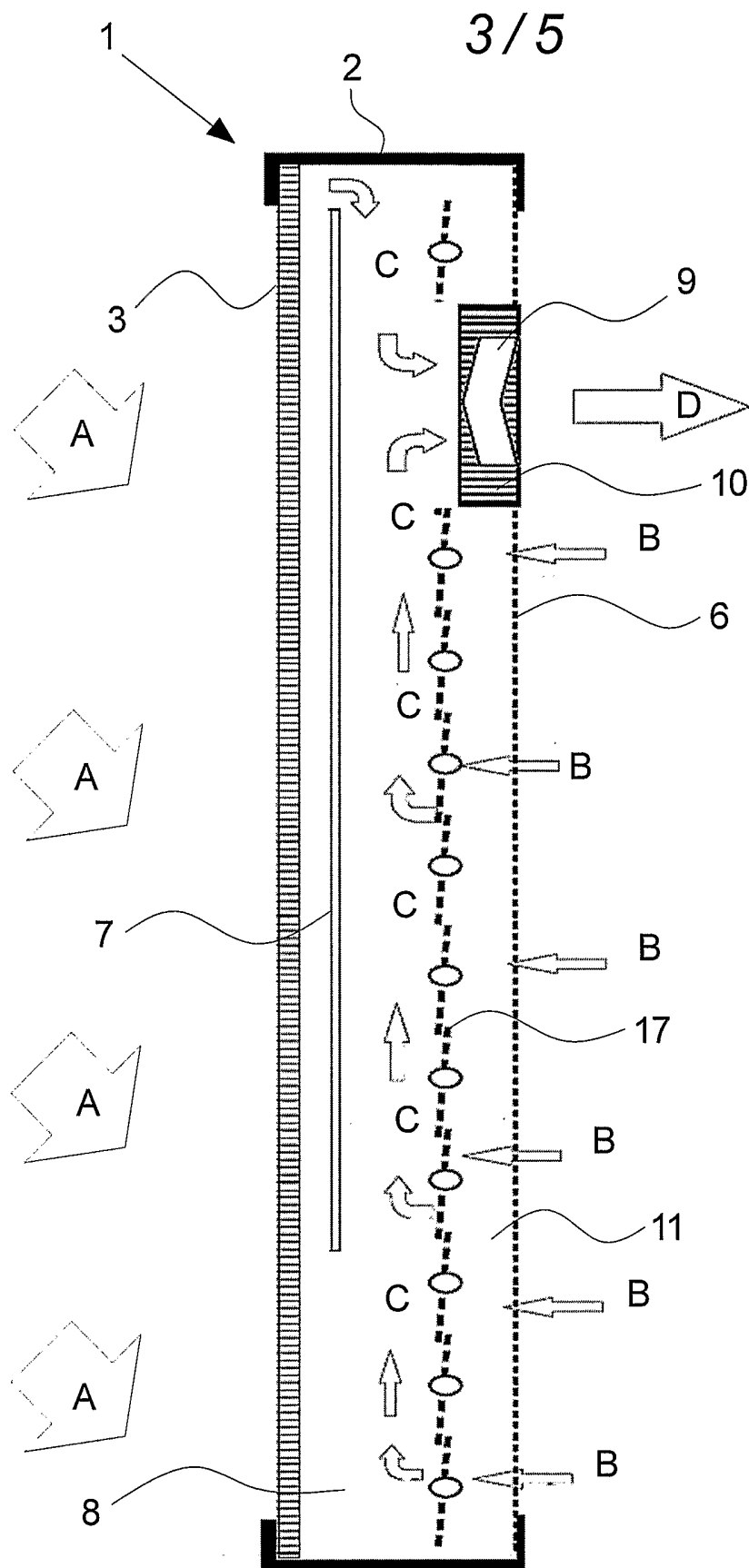


Fig. 3a

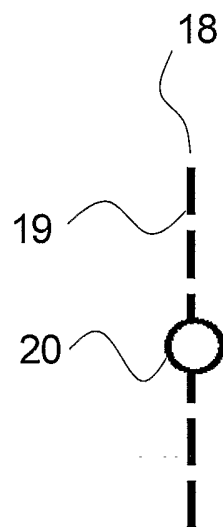


Fig. 3b

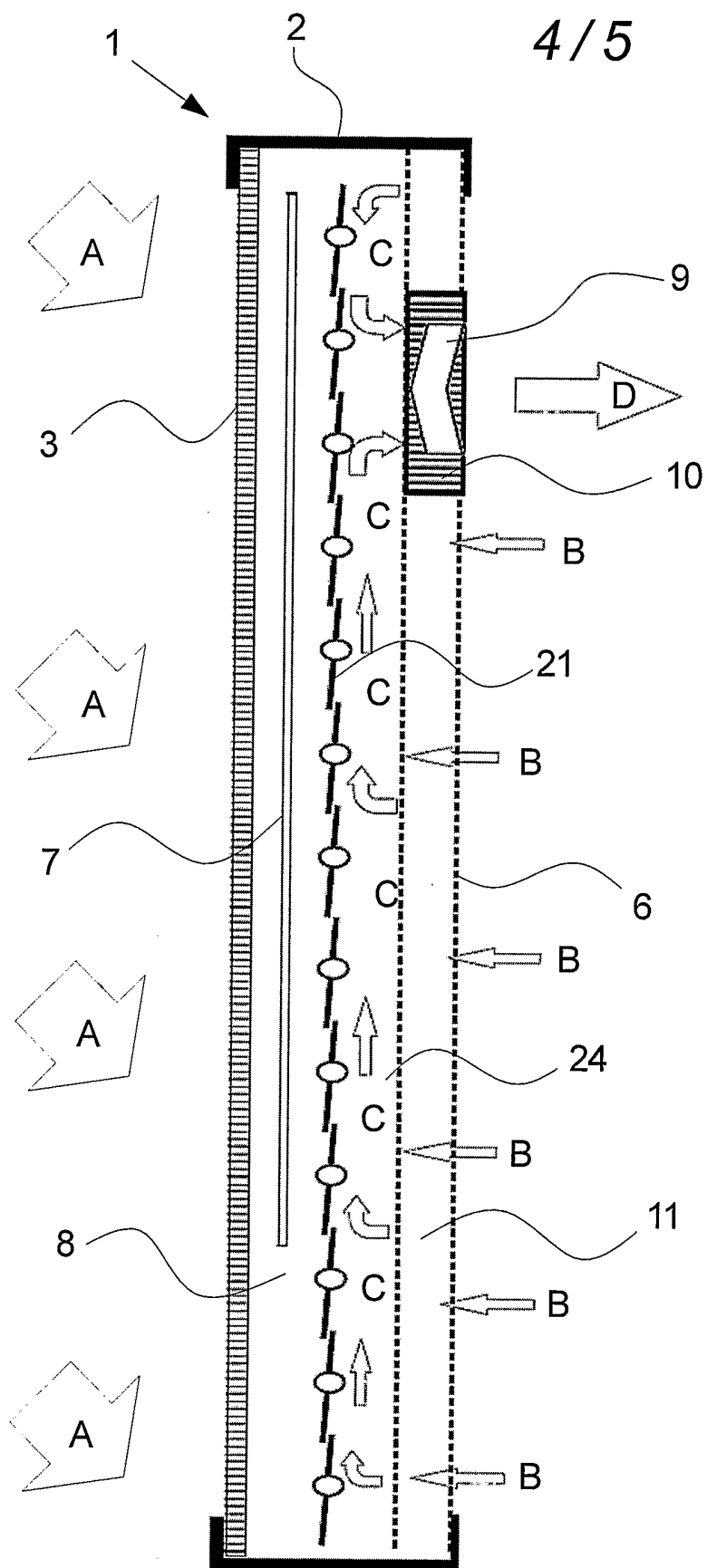


Fig. 4a

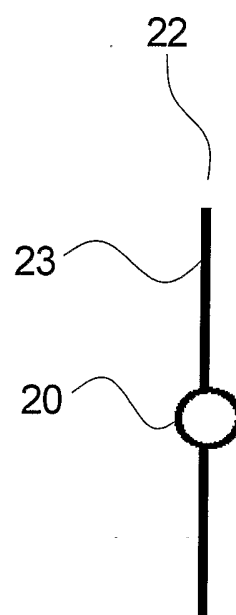


Fig. 4b

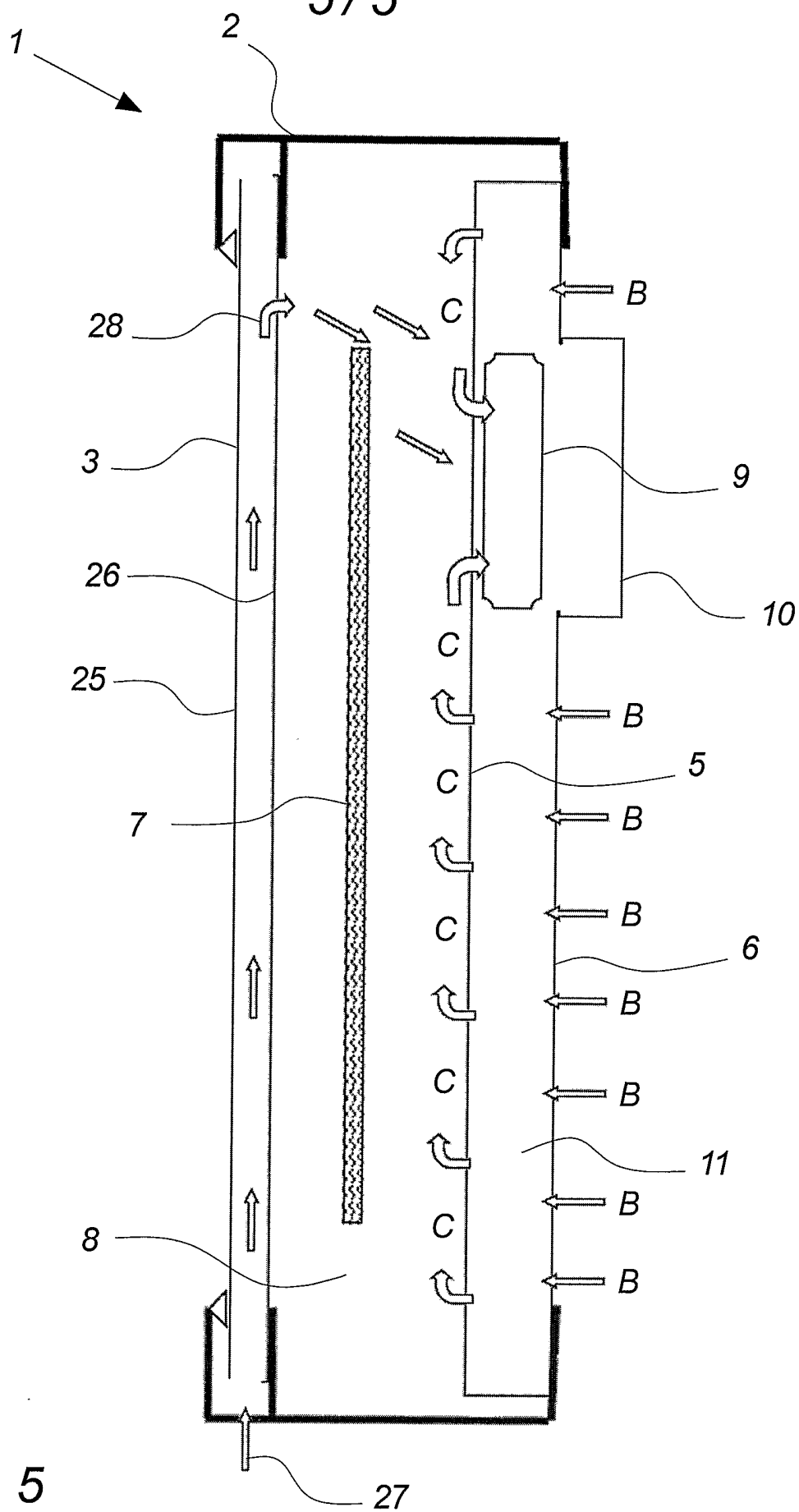


Fig. 5