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*[Continued on next page]*

(54) Title: HEAT EXCHANGER

(57) Abstract: A heat exchanger (100) is disclosed for exchanging heat with a medium across a substantially planar surface. The exchanger (100) comprises: a heat exchanging panel (101); a fluid circuit comprising a first chamber (104) disposed at a first end of the panel (101), a second chamber (105) disposed at a second end of the panel (101), a plurality of passages (103) which extend along the panel between the first and second chambers (104,105), and a duct (107) which extends between the first and second chamber (104,105); a fluid disposed within the circuit; wherein, the plurality of passages (103) are arranged in thermal communication with the panel (101) and are arranged to communicate the fluid from the first chamber (104) to the second chamber (15), and the duct (107) is arranged to communicate fluid from the second chamber (105) to the first chamber (104).

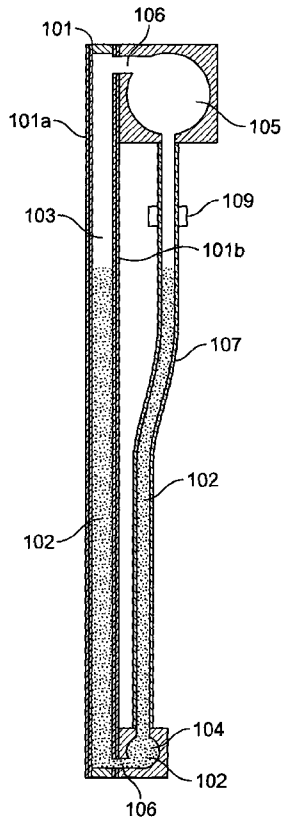


FIG. 4

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# Heat Exchanger

The present invention relates to a heat exchanger and particularly, but not exclusively to a heat exchanger for exchanging heat with a medium, across a substantially planar surface.

A heat pipe is a hermetically sealed, evacuated tube comprising a working fluid in both the liquid and vapour phase. When one end of the tube is heated the liquid turns to vapour upon absorbing the latent heat of vaporization. The hot vapour subsequently passes to the cooler end of the tube where it condenses and gives out the latent heat to the tube. The condensed liquid then flows back to the hot end of the tube and the vaporization-condensation cycle repeats. Since the latent heat of vaporization is usually very large, considerable quantities of heat can be transferred along the tube and a substantially uniform temperature distribution can be achieved along the heat pipe.

Referring to figure 1 of the drawings, there is illustrated a known heat pipe heat exchanging arrangement 10 for exchanging heat, and more particularly absorbing heat from a planar surface (not shown). The exchanger 10 comprises a plurality of heat pipes 11 which are coupled along a proximal portion 11a thereof to a rear face of a panel 12. The heat pipes 11 are arranged in a substantially parallel configuration and extend along the length of the panel 12. The panel 12 is arranged to absorb heat from the planar surface (not shown) and the heat absorbed is communicated to the proximal portion 11a of the heat pipes 11 which causes the fluid (not shown) disposed therein to turn to a vapour.

The distal portion 11b of the pipes 11 are arranged to extend within a flow duct 13 along which a cooling fluid (not shown) is arranged to pass, so that the vapour which passes to the distal portion 11b of the pipes 11 can condense. The condensate, namely the cooled working fluid, can subsequently return to the proximal portion 11a of the heat pipes 11 for further absorption of heat from the panel 12. In this respect, the cooling fluid (not shown) is arranged to extract the heat absorbed by the working fluid so that the heat pipes 11, and in particular, the fluid disposed within the heat pipes 11 can continue to absorb heat.

A problem with this arrangement however, is that the temperature of the working fluid within the heat pipes 11 rises during use, which reduces the ability of the fluid to absorb further heat from the panel 12. Furthermore, it is often difficult to separately seal the distal portion 11b of each heat pipe 11 to the flow duct 13, with the result that the cooling fluid can leak out of the duct.

We have now devised an improved heat exchanger.

In accordance with the present invention, there is provided a heat exchanger for exchanging heat with a medium across a substantially planar surface, the exchanger comprising:

a heat exchanging panel;

a fluid circuit comprising a first chamber disposed at a first end of the panel, a second chamber disposed at a second end of the panel, a plurality of passages which extend along the panel between the first and second chambers, and a duct which extends between the first and second chamber; and,

a fluid disposed within the circuit; wherein,

the plurality of passages are arranged in thermal communication with the panel and are arranged to communicate the fluid from the first chamber to the second chamber, and the duct is arranged to communicate fluid from the second chamber to the first chamber.

Advantageously, circuit provides for a separate return path, namely the duct, for the fluid so that thermal state of the fluid can recover for further heat exchange with the panel. In this respect, for situations in which the panel absorbs heat, then the heat is transferred to the fluid within the passages. The absorbed heat is arranged to cause the fluid to evaporate and this evaporate is arranged to pass to the second chamber where it can condense. The condensed, i.e. cooled, fluid can then return to the first chamber along the duct for subsequent heat exchange with the panel.

The panel is preferably arranged to exchange heat with the fluid disposed within the passages and the passages are preferably arranged to extend within the panel. The disposition of the passages within the panel provides for an intimate contact of the side walls of the passage and thus the fluid with the panel and maximises the surface area of

the passage which is in contact with the panel. It is also found that the formation of the passages within the panel facilitates an improved sealing of the chambers to the passages, compared with the prior art, since the chambers are only required to form a single seal and with a planar surface, namely the panel, as opposed to a number of separate seals to each passage.

The panel preferably comprises a heat exchanging surface which is arranged to extend adjacent the medium. Preferably, the first and second chambers are arranged to extend away from the panel from the side opposite the heat exchanging surface, and the duct is preferably arranged to extend between the first and second chambers in spaced relation to the panel. This minimises the exposure of the chambers and particularly the duct to the thermal state, for example the heated state, of the panel.

Preferably, in use, the first chamber is arranged to extend at a vertical height which is below the second chamber, such that the fluid can pass from the second chamber to the first chamber along the duct, under the influence of gravity.

In an embodiment of the present invention, at least one chamber of the heat exchanger preferably comprises a cooler for cooling the fluid disposed within the respective chamber. The cooler preferably comprises a cooling duct which extends along the chamber and which is arranged to communicate a cooling fluid between an inlet and an outlet of the cooling duct. The cooling duct is preferably arranged in thermal communication with the fluid within the respective chamber.

In a further embodiment of the present invention, the exchanger preferably comprises a cooler associated with the first and second chambers. The coolers preferably separately comprise a cooling duct which extends along the respective chamber. Preferably, the cooling ducts which extend along each chamber are arranged to communicate a cooling fluid between an inlet and an outlet of the respective duct. Preferably, the outlet of one cooling duct is coupled to the inlet of the other cooling duct. The cooler or coolers are thus arranged to reduce the working temperature of the fluid within the chambers and in this situation, provide for an increased capacity for heat absorption from the panel.

Embodiments of the present invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1a is rear, sectional view of a known heat exchanger, for exchanging heat with a substantially planar surface;

Figure 1b is a plan view of the heat exchanger illustrated in figure 1a, taken along line A-A;

Figure 2 is a view of the rear of a heat exchanger according to an embodiment of the present invention;

Figure 3 is a side view of the heat exchanger illustrated in figure 2;

Figure 4 is a sectional view of the heat exchanger illustrated in figure 2, taken along line B-B;

Figure 5 is a plan view of the panel illustrated in figure 2, taken along line C-C;

Figure 6a is a view of the rear of a heat exchanger according to a further embodiment of the present invention; and,

Figure 6b is a side view of the heat exchanger illustrated in figure 6a.

Referring to the drawings and initially figures 2-5, there is illustrated a heat exchanger 100 according to an embodiment of the present invention for facilitating the exchange of heat with a planar surface (not shown), such as a wall of a heated body, a casing of a refrigeration unit, circuit boards and the like. The exchanger 100 comprises a substantially planar, heat exchanging panel 101 which is arranged to form a thermal contact along a front surface 101a thereof with the surface with which heat exchange is desirable. The planar form of the panel 101 is arranged to conform with the planar surface (not shown) to maximise the contact area with the planar surface and thus the exchange of heat therewith.

The exchanger 100 further comprises a fluid transfer circuit for circulating a fluid 102 disposed therein, around the exchanger 100. The circuit comprises a plurality of passages 103 which are arranged to extend along the panel 101 in a direction which is within the plane of the panel 101. In this respect, the passages 103 may be formed integrally with the panel 101 by casting in a mould for example. In an alternative embodiment however, the passages 103 may extend along a rear surface 101b of the panel 101, in thermal contact therewith, although the skilled reader will recognise that this may reduce the thermal exchange with the fluid 102, compared with passages 103 which extend within the panel 101.

The circuit further comprises a first and second chamber 104, 105, disposed at a first and second end of the panel 101, respectively. The passages 103 are arranged to extend in a substantially parallel orientation, between the first end of the panel 101 and the second end of the panel 101, which is substantially opposite the first end. Each passage 103 is coupled to the first and second chamber 104, 105 by a respective transfer duct 106 which is orientated substantially perpendicular to the respective passage 103 and which is arranged to extend rearwardly of the panel 101 toward the respective chamber 104, 105. In this respect, the first and second chambers 104, 105 are disposed upon the rear face 101b of the panel 101 and extend along the panel 101 in a direction which is substantially perpendicular to the passages 103.

The circuit further comprises a duct 107, which extends between the first and second chambers 104, 105, substantially perpendicular thereto and in spaced relation to the panel 101. In use, the heat exchanger 100 is orientated so that the first chamber 104 is arranged at a vertical height which is below the second chamber 105 and the duct 107 is arranged to extend from an underside of the second chamber 105 to an upper region of the first chamber 104. The second chamber 105 comprises a substantially circular cross-sectional shape so that any fluid 102 which passes to the second chamber 105 can settle at a lower region thereof, proximate the duct 107, and pass under gravity back to the first chamber 104.

In situations where the exchanger 100 is used to extract heat from a medium, such as a heated receptacle (not shown), to cool the receptacle, the front surface 101a of the panel 101 is first disposed in thermal contact with the receptacle (not shown). This

contact may be enhanced using a thermal paste (not shown) as an interface medium between the panel 101 and the receptacle (not shown), for example. The panel 101 is orientated with the first chamber 104 disposed at a vertical height below the second chamber 105 and in an idle state in which no heat exchange takes place, the fluid 102 within the circuit is arranged to fill the first chamber 104 and extend partly along the passages 103 and the duct 107. In this respect, the first chamber 104 serves as a reservoir for the fluid 102. As the panel 101 absorbs heat from the receptacle (not shown), which may be via conduction, convection, radiation or a combination thereof, the heat will become conducted to the passages 103 and thus the fluid 102 within the passages 103.

Upon absorbing the heat from the panel 101, the fluid 102 in the passages 103 is arranged to turn to a vapour and the vapour subsequently passes along the passages 103 to the second chamber 105 disposed at the rear 101b of the panel 100, via the respective transfer ducts 106, where it cools and condenses. The condensate subsequently collects in the chamber 105 and passes to the bottom of the chamber 105 into the duct 107 and becomes returned to the first chamber 104. The spaced relation of the duct 107 from the panel 101 substantially insulates the duct 107 and the fluid 102 therein from the heat associated with the panel 101, so that the fluid 102 within the duct 107 can recover to its original thermal state for subsequent absorption of heat from the panel 101.

In an embodiment of the present invention, the second chamber 105 comprises a cooler (not shown) which is arranged to cool the fluid 102 within the circuit and in particular the condensate in the second chamber 105. The cooler comprises a cooling duct (not shown) which extends along the second chamber 105 and which comprises an inlet 108 disposed at one end of the chamber 105 and an outlet 109 disposed at an opposite end of the chamber 105. The cooling duct (not shown) is arranged to communicate a cooling fluid (not shown) between the inlet 108 and the outlet 109 thereof, within the chamber 105, so that the cooling fluid (not shown) can absorb heat associated with the fluid 102 within the chamber 105 and thus cool the fluid 102 within the chamber 105.

In a further embodiment of the present invention as illustrated in figures 6a and 6b of the drawings, the first and second chamber 104, 105 separately comprise a cooler (not

shown) which are separately arranged to cool the fluid 102 within the first and second chambers 104, 105. The coolers (not shown) separately comprise a cooling duct (not shown) which are arranged to communicate a cooling fluid (not shown) between an inlet 108a, 108b and an outlet 109a, 109b thereof, within the respective chamber 104, 105, so that the cooling fluid (not shown) can absorb heat associated with the fluid 102 within the respective chamber 104, 105 and thus cool the fluid 102. In this embodiment, the outlet 109a of the cooling duct within the first chamber 104 is coupled to the inlet 108b of the cooling duct (not shown) within the second chamber 105 via a conduit 110, so that the cooling fluid 102 can circulate from the cooler (not shown) disposed within the first chamber 104 to the cooler (not shown) disposed within the second chamber 105.

The coolers (not shown) are arranged to cool the fluid 102 within the fluid transfer circuit to reduce the working temperature of the fluid 102 and thus increase the capacity of the fluid to absorb heat from the panel 101. This therefore provides for an improved heat exchange with the receptacle (not shown), for example.

From the foregoing therefore, it is evident that the heat exchanger provides for an improved heat exchanger with a planar surface.

## Claims

1. A heat exchanger for exchanging heat with a medium across a substantially planar surface, the exchanger comprising:
a heat exchanging panel;
a fluid circuit comprising a first chamber disposed at a first end of the panel, a second chamber disposed at a second end of the panel, a plurality of passages which extend along the panel between the first and second chambers, and a duct which extends between the first and second chamber;
a fluid disposed within the circuit; wherein,
the plurality of passages are arranged in thermal communication with the panel and are arranged to communicate the fluid from the first chamber to the second chamber, and the duct is arranged to communicate fluid from the second chamber to the first chamber.
2. A heat exchanger according to claim 1, wherein the panel is arranged to exchange heat with the fluid disposed within the passages.
3. A heat exchanger according to claim 1 or 2, wherein the passages are arranged to extend within the panel.
4. A heat exchanger according to any preceding claim, wherein the panel comprises a heat exchanging surface which is arranged to extend adjacent the medium.
5. A heat exchanger according to any preceding claim, wherein the first and second chambers are arranged to extend away from the panel from the side opposite the heat exchanging surface.
6. A heat exchanger according to any preceding claim, wherein the duct is arranged to extend between the first and second chambers in spaced relation to the panel.
7. A heat exchanger according to any preceding claim, wherein the first chamber is arranged to extend at a vertical height which is below the second chamber, such that the fluid can pass from the second chamber to the first chamber along the duct, under the influence of gravity.
8. A heat exchanger according to any preceding claim, wherein at least one chamber comprises a cooler for cooling the fluid disposed within the respective chamber.

9. A heat exchanger according to claim 8, wherein the cooler comprises a cooling duct which is arranged to extend along the chamber and which is arranged to communicate a cooling fluid between an inlet and an outlet of the cooling duct.

10. A heat exchanger according to claim 9, wherein the cooling duct is arranged to extend in thermal communication with the fluid within the respective chamber.

11. A heat exchanger according to any preceding claim, wherein the first and second chamber comprises a cooler for cooling the fluid disposed therein.

12. A heat exchanger according to claim 11, wherein the coolers separately comprise a cooling duct which is arranged to extend within the respective chamber.

13. A heat exchanger according to claim 12, wherein the cooling ducts which extend within the respective chambers separately comprise an inlet and an outlet, and the outlet of one cooling duct is coupled to the inlet of the other cooling duct.

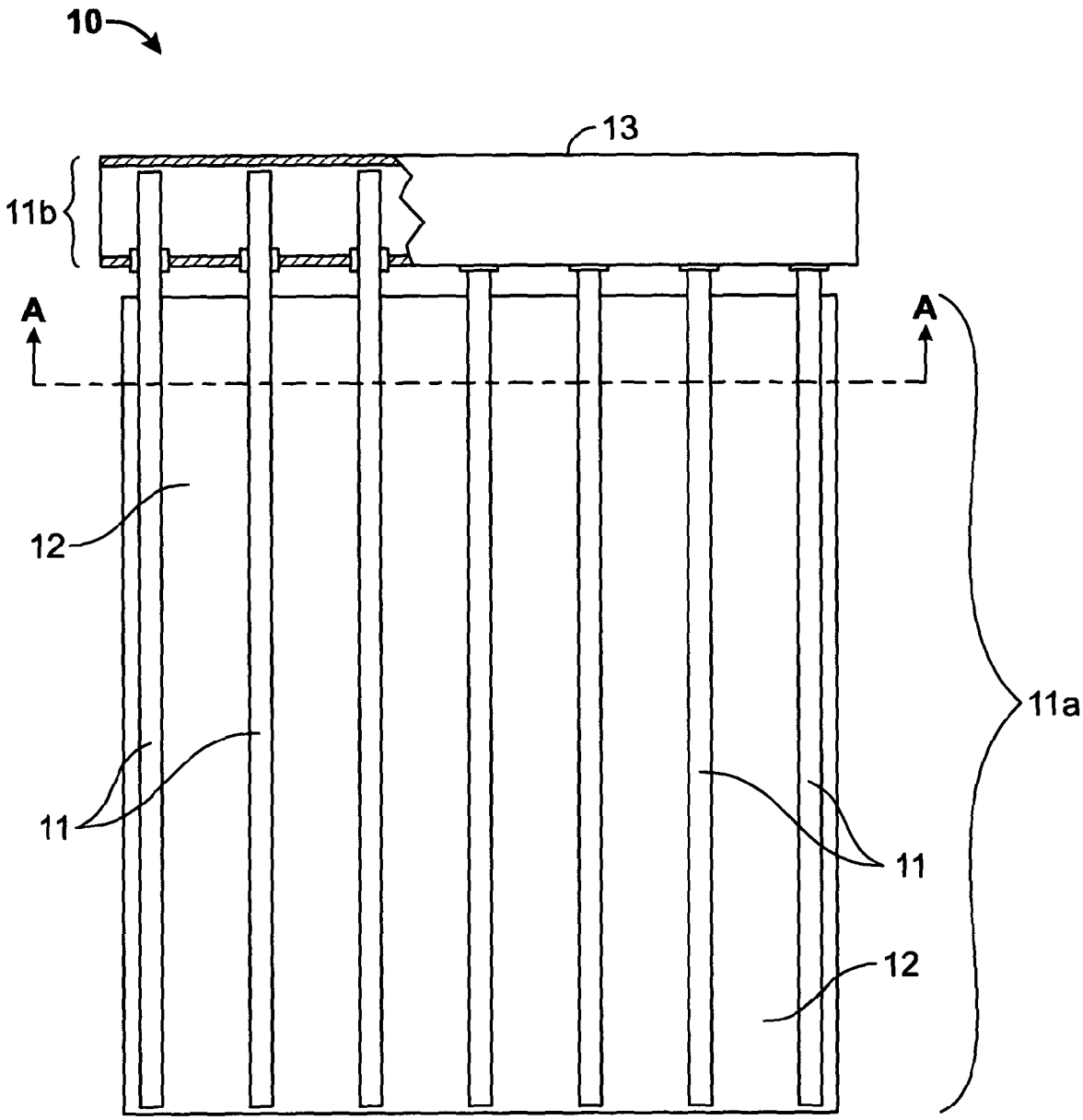



FIG. 1
(Prior Art)

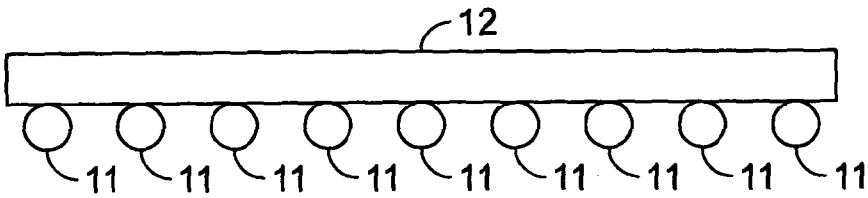



FIG. 1b
(Prior Art)

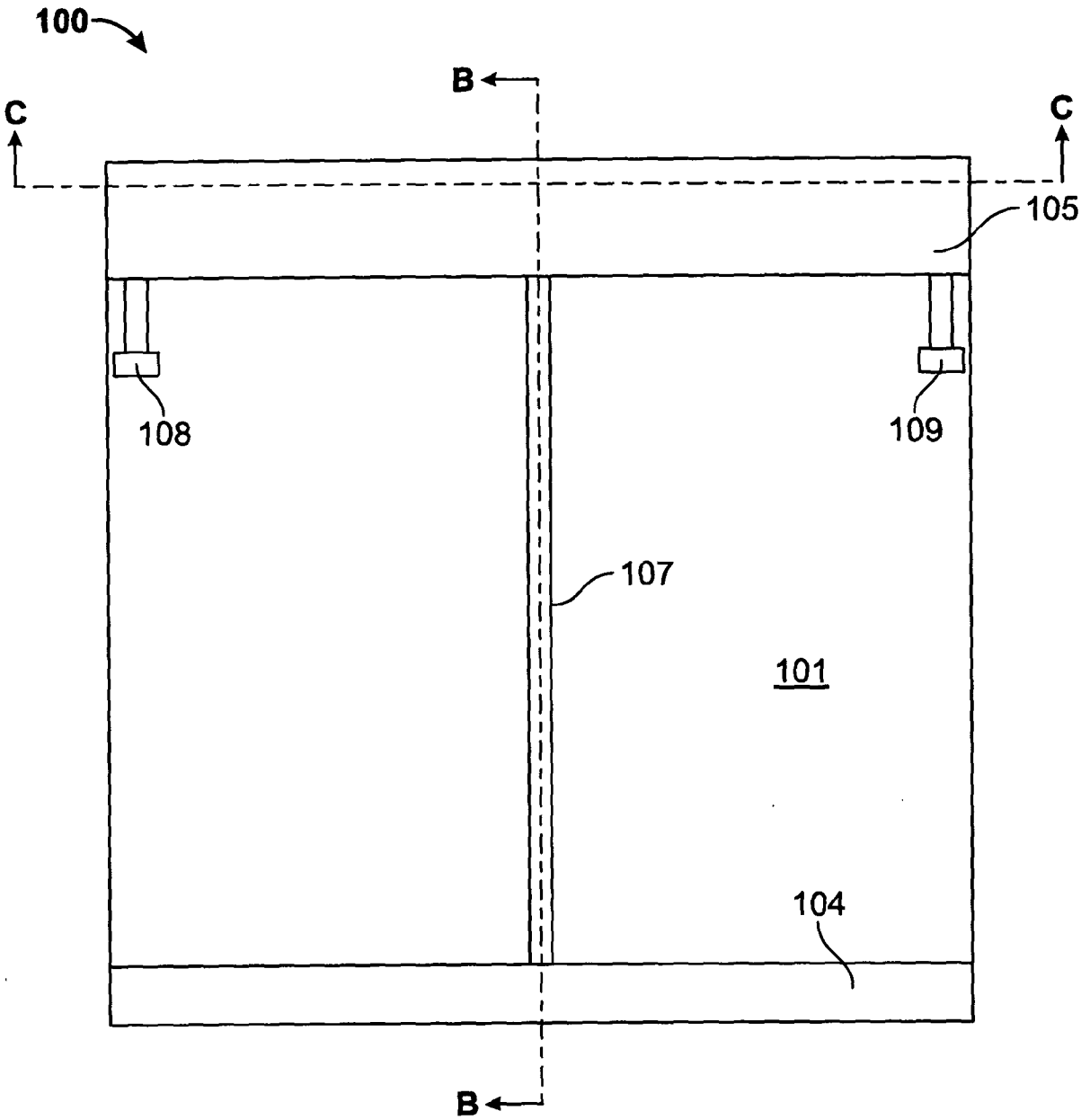



FIG. 2

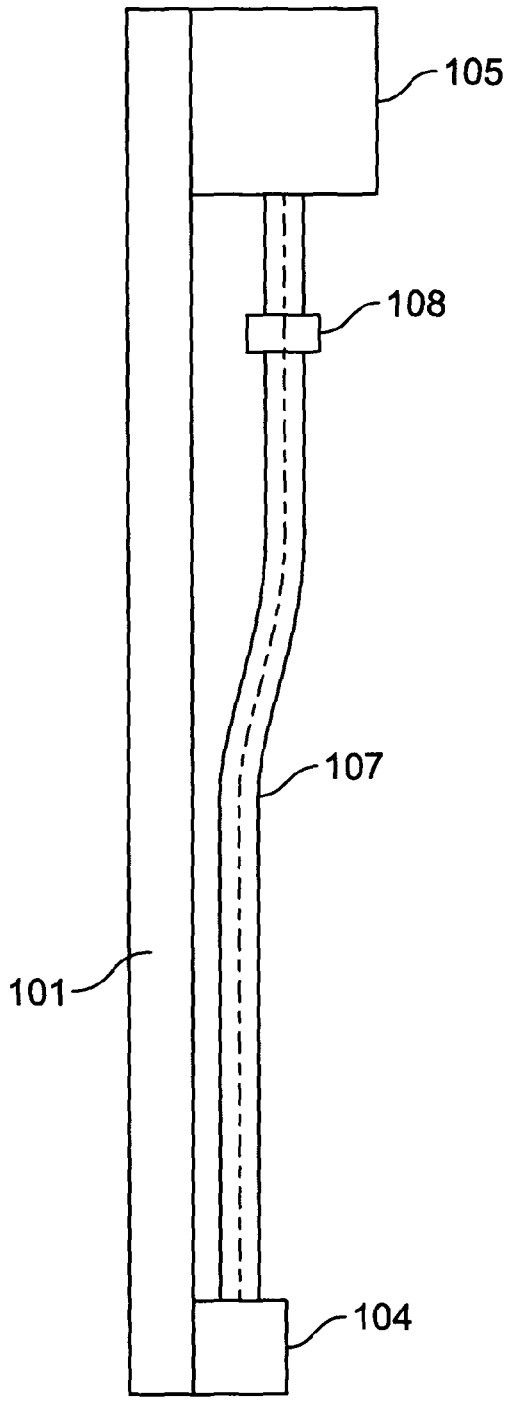



FIG. 3

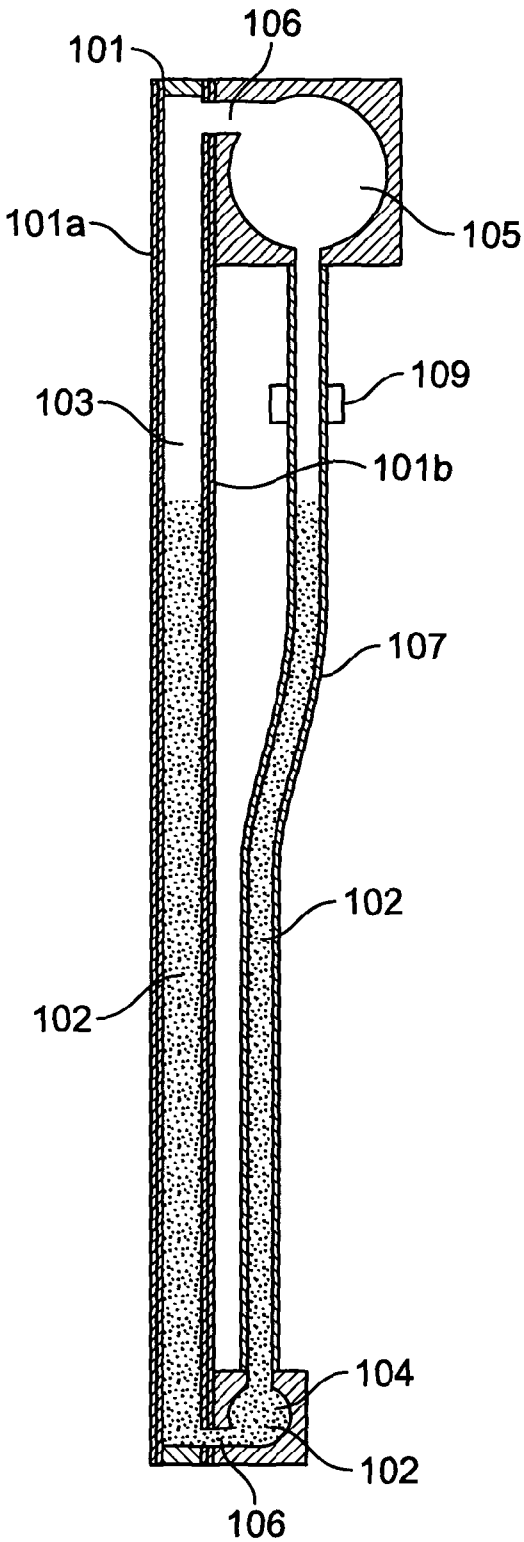
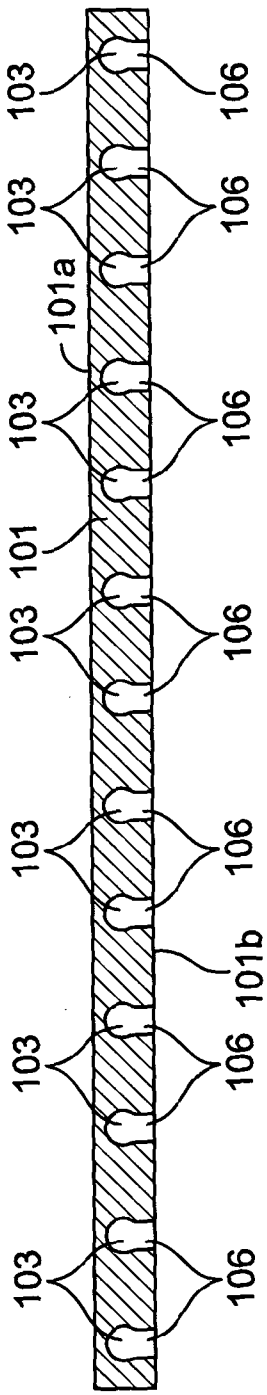



FIG. 4


103
106
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101a
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101b
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FIG. 5

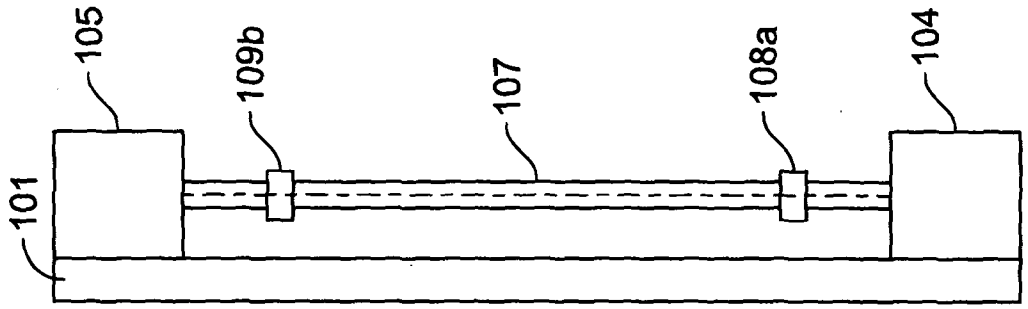


FIG. 6b

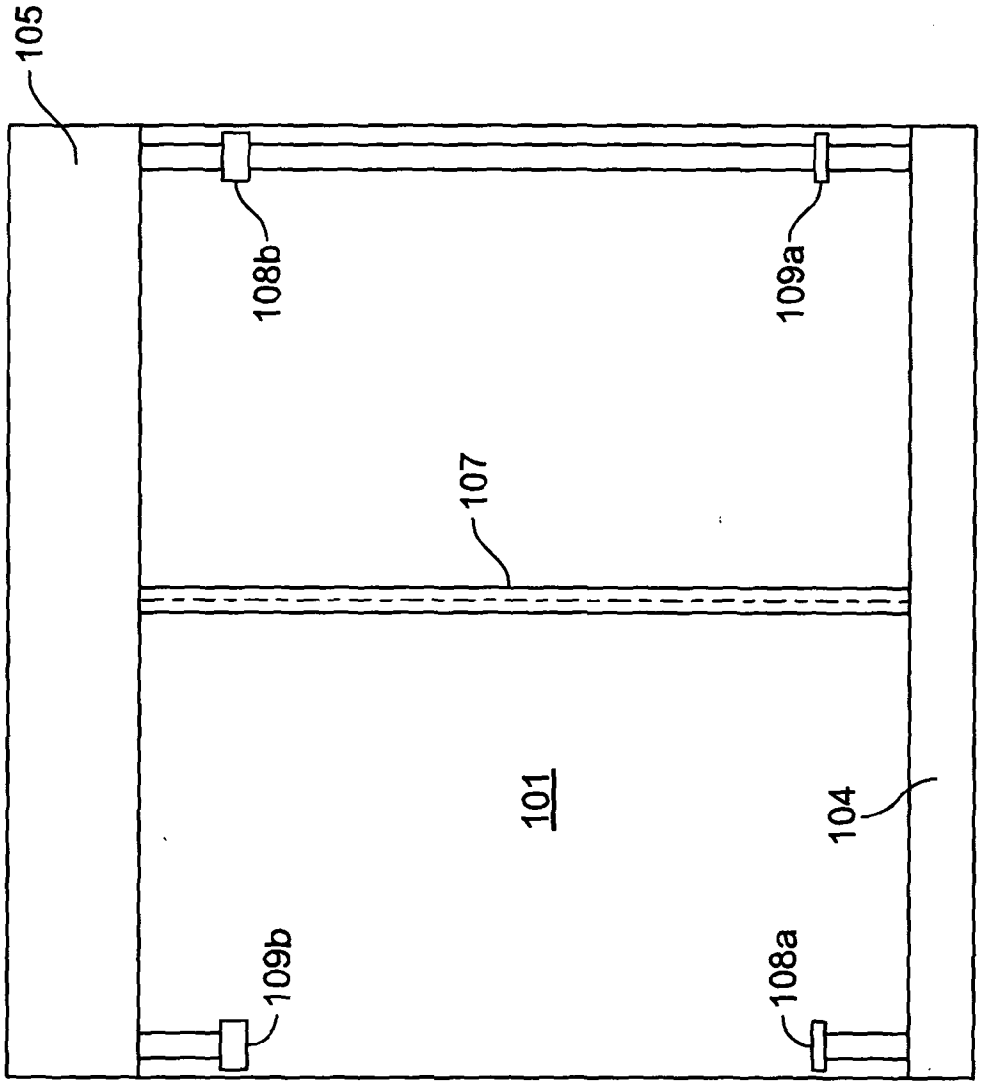


FIG. 6a

# INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2012/053199

A. CLASSIFICATION OF SUBJECT MATTER
INV. F28D15/02
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)
F28D

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

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"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 | Date of mailing of the international search report |
|---|---|
| 23 April 2013 | 03/05/2013 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Van Dooren, Marc |

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PCT/GB2012/053199

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Information on patent family members

International application No
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