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Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) Plate condenser with condensate trap

(57) A condenser device for a micro combined heat and power device comprises a plurality of substantial "U" shaped cooling plates (400 - 405), each having their gas inlet and outlets arranged at a same end of the condenser device. The plates are angled such that liquid condensing from the gas flow drains to the outlets/inlets (201 - 206) at one end of the device. The outlets and inlets open out into a plurality of transit chambers (503, 506, 509) which serve to pass gas between the outlet of one cooling plate to the gas inlet of another successive cooling plate. Liquid draining into the transit chambers drains through a plurality of drain outlets into a sump (605), and is removed from the sump via a condensate outlet.

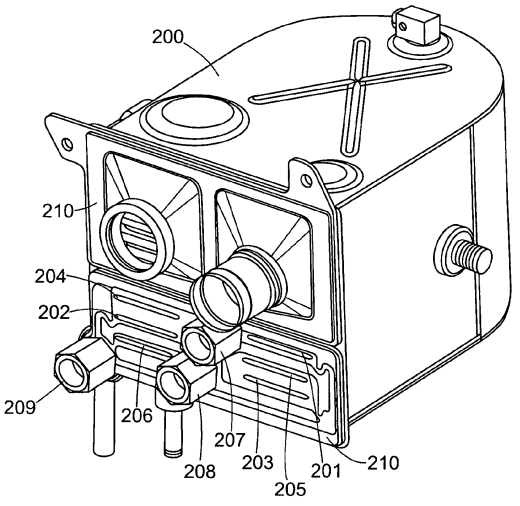

Fig. 2

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Description

Technical Field

[0001] The present invention relates to a condenser unit.

Background Art

[0002] Micro-combined heat and power (mCHP) systems are a developing technology for providing domestic electrical power and heat. Micro CHP boilers achieve high efficiency by using heat from combustion which would otherwise be wasted. Micro CHP systems offer energy usage efficiency compared to conventional delivery of electrical power over a terrestrial grid system from a set of large scale power stations.

[0003] Several known micro CHP technologies are available including:

- Small scale internal combustion engines
- Small scale stirling engines
- Small steam engines
- Micro turbines.

[0004] Future technologies will include fuel cells.

[0005] Micro CHP generators produce thermal power from a hot or warm inlet fluid which may consist of a gas, for example air or a combustion exhaust gas, water vapor and water droplets or mist.

[0006] As defined in the UK Governments product characteristics database, a non-condensing micro-CHP system is one in which condensation is not expected by design within the micro-CHP. A condensing micro-CHP means one which is designed to make use of the latent heat in the combustion products by condensing water vapor within the appliance. A condensing micro-CHP must allow the condensate to leave the heat exchanger in liquid form by way of a condensate drain.

[0007] An ongoing objective for condensing micro combined heat and power units is to make these compact and light weight. Therefore, any condensers used in these devices also need to be compact and light weight. This can be achieved by making the condenser to be a multi-pass design.

[0008] In a condensing micro-CHP boiler, humid gas is fed into a condenser and a portion of the water vapor is condensed out of the gas. As the gas becomes less humid, there is a need to separate out the waste water from the less humid gas.

Summary of the Invention

[0009] A problem occurs in that if both the condensate and the less humid gas are transferred through the condenser in the same transfer conduit, then the less humid gas can pick up some of the water condensate and become more humid, thus partially negating the condensing effect, and making the condenser less efficient.

[0010] However, adopting a multi-pass system in a condenser exacerbates the problem of separating the condensate from the gas, because there is the problem of removing the condensate from the gas flow between passes prior to the final pass in the condenser.

[0011] Specific embodiments herein are aimed at providing a "U" profile plate condenser and condensate trap which may be used with a micro combined heat and power fuel cell, but may apply to any vapour carrying waste gas.

[0012] In one embodiment, a condenser device for a micro combined heat and power device comprises a plurality of substantial "U" shaped cooling plate, having their gas inlet and outlets arranged at a same end of the condenser device. The plates are angled such that liquid condensing from the gas flow drains to the outlets/inlets that one end of the device. The outlets and inlets open out into a plurality of chambers which serve to pass gas between the outlet of one cooling plate to the gas inlet of another successive cooling plate. Liquid draining into the chambers drains through a plurality of drain outlets into a sump, and is removed from the sump via a condensate outlet.

[0013] According to a first aspect there of the present invention, there is provided a condenser device comprising:

an outer casing;

a plurality of cooling plates 400 - 401 arranged side by side;

each said cooling plate having a gas inlet 201 - 203 and a gas outlet 204 - 206 and a gas conduit extending between said gas inlet and said gas outlet;

characterised in that

said plurality of cooling plates are arranged such that said plurality of gas conduits form a continuous gas circuit; and

said gas circuit includes a plurality of condensate drains 606 - 609 spaced apart along said gas circuit.

[0014] According to a second aspect there is provided a condenser plate assembly comprising:

a plurality of cooling plates arranged side by side; each said cooling plate having a gas inlet 201 - 203 and a gas outlet 204 - 206 and a gas conduit extending between said gas inlet and said gas outlet;

characterised in that

said plurality of cooling plates are arranged such that said plurality of gas conduits have their inlets and

outlets co - located at one end of the assembly; and

comprising a plurality of condensate drains 606 - 609 co located with said plurality of inlets and outlets.

[0015] According to a third aspect there is provided a method of cooling a humid gas flow in a condenser device of a micro combined heat and power device, said method characterised by comprising:

passing said gas flow along a continuous gas circuit, wherein said gas circuit comprises a plurality of individual gas conduits arranged in sequence and interspersed with a plurality of condensate drains spaced apart along said gas circuit;

collecting liquid from said plurality of condensate drains; and

draining said liquid from said condenser device.

[0016] Other aspects are as set out in the claims herein.

[0017] By separating out the condensed liquid from the gas flow at positions along the length of the gas circuit, re - absorption of liquid back into the gas flow can be reduced, leading to a higher efficiency condenser.

Brief Description of the Drawings

[0018] For a better understanding of the invention and to show how the same may be carried into effect, there will now be described by way of example only, specific embodiments, methods and processes according to the present invention with reference to the accompanying drawings in which:

Figure 1 illustrates schematically a micro combined heat and power system, including a condenser component;

Figure 2 illustrates schematically in external perspective view, a condenser device suitable for use in a micro-combined heat and power unit;

Figure 3 illustrates schematically in external view from one side, the condenser of Figure 2 herein;

Figure 4 illustrates schematically in cut away view from one side, the condenser of Figures 2 and 3 herein;

Figure 5 illustrates schematically a view of an inlet/outlet manifold of the condenser Figures 1 to 4 herein;

Figure 6 illustrates schematically a channel plate of the condenser;

Figure 7 illustrates schematically a view of the channel plate of Figure 6 in use, and draining condensate fluid;

Figure 8 illustrates schematically in view from one end, an individual cooling plate of the condenser; and

Figure 9 illustrates schematically in view from one side, the individual cooling plate of Figure 8 herein.

Description of Embodiments

[0019] There will now be described by way of example a specific mode contemplated by the inventors. In the following description numerous specific details are set forth in order to provide a thorough understanding. It will be apparent however, to one skilled in the art, that the present invention may be practiced without limitation to these specific details. In other instances, well known methods and structures have not been described in detail so as not to unnecessarily obscure the description.

[0020] Referring to Figure 1 herein, there is illustrated schematically a micro combined heat and power generation system suitable for domestic use, utilising a Stirling engine.

[0021] The micro CHP boiler 1 comprises a conventional gas boiler burner 2 connected to a mains gas supply; a hermetically sealed Stirling Engine 3 filled with helium; and a heat exchanger 4 which recovers heat from the exhaust gasses from the boiler to heat domestic hot water.

[0022] The micro CHP boiler works by burning gas in the boiler to heat helium, which is used to drive the Stirling engine. Helium in the hermetically sealed Stirling engine expands and presses down the piston. Cold water flowing around the boiler absorbs the heat, the gas contracts and the piston rises. The heated water flows out of the boiler and into a hot water cylinder. Cold water flows into the engine and the process repeats with the Stirling engine operating at a frequency of up to 50Hz.

[0023] The piston of the Stirling engine has a magnet attached to it. As the magnetic field passes through a coil at the bottom of the engine, it generates up to one kW of electricity. Residual heat expelled in the exhaust gasses is captured by the heat exchanger and reused for generating domestic hot water.

[0024] Referring to Figure 2 herein, there is illustrated schematically in external view, a condenser device suitable for use in a micro combined heat and power application.

[0025] The condenser device comprises a cooling plate assembly and an outer canister 200. The cooling plate assembly comprises a plurality of substantially "U" shaped cooling plates stacked side by side, and connected together at their ends by a connecting plate or bulk head; a plurality of gas or vapor inlets, 201-203; a plurality of gas/vapor outlets 204-206; a gas/vapor inlet conduit 207; a gas/vapor outlet conduit 208; a condensate outlet

209; and a drainage plate 210 which fits adjacent to the bulk head, and which provides a plurality of channels for draining liquid from the vapor as it passes between inlets and outlets of the individual cooling plates. The outer canister 200 encases the plurality of cooling plates.

[0026] The inlet conduit 207 feeds gas/ vapor into a gas inlet of a first said cooling plate. The outlet conduit 208 is connected via an outlet chamber to a said outlet of a final cooling plate.

[0027] The cooling plates are connected such that they form a continuous gas circuit through the condenser device, with gas entering through the gas inlet conduit 207, into a first gas chamber which leads to a gas inlet of a first cooling plate. An outlet of the first cooling plate leads to a second gas chamber, connected to the inlet of a second gas cooling plate, so that gas transfers through the first cooling plate, via the second gas chamber, and into the second cooling plate. In an embodiment with only two cooling plates, the outlet of the second cooling plate leads to the gas outlet conduit 208 via a final gas chamber. However, in an embodiment with three or more cooling plates, the outlet of the second gas cooling plate leads via a third chamber to the inlet of a third cooling plate. Similarly, for the third and successive cooling plates, the outlet of one cooling plate leads via a gas chamber to the inlet of the next cooling plate, until an outlet of the final cooling plate in the series leads to a final output chamber which leads to the gas outlet conduit 208.

[0028] The plurality of cooling plates have their gas passages angled with respect to the horizontal, such that the inlets and outlets of the cooling plates all lie at a position below the gas passages in the cooling plates. This allows any liquid condensing in the passages to drain downwardly towards the inlets or outlets, and into the chambers. Each of the chambers is provided with its own corresponding respective drain, which leads to a sump near the lowest portion of the condenser. The sump is drained by the liquid condensate outlet 209.

[0029] Consequently, the gas passes through the condenser device sequentially through each of the cooling plates. Each time the gas encounters a chamber at the ends of the cooling plates, there is opportunity for any liquid condensed in the gas flow to drain away from the gas flow, leaving the dehumidified gas flow to pass through the next cooling plate. Because the liquid is removed from the gas flow at periodic points along the length of the gas circuit, this reduces the opportunity for reabsorption of water or moisture into the gas flow, and improves the efficiency of the condenser device.

[0030] Referring to Figure 3 herein, there is illustrated schematically the condenser device in view from one side.

[0031] The outer casing 200 encapsulates the plurality of cooling plates of the cooling plate assembly, and abuts the bulk head 300 which connects the cooling plates together. The cooling plates are rigidly connected to the bulk head, by soldering or brazing.

[0032] The gas transit chambers at the ends of the cooling plates are formed by a separate plate, which lies parallel to and abuts the bulk head, and in use a circumference around the bulk head and separate plate is sealed to avoid leakage of gas or liquid between the bulkhead and the chamber / drainage plate.

[0033] In use, the condenser unit is positioned at an angle to the horizontal as shown in Figure 3, so that condensed liquid may drain from the cooling plates, and collect at the bulk head 300, from which it can be removed via the condensate outlet 209. Typically, the device may be tilted, such that a main plane of the cooling plate rests at an angle Θ between 2.5° and 45° to the horizontal.

[0034] Referring to Figure 4 herein, there is illustrated schematically the condenser device in cut away view from one side. The cooling plate assembly comprises a plurality of cooling plates 400-405 arranged side by side and connected together at their ends by bulk head plate 300. The ends of the cooling plates may be welded or brazed to the bulk head plate. The plurality of cooling plates are arranged inside the outer canister such that coolant fluid may percolate between the gas cooling plates, cooling their outer surfaces and drawing heat out of the gas flowing through the cooling plates. The cooling plates are held within the canister, so that the edges of the cooling plates do not touch the sides of the canister, thereby allowing the plates to expand or contract in longitudinal, lateral and vertical directions within the canister without causing stresses or strains to the end of the cooling plate assembly where the cooling plates are connected.

[0035] Referring to Figure 5 herein, the condenser is illustrated schematically in partial view from one end.

[0036] Shown in Figure 5 is a gas flow between cooling plates at the end of the condenser. The gas circuit through the condenser is as follows. Humid heated gas is fed into the condenser via gas/vapor inlet conduit 207 and enters a first gas chamber 500. In the embodiment shown, three cooling plates are connected in a single gas flow circuit interspersed by a plurality of transit chambers. A gas or vapor stream is fed into a first inlet 501 of a first cooling plate, traverses around the one or plurality of gas conduits of the cooling plate and exits the first cooling plate via a first outlet 502 at a same end of the cooling plate as the first inlet. Gas or vapor exhausted from the first outlet passes into a second transit chamber 503 at the end of the condenser, formed by the drainage plate 301, and is passed into an inlet 504 of a second cooling plate. The gas or vapor passes through the gas conduits in the second cooling plate and is exhausted via an outlet 505 of the second cooling plate into a third transit chamber 506. Gas is vented from the third chamber into an inlet 507 of a third cooling plate. The vapor passes along the gas conduits of the third cooling plate, to exit the third cooling plate at a cooling plate outlet 508 which is on the first side of the condenser, and into a fourth gas chamber 509 formed by the chamber plate 301.

[0037] Gas outlets the fourth chamber 509 into the gas/

vapor outlet conduit 208.

[0038] Thus, gas enters the first chamber and into a first cooling plate and traverses the first cooling plate in an anti-clockwise direction when viewed from above to exit the first cooling plate into a second chamber. From the second chamber, the gas enters an inlet of the second cooling plate on an opposite side of the condenser, traverses the second cooling plate in a clockwise direction, to exit the second cooling plate outlet 505 into a third chamber 506. From the third chamber, the gas or vapor enters the inlet 507 of a third cooling plate, traverses through the gas conduits of the third cooling plate in an anti-clockwise direction, and exits an outlet 508 of the third cooling plate into a fourth chamber 509. From the fourth chamber, the gas, which is now much less humid, outlets the condenser via the gas outlet conduit 208.

[0039] Any water or liquid forming in the chambers, drains out of the chambers and into a sump at the end of the condenser unit.

[0040] Referring to Figure 6 herein, there is illustrated in perspective view, the chamber and drain forming plate 301 which is used at the ends of the cooling plates to provide the plurality of transit chambers, their drainage channels, and a sump. The chamber forming plate 301 is formed out of a single piece of sheet or plate metal and comprises a first aperture 600 for forming a first chamber; a second aperture 601 for forming a second chamber; a third aperture 602 for forming a third chamber and a fourth aperture 603 for forming a fourth chamber. Additionally, there is provided a slot aperture 605 extending along a lower portion of the plate which forms a sump for collection of water. The sump is accessed from each of the chambers by a separate corresponding respective drain passage way 606-609. Each of the first and second drains to the first and second chambers respectively have a substantially "U" shaped bend in which water collects, thereby forming a gas tight seal.

[0041] The "U" shaped bends prevent gas from passing from one chamber to another without flowing through the "U" shaped cooling plates.

[0042] For example taking the first passage 606 from the first chamber 600, there is a curved portion in which water collects, when drained from the first chamber. As water builds up in the first chamber it flows into a first dip 610, and pushes water out of the second end of the first dip down an upright side channel 606 into the sump 605.

[0043] Similarly, on the opposite side of the plate, the second chamber 601 drains into a second drain passage 607 which also has a dipped portion 611. Water drains into the dipped portion, and flows out of the dip over a raised exit portion of the dip and down second upright drainage channel 607 which connects to the sump.

[0044] The third chamber 602 drains via a third drainage outlet directly into the sump 605, and the fourth chamber 603 drains directly into the sump via a fourth drainage outlet 609.

[0045] The initial entrance parts of the first and second drainage outlets are each shaped as a "U" or an "S" so as to have a dip or depression, so that water collects in the drainage outlets and thereby forms a gas tight seal, preventing gas feeding forwards to the other chambers.

[0046] The third and fourth drains are of a truncated "U" shape having a dipped channel, leading directly to the sump 605.

[0047] At one end of the sump, water drains from the liquid condensate outlet 209.

[0048] Referring to Figure 7 herein, there is illustrated schematically the drainage plate 301 in use, in cut away view, showing condensate liquid which has collected in the first liquid trap 610, the second liquid trap 611, the third drain outlet 612 and the fourth drain outlet 613. The water collected in the "U" or "S" bends in the first drain acts as a non return valve which allows water to drain from the second chamber, but which prevents gas from passing forward from the first or second chambers to a subsequent chamber.

[0049] As shown in figure 7, liquid has collected in the sump 605, and is available to drain from the condensate outlet conduit at one end of the sump.

[0050] In the embodiment shown, the liquid traps 610, 611 prevent gas from passing from the first and second chambers to the third and fourth chambers or to the sump. The water in the sump 605, when high enough to reach the roof of the sump and the drains to the third and fourth chambers, acts as a non return valve to prevent gas transfer to the fourth chamber from any other chambers, and between the third chamber and any of the other chambers. The chamber arrangement thereby efficiently drains the gas flow path of liquid at four separate points in the gas flow path; firstly where the humid gas enters the first cooling plate; secondly where the gas leaves the first cooling plate and enters the second cooling plate; thirdly where the gas exits the second cooling plate and enters the third cooling plate, and fourthly as the gas outlets the third cooling plate. The liquid traps in the drains act to prevent gas transfer from chamber to chamber and prevents short circuiting of the gas flow.

[0051] Referring to Figure 8 herein, there is illustrated schematically in perspective view from one end an embodiment of an individual cooling plate comprising the cooling plate assembly of the condenser device. The cooling plate is formed of two sides of metal, each pressed or hydraulically formed to provide a plurality of gas conduits 800 - 804 each following a "U" shaped path and arranged concentrically, such that each conduit has an inlet on one side of the cooling plate and an outlet on an opposite side of the cooling plate. In various alternative embodiments the conduits may be independently gas tight along their lengths, or in other embodiments there may be provision for leakage of gas between adjacent conduits along the length of the conduits. Each conduit is formed to provide a substantially serpentine or undulating gas path, provided by a plurality of indents and protrusions in the upper and lower plates. The serpentine path of the gas conduits promotes turbulence in the gas flow and more efficient heat transfer from the hot

gas to the metal surface of the cooling plates. Similarly on the outside of the cooling plates, the protrusions and undulations provide a relatively greater surface area for contact with a liquid coolant which surrounds the plate and therefore a relatively greater heat transfer from the metal of the cooling plate to the coolant liquid flowing within the canister.

[0052] At the inlet side of the cooling plate, all of the plurality of gas conduits open out into a single manifold inlet, and similarly at the outlet side on the opposite side of the cooling plate, all of the conduit outlets open out into a single common outlet manifold. Since the cooling plate is substantially symmetrical, the gas may flow through the cooling plate in either direction, and the inlet manifold may be used as the outlet manifold and vice versa, depending upon the position of the cooling plate within the overall condenser device.

[0053] In the embodiment shown in Figure 8, there are five concentric parallel gas conduits flowing through the cooling plate. However in other embodiments there may be one, two, three, four, five, six or more gas conduits.

[0054] Referring to Figure 9 herein, there is illustrated schematically the cooling plate of Figure 8 in view from one side. The cooling plate is angled to the horizontal, such that gas flows through the conduits, up towards a rounded tip of the cooling plate, and back on the opposite side of the cooling plate down to the lower end of the cooling plate. At any point in the cooling plate, liquid which condenses out of the gas will trickle or drain down the gas passages towards the inlet and outlet manifolds, where the liquid can be collected in the transit chambers and flow out of the chambers via the respective drains and into the sump, from where it is removed from the condenser via the condensate outlet conduit 209.

Claims

1. A condenser device comprising:

an outer casing;
a plurality of cooling plates 400 - 401 arranged side by side;
each said cooling plate having a gas inlet 201-203 and a gas outlet 204-206 and a gas conduit extending between said gas inlet and said gas outlet;

characterised in that

said plurality of cooling plates are arranged such that with said plurality of gas conduits form a continuous gas circuit; and
said gas circuit includes a plurality of condensate drains 606-609 spaced apart along said gas circuit.

2. The condenser device as claimed in claim 1, wherein said continuous gas circuit comprises a plurality of individual said gas conduits arranged in series; and said plurality of drains are positioned at intersections between individual said gas conduits.

3. The condenser device as claimed in any one of the preceding claims, wherein said continuous gas circuit comprises a plurality of individual said gas conduits arranged in series; and
further comprising a plurality of chambers 503, 506, 509 arranged between individual ones of said serially connected gas conduits such that gas passing from an outlet of one gas conduit to an inlet of a successive gas conduit passes through a said chamber.

4. The condenser device as claimed in any one of the preceding claims, comprising a plurality of chambers 503, 506, 509 connected with said gas inlets and gas outlets, each said chamber having a corresponding respective said condensate drain for draining condensate from said chamber.

5. The condenser device as claimed in claim 4, wherein said chambers and drains are formed by a plate member 301 placed at the ends of said cooling plates.

6. The condenser device as claimed in any one of claims 3 to 5, comprising a hydraulic lock 610-613 for preventing gas flow between said chambers.

7. The condenser device as claimed in any one of the preceding claims, comprising a sump 605 for collecting condensed liquid from at least one drain of said plurality of condensate drains.

8. The condenser device as claimed in any one of the preceding claims, wherein said cooling plates have their inlets and outlets co-located such that a gas flow passes sequentially through said plurality of cooling plates between said outlets and inlets.

9. The condenser device as claimed in any one of the preceding claims, wherein said plurality of the cooling plates are arranged such that gas passes from an outlet of one cooling plate, through a chamber, and into a gas inlet of a successive cooling plate; and wherein said chamber comprises a condensate drain for draining condensate condensed from said gas flow.

10. The condenser device as claimed in any one of the preceding claims, wherein
each said cooling plate has a gas inlet and a gas outlet co-located on a same end of said cooling plate; and
each said gas inlet is positioned on opposite side of said cooling plate to a gas outlet of said cooling plate;

and
each said inlet and outlet connects with the corresponding chamber, said chamber having a liquid drain.

11. The condenser device as claimed in any one of the preceding claims, wherein said plurality of cooling plates are arranged such that their inlets and outlets are all located at a same end of said condenser device.

12. The condenser device as claimed in any one of the preceding claims, wherein said cooling plates are angled with respect to the horizontal such that liquid condensing in said gas conduits drains downwardly towards said gas inlet and/or said gas outlet.

13. The condenser device as claimed in any one of the preceding claims, comprising a sump arranged to collect liquid from said plurality of condensate drains.

14. A condenser plate assembly comprising:

a plurality of cooling plates arranged side by side;
each said cooling plate having a gas inlet 201-203 and a gas outlet 204 - 206 and a gas conduit extending between said gas inlet and said gas outlet;

characterised in that

said plurality of cooling plates are arranged such that said plurality of gas conduits have their inlets and outlets co - located at one end of the assembly; and
comprising a plurality of condensate drains 606 - 609 co located with said plurality of inlets and outlets.

15. A method of cooling a humid gas flow in a condenser device of a micro combined heat and power device, said method comprising:

passing said gas flow along a continuous gas circuit, wherein said gas circuit comprises a plurality of individual gas conduits arranged in sequence and interspersed with a plurality of condensate drains spaced apart along said gas circuit;
collecting liquid from said plurality of condensate drains; and
draining said liquid from said condenser device.

16. The method as claimed in claim 15, further comprising
positioning said gas conduits at an angle to the horizontal, to allow drainage of liquid along said gas conduits.

Amended claims in accordance with Rule 137(2) EPC.

1. A condenser device comprising:

an outer casing;
a plurality of cooling plates 400 - 401 arranged side by side;
each said cooling plate having a gas inlet 201 - 203 and a gas outlet 204 - 206, said gas inlet and gas outlet being located at a same end of said cooling plate, and a gas conduit extending between said gas inlet and said gas outlet;
characterised in that
said plurality of cooling plates are arranged such that said plurality of gas conduits form a continuous gas circuit; and
said gas circuit includes a plurality of condensate drains 606 - 609 spaced apart along said gas circuit.

2. The condenser device as claimed in claim 1, wherein said continuous gas circuit comprises a plurality of individual said gas conduits arranged in series; and
said plurality of drains are positioned at intersections between individual said gas conduits.

3. The condenser device as claimed in any one of the preceding claims, wherein said continuous gas circuit comprises a plurality of individual said gas conduits arranged in series; and
further comprising a plurality of chambers 503, 506, 509 arranged between individual ones of said serially connected gas conduits such that gas passing from an outlet of one gas conduit to an inlet of a successive gas conduit passes through a said chamber.

4. The condenser device as claimed in any one of the preceding claims, comprising a plurality of chambers 503, 506, 509 connected with said gas inlets and gas outlets, each said chamber having a corresponding respective said condensate drain for draining condensate from said chamber.

5. The condenser device as claimed in claim 4, wherein said chambers and drains are formed by a plate member 301 placed at the ends of said cooling plates.

6. The condenser device as claimed in any one of claims 3 to 5, comprising a hydraulic lock 610 - 613 for preventing gas flow between said chambers.

7. The condenser device as claimed in any one of

the preceding claims, comprising a sump 605 for collecting condensed liquid from at least one drain of said plurality of condensate drains.

8. The condenser device as claimed in any one of the preceding claims, wherein said cooling plates have their inlets and outlets co-located such that a gas flow passes sequentially through said plurality of cooling plates between said outlets and inlets.

9. The condenser device as claimed in any one of the preceding claims, wherein said plurality of the cooling plates are arranged such that gas passes from an outlet of one cooling plate, through a chamber, and into a gas inlet of a successive cooling plate; and
wherein said chamber comprises a condensate drain for draining condensate condensed from said gas flow.

10. The condenser device as claimed in any one of the preceding claims, wherein
each said cooling plate has a gas inlet and a gas outlet co-located on a same end of said cooling plate; and
each said gas inlet is positioned on opposite side of said cooling plate to a gas outlet of said cooling plate; and
each said inlet and outlet connects with the corresponding chamber, said chamber having a liquid drain.

11. The condenser device as claimed in any one of the preceding claims, wherein said plurality of cooling plates are arranged such that their inlets and outlets are all located at a same end of said condenser device.

12. The condenser device as claimed in any one of the preceding claims, wherein said cooling plates are angled with respect to the horizontal such that liquid condensing in said gas conduits drains downwardly towards said gas inlet and/or said gas outlet.

13. The condenser device as claimed in any one of the preceding claims, comprising a sump arranged to collect liquid from said plurality of condensate drains.

14. A condenser plate assembly comprising:

a plurality of cooling plates arranged side by side;
each said cooling plate having a gas inlet 201 - 203 and a gas outlet 204 - 206, said gas inlet and gas outlet being located at a same end of said cooling plate, and a gas conduit extending between said gas inlet and said gas outlet;

characterised in that
said plurality of cooling plates are arranged such that said plurality of gas conduits have their inlets and outlets co - located at one end of the assembly; and
comprising a plurality of condensate drains 606 - 609 co located with said plurality of inlets and outlets.

15. A method of cooling a humid gas flow in a condenser device comprising a plurality of cooling plates each comprising a gas inlet 201 - 203 and a gas outlet 204 - 206, said gas inlet and gas outlet being located at a same end of said cooling plate, , said method comprising:

passing said gas flow along a continuous gas circuit, wherein said gas circuit comprises a plurality of individual gas conduits arranged in sequence and interspersed with a plurality of condensate drains spaced apart along said gas circuit;
collecting liquid from said plurality of condensate drains; and
draining said liquid from said condenser device.

16. The method as claimed in claim 15, further comprising
positioning said gas conduits at an angle to the horizontal, to allow drainage of liquid along said gas conduits.

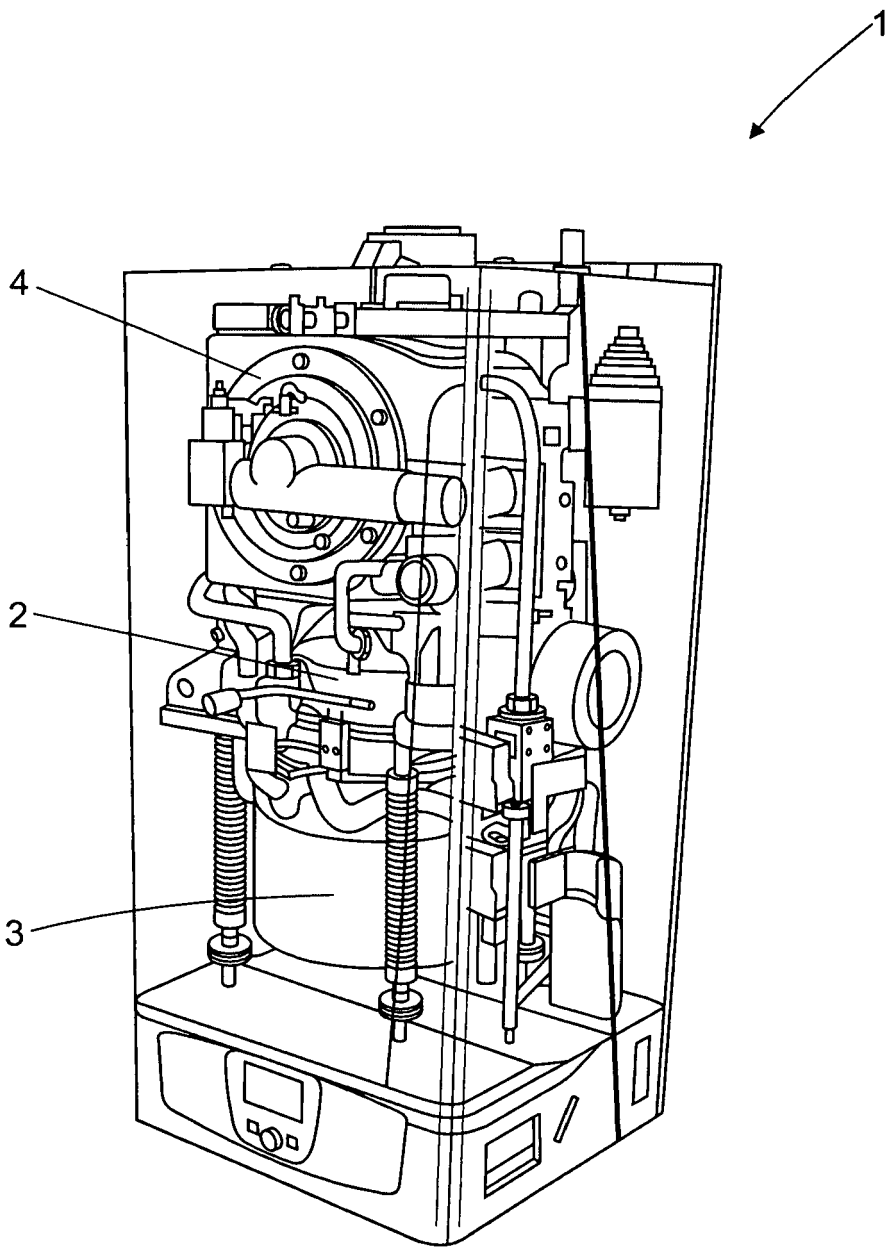

Fig. 1

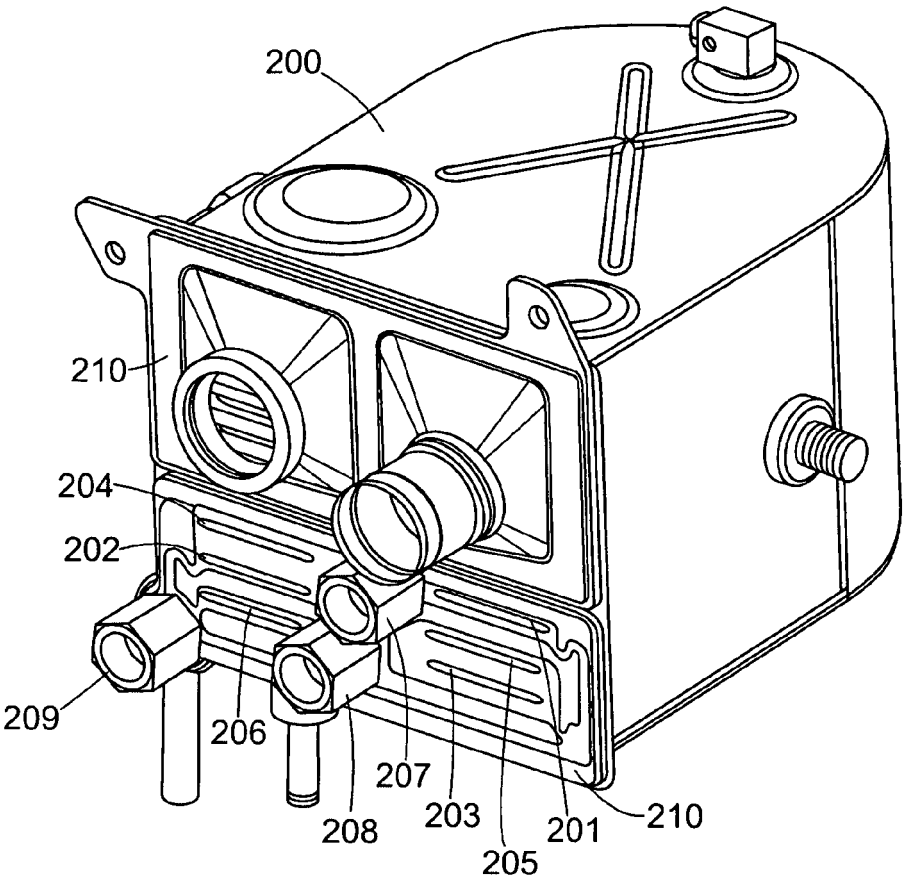

Fig. 2

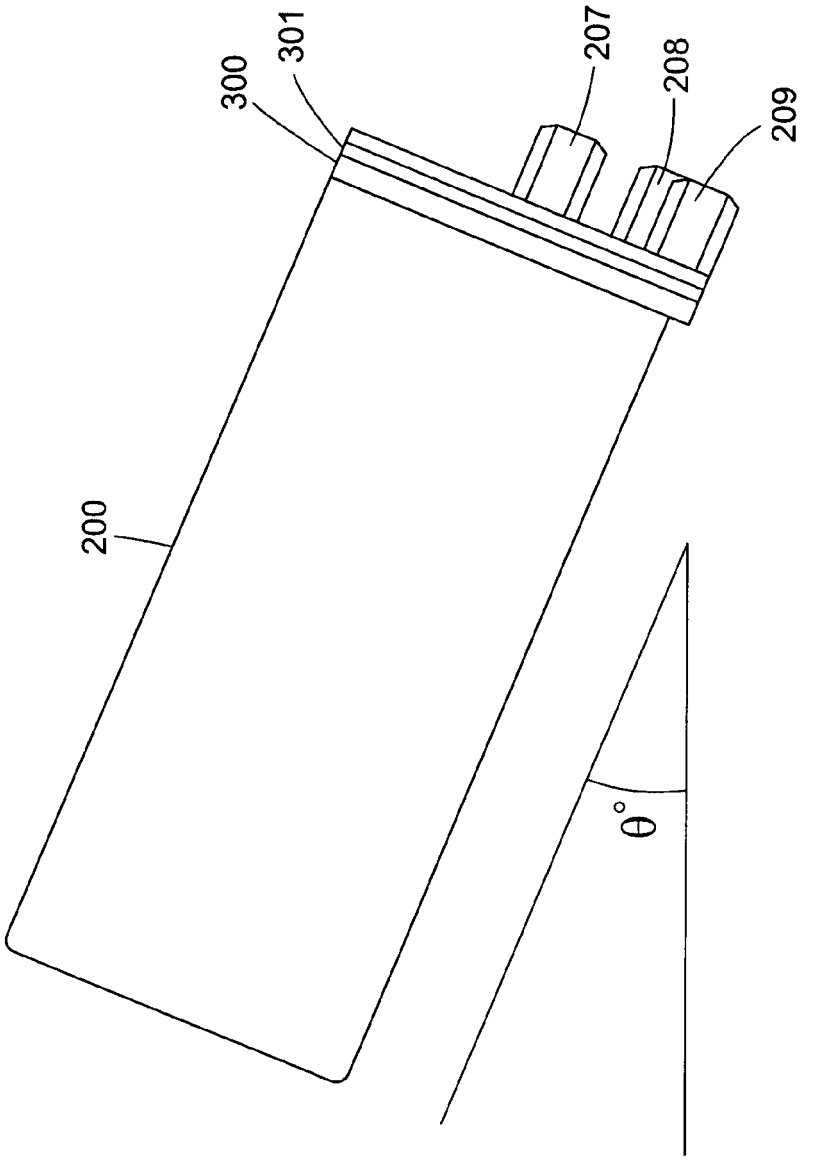

Fig. 3

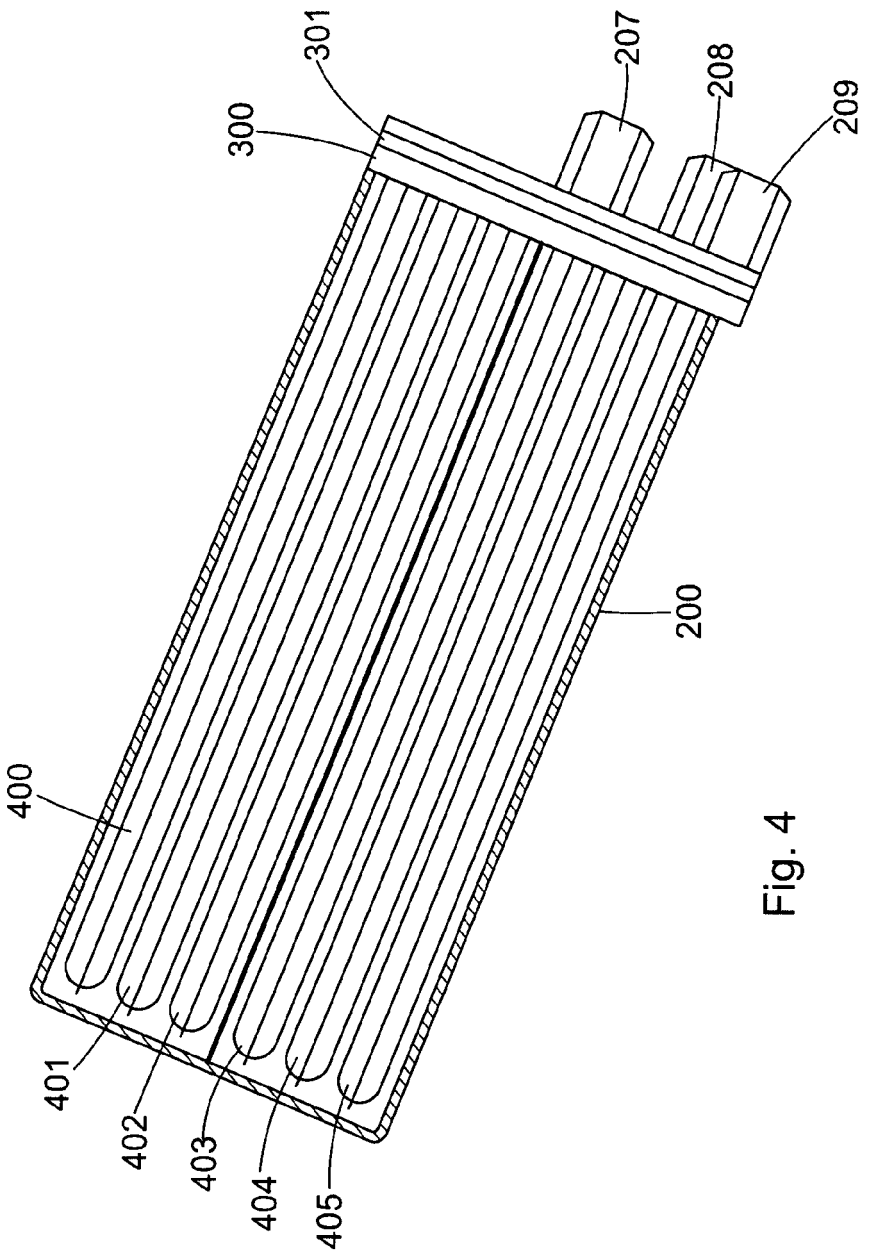

Fig. 4

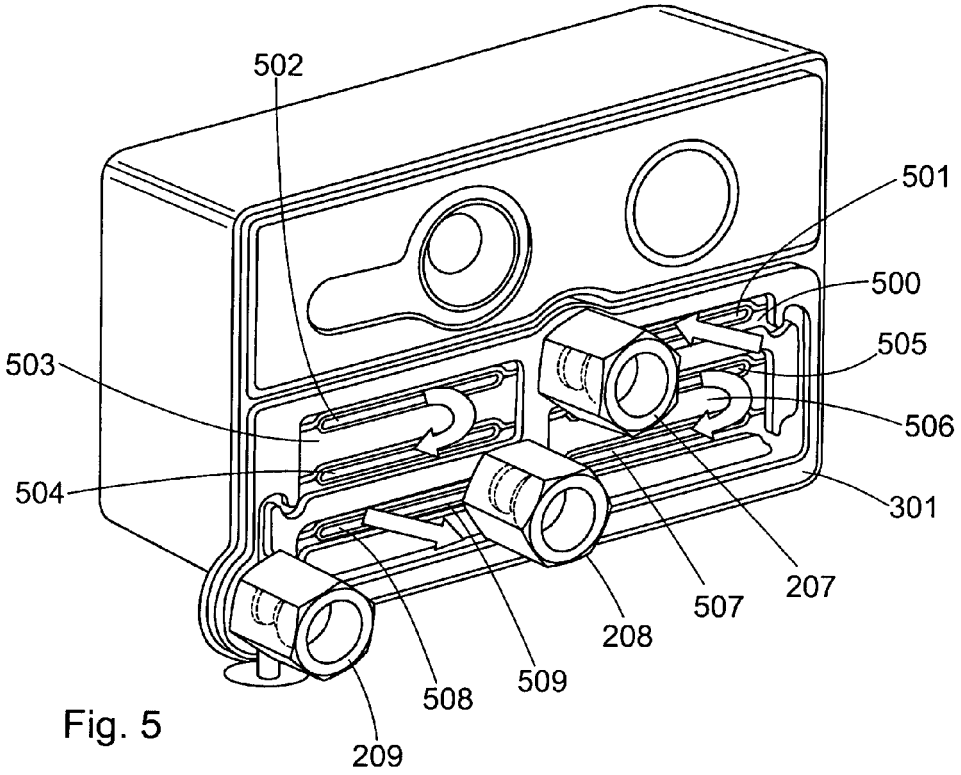
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Fig. 5

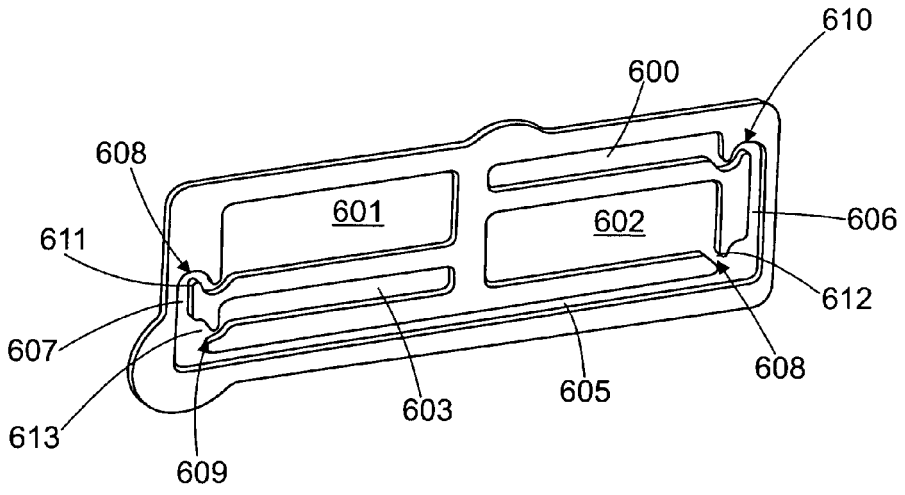
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Fig. 6

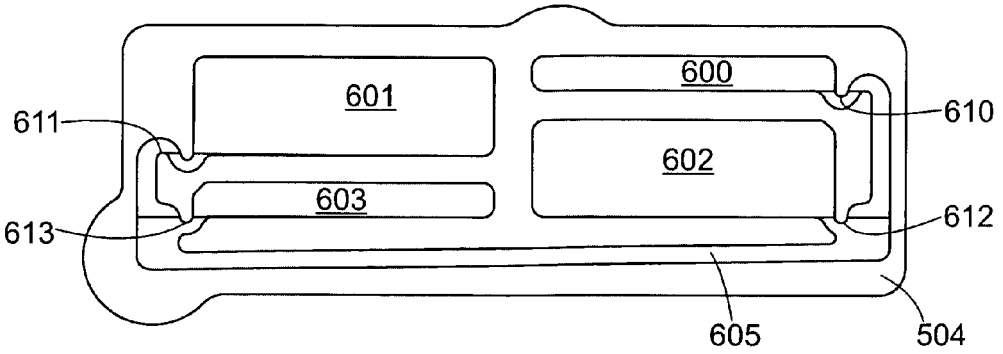

Fig. 7

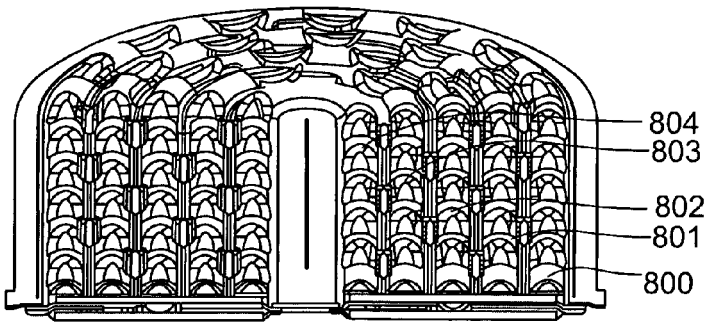

Fig. 8

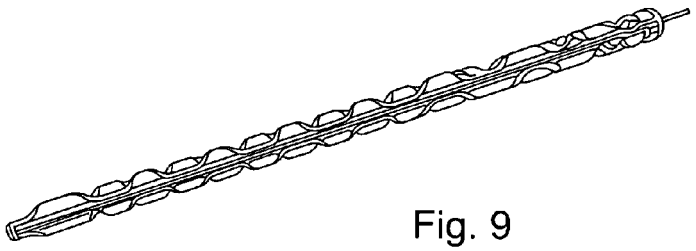

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 11 00 3328

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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
The Hague	20 October 2011	Berkus, Frank

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