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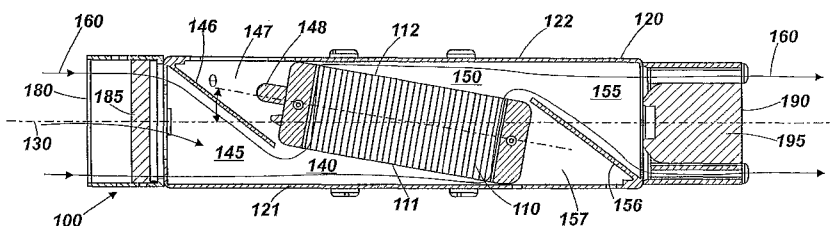


Fig. 1a

(57) Abstract: A fuel cell assembly (100) comprising: an enclosure (120) for mounting a fuel cell stack (110) therein, the enclosure comprising an air flow path (160) extending between an air inlet (180) and an air outlet (190); and a fuel cell stack (110) having a plurality of cathode air coolant paths extending between a first face (111) and an opposing second face (112) of the stack, wherein the fuel cell stack is mounted within the enclosure to provide a first tapering air volume (140) between the first face of the stack and a first side wall (121) of the enclosure and a second tapering air volume (150) between the second face of the stack and a second opposing side wall (122) of the enclosure.

FUEL CELL ASSEMBLY

The invention relates to fuel cell assemblies, in particular to enclosures for mounting open cathode fuel cell stacks.

5 Conventional electrochemical fuel cells convert fuel and oxidant, generally both in the form of gaseous streams, into electrical energy and a reaction product. A common type of electrochemical fuel cell for reacting hydrogen and oxygen comprises a polymeric ion (proton) transfer membrane, with fuel and air being passed over each side of the membrane. Protons (i.e. hydrogen ions) are conducted through the membrane, balanced
10 by electrons conducted through a circuit connecting the anode and cathode of the fuel cell. To increase the available voltage, a stack may be formed comprising a number of such membranes arranged with separate anode and cathode fluid flow paths. Such a stack is typically in the form of a block comprising numerous individual fuel cell plates held together by end plates at either end of the stack.

15

Because the reaction of fuel and oxidant generates heat as well as electrical power, a fuel cell stack requires cooling once an operating temperature has been reached. Cooling may be achieved by forcing air through the cathode fluid flow paths. In an open cathode stack, the oxidant flow path and the coolant path are the same, i.e. forcing air through the
20 stack both supplies oxidant to the cathodes and cools the stack.

In order to integrate a fuel cell stack with other equipment for the stack to provide power to, the stack may be provided as an integrated assembly, having integrated air and fuel lines and electrical outlet connections. The assembly requires coolant paths, which may
25 be the same or different to the oxidant flow paths, typically provided by manifolds leading to and from the stack. Particular care needs to be taken on how the air flow interfaces with the cathode flow paths, so that a uniform air flow and minimal pressure drop is achieved. Designing such manifolds can lead to increased complexity and cost of the operational unit.

30

A further complication is the need to design a different fuel cell assembly for each different application, since each application will tend to have its own power requirements in terms of required voltages and currents as well as space. Redesigning the assembly for each application can add considerably to the cost of each implementation.

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It is an object of the present invention to address one or more of the above mentioned problems.

In accordance with the invention there is provided a fuel cell assembly comprising:

- 5 an enclosure for mounting a fuel cell stack therein, the enclosure comprising an air flow path extending between an air inlet and an air outlet; and
- a fuel cell stack having a plurality of cathode air coolant paths extending between a first face and an opposing second face of the stack,
- 10 wherein the fuel cell stack is mounted within the enclosure to provide a tapering air volume between the first face of the stack and a first side wall of the enclosure and between the second face of the stack and a second opposing side wall of the enclosure.

An advantage of the fuel cell assembly according to the invention is that, because tapering air volumes are provided by the relative arrangement of the enclosure and the
15 faces of the stack, specially designed manifolds are not required, thereby reducing the complexity and cost of the overall assembly.

Diagonally opposing edges of the stack can be sealed against the respective first and second opposing side walls of the enclosure, to allow for a sealed air flow path through
20 the enclosure.

The enclosure may comprise an inlet air filter at a first end of the air flow path and an air exhaust at a second opposing end. This helps to reduce the overall height and width of the assembly. A reducing tapered section may be incorporated, extending from the inlet
25 air filter to the first tapered air volume, to improve uniformity of air flow to the stack.

An increasing tapered section may also be provided extending from the second tapered air volume to the air exhaust, so as to improve air flow and reduce any pressure drop across the assembly.
30

A fan may be provided at the air exhaust for drawing air through the air flow path. The fan may alternatively be provided at the air inlet for blowing air through the air flow path.

The enclosure may have a substantially cuboid external shape, which allows multiple
35 assemblies to be stacked on top of one another, for increasing the power available from the stacks.

The fuel cell stack may be mounted within the enclosure at an angle of between 5 and 45 degrees to a longitudinal axis of the enclosure. This preferred range of angles allows for air flow to be uniformly distributed along the stack, while keeping the additional height required for the enclosure to a minimum. A particular preferred angle is around 8.5 degrees.

The fuel cell stack may in certain embodiments comprise a staggered array of planar fuel cells between opposing end plates laterally offset from one another. Alternatively, the stack may be substantially cuboid in shape, with the end plates in line with each other and the stack having a uniform cross-section between the end plates.

The fuel cell stack may alternatively have a cross-sectional shape in the form of a parallelogram

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In preferred embodiments, including those where the cross-sectional shape of the stack is other than rectangular as well as those where the stack is substantially cuboid in shape, planar fuel cells making up the fuel cell stack are aligned parallel to the longitudinal axis of the enclosure. Aligning the cells parallel, rather than laterally, to the enclosure axis allows for a more uniform pressure distribution across stack, thereby ensuring that air flow through the stack is more uniform.

20

The fuel cell assembly optionally comprises an air recirculation duct extending between the air outlet and air inlet, the assembly comprising a retractable baffle adjacent the air outlet, the baffle being operable between a closed position and an open position in which a proportion of air passing through the second tapering air volume is redirected back towards the air inlet via the recirculation duct.

25

An air deflector assembly is optionally provided between the air inlet and first face of the fuel cell stack, the air deflector assembly preferably comprising a plurality of vanes arranged to direct air towards one or more portions of the inlet face of the fuel cell stack. In one particular embodiment, the plurality of vanes are arranged as one or more rotatable air deflector assemblies configured to rotated in response to air flowing through the air inlet to increase turbulence in the tapered air inlet volume, and thereby reduce preferential air flow through particular portions of the fuel cell stack.

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A modular fuel cell assembly may be constructed from a plurality of the fuel cell assemblies according to the invention, with the assemblies arranged in a regular array. The regular array may be a rectangular array.

5 The invention will now be described by way of example, and with reference to the enclosed drawings in which:

figure 1a is a cross-sectional view of an enclosure with a fuel cell stack mounted therein;

figure 1b is a plan view of the enclosure of figure 1a;

10 figure 2 is a cut-away perspective view of an enclosure with a fuel cell stack mounted therein;

figure 3 is a perspective view of the enclosure of figure 2;

figure 4 is a perspective view of a modular assembly of enclosures containing fuel cell stacks;

15 figure 5 is a perspective view of an alternative fuel cell stack;

figure 6 is a cross-sectional view of the alternative fuel cell stack of figure 5 mounted between opposing side walls of an enclosure;

figure 7 is a perspective partially transparent view of a further alternative form of fuel cell assembly;

20 figure 8 is a cross-sectional view of the further alternative form of fuel cell assembly;

figure 9 is an end elevation view of the further alternative form of fuel cell assembly;

25 figure 10 is a cross-sectional drawing of a further alternative embodiment, having an air recirculation path in a closed / non-recirculating configuration;

figure 11 is a cross-sectional drawing of the further alternative embodiment of figure 10, with the air recirculation path in a partially open / recirculating configuration;

figure 12 is a perspective drawing of a further alternative embodiment, having a first type of air inlet deflector in the air inlet manifold;

30 figure 13 is a perspective drawing of a further alternative embodiment, having a second type of air inlet deflector in the air inlet manifold;

figure 14 is a perspective drawing of a further alternative embodiment, having a third type of air inlet deflector in the air inlet manifold together with an air outlet manifold;

35 figure 15a is a perspective drawing of a further alternative embodiment, having a fourth type of air inlet deflector in the air inlet manifold; and

figure 15b is a perspective drawing of a rotatable air deflector for use in the embodiment of figure 15a.

Shown in figure 1a is a cross-sectional view of a fuel cell assembly 100 comprising a fuel
5 cell stack 110 mounted within an enclosure 120. The stack 110 is mounted at an angle θ
of preferably between 5 and 45 degrees to the longitudinal axis 130 of the enclosure 120,
with a particular preferred angle being around 8.5 degrees. This mounting arrangement
results in a first tapered air volume 140 between a first face 111 of the stack 110 and a
10 first wall 121 of the enclosure, and a second tapered air volume 150 between a second
face 112 of the stack 110 and a second wall 122 of the enclosure 120. The first and
second tapered air volumes 140, 150 form part of an air flow path 160 between an air inlet
180 and an air exhaust 190 of the enclosure 120. A reducing tapered inlet manifold 145
extends between an air filter 185 at the air inlet and the first tapered air volume 140. An
15 increasing tapered outlet manifold 155 extends between the second tapered air volume
150 and a fan 195 provided at the air exhaust 180. The fan 195 may alternatively be
provided at the air inlet 180 to blow air through the enclosure 120.

The enclosure 120 may additionally provide part of the structure of the stack 110, for
example taking the place of tie bolts that would otherwise be provided to clamp the end
20 plates in position.

The tapered air volumes 140, 150 either side of the stack 110 act to reduce the pressure
drop in the air flow path leading through the stack, and improves the distribution of air in
the fuel cells making up the stack 110.

25 Cover plates 146, 156 may be provided in the enclosure 120 to form tapering inlet and
outlet manifolds 145, 155 leading to and from the stack 110. The cover plates may be
planar, as shown in figure 1a, or alternatively may be curved to form a desired shape of
air flow path leading to and away from the stack 110. The cover plates 146, 156 are
30 preferably sealed against diagonally opposing edges of the stack 110 and against the
internal faces of the enclosure 120, in order to prevent leakage of air from the air flow
coolant path 160. One or both of the cover plates 146, 156 may be formed as part of the
cross-sectional shape of the enclosure 120. Further internal volumes 147, 157 provided
by the cover plates 146, 156 could be used to contain other components of the fuel cell
35 assembly, for example relating to electrical connections, and/or regulation of the fuel
supply, to the stack 110. Internal volume 147 is additionally shown in figure 1b, beneath

an opening in a face of the enclosure 120 provided to allow access to connections 148 on the fuel cell stack 110.

5 Air, which for an open cathode stack acts as both coolant and oxidant, enters the enclosure 120 through a filter 185 and into the tapered inlet manifold 145 before entering the first tapered air volume 140 leading to a first face 111 of the stack 110. The air passes through the stack 110 and out from the second face 112 into the second tapered volume 150 above the stack. The air then passes through the outlet manifold 155 and is drawn out of the enclosure through one or more fans 195. In order to ensure that a reasonably uniform air flow is provided through each of the cells making up the stack 110, the cells are preferably aligned to be parallel to the longitudinal axis 130 of the enclosure 120, as shown more clearly in figure 2. Other arrangements where the cells are aligned laterally to the longitudinal axis 13, as for example shown in figures 5 and 6, are however, also possible.

15

At least in relation to open cathode air-cooled fuel cell stacks, the layout shown in figures 1a and 1b allows for the total height and the overall volume of the fuel cell assembly to be reduced and allows for a more rugged package with a minimum number of components. Selection of the angle of the fuel cell stack 110 to the longitudinal axis of the enclosure 20 allows for optimisation of the space used within the enclosure, both in terms of the inlet and outlet manifolds and the space required for other components.

Figure 2 shows a perspective cutaway view of the fuel cell stack 110 and enclosure 120, illustrating the cover plates 146, 156 forming the inlet and outlet manifolds 145, 155 and further volumes 147, 157.

Figure 3 shows a perspective view of the assembled enclosure 120. The regular cuboid shape of the enclosure, in combination with the air inlet 180 and outlet 190 being provided at opposing ends of the enclosure 120, allows the fuel cell assembly 100 to be provided in a modular form, i.e. allowing a plurality of such fuel cell modules to be connected together physically and electrically. An exemplary arrangement of this is shown in the perspective view of such a modular assembly in figure 4, illustrating a rectangular array 400 of eight such modules. An advantage of such an array 400 is that manufacturing costs can be minimised across a range of applications requiring different levels of electrical power.

35

Although the present invention is particularly suitable for open cathode air-cooled designs of fuel cell stacks, other fuel cell stacks where air flow through the stack is an important feature may be incorporated into an enclosure of the type described herein.

5 Shown in figure 5 is an alternative arrangement of a fuel cell stack 510 suitable for use in an embodiment of the invention. The stack 510 comprises a staggered array of fuel cells 520, with opposing parallel end plates 530a, 530b laterally offset from one another. The arrangement shown can thereby be mounted within an enclosure with the end plates 530a, 530b arranged orthogonally to opposing faces of the enclosure. The arrangement
10 is shown in cross-sectional view in figure 6, with the end plates 530a, 530b shown in relation to side walls 610a, 610b of the enclosure, with tapered air volumes 640, 650 provided between the stack 510 and side walls 610a, 610b. Other components making up a fuel cell assembly with the arrangement shown in figures 5 and 6 may be similar to those illustrated in figures 1a to 4.

15

Figure 7 shows a further alternative form of fuel cell assembly 700 according to the invention, in which the fuel cell stack 710 has a cross-sectional shape in the form of a parallelogram, rather than the rectangular forms shown in figures 1a and 2. Figure 8 shows a cross-sectional view through the fuel cell stack 710, in which the alignment of
20 each of the individual fuel cell plates can be seen. The parallelogram form of the stack 710 allows the plates to be aligned towards the air flow direction through the enclosure, indicated by air flow paths 810, thereby aiming to reduce turbulence and pressure drop between the inlet 820 and outlet 830 of the enclosure 720. An outlet end elevation view of the fuel cell assembly 700 is shown in figure 9, indicating the section (C-C) through which
25 figure 8 is taken.

Figure 10 illustrates in cross-section a further alternative embodiment of a fuel cell assembly 1000 according to the invention. The fuel cell stack 1010 is mounted and oriented within the enclosure 1020 in a similar way to the assemblies described above,
30 but with some modifications to the form of the enclosure 1020 to improve air flow through the stack 1010 and allow for air recirculation when required. Air flow through the enclosure 1020 is indicated by arrows 1060, showing air entering the enclosure 1020 through an air inlet 1080 (optionally comprising an air filter 1085), through a tapering air inlet volume 1040, entering a first face 1011 of the stack 1010, exiting the stack 1010
35 through a second opposing face 1012 into a tapered air outlet volume 1050, and out from the enclosure 1020 through an air outlet 1090, optionally provided with a fan 1095.

Different to the previously described embodiments, the air outlet 1090 cross-section in the embodiment shown in figure 10 is smaller than that of the air inlet 1090 so as to allow for an air recirculation path, described in more detail below.

5 Flow correctors 1030a, 1030b are provided along opposing internal side walls 1021, 1022 of the enclosure 1020, the flow correctors facing opposing faces 1011, 1012 of the stack 1010. The flow correctors 1030a, 1030b are in the form of narrowed portions of the internal volume defined by the opposing internal side walls of the enclosure 1020, the flow correctors being configured to provide a further tapering of the air inlet volume 1040 and
10 air outlet volume 1050 adjacent either face 1011, 1012 of the stack 1010. The effect of this further tapering is to redistribute air flow through the stack 1010 across the inlet and outlet faces 1011, 1012, allowing a more even distribution of air flow across the stack 1010.

15 An air recirculation path is provided in the assembly 1000, connecting the air outlet 1090 with the air inlet 1080 by means of a recirculation duct 1092. A retractable baffle 1091 is provided adjacent the air outlet 1090, the baffle 1091 being operable by means of a baffle actuator 1096 for actuating the baffle between a closed position, as shown in figure 10, and an open position in which a proportion of the air passing through the tapered air outlet
20 volume 1050 is redirected back towards the air inlet 1080 via the recirculation duct 1092.

Figure 11 shows the assembly 1000 of figure 10 with the retractable baffle 1091 in a partially open position, causing a proportion of air to be recirculated through the recirculation duct 1092 (indicated by arrow 1061) towards the air inlet 1080. The
25 recirculated air exits the recirculation duct 1092 through one or more holes 1093 provided adjacent the air inlet 1080, the holes 1093 being for example in the form of a series of perforations. In the configuration shown in figure 11, a portion of the retractable baffle 1091 extends across a face of the fan 1095 to force air into the recirculation duct 1092. The baffle 1091 is preferably slidably actuated across air outlet 1090, and comprises a
30 curved end portion 1094 configured to direct air into the recirculation duct 1092.

One or more baffle actuators 1096 are provided to operate the baffle 1091 between the closed and open positions. The actuator 1096 may, for example, be a linear or rotary actuator, arranged to slidably actuate the baffle 1091 across the air outlet 1090.

35

With the baffle 1091 in the closed position shown in figure 10, air passes through the fuel cell stack and provides oxygen and cooling during normal operation. With the baffle in the open position shown in figure 11, recirculation of air through the recirculation duct 1092 allows air that has been heated by passing through the stack 1010 to further heat the stack, for example during a cold start-up procedure. Once a measured temperature of the stack reaches a desired threshold, the baffle 1091 can be caused to retract and allow for cooling of the stack. The baffle 1091 may also be operated in a partially open position, for example during a gradual transition from a cold start to normal operation.

Shown in figure 12 is an alternative embodiment similar to the assembly 1000 of figures 10 and 11, in which an air deflector assembly 1210 is provided within the tapered air inlet volume 1040 in place of the flow correctors 1030a, 1030b. The air deflector assembly comprises a plurality of curved vanes 1211 configured to redirect air from the tapered air inlet volume across the inlet face 1011 of the stack 1010, thereby redistributing air flow across the inlet face 1010.

An alternative fuel cell assembly 1300 embodiment is shown in figure 13, in which an air deflector assembly 1310 is provided in the form of a regular series of curved vanes across the inlet face 1011 of the stack 1010, the curved shape of the vanes being configured to deflect air flowing through the tapered air inlet volume towards portions of the face 1011 of the stack 1010.

A further alternative fuel cell assembly embodiment 1400 is shown in figure 14, in which a deflector assembly 1410a is provided in the form of a series of curved vanes providing multiple parallel flow paths between the air inlet and the first face 1011 of the stack 1010. A corresponding air deflector assembly 1410b is also optionally provided on the outlet face of the stack, providing multiple parallel flow paths between the outlet face 1012 of the stack 1010 and the air outlet 1090.

An alternative type of air deflector assembly is illustrated in the fuel cell assembly embodiment 1500 shown in figure 15a. The air deflector is in the form of one or more rotatable blade assemblies 1510a, 1510b, each assembly being configured to be driven by the incoming air stream from the air inlet 1080 so as to convert an inlet air flow from being relatively laminar to a more turbulent flow. Each blade assembly 1510a, 1510b is oriented such that the rotation axis is substantially orthogonal to the direction of air flow from the air inlet 1080. The more turbulent air flow in the tapered air inlet volume assists

in reducing preferential air flow through particular channels in the stack. A further view of a single air deflector 1510 is shown in figure 15b, the deflector being in the form of a circular cylindrical element having a plurality of vanes extending longitudinally along the axis of the cylinder.

5

Other embodiments are intentionally within the scope of the invention as defined by the appended claims.

CLAIMS

1. A fuel cell assembly comprising:
an enclosure for mounting a fuel cell stack therein, the enclosure comprising an air
5 flow path extending between an air inlet and an air outlet; and
a fuel cell stack having a plurality of cathode air coolant paths extending between
a first face and an opposing second face of the stack,
wherein the fuel cell stack is mounted within the enclosure to provide a first
10 tapering air volume between the first face of the stack and a first side wall of the enclosure
and a second tapering air volume between the second face of the stack and a second
opposing side wall of the enclosure.
2. The fuel cell assembly of claim 1 wherein diagonally opposing edges of the stack
15 are sealed against the respective first and second opposing side walls of the enclosure.
3. The fuel cell assembly of claim 1 wherein the enclosure comprises an inlet air filter
at a first end of the air flow path and an air exhaust at a second opposing end.
4. The fuel cell assembly of claim 3 comprising a reducing tapered section extending
20 from the inlet air filter to the first tapered air volume.
5. The fuel cell assembly of claim 3 or claim 4 comprising an increasing tapered
section extending from the second tapered air volume to the air exhaust.
- 25 6. The fuel cell assembly of any one of claims 3 to 5 comprising a fan provided at the
air exhaust for drawing air through the air flow path.
7. The fuel cell assembly of any one of claims 1 to 6 wherein the enclosure has a
substantially cuboid external shape.
30
8. The fuel cell assembly of any preceding claim wherein the fuel cell stack is
mounted at an angle of between 5 and 45 degrees to a longitudinal axis of the enclosure.
9. The fuel cell assembly of any one of claims 1 to 7 wherein the fuel cell stack
35 comprises a staggered array of planar fuel cells between opposing end plates laterally
offset from one another.

10. The fuel cell assembly of any one of claims 1 to 7 wherein the fuel cell stack has a cross-sectional shape in the form of a parallelogram.

5 11. The fuel cell assembly of any preceding claim comprising an air recirculation duct extending between the air outlet and air inlet, the assembly comprising a retractable baffle adjacent the air outlet, the baffle being operable between a closed position and an open position in which a proportion of air passing through the second tapering air volume is redirected back towards the air inlet via the recirculation duct.

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12. The fuel cell assembly of any preceding claim wherein an air deflector assembly is provided between the air inlet and first face of the fuel cell stack.

15 13. The fuel cell assembly of claim 12 wherein the air deflector assembly comprises a plurality of vanes arranged to direct air towards one or more portions of the inlet face of the fuel cell stack.

20 14. The fuel cell assembly of claim 13 wherein the plurality of vanes are arranged as one or more rotatable air deflector assemblies configured to rotated in response to air flowing through the air inlet to increase turbulence in the tapered air inlet volume.

15. A modular fuel cell assembly comprising a plurality of fuel cell assemblies according to any one of claims 1 to 11 arranged in a regular array, the array being optionally a rectangular array.

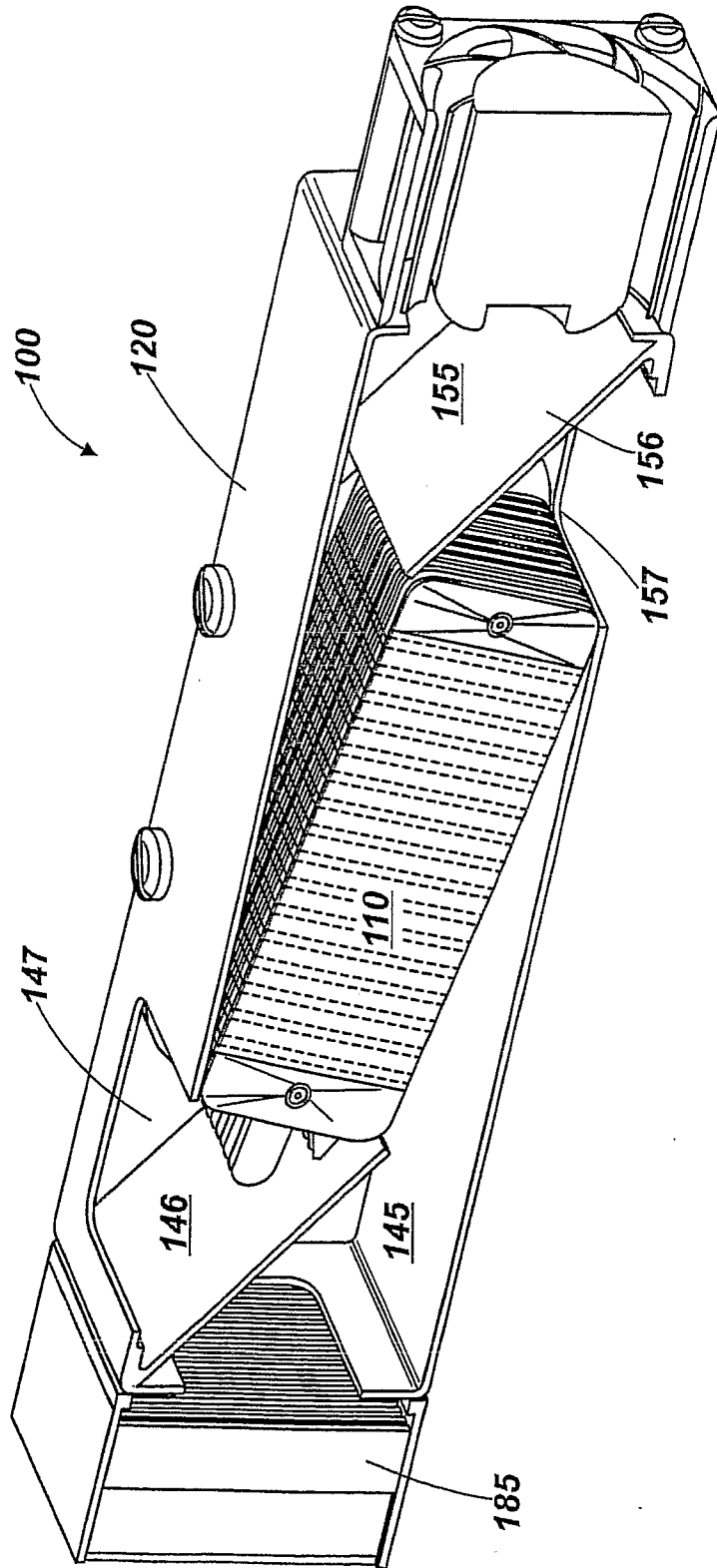


Fig. 2

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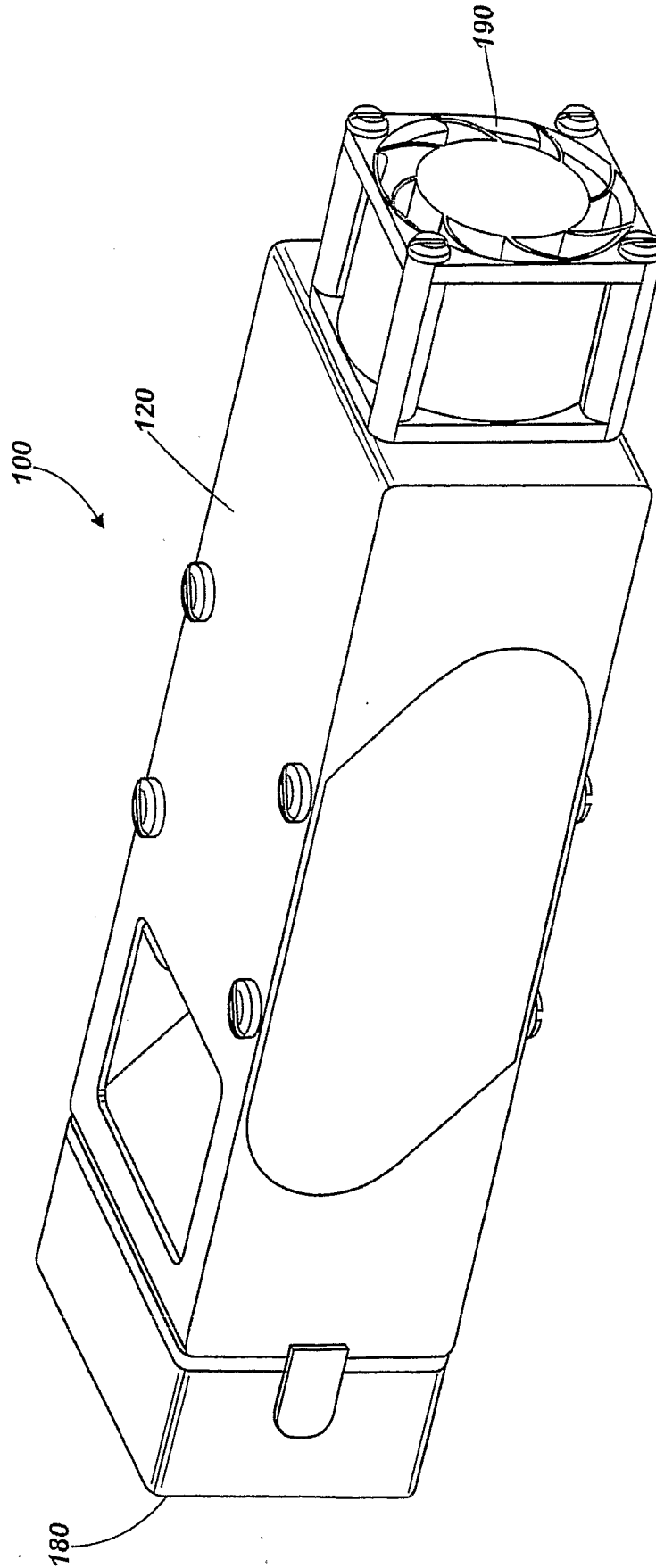


Fig. 3

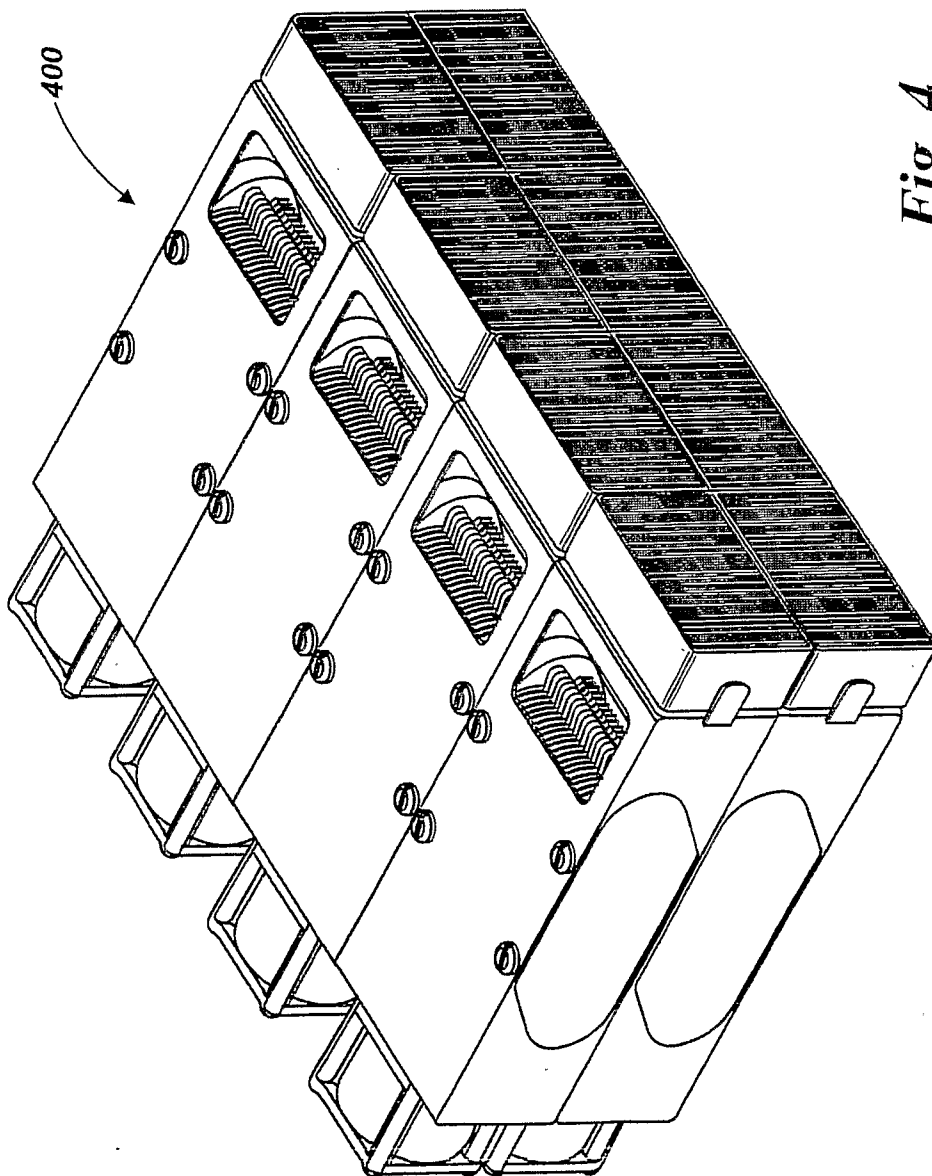


Fig. 4

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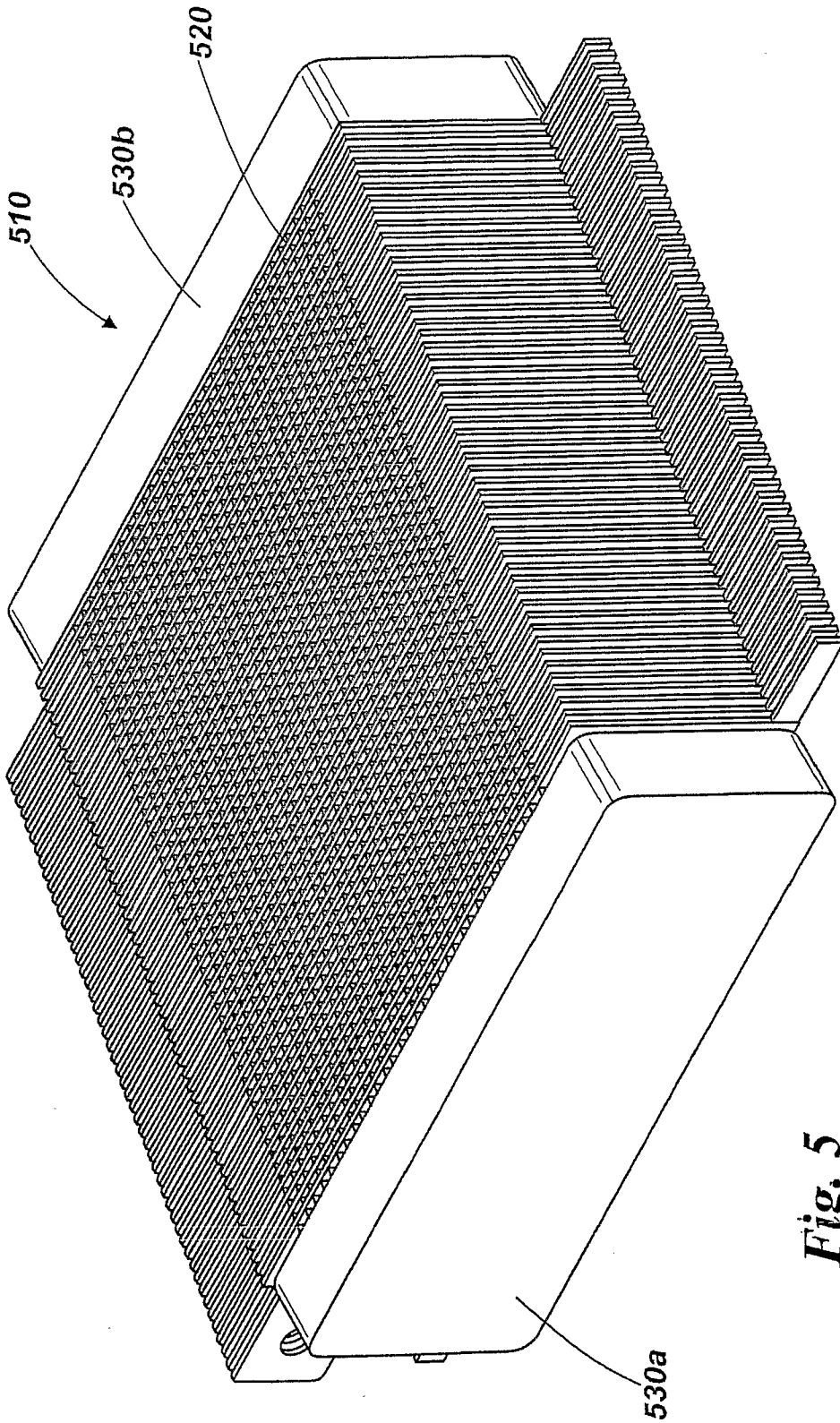


Fig. 5

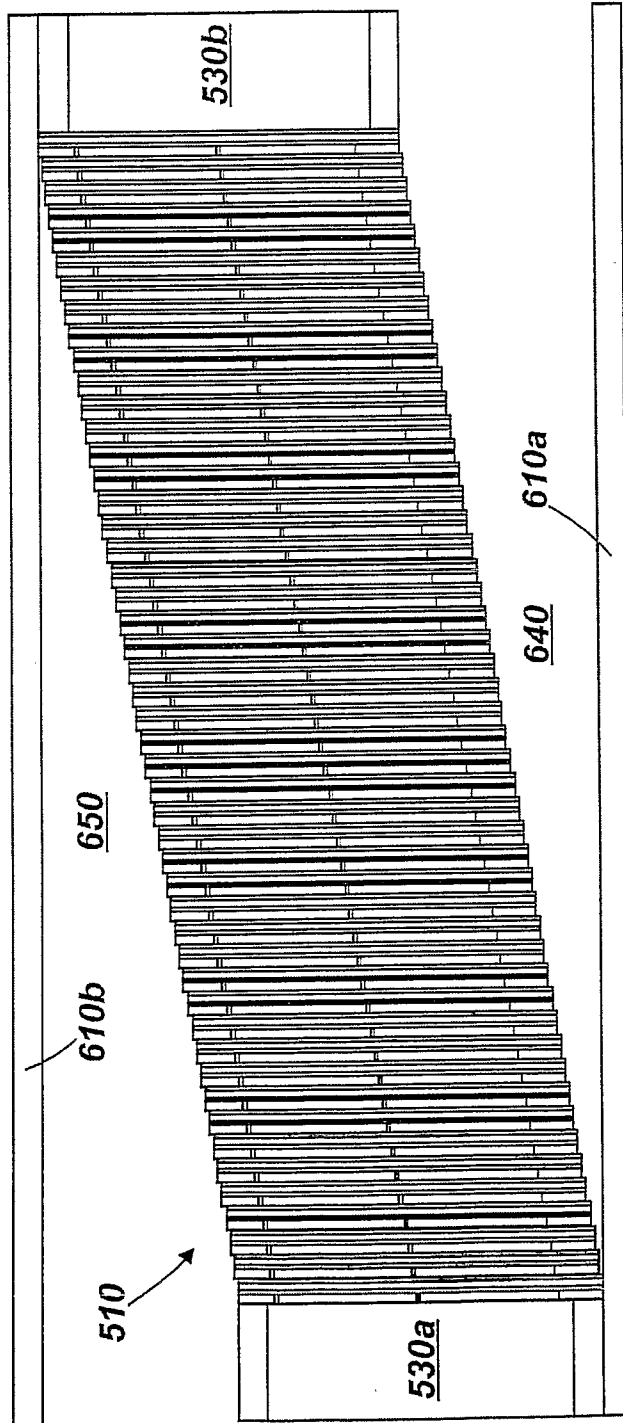


Fig. 6

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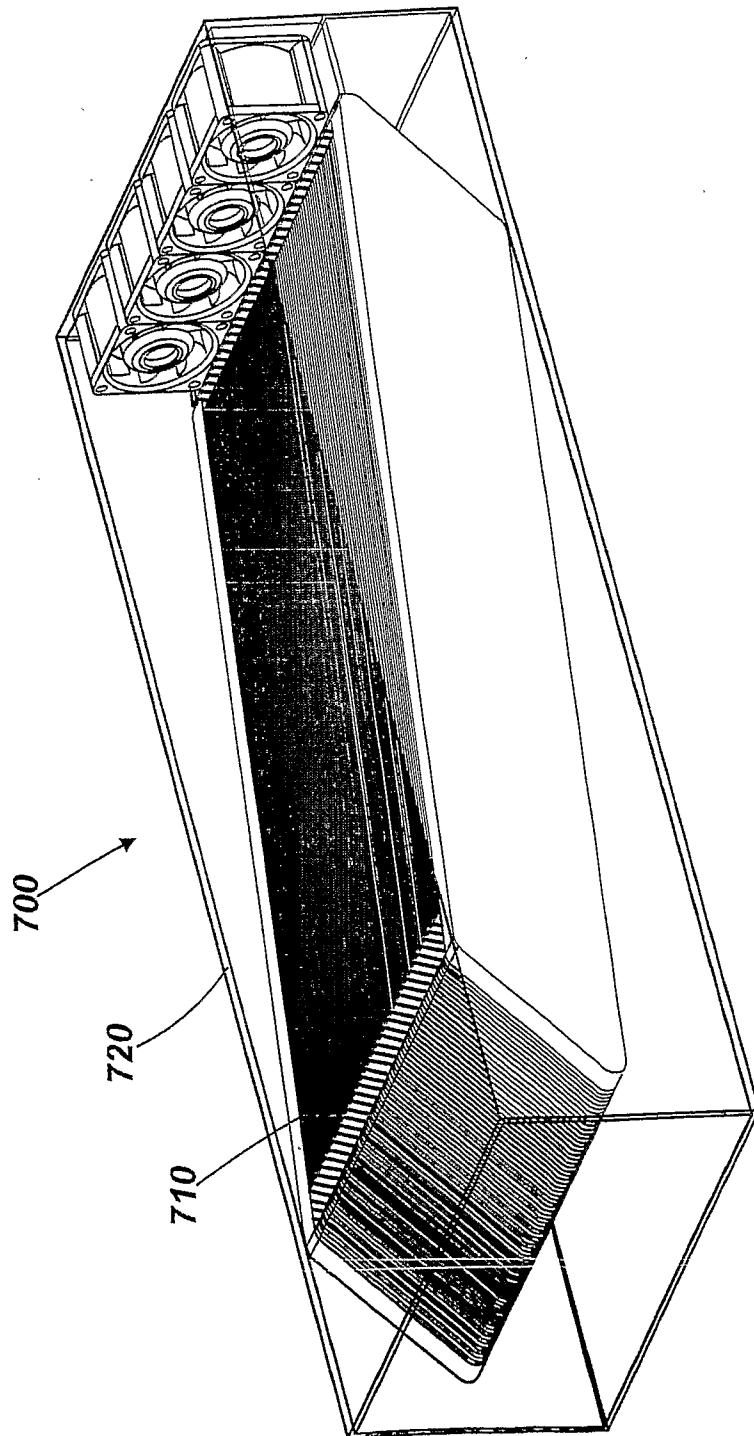


Fig. 7

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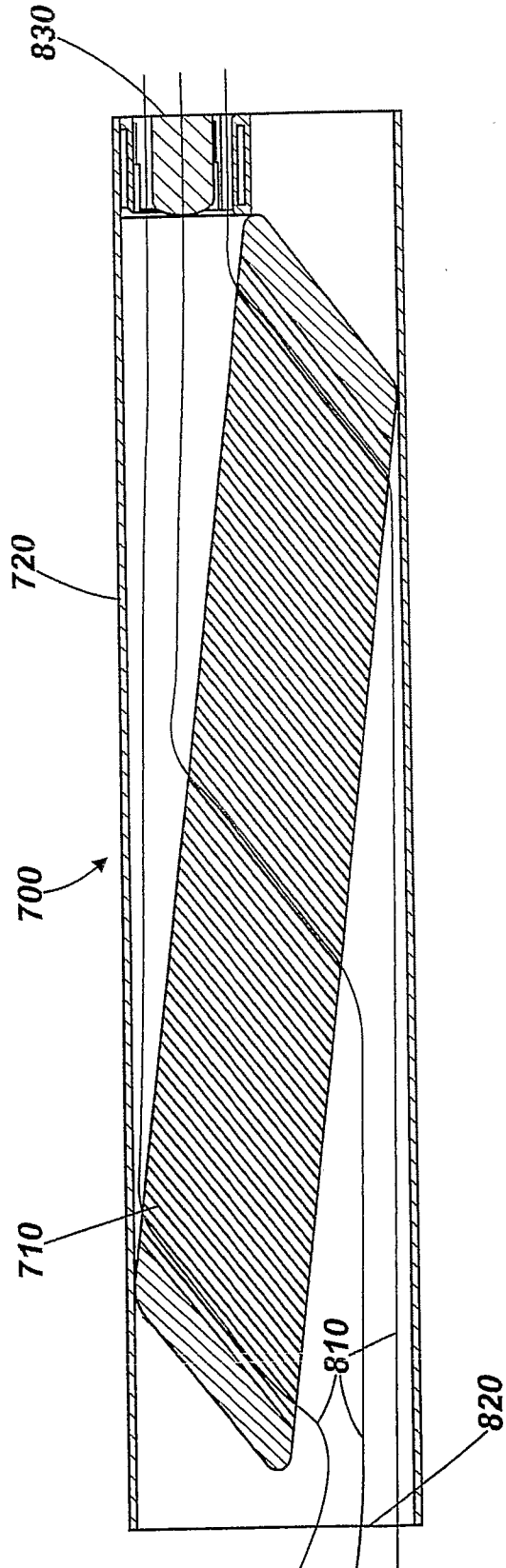


Fig. 8

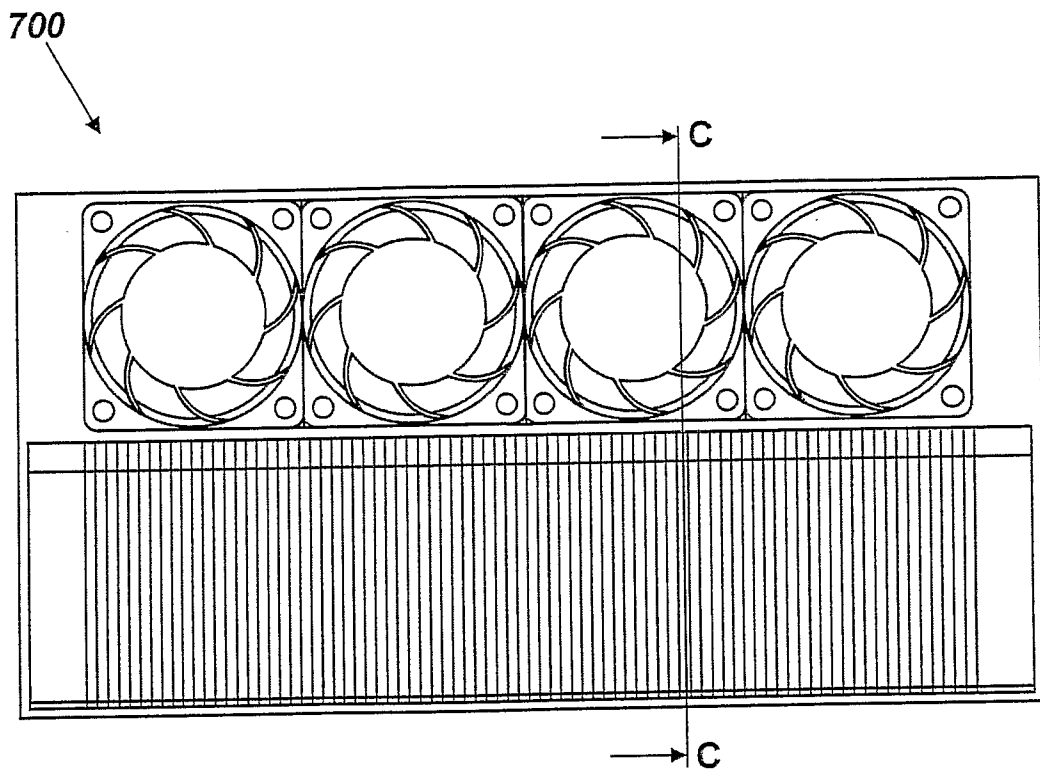


Fig. 9

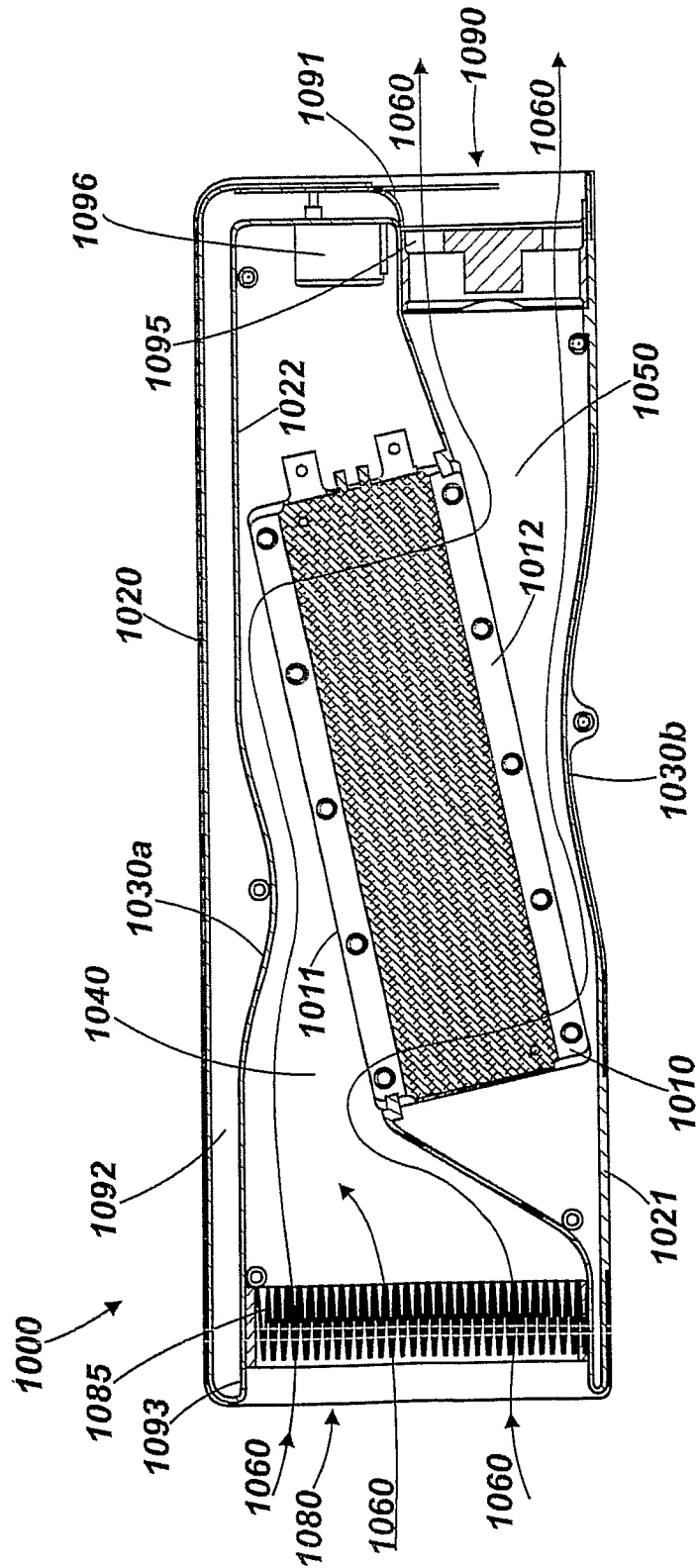


Fig. 10

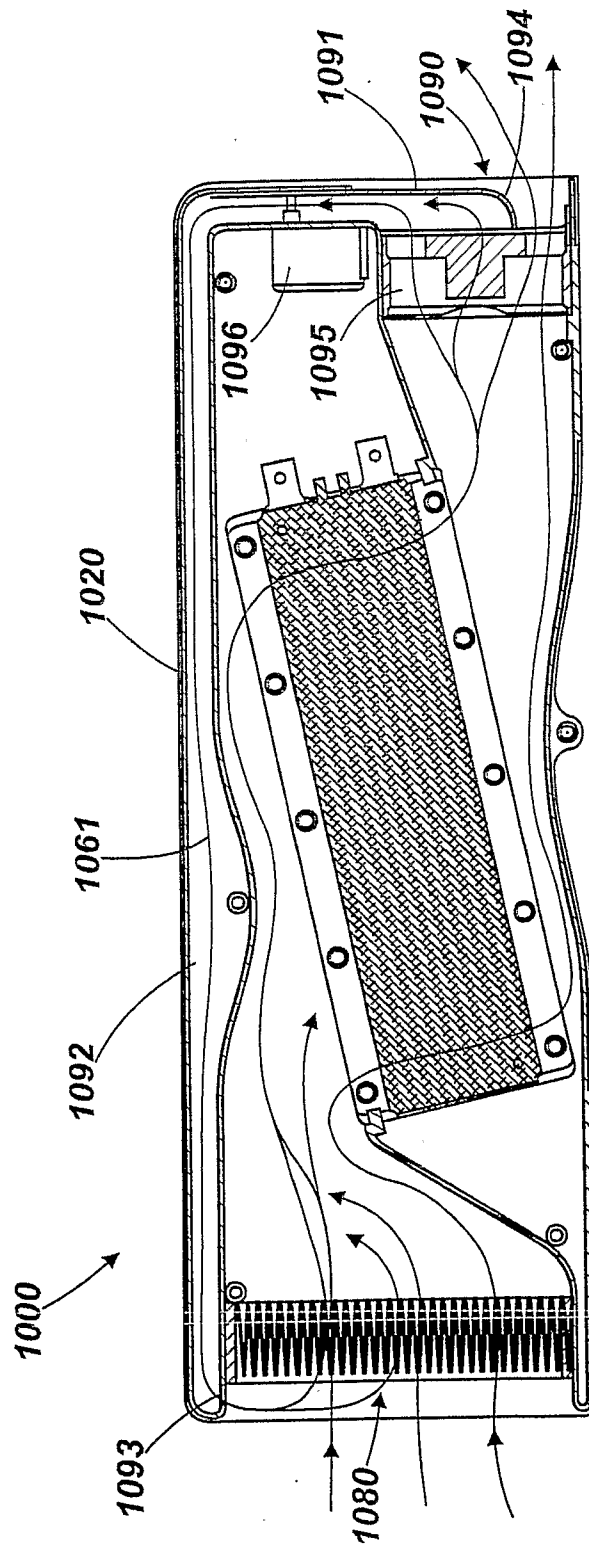


Fig. 11

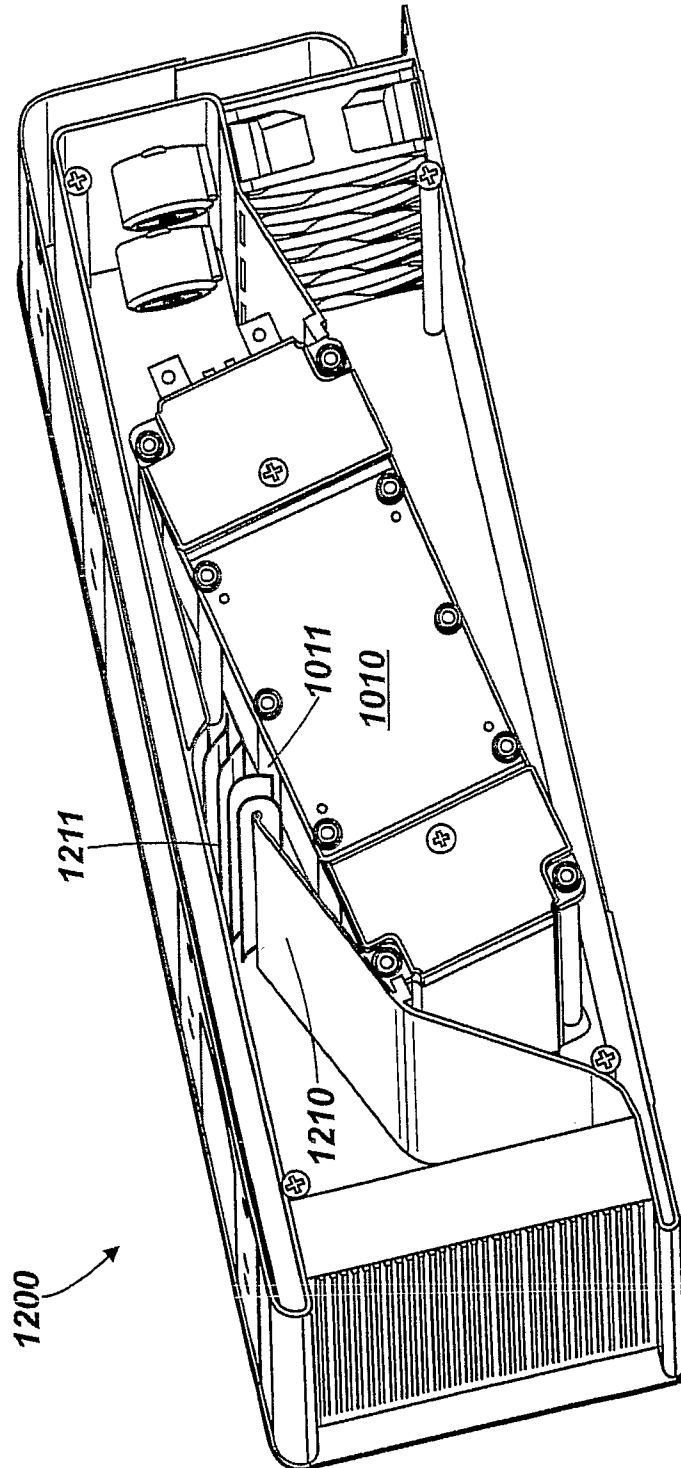


Fig. 12

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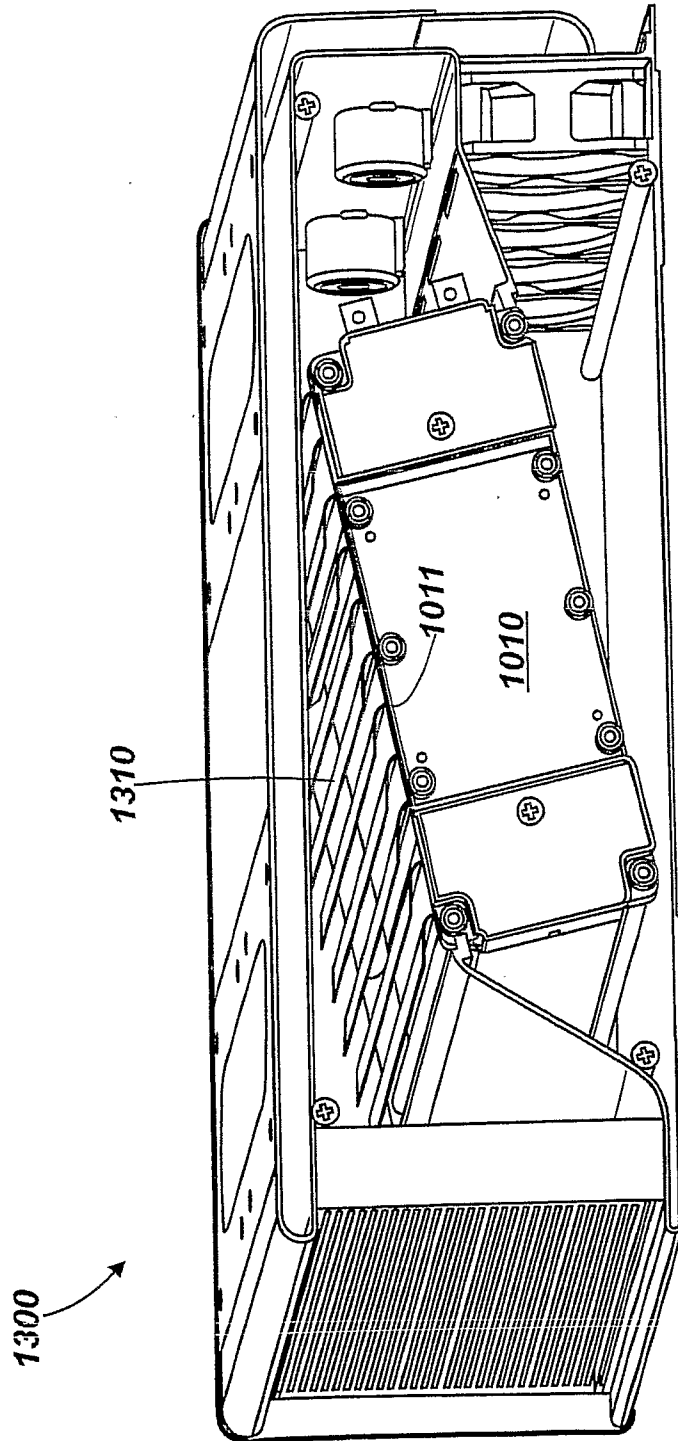


Fig. 13

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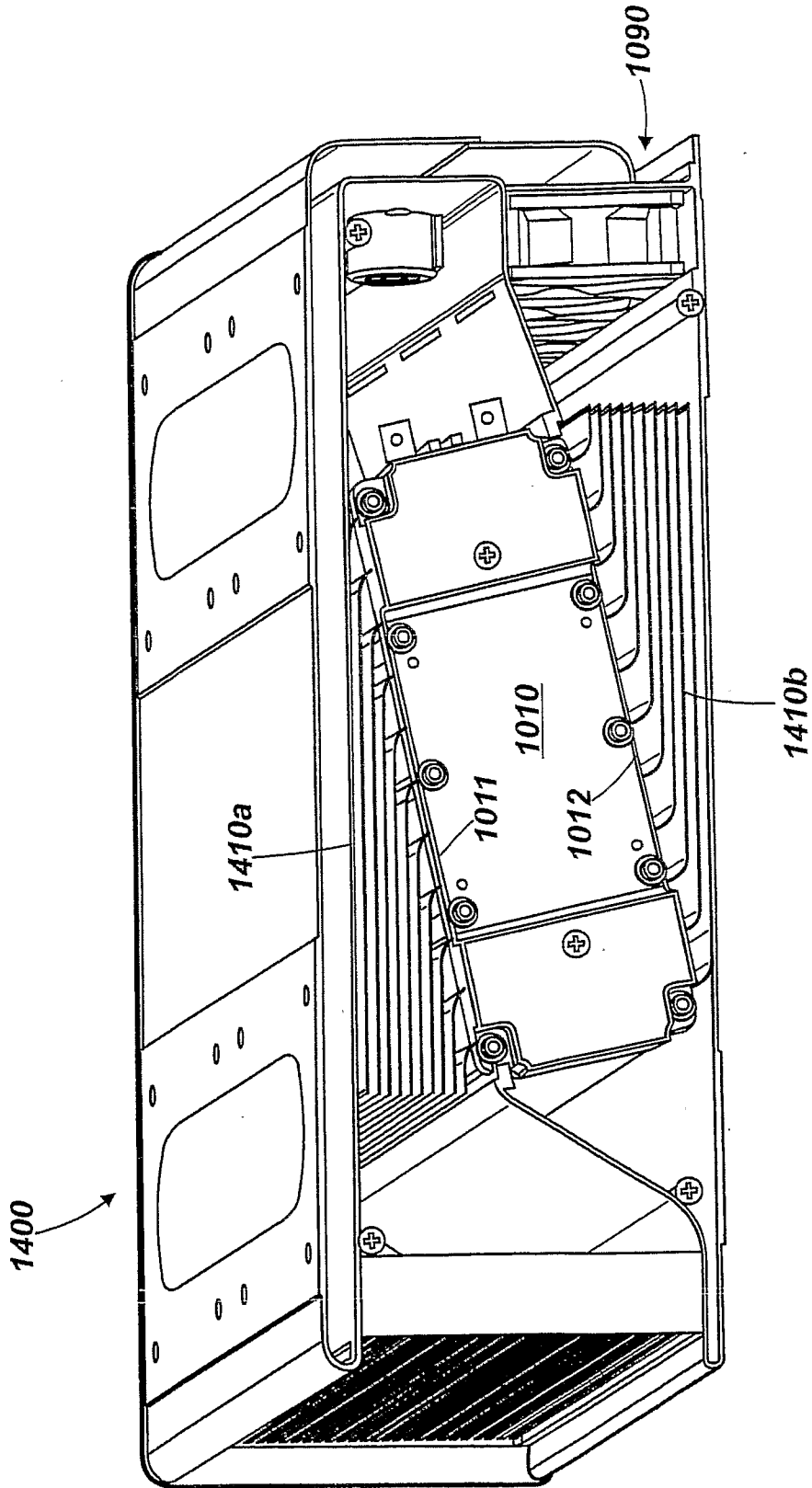


Fig. 14

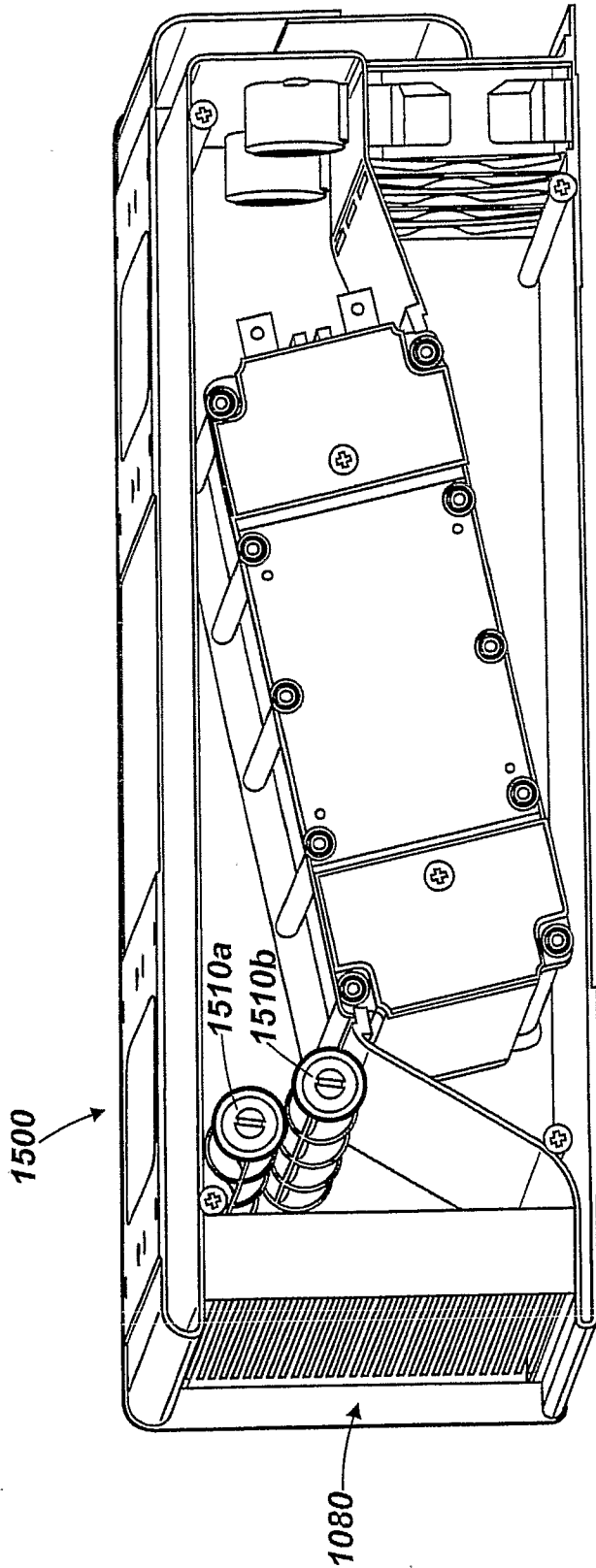


Fig. 15a

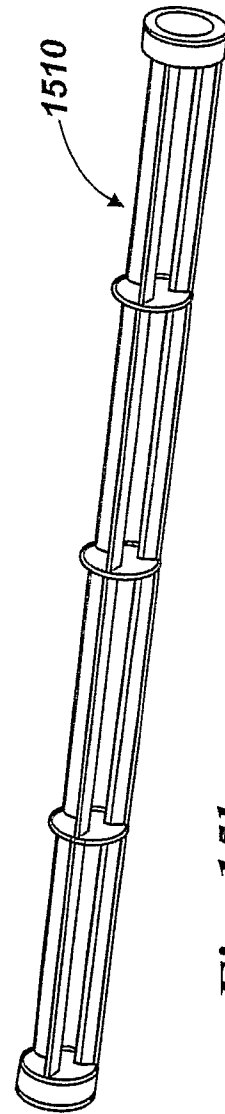


Fig. 15b

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2009/002402A. CLASSIFICATION OF SUBJECT MATTER
INV. H01M8/24

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)
H01M

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 practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 02/072252 A1 (FORSCHUNGSZENTRUM JUELICH GMBH [DE]; BEWER THOMAS [DE]; BECKMANN THOMA) 19 September 2002 (2002-09-19) claims 1-8; figures 1-2	1,4-5, 10,15
X	EP 1 515 383 A2 (P 21 POWER FOR THE 21ST CENTUR [DE]) 16 March 2005 (2005-03-16) paragraphs [0075] - [0128]; figures 1-4,6-14	1,3-7, 10, 12-13,15
E	WO 2009/127743 A1 (HELIOCENTRIS ENERGIESYSTEME GM [DE]; ARAS OEZER [DE]; LEU CHRISTIAN [D]) 22 October 2009 (2009-10-22) pages 7-10; figures 4-8	1-3,6-8, 10,15
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 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

12 March 2010

Date of mailing of the international search report

19/03/2010

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

Maître, Jérôme

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2009/002402

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/022050 A1 (TOYOTA MOTOR CO LTD [JP]; WATANABE KO [JP]) 2 March 2006 (2006-03-02) pages 13-14; figure 6 -----	1,4-5, 10,15
X	JP 2003 036878 A (EQUOS RES CO LTD) 7 February 2003 (2003-02-07) -----	1,3-6, 10, 12-13,15
Y	paragraphs [0010] - [0034]; figures 1-4 -----	2,8-9,14
Y	JP 2002 373709 A (DENSO CORP; TOYOTA MOTOR CORP; TAIHEIYO KOGYO KK) 26 December 2002 (2002-12-26) -----	2,8
A	paragraph [0022]; figures 1-6 -----	1
Y	US 6 094 927 A (ANAZAWA MAKOTO [JP] ET AL) 1 August 2000 (2000-08-01) columns 3-10; figures 5-9 -----	2,8
Y	JP 2004 335307 A (NISSAN MOTOR) 25 November 2004 (2004-11-25) figures 1-3 -----	9
Y	WO 02/053402 A1 (SIEMENS AG [DE]; EMITEC EMISSIONSTECHNIK [DE]; POPPINGER MANFRED [DE];) 11 July 2002 (2002-07-11) -----	14
A	figures 1-2 -----	12-13
X	WO 01/71842 A2 (ALLEN ENGINEERING COMPANY INC [US]) 27 September 2001 (2001-09-27) pages 11,18-20; figure 10 -----	1,11
A	GB 2 442 252 A (INTELLIGENT ENERGY LTD [GB]) 2 April 2008 (2008-04-02) pages 6-9; figures 1-2 -----	11
A	JP 01 281682 A (TOSHIBA CORP) 13 November 1989 (1989-11-13) the whole document -----	12-13
A	WO 2008/043838 A1 (FUTUREE FUEL CELL SOLUTIONS GM [DE]; KATTNER ULRICH [DE]; LIMMER SIEGF) 17 April 2008 (2008-04-17) figure 3 -----	12-13
A	WO 03/034524 A2 (METALIC POWER INC [US]) 24 April 2003 (2003-04-24) abstract; figures 1-2 -----	4-5, 12-13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2009/002402

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/GB2009 /002402

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 2-8, 10, 15(completely); 1(partially)

Fuel cell assembly with tapered air inlet and exhaust

2. claims: 9(completely); 1(partially)

Fuel cell assembly with a staggered array of planar fuel cells between opposing end plates laterally offset

3. claims: 11(completely); 1(partially)

Fuel cell assembly with an air recirculation system

4. claims: 12-14(completely); 1(partially)

Fuel cell assembly with an air deflector assembly

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2009/002402

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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