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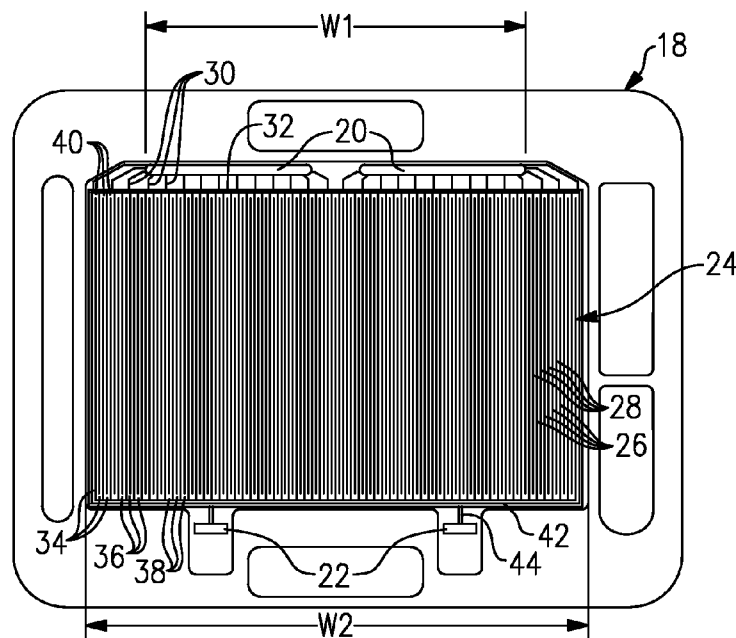
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(54) Title: FUEL CELL PLATE FLOW FIELD

FIG.2



(57) Abstract: A method of manufacturing a fuel cell flow field plate is disclosed in which a generally even flow distribution across the flow field is provided. The method includes providing an inlet manifold in fluid communication with the flow field. The flow field includes multiple channels for which some of the channels receive restricted flow from the inlet manifold as compared to other channels. A relative pressure drop between the channels is altered with a pressure drop feature to encourage fluid flow from the inlet manifold to the channels with restricted flow, which results in a generally even flow distribution across the flow field.



Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

FUEL CELL PLATE FLOW FIELD

BACKGROUND

This disclosure relates to a fuel cell plate flow field configuration.

5 A fuel cell includes an anode and a cathode arranged on either side of a membrane electrode assembly. The anode and the cathode are provided by a plate, which includes a flow field. The anode plate flow field delivers fuel to the membrane electrode assembly, and the cathode plate flow field delivers a reactant to the membrane electrode assembly.

10 The flow fields are provided by multiple channels that are provided fluid from an inlet manifold. The channels have been arranged in a variety of configurations depending upon a variety of factors, such as packaging constraints. Typically, it is desirable to provide a manifold that is wider than inlets to the channels to ensure a generally even distribution of flow across the channels. Occasionally, it is not possible
15 to supply each of the channel inlets with unobstructed flow from the inlet manifold. As a result, some of the channels receive a somewhat limited flow, which results in an uneven distribution of flow across the flow field. Uneven flow distribution can create temperature gradients across the plate and reduce the efficiency of the chemical reactions within the fuel cell. In the case of anode flow fields, insufficient hydrogen at
20 a location can create carbon corrosion of the anode plates. In the case of cathode flow fields, insufficient oxygen at a location can cause high temperatures and cell voltage dropoff.

 What is needed is a fuel cell plate having a flow field with a generally even flow distribution in configurations where it is not possible to supply an uninhibited flow to at
25 least some of the channels.

SUMMARY

A method of manufacturing a fuel cell plate flow field is disclosed in which a generally even flow distribution across the flow field is provided. The method includes providing an inlet manifold in fluid communication with the flow field. The flow field
5 includes multiple channels for which some of the channels receive restricted flow from the inlet manifold as compared to other channels. A relative pressure drop between the channels is altered with a pressure drop feature to encourage fluid flow from the inlet manifold to the channels with restricted flow, which results in a generally even flow distribution across the flow field.

10 In one example, first and second sets of channels are arranged in alternating relationship. Inlet passages from the inlet manifold are misaligned with the first channels to encourage fluid flow from across first set of channels in a balanced manner. In another example, unobstructed channels include a shallow channel portion to increase the pressure drop along those channels. Cross-cuts can be used from the
15 unobstructed channels to the obstructed channels to reduce the pressure drop along the obstructed channels.

What is needed is a fuel cell plate having a flow field with a generally even flow distribution in configurations where it is not possible to supply an uninhibited flow to at least some of the channels.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a highly schematic view of a fuel cell.

Figure 2 is a plan view of an example fuel cell plate having a flow field.

Figure 3 is an enlarged view of a portion of the plate shown in Figure 2.

25 Figure 4 is an enlarged view of another portion of the plate shown in Figure 2.

Figure 5 is a plan view of another example fuel cell plate.

Figure 6 is an enlarged perspective view of a portion of the fuel cell plate shown in Figure 5.

DETAILED DESCRIPTION

A fuel cell 10 is shown in a highly schematic fashion in Figure 1. The fuel cell 10 includes a membrane electrode assembly 16 arranged between an anode 12 and a cathode 14. The membrane electrode assembly 16 comprises a proton exchange membrane arranged between gas diffusion layers, for example. The anode 12 and the cathode 14 respectively provide fuel and reactant flow fields provided by channels in a solid or porous plate. The flow fields are fluidly connected to flow field inlets and exhausts using either internal or external manifolds that are in fluid communication with their respective fluid flow component.

A plate 18 is illustrated in Figures 2-4 having internal inlet and exhaust manifolds 20, 22. A flow field 24 is fluidly interconnected between the inlet and exhaust manifolds 20, 22. In the example, the inlet and exhaust manifolds are arranged on opposite sides of the plate 18. Parallel channels 26 arranged between risers 28 provide the flow field 24. In the example, the channels 26 extend a length L and are parallel with one another along the length without any significant bends. That is, there are no right angle turns and a given channel does not double back on itself as is typical with some flow fields. The flow field 24 has a width W2 that is greater than the width of the inlet manifold 20. This configuration presents a challenge of evenly distributing fluid across the flow field 24. Specifically, the channels outboard of the inlet manifold 20 are typically starved of fluid, resulting in an uneven chemical reaction at the proton exchange membrane and hot-cold spots on the plate 18 or carbon corrosion on the anode side.

In one example, the channels 26 are divided into first and second sets of channels 34, 36 arranged in alternating relationship with one another to provide an interdigitated flow field. The first set of channels 34 are fluidly interconnected by a lateral inlet passage 32, extending a width W2, that is supplied fluid from the inlet manifold 20 through discrete, spaced apart inlet passages 30. In the example, the inlet passages 30 are generally evenly spaced laterally from one another and misaligned with

the channels in the first set of channels 34. This misalignment encourages even fluid distribution across the first set of channels 34. Each channel of the first set of channels 34 extends from the lateral inlet passage 32 to a first terminal end 38, best shown in Figure 4.

5 Each channel of the second set of channels 36 extend from a second terminal end 40, which is arranged near the lateral inlet passage 32 (best shown in Figure 3), to a lateral exhaust passage 42 that fluidly interconnects the second set of channels 36 with one another. In the example, there is a pair of lateral exhaust passages 42 interconnected to and parallel with one another, extending the width W2, as best shown
10 in Figure 4. The first terminal ends 38 are arranged near the lateral exhaust passages 42. Discrete exhaust passages 44 fluidly connect the lateral exhaust passages 42 to the exhaust manifold 22.

In operation, fluid is supplied to the first set of channels 34 by the inlet manifold 20 via the inlet passages 30. Since the first set of channels 34 is dead-ended at the first
15 terminal ends 38, fluid will flow into the gas diffusion layer of the membrane electrode assembly 16, for example, and into the second set of channels 36. This interdigitated arrangement of channels provides a pressure drop feature between the first and second sets of channels 34, 36 that evenly distributes flow across the flow field 24. Fluid from the gas diffusion layer is provided to the proton exchange membrane for chemical
20 reaction. From the second set of channels 36, fluid is returned to the exhaust manifold 22.

Another plate 118, which has an external inlet manifold 46, is shown in Figure 5. Fluid is supplied to a header within the plate 118, which provides the lateral inlet passage 132, through inlet passages 48. Flow from the inlet passages 48 encounters
25 baffles 50 that distribute the flow within the header. The flow field 124 has a width W2 that is wider than the width of the manifold 46, W1. Flow to the first set of channels 134 is generally unobstructed. In the configuration shown in Figure 5, the flow becomes choked at the extremities within the header at a restricted flow region 52 such that flow

to the second set of channels 136 is obstructed. Risers 128 separate the first and second sets of channels 134, 136.

Obstructed flow to the second set of channels 136 would create a pressure drop across a length L of the second set of channels 136. To counter this pressure drop and provide an even flow distribution across the flow field 124, cross-cuts or cross passages 54 are arranged from some of the first set of channels 134 near the header and extending at an angle and away from the header into the second set of channels 136 beneath the restricted flow region 52. The cross passages 54 can also be arranged perpendicular to the channels. As a result, flow will be evenly distributed across the flow field 124 from the inlet manifold 46 to the exhaust manifold through passages 56.

Referring to Figure 6, another pressure drop feature is shown that can be used instead of or in addition to the cross passages 54 in the plate 118. The first set of channels 134, which would otherwise be unobstructed, include shallow channel portions 58 providing a smaller cross-sectional area that create a pressure drop across the length L of the first set of channels 134. The second set of channels 136 include a channel depth D1 that is greater than the channel depth D2 associated with the shallow channel portion 58, which is arranged near the header. The first set of channels 134 may transition from the depth D2 at the shallow channel portion 58 to the depth D1 further downstream. The length of the shallow channel portion 58 and its depth are selected to achieve a desired pressure drop that results in an even flow distribution across the flow field 124. The term “depth” is also intended to include width.

Although example embodiments have been disclosed, a worker of ordinary skill in this art would recognize that certain modifications would come within the scope of the claims. For that reason, the following claims should be studied to determine their true scope and content.

CLAIMS

1. A method of manufacturing a fuel cell plate flow field having generally even flow distribution across the flow field, the method comprising the steps of:

5 providing an inlet manifold in fluid communication with a flow field, the flow field having multiple channels including first and second channels with second channels receiving restricted fluid flow from the inlet manifold compared to first channels;

altering the relative pressure drop between the first channels and the second channels with a pressure drop feature; and

10 encouraging fluid flow from the inlet manifold to the second channels in response to the pressure drop feature to provide generally even flow distribution between the first channels and the second channels.

2. The method according to claim 1, wherein providing step includes the inlet manifold having a first width and the flow field having a second width greater than the first width, and inlets to the flow field arranged across the second width.

3. The method according to claim 2, wherein the providing step includes the first and second channels extending along a length, the first and second channels parallel with one another along the length.

4. The method according to claim 1, wherein the providing step includes a lateral inlet passage fluidly interconnecting the first channels to one another, the lateral inlet passage fluidly interconnected to the inlet manifold by inlet passages, a lateral exhaust passage fluidly interconnecting the second channels to one another, the lateral exhaust passage in fluid communication with an exhaust manifold, the pressure drop feature provided by the first and second channels being dead-ended by respectively extending from the inlet and exhaust lateral passages to first and second terminal ends, the first

and second terminal ends respectively near the exhaust and inlet lateral passages, the first and second channels arranged in alternating relationship with one another.

5 5. The method according to claim 1, wherein the providing step includes a restricted flow area at inlets to the second channels, and the pressure drop feature includes a cross passage from the first channel near first channel inlets to the second channel beneath the restricted flow area.

10 6. The method according to claim 5, wherein the cross passage extends at an angle relative to a length of the first channels and away from the restricted flow area to the second channels.

15 7. The method according to claim 1, wherein the pressure drop feature includes shallow channel portions in the first channels providing a second channel depth that is less than a first channel depth of the second channels.

8. A fuel cell comprising:
a structure including a flow field having multiple channels each with an inlet end, and a header in fluid communication with the inlet ends, the header including a restricted flow region in which fluid flow is restricted to the inlet ends of a set of channels, and at least some of the channels having a pressure drop feature configured to increase fluid flow to the set of channels.

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25 9. The fuel cell according to claim 8, wherein the pressure drop feature includes a cross passage from first channels near first channel inlets to second channels beneath the restricted flow area.

10. The fuel cell according to claim 9, wherein the cross passage extends at an angle relative to a length of the first channels and away from the restricted flow area to the second channels.

5 11. The fuel cell according to claim 9, comprising an inlet manifold having a first width and the flow field having a second width greater than the first width, and inlets to the flow field arranged across the second width.

10 12. The fuel cell according to claim 11, wherein the restricted flow region is arranged on either side of the flow field at the inlet ends, the channels extending along a length from the inlet header toward an exhaust header, the channels parallel with one another along the length.

15 13. The fuel cell according to claim 8, wherein the pressure drop feature includes shallow channel portions in first channels providing a second channel depth that is less than a first channel depth of the second channels, the second channels arranged beneath the restricted flow area.

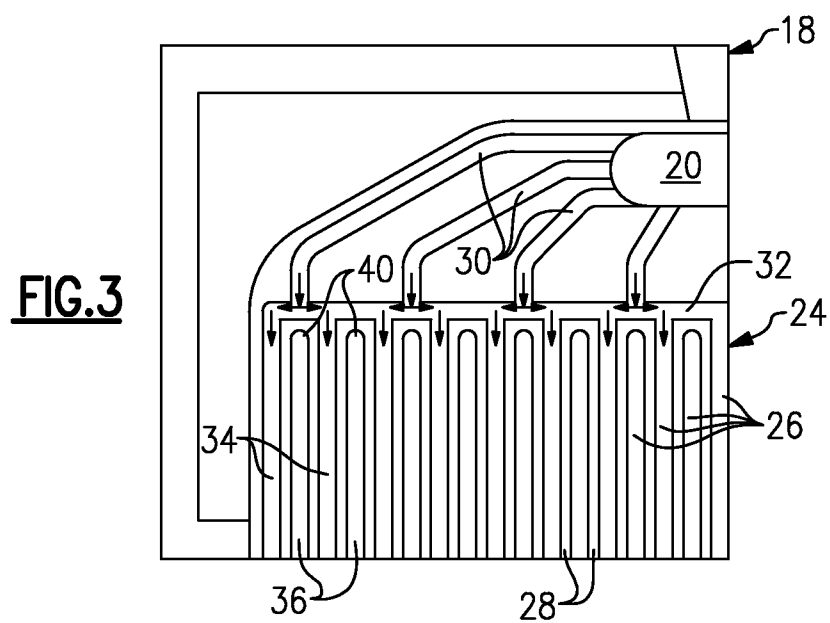
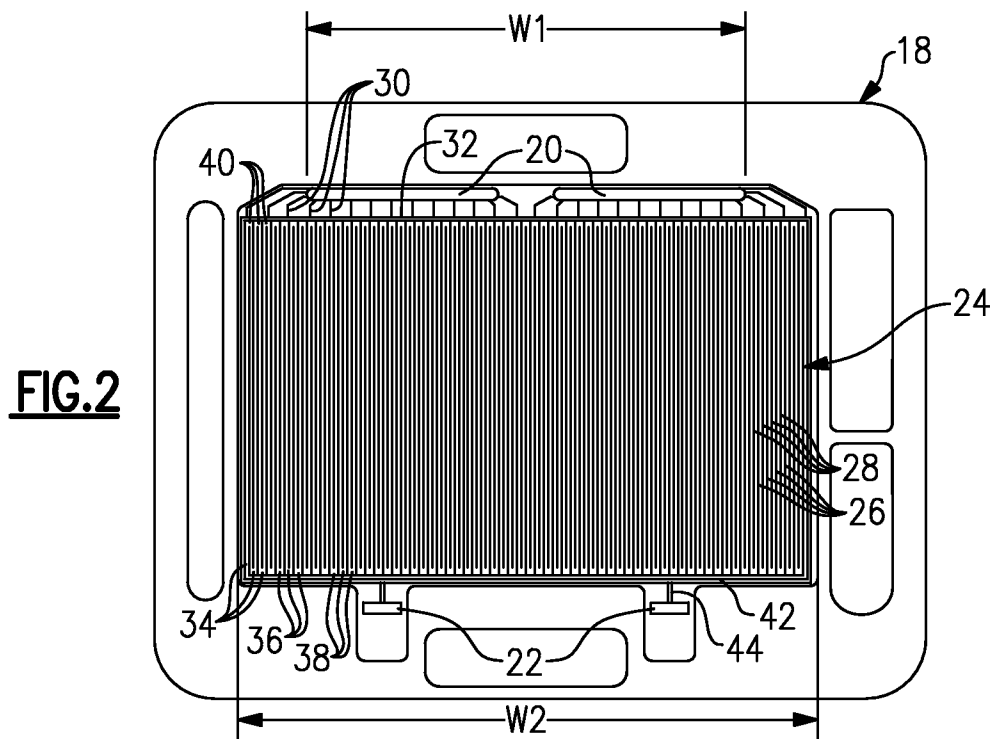
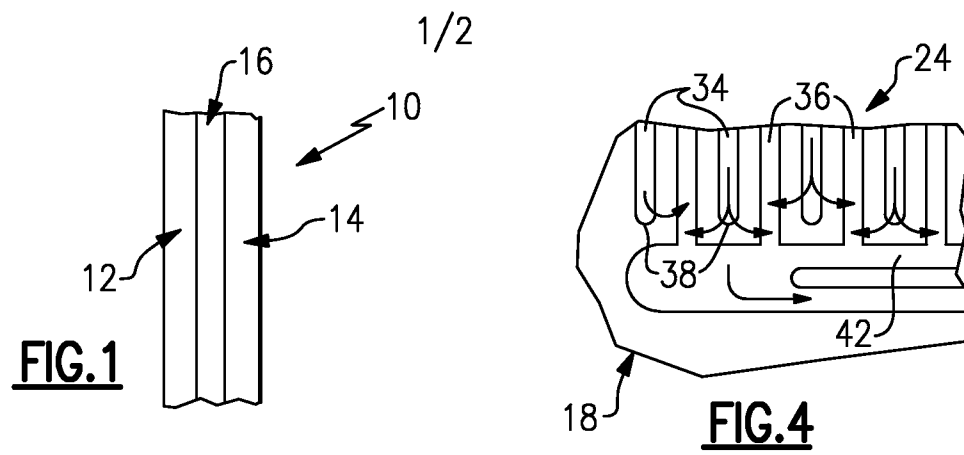
14. A fuel cell comprising:
20 a structure including a flow field having first and second sets of channels, each channel of the first set of channels extending from an inlet end to a first terminal end, the inlet ends fluidly interconnected with one another by a lateral inlet passage that is configured to receive fluid from an inlet manifold, each channel of the second set of channels extending from an exhaust end to a second terminal end, the exhaust ends
25 fluidly interconnected with one another by an lateral exhaust passage that is configured to provide fluid to an exhaust manifold, the first and second channels in alternating relationship with one another with the first and second terminal ends arranged near the lateral exhaust and inlet passages, respectively.

15. The fuel cell according to claim 14, wherein the structure includes the inlet manifold, the inlet manifold having a first width and the lateral inlet passage having a second width that is greater than the first width.

5

16. The fuel cell according to claim 14, wherein the first and second sets of channels extend from their respective lateral passages to their respective terminal end along a length, the first and second sets of channels parallel with one another along the length.

10 17. The fuel cell according to claim 14, wherein laterally spaced inlet passages fluidly interconnect the inlet manifold and the lateral inlet passage, the inlet passages misaligned with the channels of the first set of channels.



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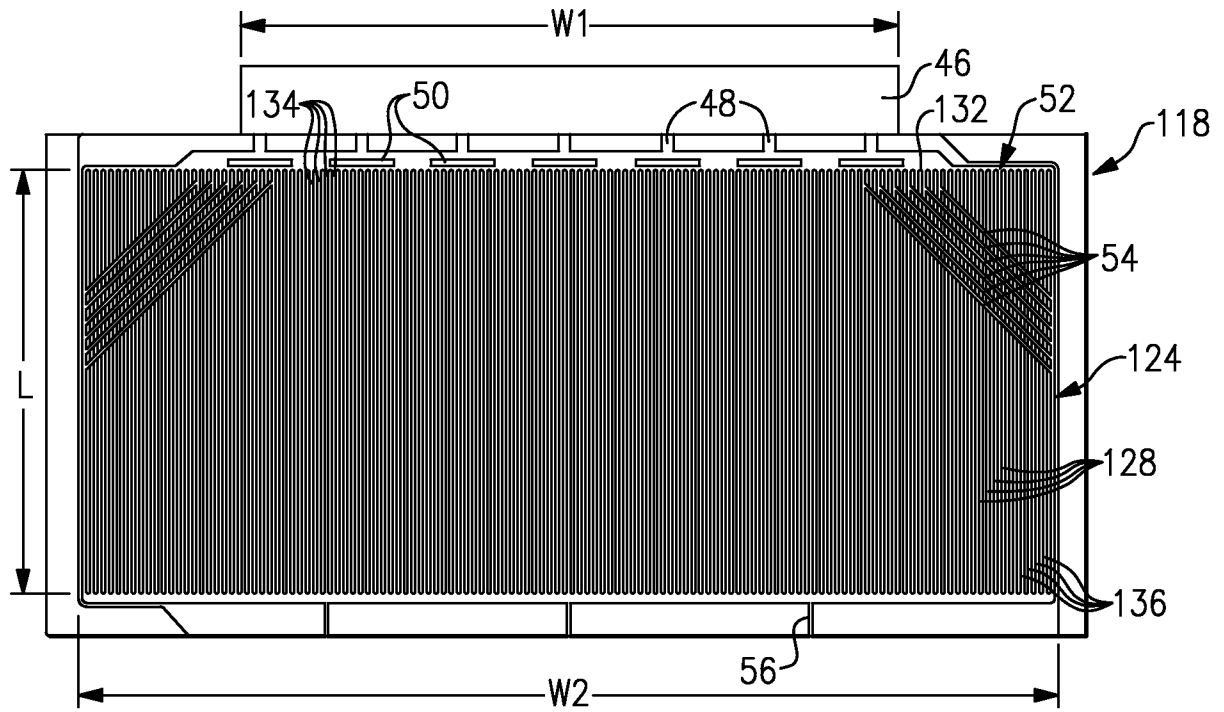


FIG. 5

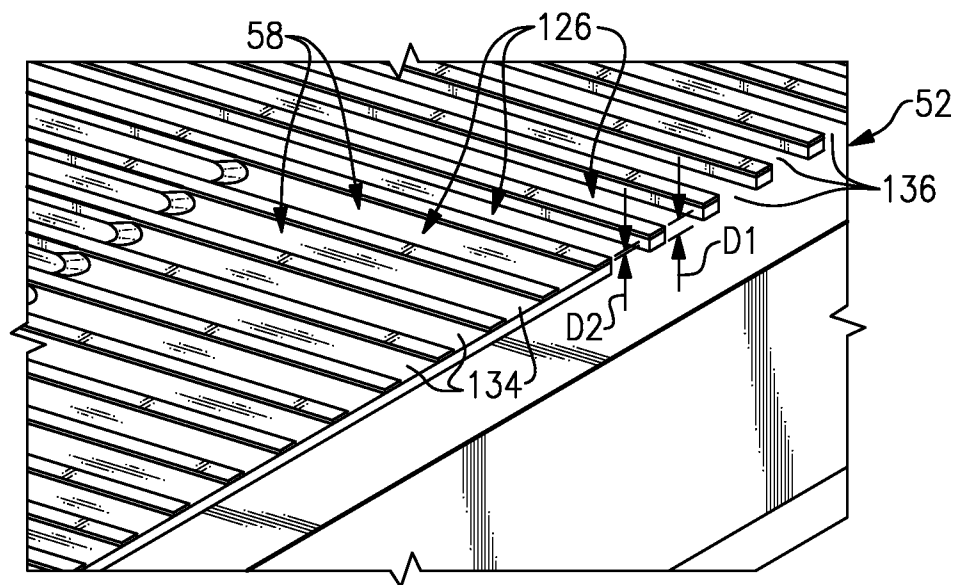


FIG. 6

A. CLASSIFICATION OF SUBJECT MATTER***H01M 8/02(2006.01)i, H01M 8/04(2006.01)i***

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)

IPC H01M 8/02

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)

eKOMPASS(KIPO internal), DELPHION, "fuel cell ,manifold, multi channel pressure drop and similar terms"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002-0081477 A1(MCLEAN et al.) 27.JUN.2002 See the abstract, fig. 4 ~ 14, Paragraph <0008> ~ <0058> whole claims	1-17
A	EP 1264360 B1(THE MORGAN CRUCIBLE COMPANY PLC)07.06.2006 See the abstract, fig. 1,2,5, Paragraph <0038> ~ <0048>, whole claims	1-17
A	US 2005-00118489 A1(FREDKIKSEN et al.) 02.JUN.2005 See the whole document	1-17



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"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

17 AUGUST 2009 (17.08.2009)

Date of mailing of the international search report

17 AUGUST 2009 (17.08.2009)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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