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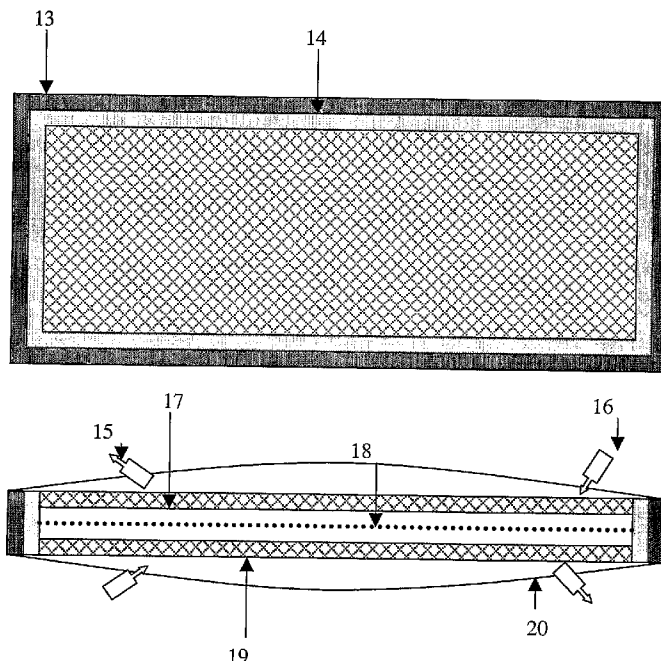
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(54) Title: MEMBRANE ELECTRODE ASSEMBLIES



(57) Abstract: Flexible MEA comprising an integral assembly of electrode, catalyst and ionomeric membrane material.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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A. CLASSIFICATION OF SUBJECT MATTER
INV. H01M8/10 C25B9/00 H01M10/40 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 C25B C08J

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 2004/021486 A (UNIV NEWCASTLE VENTURES LTD [GB]; SCOTT KEITH [GB]; CHENG HUA [GB]) 11 March 2004 (2004-03-11) page 4, line 18 - line 25 page 5, line 12 - page 6, line 2 page 11, line 20 - page 12, line 24 page 15, line 3 - page 16, line 24 page 21, line 22 - page 22, line 17 page 31, line 10 - line 24 page 34, line 7 - page 35, line 12 | 1,2,4, 7-9,11, 12 |
| Y | ----- -/-- | 3,13 |

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
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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.
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INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-------------------------|
| A | WO 03/023890 A (ITM POWER LTD [GB]; HIGHGATE DONALD JAMES [GB]) 20 March 2003 (2003-03-20) cited in the application | 1-4,6-9, 11,12 |
| Y | page 2, line 12 - line 33 page 2, line 9 - line 21 page 3, line 6 - line 14 page 5, line 3 - page 6, line 8 page 8, line 33 - page 9, line 6 page 13, line 13 - line 34 page 20, line 26 - line 35 claims 17-23 | 13 |
| A | ----- US 2005/014056 A1 (ZUBER RALF [DE] ET AL) 20 January 2005 (2005-01-20) | 1,2,4, 6-9, 11-13 |
| Y | paragraphs [0012], [0037], [0038], [0042], [0044], [0045] claims 6-12 | 3 |
| A | ----- GB 1 463 301 A (HIGHGATE D J) 2 February 1977 (1977-02-02) cited in the application page 1, line 9 - line 18 page 1, line 40 - line 45 page 3, line 60 - line 111 | 1-4,6-9, 11-13 |
| A | ----- US 2003/148159 A1 (COX PHILIP [US] ET AL) 7 August 2003 (2003-08-07) paragraphs [0001], [0046], [0049], [0052] - [0055] | 1-4,6-9, 11-13 |
| X | ----- US 2005/048346 A1 (FANNON MEGAN A [US] ET AL) 3 March 2005 (2005-03-03) figures 1b,4 paragraphs [0001], [0003], [0013] - [0015], [0-17], [0019], [0022], [0023], [0041], [0053], [0054], [0059], [0065] | 10 |
| X | ----- US 2004/142227 A1 (SUGAI KOICHIRO [JP] ET AL) 22 July 2004 (2004-07-22) figures 1,5,7,16 paragraphs [0062], [0065], [0231], [0250], [0256], [0366], [0392] | 10 |
| P,X | ----- US 2005/196666 A1 (GOTTESFELD SHIMSHON [US] ET AL) 8 September 2005 (2005-09-08) figures 2-4 paragraphs [0012], [0013], [0008], [0010], [0037], [0038], [0047] - [0049], [0052], [0054] claim 1 | 10 |
| | ----- -/-- | |

INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|---|-----------------------|
| A | <p>MCELROY J F ET AL: "SPE hydrogen/oxygen fuel cells for rigorous naval applications" PROCEEDINGS OF THE INTERNATIONAL POWER SOURCES SYMPOSIUM, CHERRY HILL, JUNE 25 - 28, 1990, NEW YORK, IEEE, US, vol. SYMP. 34, 25 June 1990 (1990-06-25), pages 403-407, XP010038422 ISBN: 0-87942-604-7 abstract</p> | 10 |
| A | <p>EP 1 001 666 A2 (BALLARD POWER SYSTEMS [CA]) 17 May 2000 (2000-05-17) figure 5 paragraphs [0030], [0032], [0033], [0035]</p> | 10 |
| P,X | <p>US 2006/127734 A1 (MCLEAN GERARD F [CA] ET AL) 15 June 2006 (2006-06-15) figures 1b,1c,15 paragraphs [0012], [0039] - [0041], [0045] - [0051], [0057]</p> | 10 |

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2006/002369

Box 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.: **5, 14, 15**
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:
see FURTHER INFORMATION sheet PCT/ISA/210

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 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 fee, this Authority did not invite payment of any additional fee.

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.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-9,11-15

A membrane electrode assembly made up of a flexible woven metal electrode mesh on one side of an elastic ionomeric membrane and a flexible woven metal electrode on the other side of the elastic ionomeric membrane with catalyst on or within both flexible woven metal electrode meshes (see examples 1 and Figures 1 and 3) and the method of producing such a membrane electrode assembly.

2. claim: 10

A stack of membrane electrode assemblies with one or more rigid membrane electrode assemblies fitted into rigid Perspex cell housing (26), and then fitted into a flexible foam frame (see example 2 and Figure 4).

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 5,14,15

Present claim 5 relates to an assembly with an insulating portion which has a given desired property or effect, namely absorb water and expand, whereby the insulating portion is prestressed such that it expands to the same degree as the ionomer. However, the description does not provide support and disclosure in the sense of Article 6 and 5 PCT for any such assembly having the said property or effect and there is no common general knowledge of this kind available to the person skilled in the art. This non-compliance with the substantive provisions is to such an extent, that the search was performed taking into consideration the non-compliance in determining the extent of the search of the claim (PCT Guidelines 9.19 and 9.20).

Present claim 14 relates to a method which has a given desired effect, namely that "the polymerising also forms said electrode. However, the description does not provide support and disclosure in the sense of Article 6 and 5 PCT for any such a method having the said property or effect and there is no common general knowledge of this kind available to the person skilled in the art. This non-compliance with the substantive provisions is to such an extent, that the search was performed taking into consideration the non-compliance in determining the extent of the search of the claim (PCT Guidelines 9.19 and 9.20).

Present claim 15 relates to an assembly comprising an interpenetrated network and a method which has a given desired effect, namely that "the polymerising also forms said network". However, the description does not provide support and disclosure in the sense of Article 6 and 5 PCT for any such a method having the said effect and there is no common general knowledge of this kind available to the person skilled in the art. This non-compliance with the substantive provisions is to such an extent, that the search was performed taking into consideration the non-compliance in determining the extent of the search of the claim (PCT Guidelines 9.19 and 9.20).

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.5), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

| |
|---|
| International application No PCT/GB2006/002369 |
|---|

| Patent document cited in search report | A | Publication date | Patent family member(s) | Publication date |
|--|------------|------------------|-------------------------|------------------|
| WO 2004021486 | A | 11-03-2004 | AU 2003259369 A1 | 19-03-2004 |
| | | | CA 2497105 A1 | 11-03-2004 |
| | | | EP 1537617 A2 | 08-06-2005 |
| | | | JP 2005537618 T | 08-12-2005 |
| | | | KR 20050083660 A | 26-08-2005 |
| | | | US 2006099482 A1 | 11-05-2006 |
| WO 03023890 | A | 20-03-2003 | AT 313858 T | 15-01-2006 |
| | | | CA 2459340 A1 | 20-03-2003 |
| | | | CN 1565066 A | 12-01-2005 |
| | | | DE 60208215 T2 | 20-07-2006 |
| | | | DK 1428284 T3 | 08-05-2006 |
| | | | EP 1428284 A2 | 16-06-2004 |
| | | | ES 2256513 T3 | 16-07-2006 |
| | | | GB 2380055 A | 26-03-2003 |
| | | | HK 1067790 A1 | 11-08-2006 |
| | | | JP 2005502990 T | 27-01-2005 |
| | | | MX PA04002161 A | 29-06-2004 |
| | | | NZ 531551 A | 30-03-2007 |
| | | | US 2003113603 A1 | 19-06-2003 |
| | | | US 2005014056 | A1 |
| CN 1853301 A | 25-10-2006 | | | |
| GB 1463301 | A | 02-02-1977 | US 3961379 A | 08-06-1976 |
| US 2003148159 | A1 | 07-08-2003 | NONE | |
| US 2005048346 | A1 | 03-03-2005 | US 2007087253 A1 | 19-04-2007 |
| | | | US 2005048349 A1 | 03-03-2005 |
| US 2004142227 | A1 | 22-07-2004 | DE 10355191 A1 | 03-03-2005 |
| US 2005196666 | A1 | 08-09-2005 | NONE | |
| EP 1001666 | A2 | 17-05-2000 | AT 333207 T | 15-08-2006 |
| US 2006127734 | A1 | 15-06-2006 | NONE | |