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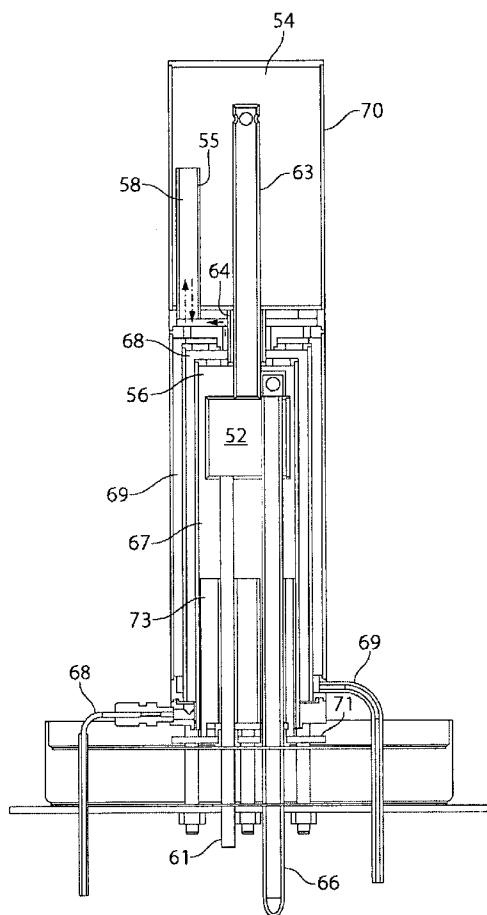
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[Continued on next page]

(54) **Title:** ARCHITECTURES FOR ELECTROCHEMICAL SYSTEMS



(57) **Abstract:** The present invention generally relates to electrochemical systems for producing hydrogen and/or power. Various aspects of the invention are directed to reactor designs for producing hydrogen and/or power from a fuel and water, conducting ceramics and other materials for such systems, including mixed ionically and electrically conducting ceramics which can be used for hydrogen gas generation, control systems for such systems, and methods of operating such systems.

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European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,  
FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL,  
NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG,  
CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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# INTERNATIONAL SEARCH REPORT

International application No

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**A. CLASSIFICATION OF SUBJECT MATTER**

INV. H01M8/04 H01M8/06 C01B3/04 C01B3/34

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)

C01B 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.                                   |
|-----------|--|---|
| Y         | <p>WO 2006/041854 A (CTP HYDROGEN CORP [US]; RACKEY SCOTT C [US]; WANG GONGHOU [US]; BOERSM) 20 April 2006 (2006-04-20)</p> <p>figures 4,5<br/>                     page 8, line 31 - page 17, line 21<br/>                     page 18, line 29 - line 32<br/>                     page 20, line 31 - page 21, line 9<br/>                     page 21, line 18 - page 22, line 3<br/>                     page 22, line 17 - line 20<br/>                     page 23, line 5 - line 8</p> <p style="text-align: center;">-----<br/>-/--</p> | <p>1-14,<br/>16-18,<br/>23-26,<br/>28-70,<br/>73-77</p> |

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

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- \*E\* earlier document but published on or after the international filing date
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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

15 July 2008

Date of mailing of the international search report

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Name and mailing address of the ISA/

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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.   |
| Y  | <p>JP 01 242401 A (MITSUBISHI HEAVY IND LTD;<br/>IWAHARA HIRONARI; EZAKA YUKIO)<br/>27 September 1989 (1989-09-27)</p> <p>abstract; figure 3</p>   | <p>1,3-10,<br/>13,<br/>23-25,<br/>28-62,<br/>67-70,<br/>73-77</p> |
| Y  | <p>WO 03/093536 A (HYDROGEN ADVANCE LTD [GB];<br/>KENDALL KEVIN [GB]; SAUNDERS GARY JOHN<br/>[GB]) 13 November 2003 (2003-11-13)</p> <p>page 9, line 16 - page 13, line 27; figure<br/>1</p> | <p>1,3-10,<br/>13,<br/>23-25,<br/>28-62,<br/>67-70,<br/>73-77</p> |
| Y  | <p>US 2006/048808 A1 (RUCKMAN JACK H [US] ET<br/>AL) 9 March 2006 (2006-03-09)<br/>abstract; figure 9<br/>paragraph [0124]</p>   | <p>11,12,26</p>   |
| Y  | <p>EP 1 357 084 A (NISSAN MOTOR [JP])<br/>29 October 2003 (2003-10-29)<br/>figure 1</p>  | <p>14,16-18</p>   |
| Y  | <p>WO 00/22690 A (NORTHWEST POWER SYS LLC<br/>[US]; EDLUND DAVID J [US]; PLEDGER WILLIAM<br/>A []) 20 April 2000 (2000-04-20)<br/>abstract<br/>page 39, line 19 - page 40, line 18</p>       | <p>2,63-66</p>  |
| A  | <p>EP 0 962 423 A (PRAXAIR TECHNOLOGY INC<br/>[US]) 8 December 1999 (1999-12-08)</p> <p>the whole document</p>   | <p>1,11-14,<br/>16,18,<br/>23,25,<br/>26,28,29</p>                |

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US2008/001543

## 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 allsearchable 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.:

see additional sheet

### 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.

## 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 - 14, 16' - 18, 23 - 26, and 28 - 79

A hydrogen production apparatus and method comprising the features "source of fuel", "source of water", "oxidation chamber", "reaction chamber", "water conversion chamber", "fluid connection between these chambers" and wherein the water conversion chamber "is located within but fluidically separate from the reaction chamber".

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2. claims: 15, 16, 19, 20, 22, 23, and 27

A hydrogen production apparatus and method comprising the features "source of fuel", "source of water", "oxidation chamber", "reaction chamber", "water conversion chamber", "fluid connection between these chambers" and wherein a "clean-up chamber" is provided which is "in fluid communication with the reaction chamber".

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3. claim: 21

A method of reacting a fuel and water across a mixed ionically and electrically conducting material to generate hydrogen, the water being isolated from the fuel except for ionic and electronic conduction across the material, wherein the Nernst potential created across the material is at least about 0.005 V; and reacting at least a portion of the hydrogen to produce electricity.

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

|   |
|---|
| International application No<br>PCT/US2008/001543 |
|---|

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