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- (71) Applicant (for all designated States except US): **EVEREADY BATTERY COMPANY, INC.** [US/US]; 533 Maryville University Drive, St. Louis, MO 63141 (US).
- (72) Inventor; and
(75) Inventor/Applicant (for US only): **MARPLE, Jack** [US/US]; 2154 Clifton Way, Avon, OH 44011 (US).
- (74) Agent: **BARAONA, Robert, C.**; Eveready Battery Company, Inc., 25225 Detroit Road, Westlake, OH 44145 (US).
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[Continued on next page]

(54) Title: LITHIUM-IRON DISULFIDE CELL DESIGN

(57) Abstract: The invention relates to electrochemical cells having a jellyroll electrode assembly that includes a lithium-based negative electrode, a positive electrode with a coating comprising greater than about 94 wt.% of iron disulfide.

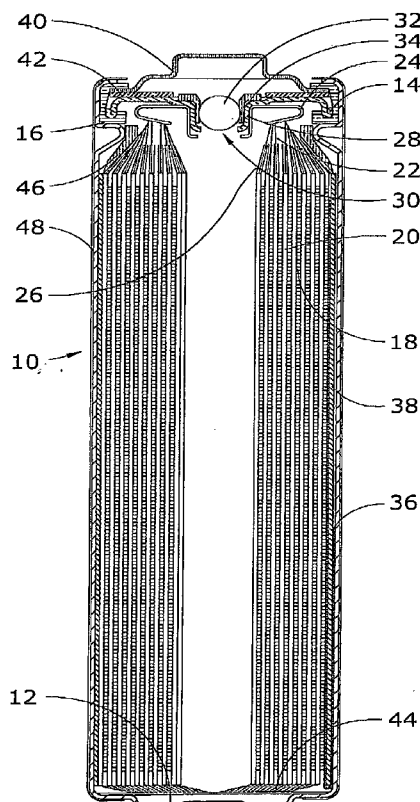


FIGURE 2



KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

INV. H01M2/16 H01M4/38 H01M4/58 H01M6/16
ADD.

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.
Y	US 2005/112462 A1 (MARPLE JACK W [US]) 26 May 2005 (2005-05-26) cited in the application abstract figure 1 paragraphs [0013], [0014], [0040], [0041], [0056], [0058], [0069], [0080] examples table 3	1-7
Y	JP 2005 123183 A (TOSHIBA CORP) 12 May 2005 (2005-05-12) claims paragraphs [0041], [0044], [0046] - [0050], [0063] - [0065], [0069], [0070] figures 1,2 ----- -/--	1-7

☒ 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

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Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Riba Vilanova, Marta

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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	STRAUSS E ET AL: "To the electrochemistry of pyrite in Li/solid composite-polymer-electrolyte battery", JOURNAL OF POWER SOURCES, ELSEVIER SA, CH LNKD- DOI:10.1016/S0378-7753(03)00013-2, vol. 115, no. 2, 10 April 2003 (2003-04-10), pages 323-331, XP004416046, ISSN: 0378-7753 sections "1. Introduction", "2.Experimental"	1-7
X	----- CN 1 564 370 A (PENGHUI BATTERY CO LTD GUANGZH [CN]) 12 January 2005 (2005-01-12) cited in the application abstract claims example 1 -----	8-10, 13-16
A	----- US 5 571 640 A (TAKEUCHI ESTHER S [US] ET AL) 5 November 1996 (1996-11-05) column 4, line 32 - column 5, line 19 column 6, line 53 - column 7, line 42 claims 1-6 -----	8-10, 13-16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/011851

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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-7

A battery comprising: a. a jellyroll electrode assembly comprising a lithium anode, a microporous separator having a thickness between 16 and 22 micrometers, and a cathode comprising a current collector and a coating, wherein the coating has a dry mix density of at least 4.4 g/cm³; b. an organic electrolyte comprising 1,3-dioxolane and 1,2-dimethoxyethane; and c. a cylindrical container.

2. claims: 8-16

A lithium-iron disulfide battery comprising: a. a jellyroll electrode assembly comprising a spirally wound anode, a separator, and a cathode, said anode consisting of lithium or a lithium alloy and said cathode consisting of a slurry coating dried on a metallic foil current collector, said coating consisting of: (i) 95.0 - 98.0 wt.% FeS₂, , (ii) 2.0 - 5.0 wt.% of inactive materials, wherein all of said wt.% are based upon total weight of the dried coating but excluding the weight of the current collector and wherein said inactive materials are at least one selected from the group consisting of: conductor, binder and processing aids; b. an organic electrolyte; and c. a cylindrical container.

A method of making a lithium-iron disulfide battery comprising the steps of: a. selecting a container having a size appropriate for either a FR6 or FR03 battery; b. providing FeS₂ in the determined amount to a slurry mixture and coating the slurry mixture onto a metallic foil current collector, said slurry mixture having greater than 94 wt.% of FeS₂ as compared to the total weight of solids provided to said slurry mixture; c. forming a jellyroll electrode assembly by winding the coated current collector with a separator and an anode strip consisting essentially of lithium or a lithium alloy; e. placing the jellyroll electrode assembly within the cylindrical container and closing the container. Batteries formed by said method.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2008/011851

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2005112462 A1	26-05-2005	CA 2540759 A1 CN 1883065 A EP 1685612 A2 JP 2007513474 T KR 20060120117 A WO 2005053067 A2	09-06-2005 20-12-2006 02-08-2006 24-05-2007 24-11-2006 09-06-2005
JP 2005123183 A	12-05-2005	JP 3866740 B2	10-01-2007
CN 1564370 A	12-01-2005	NONE	
US 5571640 A	05-11-1996	AU 673299 B2 AU 7932794 A DE 69417011 D1 DE 69417011 T2 EP 0677027 A1 JP 10508141 T WO 9512556 A1 US 5435874 A	31-10-1996 23-05-1995 15-04-1999 15-07-1999 18-10-1995 04-08-1998 11-05-1995 25-07-1995