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(54) Title: LIQUID COOLANT LEAK PROTECTION FOR BATTERY MODULE OF AN ENERGY STORAGE SYSTEM

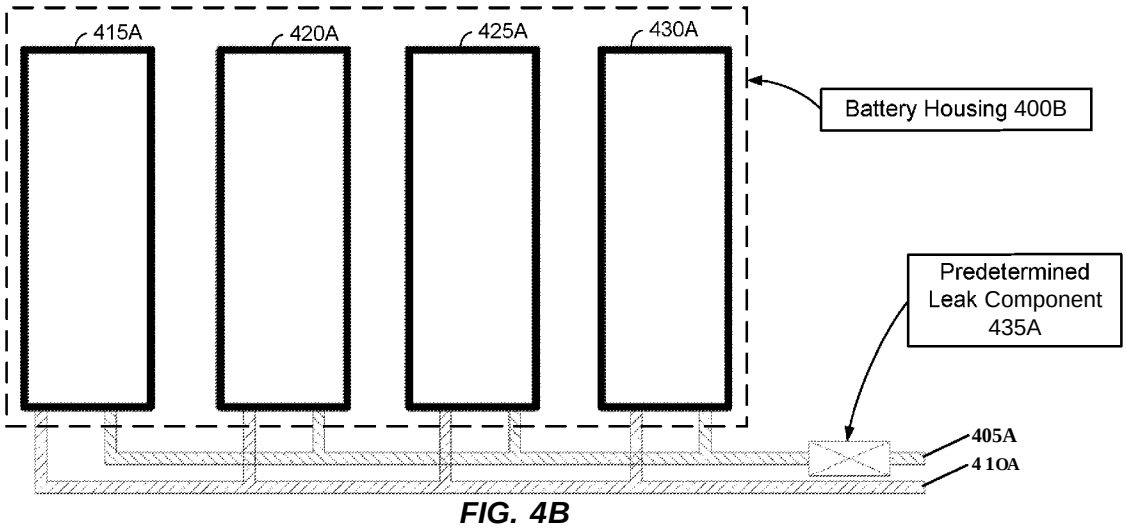

FIG. 4B

(57) Abstract: In an embodiment, a cooling manifold for cooling battery modules in a battery housing of an electric vehicle is configured with a predetermined leak component arranged at a defined section of the cooling manifold that is outside of the battery housing. In response to crash forces, the predetermined leak component is configured to cause the liquid coolant to leak out of the defined section of the cooling manifold (e.g., to avoid flooding of the battery housing). In a further embodiment, a controller determines a pressure differential between inlet and outlet sides of a cooling tube of a battery module. A valve is configured to selectively shut off a flow of liquid coolant through the cooling tube based at least in part on whether the determined differential exceeds the threshold (e.g., indicative of a leak condition inside the battery module).

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[Continued on next page]

MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
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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 practicable, 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 Y A	EP 2 746 110 A1 (HITACHI LTD [JP]) 25 June 2014 (2014-06-25) paragraphs [0001], [0010], [0011], [0015], [0046] - [0053]; figures 4-6 -----	1,2,5-7, 9,10 8,12 3,4,11
X A	EP 2 518 816 A1 (VALEO JAPAN CO LTD [JP]) 31 October 2012 (2012-10-31) paragraphs [0001], [0010], [0011], [0056], [0057], [0078] - [0081], [0087], [0089] - [0092] paragraphs [0094] , [0099] , [0101] ; figures 5,6,13,14 -----	1,5-7,9, 10 3,4,11
Y	US 2014/134469 A1 (DAMON PETER [AT] ET AL) 15 May 2014 (2014-05-15) paragraphs [0010] - [0012], [0029], [0033]; figures 1,2 -----	8,19

-/- .

[X] Further documents are listed in the continuation of Box C. [X] 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 application or patent but published on or after the international filing date

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 March 2018	19/09/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Mugnaini , Veronica

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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2014/020763 A1 (PHLEGM HERMAN K [US] ET AL) 23 January 2014 (2014-01-23) paragraphs [0001], [0016] - [0023], [0025], [0026]; figure 1	1,5-7,9 12
X Y	DE 10 2014 219267 A1 (VOLKSWAGEN AG [DE]) 24 March 2016 (2016-03-24) paragraphs [0009], [0010], [0013], [0014], [0017], [0021] - [0025]; figure 1	12-18 12,19
Y	DE 10 2013 221137 B3 (VOLKSWAGEN AG [DE]) 30 October 2014 (2014-10-30) paragraphs [0009], [0022], [0023], [0025], [0026]; figure 1	12
Y	CN 205 621 818 U (NEUSOFT CORP; NEUSOFT RUICHI AUTOMOTIVE TECH CO LTD) 5 October 2016 (2016-10-05) page 2, line 1 - line 26; figure 1	12
A	US 2014/190568 A1 (PHLEGM HERMAN K [US] ET AL) 10 July 2014 (2014-07-10) paragraphs [0002], [0021] - [0026], [0035]; figures 1-6,10	1-11

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/058862

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: 1-11

Cooling manifold arrangement suitable for cooling a plurality of battery modules comprising cooling tubes arranged inside the plurality of battery modules; two cooling interfaces, one coupled to a plurality of cooling tube inlets, and a second one coupled to a plurality of cooling tube outlets of the plurality of battery modules; a leak component arranged at a defined section of the cooling manifold that is outside of the battery housing and configured to cause the liquid coolant to leak out of the defined section of the cooling manifold in response to crash forces.

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2. claims: 12-19

A control mechanism configured to control cooling of a battery module, comprising a cooling tube and two pressure sensors configured to measure pressure of the liquid coolant on an inlet side and an outlet side of the cooling tube; a controller configured to determine whether a differential between the first and second liquid pressures exceeds a threshold; and a valve configured to selectively shut off a flow of the liquid coolant through the cooling tube when the determined differential between the first and second liquid pressures exceeds the threshold.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2017/058862

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