



(51) International Patent Classification:

F25D 11/00 (2006.01) B65D 83/72 (2006.01)
B60H 1/32 (2006.01) F28D 20/00 (2006.01)

(21) International Application Number:

PCT/US2024/032907

(22) International Filing Date:

07 June 2024 (07.06.2024)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/471,759 07 June 2023 (07.06.2023) US
63/536,433 03 September 2023 (03.09.2023) US
63/542,409 04 October 2023 (04.10.2023) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO,

(54) Title: RECHARGEABLE THERMAL BATTERY SYSTEMS FOR USE IN TRANSPORTING OR STORING PERISHABLE ITEMS

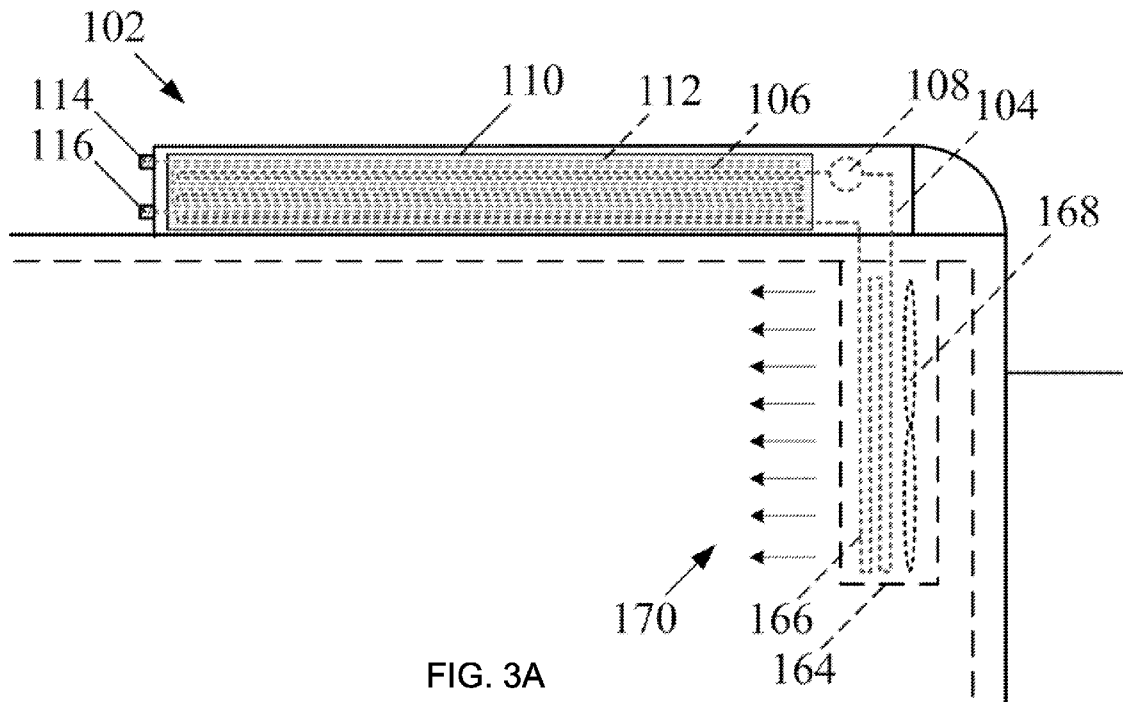


FIG. 3A

(57) Abstract: An apparatus includes a cargo area with a heat exchanger; a thermal battery system having a phase change material (PCM) with first and second heat exchangers embedded in the PCM; fluid conduits defining fluid passageways interconnecting the cargo area heat exchanger and the first PCM-embedded heat exchanger; and a pump creating a fluid flow through the fluid conduits between the cargo area heat exchanger and the first PCM-embedded heat exchanger. The apparatus also includes external ports configured for connecting to an external charging source for charging the PCM; and fluid conduits defining fluid passageways interconnecting the external ports and the second PCM-embedded heat exchanger. The first PCM-embedded heat exchanger, pump, and cargo area heat exchanger form part of a first closed-loop circuit for transferring heat between the cargo area and the thermal battery system. The second PCM-embedded heat exchanger and external ports do not part of the first closed-loop circuit.



WO 2024/254375 A3

RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS,
ZA, ZM, ZW.

- (84) Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, 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).

Published:

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

(88) Date of publication of the international search report:

24 April 2025 (24.04.2025)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2024/032907

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. F25D 11/00; B60H 1/32; B65D 83/72; F28D 20/00 (2024.01)

ADD.

CPC - INV. F25D 11/003; B60H 1/32; B65D 83/72; B65D 88/744; F25D 11/006; F28D 20/00

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)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History document

Electronic database consulted during the international search (name of database and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y --- A	US 2008/0022713 A1 (JACOBI) 31 January 2008; Fig. 1; Fig. 3; paragraph 0012, paragraph 0014, paragraph 0015, paragraph 0017	1-6, 14-20, 22-27 --- 7-13, 21, 28-35
Y --- A	US 2021/0139151 A1 (B/E AEROSPACE) 13 May 2021; Fig. 1; Fig. 2; paragraph 0045, paragraph 0056, paragraph 0047	1-6, 14-20, 22-27 --- 7-13, 21, 28-35
Y --- A	US 6,308,518 B1 (HUNTER) 30 October 2001; column 7, lines 32-35	5, 6 --- 7-13, 21, 28-35
Y --- A	US 5,975,202 A (GRANDI) 02 November 1999; Fig. 1; column 3, lines 52-54, column 1, lines 60-65	16 --- 7-13, 21, 28-35
Y --- A	US 2018/0245822 A1 (THERMO KING CORPORATION) 30 August 2018; Fig. 1; paragraph 0023; paragraph 0028; paragraph 0042	23, 24 --- 7-13, 21, 28-35
Y --- A	US 5,520,237 A (FINKELSTEIN ET AL.) 28 May 1996; Fig. 1; column 2, lines 49-55; column 1, lines 12-18	24 --- 7-13, 21, 28-35
Y	US 2016/0109186 A1 (THERMO KING CORPORATION) 21 April 2016; Fig. 1; paragraph	25

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"D" document cited by the applicant in the international application	"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
"E" earlier application or patent but published on or after the international filing date	"&" document member of the same patent family
"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	

Date of the actual completion of the international search	Date of mailing of the international search report
14 September 2024 (14.09.2024)	21 November 2024 (21.11.2024)

Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Shane Thomas Telephone No. PCT Helpdesk: 571-272-4300
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2024/032907

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:

Group I: Claims 1-35
Group II: Claims 36-43

- 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 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. [X] 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.:
1-35

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.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2024/032907

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
---	0071; paragraph 0063; paragraph 0049	---
A		7-13, 21, 28-35
Y	US 2007/0209383 A1 (HUTTON) 13 September 2007; Fig. 3; Fig. 4; paragraph 0045; paragraph 0046; paragraph 0048	26, 27
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A		7-13, 21, 28-35
A	US 2016/0243000 A1 (GRAY ET AL.) 25 August 2016; Figs. 3-7; paragraph 0022; paragraph 0071	7-13, 21, 28-35
A	US 2016/0201931 A1 (CARRIER CORPORATION) 14 July 2016; Fig. 1; Abstract	7-13, 21, 28-35
A	US 10,752,434 B2 (SONOCO DEVELOPMENT, INC) 25 August 2020; Fig. 13; column 11, lines 40-64; column 11, lines 13-14	7-13, 21, 28-35
A	US 3,528,260 A (BINDER) 15 September 1970; Fig. 1; column 1, lines 24-27	7-13, 21, 28-35
A	US 2021/0045265 A1 (CHANGSHA UNIVERSITY OF SCIENCE AND TECHNOLOGY) 11 February 2021; Fig. 1; paragraph 0042	7-13, 21, 28-35
A	US 6,105,659 A (POCOL ET AL.) 22 August 2000; Fig. 8; column 13, lines 42-58	7-13, 21, 28-35