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61/369,133 30 July 2010 (30.07.2010) US(71) Applicant (for all designated States except US):
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Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

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

[Continued on next page]

(54) Title: MULTI-REFRIGERATOR HIGH SPEED CRYOPUMP

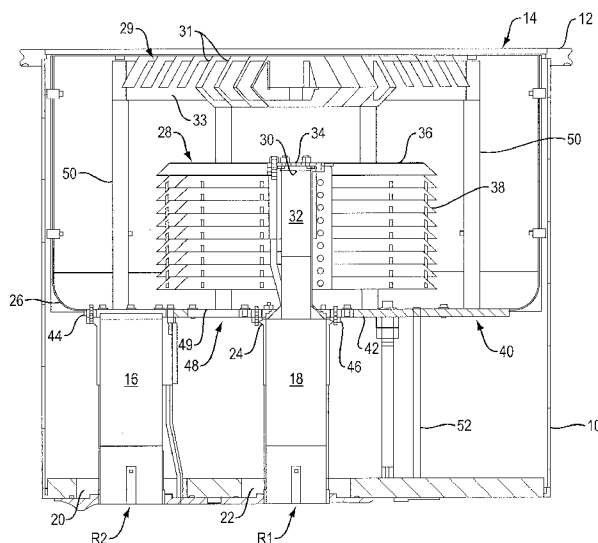


FIG. 2

(57) Abstract: A refrigeration system includes a first refrigerator having a first cooling load at a first temperature and a second refrigerator having a second cooling load at a second temperature. Also included is a thermal coupling between the two refrigerators to share thermal load, e.g., cooling load, between the refrigerators, the coupling being restricted to maintain a difference between the first and second temperatures. A cryopump includes a first refrigerator having at least first and second stages, and a second refrigerator. A thermal coupling between the first stage of the first refrigerator and a cold end of the second refrigerator is restricted to maintain a temperature difference between the cold end of the second refrigerator and the first stage of the first refrigerator. The cryopump also includes a radiation shield in thermal contact with the cold end of the second refrigerator, and a condensing surface, spaced from and surrounded by the radiation shield, and in thermal contact with a second stage, e.g., coldest stage, of the first refrigerator. The restricted thermal coupling can be configured to balance the cooling load on the two refrigerators. The thermal coupling can be formed in a base plate of the radiation shield, the base plate having varying cross-sectional area to maintain a substantially uniform temperature at a periphery of the base plate.

tain a substantially uniform temperature at a periphery of the base plate.



— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(88) **Date of publication of the international search report:**
5 July 2012

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/045977

A. CLASSIFICATION OF SUBJECT MATTER
INV. F25B9/10
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)
F25B

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)

EP0-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	US 2 984 458 A (MCFARLAN ALDEN I) 16 May 1961 (1961-05-16) column 3, line 53 - column 4, line 11 -----	1,6-8
X	US 2009/120117 A1 (MARTIN JON SCOTT [US] ET AL) 14 May 2009 (2009-05-14) paragraph [0025] - paragraph [0031]; figures 3,5 -----	1,3,4, 6-8
X	WO 2009/014152 A1 (COCA COLA COMPAGNY [US]; SANYO ELECTRIC CO [JP]; TACHIBANA YOSHIHISA []) 29 January 2009 (2009-01-29) paragraph [0016] - paragraph [0026]; figure 3 -----	1,4,6-8



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 application or patent 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

Date of the actual completion of the international search

13 February 2012

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24/05/2012

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/045977

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.:

see additional sheet(s)

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

Information on patent family members

International application No

PCT/US2011/045977

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2984458	A	16-05-1961	NONE

US 2009120117	A1	14-05-2009	US 2009120117 A1 14-05-2009
			US 2011061419 A1 17-03-2011

WO 2009014152	A1	29-01-2009	CA 2694487 A1 29-01-2009
			CN 101835705 A 15-09-2010
			EP 2178788 A1 28-04-2010
			JP 2009023695 A 05-02-2009
			US 2010276451 A1 04-11-2010
			WO 2009014152 A1 29-01-2009

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, 3, 4, 6-8

Directed to a refrigeration system with a first refrigerator having at least first and second stages, the first stage in thermal contact with a thermal coupling

2. claims: 1, 5

Directed to a refrigeration system wherein a second cooling load comprises a radiation shield of a cryopump.

3. claims: 2, 6-19

Directed to a cryopump and method comprising a first refrigerator having at least first and second stages; a radiation shield in thermal contact with the cold end of a second refrigerator; and a condensing surface, spaced from and surrounded by the radiation shield, in thermal contact with the second stage of the first refrigerator.

4. claim: 20

Directed to a cryopump shield for a cryopump comprising a radiation shield including a sidewall having an open end and a closed end; and a base plate coupled to the closed end of the radiation shield, the base plate including an outer section and an inner section, the sections connected by a bridge and defining an opening through the plate, the inner section configured to be in direct thermal contact with a first refrigerator, the outer section configured to be in direct thermal contact with a second refrigerator, the bridge forming a restricted thermal coupling between two refrigerators.
