



- (51) **International Patent Classification:**  
F25J1/00 (2006.01) F25J 1/02 (2006.01)
- (21) **International Application Number:**  
PCT/US2009/055473
- (22) **International Filing Date:**  
31 August 2009 (31.08.2009)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**  
61/098,134 18 September 2008 (18.09.2008) US
- (71) **Applicant (for all designated States except US):**  
**NELLCOR PURITAN BENNETT LLC** [US/US]; 6135  
Gunbarrel Avenue, Boulder, Colorado 80301 (US).
- (72) **Inventors; and**
- (75) **Inventors/Applicants (for US only):** **HUANG, Gene**  
[US/US]; 6579 Wilder Wood Way, Mason, Ohio 45040  
(US). **TREBOTICH, Steve** [US/US]; 35444 Provance  
Street, Newark, California 94560 (US). **KUDARAVALLI,**  
**Ravikumar V.** [US/US]; 11021 Edgepark Circle, Apt. 101,  
Manassas, Virginia 20109 (US).
- (74) **Agent:** **MAJORS, Timothy G.**; 6135 Gunbarrel Avenue,  
Boulder, Colorado 80301 (US).
- (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, BR, BW, BY, BZ,  
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO,  
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,  
HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR,  
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, PE, 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.

- (84) **Designated States (unless otherwise indicated, for every  
kind of regional protection available):** ARIPO (BW, GH,  
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,  
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),  
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,  
FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK,  
MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI  
(BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR,  
NE, SN, TD, TG).

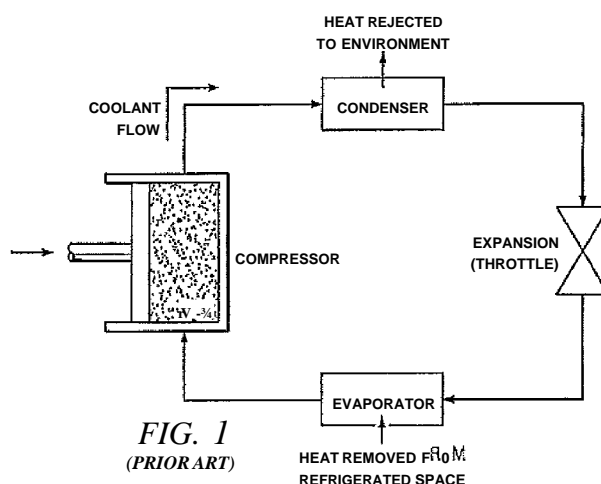
**Published:**

- with international search report (Art. 21(3))
- 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:**

27 December 2013

(54) **Title:** COMPACT CRYOGENIC COOLING CHAMBER FOR OXYGEN LIQUEFACTION SYSTEM



(57) **Abstract:** The disclosure provides a cryogenic cooling chamber configured for use with an oxygen liquefaction system. The cooling chamber may include an oxygen condensing heat exchanger, a recuperator, a throttle, an evaporator tube, and a housing. The oxygen condensing heat exchanger may have a cylindrical shape. The recuperator may be adjacent the oxygen condensing heat exchanger and may be configured to receive coolant entering the cryogenic chamber. The throttle may be configured to receive the coolant from the recuperator and to throttle the coolant. The evaporator tube may extend around a perimeter of the oxygen condensing heat exchanger and configured to receive the coolant from the throttle and to transfer heat from the oxygen condensing heat exchanger to the coolant in the evaporator tube. The recuperator may be configured to transfer heat from the coolant exiting the evaporator tube to the coolant entering the cryogenic chamber. The housing may be configured to house the oxygen condensing heat exchanger, the throttle, the evaporator tube, and the recuperator.



## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2009/055473

A. CLASSIFICATION OF SUBJECT MATTER  
 INV. F25J1/00 F25J1/02  
 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)  
 F25J

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

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	wo 98/58219 AI (SEQUAL TECHNOLOGIES INC [US]) 23 December 1998 (1998-12-23) abstract figures 1,2, 13-17 page 13, lines 1-24 page 16, lines 19-31 -----	1-22
A	wo 2006/052818 A2 (MMR TECHNOLOGIES INC [US]; LITTLE WILLIAM A [US]) 18 May 2006 (2006-05-18) abstract figure 1 page 9, lines 5-26 -----	1-22
A	US 2005/011583 AI (GALE PETER P [US] ET AL) 20 January 2005 (2005-01-20) abstract figure 1 ----- -/- .	1-22



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

30 September 2013

Date of mailing of the international search report

17/10/2013

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

Al varez Rodri guez , C

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2009/055473

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 211 086 A (HULSTYN JAN [US] ET AL) 8 July 1980 (1980-07-08) abstract -----	1-22

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2009/055473

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9858219	AI	23-12-1998	AT 200349 T 15-04 -2001
		CA 2293287 AI	23-12 -1998
		DE 69800669 DI	10-05 -2001
		DE 69800669 T2	08- 11-2001
		EP 0990107 AI	05-04 -2000
		JP 4183760 B2	19- 11-2008
		JP 4729593 B2	20- 07-2011
		JP 2002510226 A	02-04 -2002
		JP 2008183422 A	14-08 -2008
		US 5979440 A	09- 11-1999
		US 6651653 BI	25-11 -2003
		US 6681764 BI	27-01 -2004
		US 6698423 BI	02-03 -2004
		Wo 9858219 AI	23-12 -1998
-----			
WO 2006052818	A2	18-05-2006	EP 1812761 A2 01-08-2007
			JP 5143563 B2 13-02-2013
			JP 2008519242 A 05-06-2008
			JP 2012163329 A 30-08-2012
			KR 20070087588 A 28-08-2007
			US 2006130519 AI 22-06-2006
			WO 2006052818 A2 18-05-2006
-----			
US 2005011583	AI	20-01-2005	NONE
-----			
US 4211086	A	08-07-1980	NONE
-----			