



- (51) **International Patent Classification:**  
*B01D 53/34* (2006.01)    *B01D 53/00* (2006.01)  
*F25J 3/06* (2006.01)
- (21) **International Application Number:**  
PCT/US2012/039775
- (22) **International Filing Date:**  
26 May 2012 (26.05.2012)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**  
61/519,667    26 May 2011 (26.05.2011)    US
- (72) **Inventor; and**
- (71) **Applicant :** BAXTER, Larry, L. [US/US]; Sustainable Energy Solutions, 1489 West 105 North, Orem, UT 84057 (US).
- (74) **Agent:** GUYNN, John, M.; Workman Nydegger, 1000 Eagle Gate Tower, 60 E. South Temple, Salt Lake City, Utah 84111 (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, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, 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, LR, LS, MW, MZ, NA, RW, SD, SL, 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, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) **Title:** SYSTEMS AND METHODS FOR SEPARATING CONDENSABLE VAPORS FROM LIGHT GASES OR LIQUIDS BY RECUPERATIVE CRYOGENIC PROCESSES

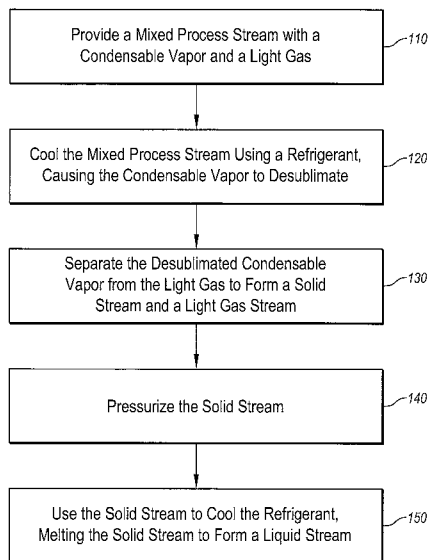


FIG. 1

(57) **Abstract:** Methods and systems of the current invention separate condensable vapors such as carbon dioxide from light gases or liquids in a mixed process stream. The separation is carried out in a cryogenic process using one or more external cooling loops (ECLs) that first cool down (120) a mixed process stream containing condensable vapors and light gases or liquids, causing the condensable vapors to desublimates and form solids. Next, the solids are separated (130) from the light gases or liquids, forming a solid stream and a light gas or liquid stream. Then the refrigerants of the ECL are cooled (150) by warming the separated solid stream and light gas or liquid stream, efficiently recovering energy used in cooling and desublimating the condensable vapors.



**Published:**

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

2 April 2015

- *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))*

INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2012/039775

A. CLASSIFICATION OF SUBJECT MATTER  
INV. B01D53/34 F25J3/06 B01D53/00  
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)  
F25J B01D  
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	FR 2 949 553 A1 (AIR LIQUIDE SA) 4 March 2011 (2011-03-04) page 1, line 1 - page 1, line 4; figure 2 page 5, line 31 - page 5, line 32 page 9, line 3 - page 9, line 5 page 9, line 25 - page 9, line 34 page 10, line 22 - page 10, line 30 -----	1-21
X	JP H03 17490 A (MITSUBISHI HEAVY IND LTD) 25 January 1991 (1991-01-25) abstract; figure 1 -----	1,9,11
X	JP H09 70521 A (TOKYO ELECTRIC POWER CO; MITSUBISHI HEAVY IND LTD) 18 March 1997 (1997-03-18) abstract; figure 1 -----	1,9,11
	-/--	

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  19 January 2015	Date of mailing of the international search report  13/02/2015
--	--

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  Petereit, A
--	---------------------------------------

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2012/039775

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2009/070785 A2 (UNIV BRIGHAM YOUNG [US]; BAXTER LARRY L [US]) 4 June 2009 (2009-06-04) page 3, line 23 - page 3, line 24; figure 1  -----	1-21

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2012/039775
---

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2949553	A1	04-03-2011	
		AU 2010291032 A1	19-04-2012
		CA 2771059 A1	10-03-2011
		CN 102497917 A	13-06-2012
		EP 2488278 A1	22-08-2012
		ES 2523754 T3	01-12-2014
		FR 2949553 A1	04-03-2011
		JP 2013503808 A	04-02-2013
		US 2012180657 A1	19-07-2012
		WO 2011027079 A1	10-03-2011
JP H0317490	A	25-01-1991	
		JP 2686320 B2	08-12-1997
		JP H0317490 A	25-01-1991
JP H0970521	A	18-03-1997	NONE
WO 2009070785	A2	04-06-2009	
		CN 101939075 A	05-01-2011
		EP 2234694 A2	06-10-2010
		US 2011226010 A1	22-09-2011
		WO 2009070785 A2	04-06-2009