(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
30 September 2004 (30.09.2004)

PCT

(10) International Publication Number
WO 2004/083752 A1

(51) International Patent Classification[7]: F25J 1/02

(21) International Application Number:
PCT/IB2004/000908

(22) International Filing Date: 16 March 2004 (16.03.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/391,390 18 March 2003 (18.03.2003) US
10/780,613 19 February 2004 (19.02.2004) US

(71) Applicant *(for all designated States except US)*: **AIR PRODUCTS AND CHEMICALS, INC.** [US/US]; 7201 Hamilton Boulevard, Allentown, PA 18195-1501 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **ROBERTS, Mark, Julian** [US/US]; 8866 Canaris Drive, Kempton, PA 19529 (US).

(74) Common Representative: **AIR PRODUCTS AND CHEMICALS, INC.**; c/o BURFORD, Anthony, F., W.H. Beck, Greener & Co., 7 Stone Buildings, Lincoln's Inn, London WC2A 3SZ (GB).

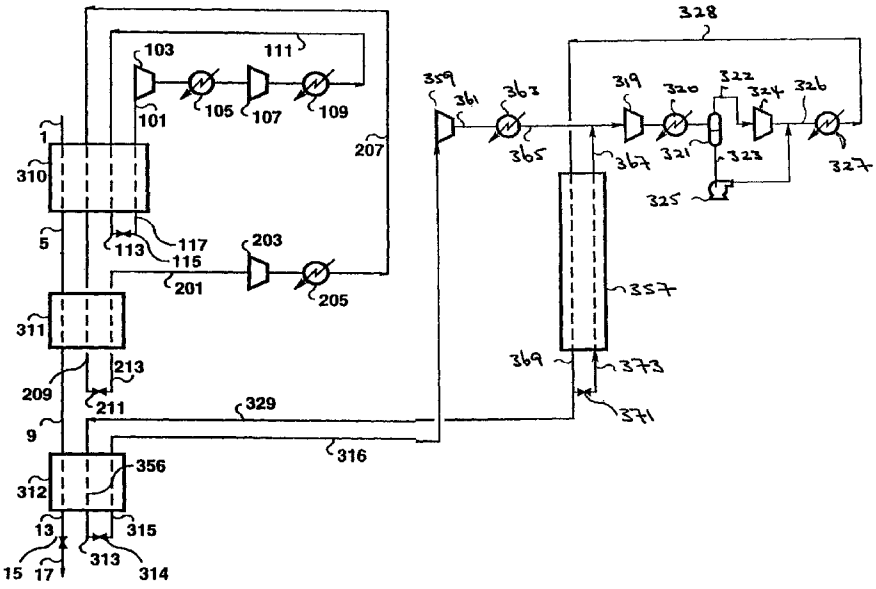
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, 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, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**
— *with international search report*

*[Continued on next page]*

(54) Title: INTEGRATED MULTIPLE-LOOP REFRIGERATION PROCESS FOR GAS LIQUEFACTION




(57) Abstract: A gas (1) is liquefied by cooling successively through at least two temperature ranges by vaporization of respective refrigerants (117, 213 & 315) with additional refrigeration being provided by vaporization (357; 379), at temperatures above the highest temperature in the coldest heat exchange zone (312), of an auxiliary refrigerant (373, 377) derived from the refrigerant (315) vaporized in said zone (312). The auxiliary refrigerant may have the same composition as the refrigerant vaporized in the coldest heat exchange zone but is vaporized at a different pressure or can have a different composition.

WO 2004/083752 A1

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*