



(51) International Patent Classification:

F25B 9/12 (2006.01) B33Y 80/00 (2015.01)
F25D 3/10 (2006.01)

(21) International Application Number:

PCT/US2022/036531

(22) International Filing Date:

08 July 2022 (08.07.2022)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/219,795 08 July 2021 (08.07.2021) US
63/319,248 11 March 2022 (11.03.2022) US

(71) Applicant: **MAYBELL QUANTUM INDUSTRIES, INC.** [US/US]; 7100 Broadway Building 3, Suite D-E, Denver, Colorado 80221 (US).

(72) Inventors; and

(71) Applicants: **TILLEMANN-DICK, Corban** [US/US]; 1811 Oneida St., Denver, Colorado 80220 (US). **THOMPSON, Kyle** [US/US]; 3795 Moorhead Ave, Boulder, Colorado 80305 (US). **OGANDO DOS SANTOS ALLAN, John** [US/US]; 1565 Linden Ave, Boulder, Colorado 80304 (US). **CHOO, Bryan** [US/US]; 4 Saint Marks Place, 3S,

New York, New York 10003 (US). **BYARS, Jonathan, Michael** [US/US]; 14830 W 53rd Ave., Golden, Colorado 80403 (US). **HARRIS, Steven, William** [US/US]; 137 W 2nd Ave., Unit 2, Denver, Colorado 80223 (US). **ZULTAK, Johanna** [US/US]; 3301 Arapahoe Ave. #221, Boulder, Colorado 80303 (US). **PLANT, Tyler, James** [US/US]; 10101 Jackson Ct., Apt. 5-204, Thornton, Colorado 80229 (US).

(74) Agent: **SCHLOTTER, Sarah, C.C.** et al.; Wolf, Greenfield & Sacks, P.C., 600 Atlantic Avenue, Boston, Massachusetts 02210-2206 (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, 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, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, 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.

(54) Title: INTEGRATED DILUTION REFRIGERATORS

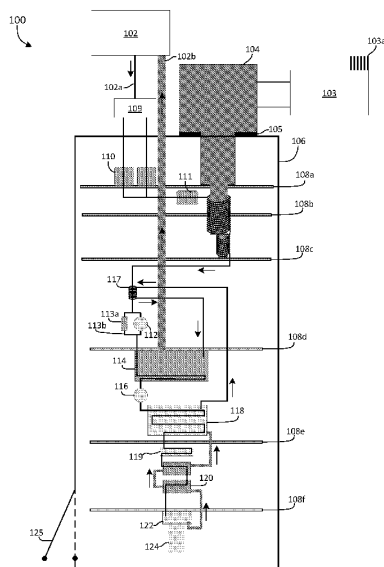


FIG. 1

(57) Abstract: Systems and techniques for improved, user-friendly, and integrated dilution refrigerators are provided. The improved dilution refrigerator includes a plurality of thermalization plates configured to be cooled to a plurality of temperatures, wherein: a first thermalization plate of the plurality of thermalization plates comprises an integrated heat exchanger, the integrated heat exchanger comprises channels formed in the first thermalization plate, and the channels are configured to allow helium to flow through the first thermalization plate during operation of the dilution refrigerator.

(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, 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, 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))*
- *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))*