



(51) International Patent Classification:

H01L 27/18 (2006.01) H01L 39/22 (2006.01)
G06N 10/00 (2019.01) H01L 39/24 (2006.01)

(21) International Application Number:

PCT/EP2020/059725

(22) International Filing Date:

06 April 2020 (06.04.2020)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

16/381,563 11 April 2019 (11.04.2019) US

(71) Applicant: **INTERNATIONAL BUSINESS MACHINES CORPORATION** [US/US]; New Orchard Road, Armonk, New York 10504 (US).

(71) Applicant (for MG only): **IBM DEUTSCHLAND GMBH** [DE/DE]; c/o IBM Deutschland Management & Business Support GmbH, Patentwesen und Urheberrecht, IBM Allee 1, 71139 Ehningen (DE).

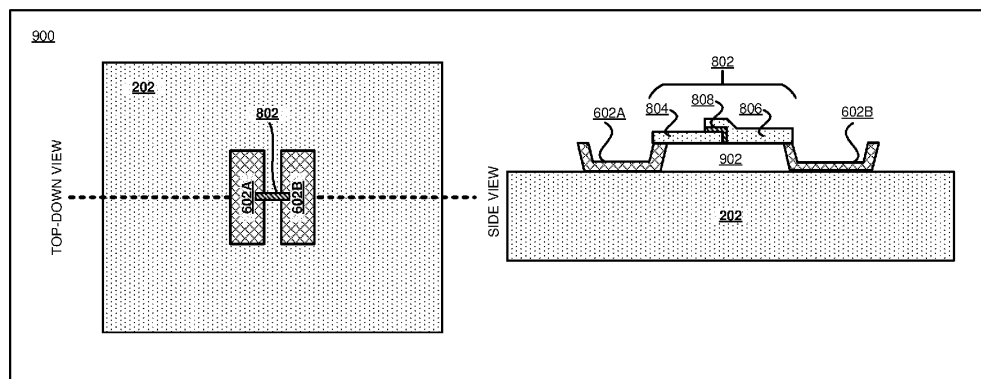
(72) Inventors: **ADIGA, Vivekananda**; c/o IBM Thomas J Watson Research Center, 1101 Kitchawan Road, Route 134, P.O. Box 218, Yorktown Heights, New York 10598 (US). **SANDBERG, Martin**; c/o IBM Thomas J Watson Research Center, 1101 Kitchawan Road, Route 134, P.O. Box 218, Yorktown Heights, New York 10598 (US). **CHOW, Jerry**; c/o IBM Thomas J Watson Research Center, 1101 Kitchawan Road, Route 134, P.O. Box 218, Yorktown Heights, New York 10598 (US). **PAIK, Hanhee**; c/o IBM Thomas J Watson Research Center, 1101 Kitchawan Road, Route 134, P.O. Box 218, Yorktown Heights, New York 10598 (US).

(74) Agent: **LAUX, Felix**; c/o IBM Deutschland Management & Business Support GmbH, Patentwesen und Urheberrecht, IBM Allee 1, 71139 Ehningen (DE).

(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, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,

(54) Title: TRANSMON QUBITS WITH TRENCHED CAPACITOR STRUCTURES

FIGURE 9



(57) Abstract: A qubit includes a substrate, and a first capacitor structure having a lower portion formed on a surface of the substrate and at least one first raised portion extending above the surface of the substrate. The qubit further includes a second capacitor structure having a lower portion formed on the surface of the substrate and at least one second raised portion extending above the surface of the substrate. The first capacitor structure and the second capacitor structure are formed of a superconducting material. The qubit further includes a junction between the first capacitor structure and the second capacitor structure. The junction is disposed at a predetermined distance from the surface of the substrate and has a first end in contact with the first raised portion and a second end in contact with the second raised portion.

[Continued on next page]

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.

(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))*