



(51) International Patent Classification:

H01L 39/22 (2006.01) *B82Y 10/00* (2011.01)
G06N 99/00 (2019.01) *H01P 5/18* (2006.01)
H03K 19/195 (2006.01)

(21) International Application Number:

PCT/US2019/012440

(22) International Filing Date:

05 January 2019 (05.01.2019)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/613,937 05 January 2018 (05.01.2018) US
62/733,326 19 September 2018 (19.09.2018) US

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(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, 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, 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, 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).

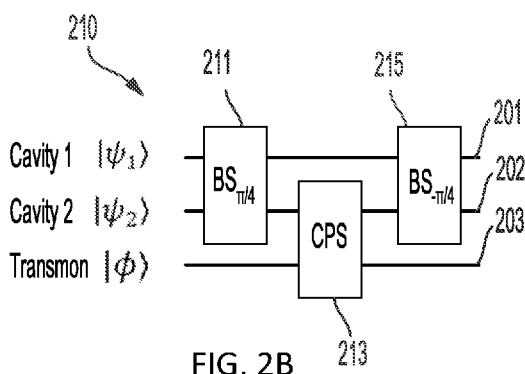
Published:

- 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))

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

26 September 2019 (26.09.2019)

(54) Title: ROBUST QUANTUM LOGICAL GATES



(57) Abstract: Techniques for implementing robust quantum logic gates are provided and described. In some aspects, a quantum logic gate between a plurality of cavities comprising a first cavity and a second cavity is implemented by performing a first beam splitter operation between the first cavity and the second cavity using a coupling transmon that is dispersively coupled to both the first cavity and the second cavity, and performing a controlled phase shift operation between the second cavity and an ancilla transmon that is dispersively coupled to the second cavity but not dispersively coupled to the first cavity.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 19/12440

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

- 1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

- 2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

- 3. Claims Nos.: 4-14, 17-20
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

- 1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
- 2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
- 3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

- 4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

- Remark on Protest**
- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
 - The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
 - No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 19/12440

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - H01L 39/22, G06N 99/00, H03K 19/195, B82Y 10/00, H01P 5/18 (2019.01)

CPC - B82Y 10/00, G06N 10/00, H01L 49/006, H03K 19/1958, Y10S 977/933, Y10S 977/94, H01L 39/223, H01L 39/025, H01P 5/18, H01P 1/18

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)

See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

See Search History Document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2017/151200 A1 (YALE UNIVERSITY) 08 September 2017 (08.09.2017), para [0041], [0053], [0059], [00125], [00126]	1-3, 15, 16
A	JOHNSON et al., "Quantum Non-demolition Detection of Single Microwave Photons in a Circuit" Nature Physics 6.9 (2010): 663; Fig 1; pg 1, col 1-pg 2, col 1 [online] URL < https://arxiv.org/pdf/1003.2734.pdf >	1-3, 15, 16
A	US 2016/0308502 A1 (YALE UNIVERSITY) 20 October 2016 (20.10.2016), para [0003], [0006], [0042]	1-3, 15, 16
A	US 2017/0193388 A1 (INTERNATIONAL BUSINESS MACHINES CORPORATION) 06 July 2017 (06.07.2017), entire document	1-3, 15, 16
A	US 2016/0364653 A1 (INTERNATIONAL BUSINESS MACHINES CORPORATION) 15 December 2016 (15.12.2016), entire document	1-3, 15, 16
A	US 2006/0017992 A1 (BEAUSOLEIL et al.) 26 January 2006 (26.01.2006), entire document	1-3, 15, 16
A	US 2017/0201224 A1 (MICROSOFT TECHNOLOGY LICENSING, LLC) 13 July 2017 (13.07.2017), entire document	1-3, 15, 16

 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

10 July 2019

Date of mailing of the international search report

29 JUL 2019

Name and mailing address of the ISA/US

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