

(51) International Patent Classification:
G11C 11/00 (2006.01)(21) International Application Number:
PCT/US2012/029881(22) International Filing Date:
21 March 2012 (21.03.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
13/100,032 3 May 2011 (03.05.2011) US(71) Applicant (for all designated States except US): **INTERNATIONAL BUSINESS MACHINES CORP.** [US/US];
New Orchard Road, Armonk, New York 10504 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **ABRAHAM, David W.** [US/US]; 1101 Kitchawan Road, Yorktown Heights, New York 10598 (US). **MOJUMDER, Niladri N.** [IN/US]; 318 South 5th Street, Lafayette, Indiana 47901-1602 (US). **WORLEDGE, Daniel C.** [US/US]; 1101 Kitchawan Road, Yorktown Heights, New York 10598 (US).(74) Agent: **SULLIVAN, Sean F.**; Cantor Colburn LLP, 20 Church St., 22nd Floor, Hartford, Connecticut 06103-3207 (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.

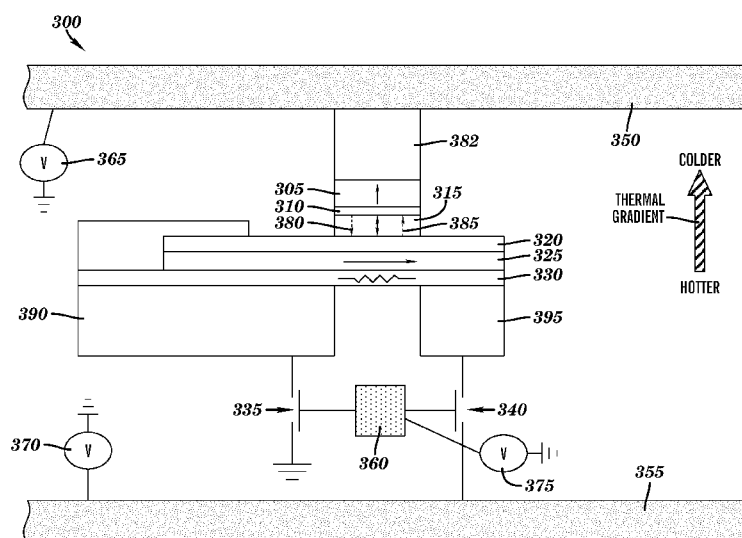
(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, 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).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

[Continued on next page]

(54) Title: MAGNONIC MAGNETIC RANDOM ACCESS MEMORY DEVICE

**FIG. 3**

(57) **Abstract:** A mechanism is provided for bidirectional writing. A structure includes a reference layer on top of a tunnel barrier, a free layer underneath the tunnel barrier, a metal spacer underneath the free layer, an insulating magnet underneath the metal spacer, and a high resistance layer underneath the insulating layer. The high resistance layer acts as a heater in which the heater heats the insulating magnet to generate spin polarized electrons. A magnetization of the free layer is destabilized by the spin polarized electrons generated from the insulating magnet. A voltage is applied to change the magnetization of the free layer when the magnetization is destabilized. A polarity of the voltage determines when the magnetization of the free layer is parallel and antiparallel to a magnetization of the reference layer.

WO 2012/151007 A3



Published:

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

— *with international search report (Art. 21(3))*

10 April 2014

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2012/029881

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G11C 11/00 (2012.01)

USPC - 365/158

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)

IPC(8) - G11C 11/00, 11/14; H01L 29/82 (2012.01)

USPC - 365/158, 171, 157; 257/421

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)

PatBase, Proquest, Orbit.com, Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005/0117392 A1 (HAYAKAWA et al) 02 June 2005 (02.06.2005) entire document	1-20
Y	US 2011/0063758 A1 (WANG et al) 17 March 2011 (17.03.2011) entire document	1-20
Y	US 2010/0208516 A1 (JAVERLIAC et al) 19 August 2010 (19.08.2010) entire document	1-20
Y	US 2010/0271870 A1 (ZHENG et al) 28 October 2010 (28.10.2010) entire document	4, 8, 14, 20
A	US 7,411,815 B2 (GOGL) 12 August 2008 (12.08.2008) col. 3, lines 15-23; col. 4, lines 58-64	2, 6, 12, 18
A	US 2009/0161422 A1 (ZHU et al) 25 June 2009 (25.06.2009) entire document	1-20
A	US 2009/0175110 A1 (ZAYETS et al) 09 July 2009 (09.07.2009) entire document	1-20

☐ Further documents are listed in the continuation of Box C.


* 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

31 May 2012

Date of mailing of the international search report

08 JUN 2012

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300

PCT OSP: 571-272-7774