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(54) **THERMALLY STABLE REFERENCE VOLTAGE GENERATOR FOR MRAM**

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**G11C 11/34** (2006.01)

**G11C 16/04** (2006.01)

**G11C 11/14** (2006.01)

(52) **U.S. Cl.** ..... **365/210.1**; 385/209; 385/185.2; 385/171

(58) **Field of Classification Search** ..... 365/171, 365/185.2, 210.1  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,524,431 A 6/1985 Haken et al.  
5,022,031 A 6/1991 Baggen  
5,719,808 A 2/1998 Harari et al.  
5,999,439 A \* 12/1999 Seyyedy ..... 365/145  
6,445,612 B1 9/2002 Naji  
6,600,690 B1 7/2003 Nahas et al.

(Continued)

FOREIGN PATENT DOCUMENTS

WO 2004/049343 A1 6/2004

OTHER PUBLICATIONS

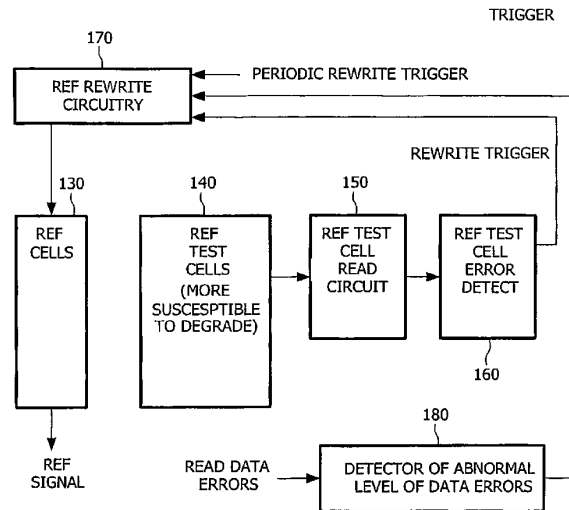
"Magnetoresistive Random Access Memory Using Magnetic Tunnel Junctions" by Tehrani, et al. IEEE, vol. 91, No. 5, May 2003, pp. 703-714.

Primary Examiner—Ly D Pham

(57) **ABSTRACT**

A non volatile memory device comprises memory cells such as MRAM cells, reading circuits and a reference cell for generating a reference for use by the reading circuits, and can determine if the reference is degraded by thermal instability. This can help reduce a data error rate. Detecting such degradation can prove to be more effective than trying to design in enough margins for the lifetime of the device. The reference cell can be less susceptible to degradation than other cells by using different shape of cells and different write currents. Where each reference cell is used by many memory cells, the reference cell tends to be used more often than any particular memory cell and so can be more susceptible to degradation. Another way of ensuring against longer term degradation of the reference is periodically rewriting the reference cell.

**5 Claims, 5 Drawing Sheets**



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U.S. PATENT DOCUMENTS			
6,621,729	B1	9/2003	Garni et al.
6,704,230	B1	3/2004	DeBrosse et al.
7,038,950	B1*	5/2006	Hamilton et al. .... 365/185.28
2002/0008987	A1	1/2002	Numata et al.
2002/0159308	A1	10/2002	Fournel et al.
2003/0086314	A1	5/2003	Okazawa et al.
2004/0017718	A1*	1/2004	Ooishi ..... 365/210
2004/0233716	A1*	11/2004	Tran et al. .... 365/185.09
2006/0092699	A1*	5/2006	Higashi et al. .... 365/177
2006/0114738	A1*	6/2006	Lee et al. .... 365/230.03
2006/0274576	A1*	12/2006	Redaelli et al. .... 365/185.2
2007/0113150	A1*	5/2007	Resnick et al. .... 714/763

\* cited by examiner

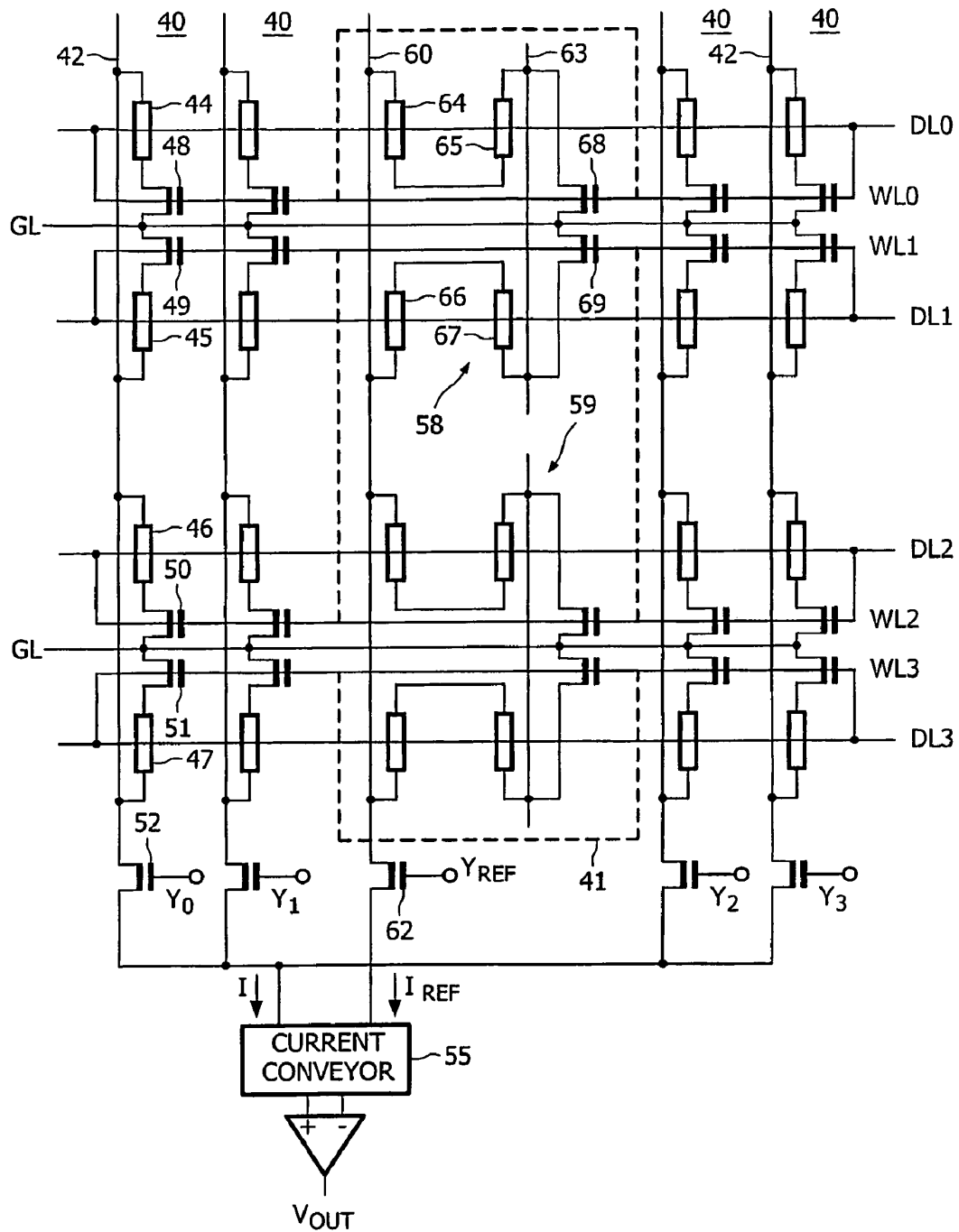


FIG. 1 PRIOR ART

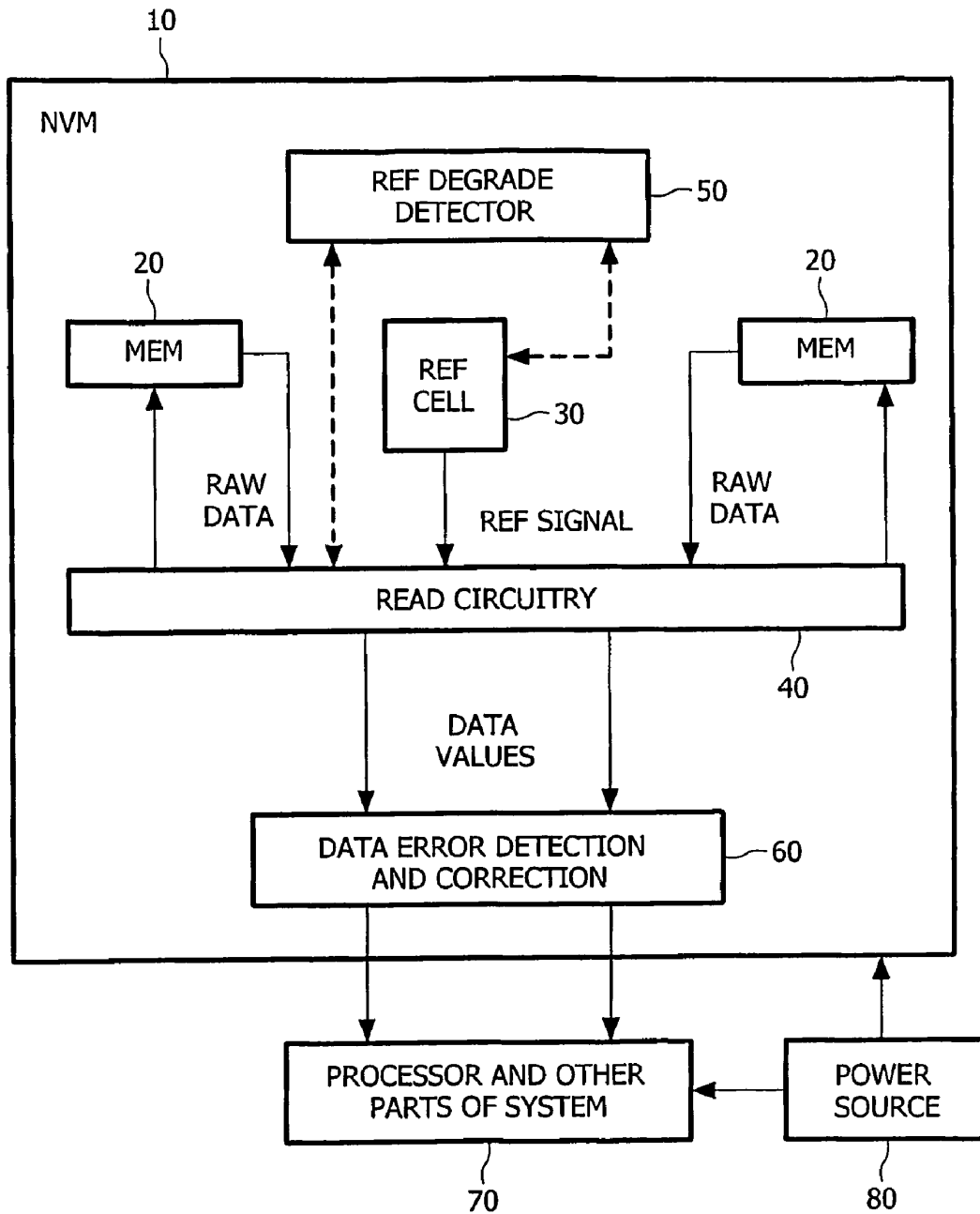


FIG. 2

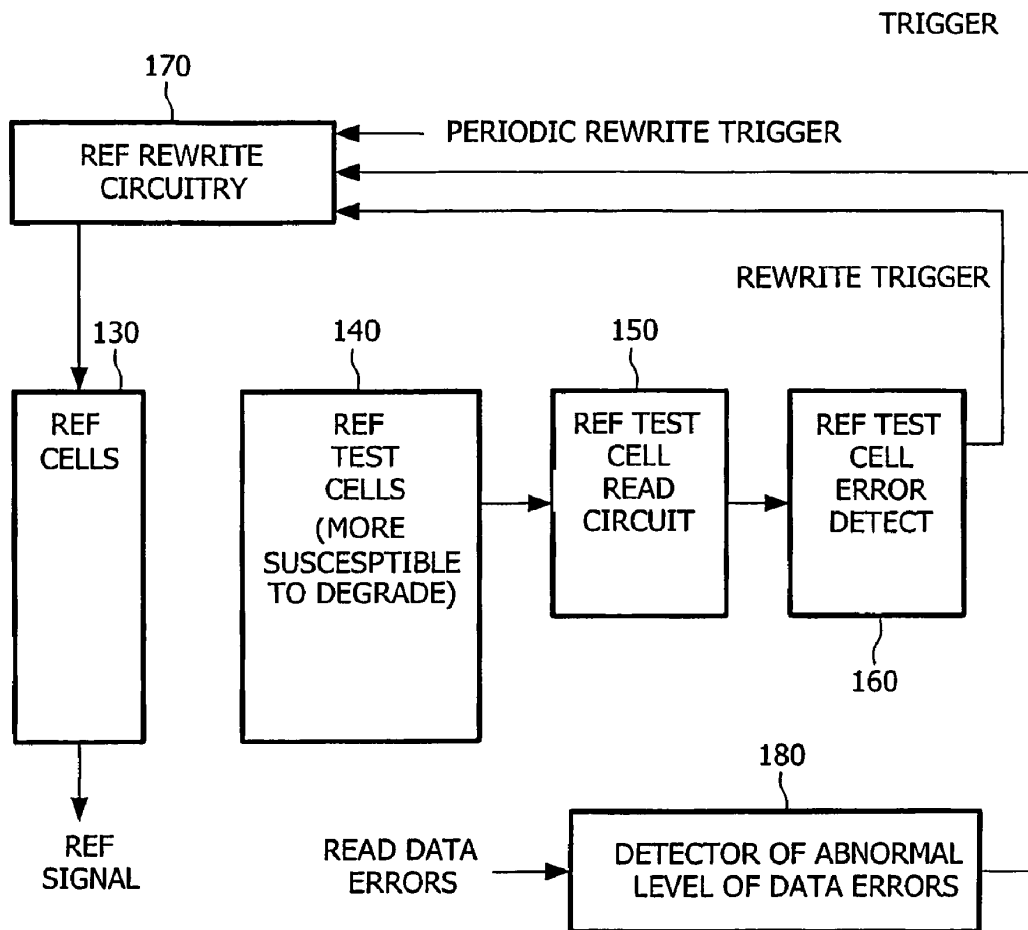


FIG. 3

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