## (12) United States Patent
### Gorobets et al.

(10) Patent No.: **US 7,366,826 B2**
(45) Date of Patent: **Apr. 29, 2008**

(54) **NON-VOLATILE MEMORY AND METHOD WITH MULTI-STREAM UPDATE TRACKING**

(75) Inventors: **Sergey Anatolievich Gorobets**, Edinburgh (GB); **Peter John Smith**, Eskbank (GB); **Alan David Bennett**, Edinburgh (GB)

(73) Assignee: **Sandisk Corporation**, Milpitas, CA (US)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 272 days.

(21) Appl. No.: **11/192,220**

(22) Filed: **Jul. 27, 2005**

(65) **Prior Publication Data**

US 2006/0155921 A1    Jul. 13, 2006

**Related U.S. Application Data**

(63) Continuation-in-part of application No. 11/016,285, filed on Dec. 16, 2004, now Pat. No. 7,315,916.

(51) **Int. Cl.**
*G06F 12/00* (2006.01)

(52) **U.S. Cl.** ...................................................... **711/103**

(58) **Field of Classification Search** ................ 711/103; 365/185.33

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | |
|---|---|---|---|
| 4,694,454 A | 9/1987 | Matsuura | |
| 5,043,940 A | 8/1991 | Harari | |
| 5,070,032 A | 12/1991 | Yuan et al. | |
| 5,095,344 A | 3/1992 | Harari | |
| 5,172,338 A | 12/1992 | Mehrotra et al. | |
| 5,263,032 A | 11/1993 | Porter et al. | |
| 5,270,979 A | 12/1993 | Harari et al. | |
| 5,313,421 A | 5/1994 | Guterman et al. | |
| 5,315,541 A | 5/1994 | Harari et al. | |
| 5,343,063 A | 8/1994 | Yuan et al. | |
| 5,404,485 A | 4/1995 | Ban | |
| 5,475,693 A | 12/1995 | Christopherson et al. | |

(Continued)

FOREIGN PATENT DOCUMENTS

GB          2289779 A     11/1995

(Continued)

OTHER PUBLICATIONS

ISA/EPO, "Invitation to Pay Additional Fees (including Partial International Search Report)", mailed on Feb. 21, 2005 in corresponding PCT/US2004/031788, 5 pages.

(Continued)

*Primary Examiner*—Hiep T. Nguyen
(74) *Attorney, Agent, or Firm*—Davis Wright Tremaine LLP
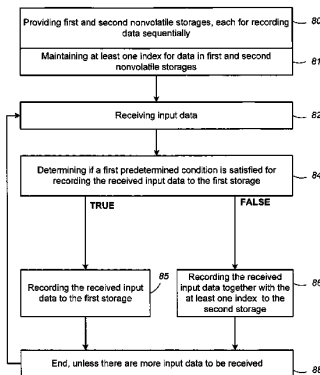
(57)          **ABSTRACT**

Update data to a non-volatile memory may be recorded in at least two interleaving streams such as either into an update block or a scratch pad block depending on a predetermined condition. The scratch pad block is used to buffered update data that are ultimately destined for the update block. Synchronization information about the order recording of updates among the streams is saved with at least one of the streams. This will allow the most recently written version of data that may exist on multiple memory blocks to be identified. In one embodiment, the synchronization information is saved in a first block and is a write pointer that points to the next recording location in a second block. In another embodiment, the synchronization information is a time stamp.

**41 Claims, 43 Drawing Sheets**



Updating Using Two Streams With Index Stored In One Stream

### U.S. PATENT DOCUMENTS

| | | | |
|---|---|---|---|
| 5,504,760 | A | 4/1996 | Harari et al. |
| 5,532,962 | A | 7/1996 | Auclair et al. |
| 5,570,315 | A | 10/1996 | Tanaka et al. |
| 5,598,370 | A | 1/1997 | Niijima et al. |
| 5,652,720 | A | 7/1997 | Aulas et al. |
| 5,657,332 | A | 8/1997 | Auclair et al. |
| 5,661,053 | A | 8/1997 | Yuan |
| 5,696,929 | A | 12/1997 | Hasbun et al. |
| 5,699,297 | A | 12/1997 | Yamazaki et al. |
| 5,774,397 | A | 6/1998 | Endoh et al. |
| 5,798,968 | A | 8/1998 | Lee et al. |
| 5,835,413 | A | 11/1998 | Hurter et al. |
| 5,835,921 | A | 11/1998 | Sunakawa et al. |
| 5,890,192 | A | 3/1999 | Lee et al. |
| 5,909,449 | A | 6/1999 | So et al. |
| 5,930,167 | A | 7/1999 | Lee et al. |
| 5,933,368 | A | 8/1999 | Ma et al. |
| 5,937,425 | A | 8/1999 | Ban |
| 5,963,473 | A | 10/1999 | Norman |
| 6,046,935 | A | 4/2000 | Takeuchi et al. |
| 6,049,899 | A | 4/2000 | Auclair et al. |
| 6,125,435 | A | 9/2000 | Estakhri et al. |
| 6,145,051 | A | 11/2000 | Estakhri et al. |
| 6,151,246 | A | 11/2000 | So et al. |
| 6,189,081 | B1 | 2/2001 | Fujio |
| 6,199,139 | B1 | 3/2001 | Katayama et al. |
| 6,222,762 | B1 | 4/2001 | Guterman et al. |
| 6,307,776 | B1 | 10/2001 | So et al. |
| 6,345,001 | B1 | 2/2002 | Mokhlesi |
| 6,415,352 | B1 | 7/2002 | Asami et al. |
| 6,426,893 | B1 | 7/2002 | Conley et al. |
| 6,434,658 | B1 | 8/2002 | Fukuzumi |
| 6,456,528 | B1 | 9/2002 | Chen |
| 6,459,644 | B2 | 10/2002 | Mizushima et al. |
| 6,522,580 | B2 | 2/2003 | Chen et al. |
| 6,560,152 | B1 | 5/2003 | Cernea |
| 6,567,307 | B1 | 5/2003 | Estakhri |
| 6,678,785 | B2 | 1/2004 | Lasser |
| 6,725,321 | B1 | 4/2004 | Sinclair et al. |
| 6,725,322 | B1 | 4/2004 | Shiraishi et al. |
| 6,760,255 | B2 | 7/2004 | Conley et al. |
| 6,763,424 | B2 | 7/2004 | Conley |
| 6,772,274 | B1 | 8/2004 | Estakhri |
| 6,829,167 | B2 | 12/2004 | Tu et al. |
| 6,898,662 | B2 | 5/2005 | Gorobets |
| 6,925,007 | B2 | 8/2005 | Harari et al. |
| 6,928,511 | B2 | 8/2005 | Chiu |
| 7,076,598 | B2 * | 7/2006 | Wang ......................... 711/103 |
| 7,185,154 | B2 * | 2/2007 | Wong et al. ................ 711/156 |
| 7,233,336 | B2 * | 6/2007 | Mondal ...................... 345/547 |
| 2002/0083262 | A1 | 6/2002 | Fukuzumi |
| 2002/0085416 | A1 * | 7/2002 | Yamagami et al. .... 365/185.09 |
| 2002/0099904 | A1 | 7/2002 | Conley |
| 2003/0065699 | A1 | 4/2003 | Burns |
| 2003/0109093 | A1 | 6/2003 | Harari et al. |
| 2003/0206449 | A1 | 11/2003 | Harari et al. |
| 2004/0083335 | A1 | 4/2004 | Gonzalez et al. |
| 2004/0109357 | A1 | 6/2004 | Cernea et al. |
| 2004/0177214 | A1 | 9/2004 | Chiu |
| 2004/0255076 | A1 * | 12/2004 | Oyaizu et al. .............. 711/103 |
| 2005/0144357 | A1 | 6/2005 | Sinclair |
| 2005/0144358 | A1 | 6/2005 | Conley et al. |
| 2005/0144360 | A1 | 6/2005 | Bennett et al. |
| 2005/0144363 | A1 | 6/2005 | Sinclair |
| 2005/0144365 | A1 | 6/2005 | Gorobets et al. |
| 2005/0169259 | A1 | 8/2005 | Su |
| 2005/0235098 | A1 | 10/2005 | Tamura et al. |
| 2006/0133141 | A1 | 6/2006 | Gorobets |
| 2006/0161722 | A1 | 7/2006 | Bennett et al. |
| 2007/0005829 | A1 | 1/2007 | Fujimoto |

### FOREIGN PATENT DOCUMENTS

| | | |
|---|---|---|
| JP | 8-147988 | 6/1996 |
| JP | 8-279295 | 10/1996 |
| JP | 2000-187992 | 7/2000 |
| WO | WO 02/058074 | 7/2002 |

### OTHER PUBLICATIONS

ISA/EPO, "Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration", mailed on May 31, 2005 in corresponding PCT/US2004/031788, 21 pages.

Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration, for corresponding Patent Application No. PCT/US2005/044001, mailed May 17, 2006, 9 pages.

Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration, for corresponding Patent Application No. PCT/US2005/043811, mailed May 19, 2006, 10 pages.

International Search Report and Written Opinion for related International Application No. PCT/US2005/043285, mailed May 8, 2006, 13 pages.

International Search Report and Written Opinion for related International Application No. PCT/US2005/044649, mailed May 4, 2006, 10 pages.

Imamiya et al., "A 125-mm$^2$ 1-Gb NAND Flash Memory With 10-Mbyte/s Program Speed", IEEE Journal of Solid State Circuits, vol. 37, No. 11, Nov. 2002, 10 pages.

Notification of Transmittal of the International Search Report and the Written Opinion of the International Searching Authority, or the Declaration, for corresponding Patent Application No. PCT/US2005/044720, mailed Oct. 10, 2006, 10 pages.

USPTO, "Office Action," mailed in related U.S. Appl. No. 11/192,386 on Jul. 27, 2007, 14 pages.

USPTO, "Office Action," mailed in related U.S. Appl. No. 11/191,686 on Jul. 31, 2007, 14 pages.
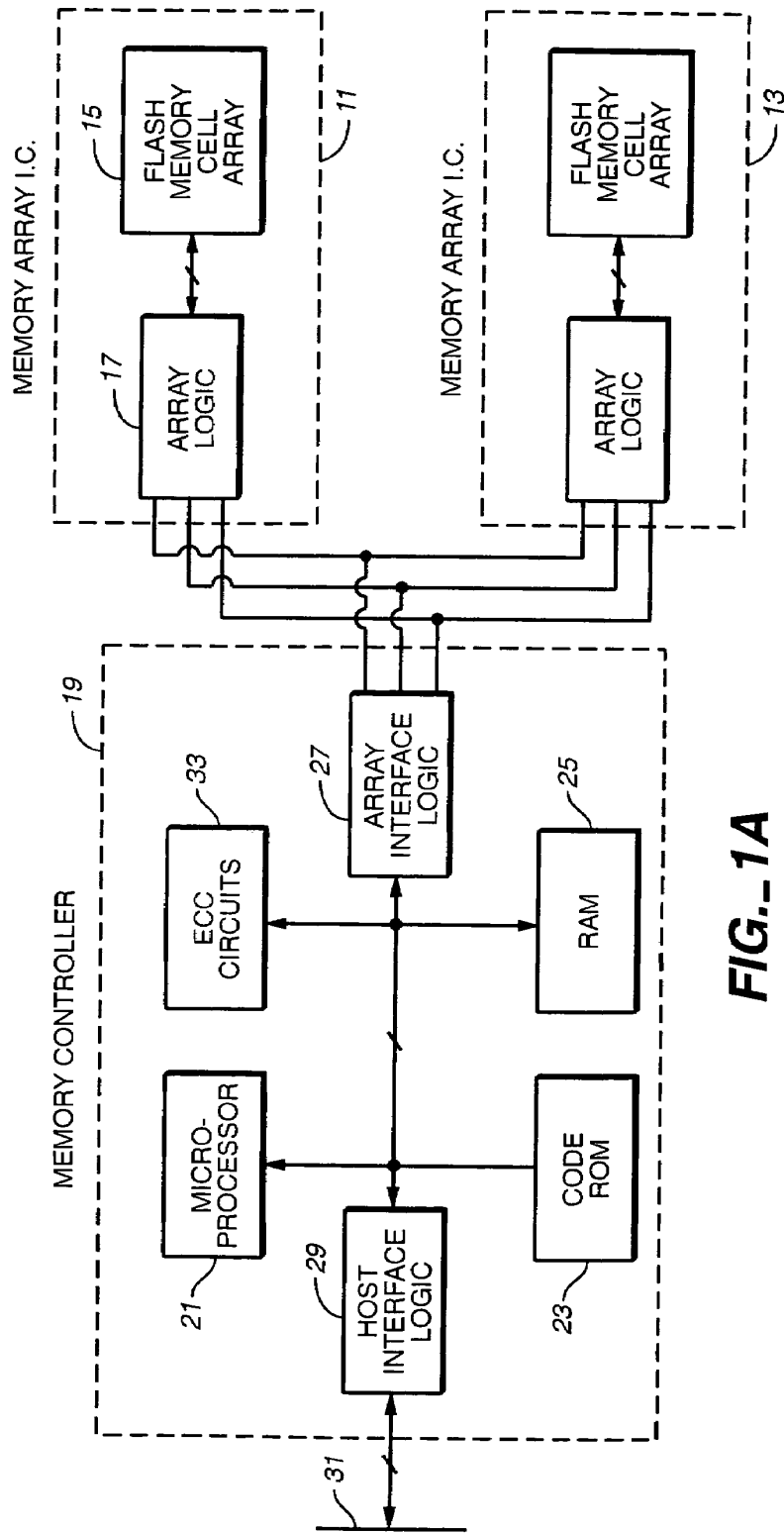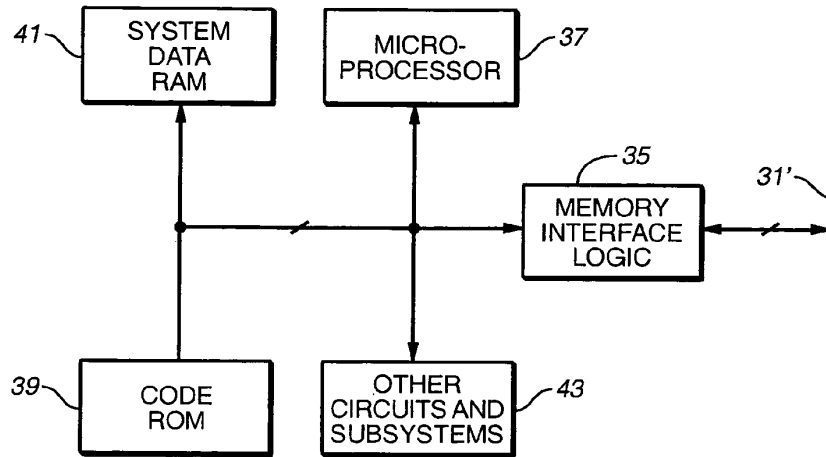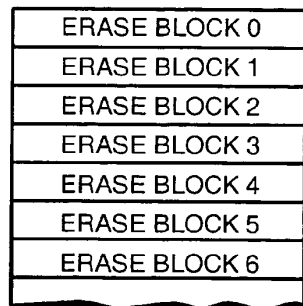
* cited by examiner

FIG._1A

41 — SYSTEM DATA RAM
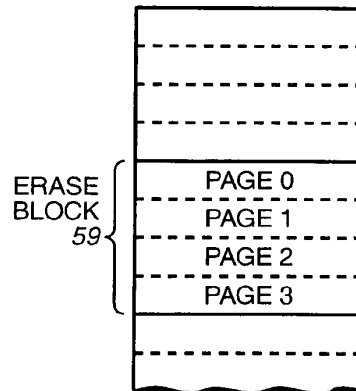
MICRO-PROCESSOR — 37

35 — MEMORY INTERFACE LOGIC

31' —

39 — CODE ROM

OTHER CIRCUITS AND SUBSYSTEMS — 43

**FIG._1B**

| ERASE BLOCK 0 |
| ERASE BLOCK 1 |
| ERASE BLOCK 2 |
| ERASE BLOCK 3 |
| ERASE BLOCK 4 |
| ERASE BLOCK 5 |
| ERASE BLOCK 6 |

**FIG._2**

ERASE BLOCK 59

| PAGE 0 |
| PAGE 1 |
| PAGE 2 |
| PAGE 3 |

**FIG._4**

51 — HOST USER DATA SECTOR

53 — DATA ECC

55 — DATA/BLOCK PARAMETERS

57 — O.H. ECC

OVERHEAD ("O.H.") DATA

**FIG._3**

FIG._5

# DOCKET ALARM
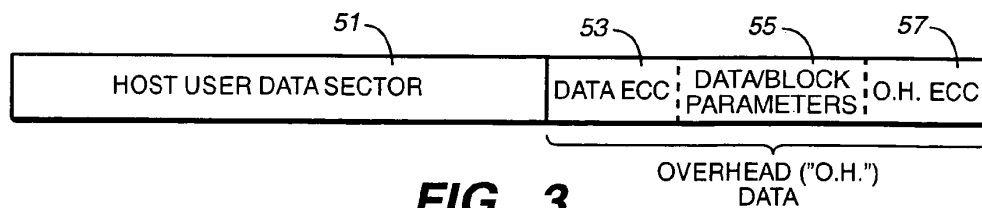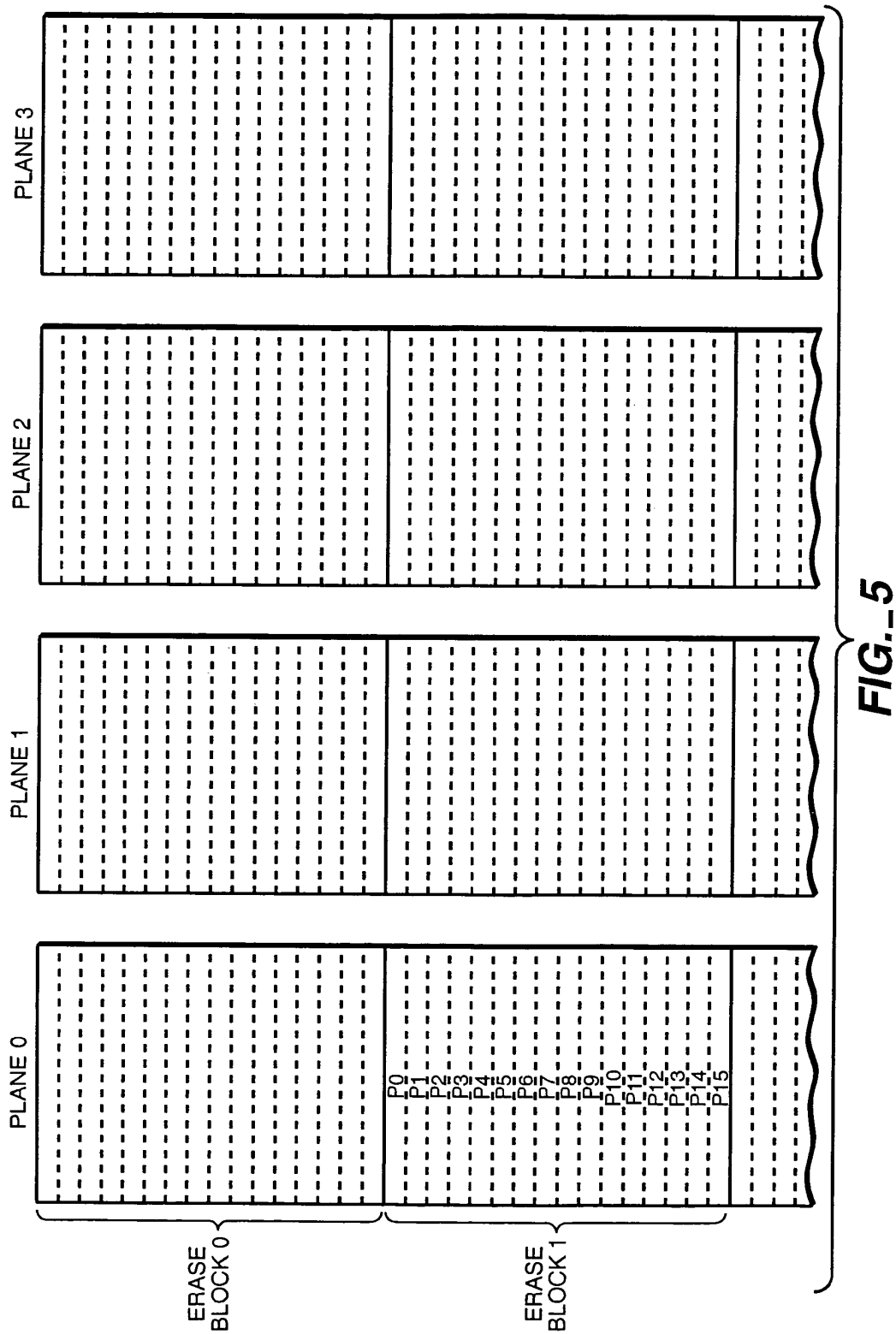
# Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

## Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

## Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

## Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

## API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

### LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

### FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

### E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.