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Ewertz et al.

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- [54] **COMPUTER SYSTEM WITH A PAGED NON-VOLATILE MEMORY**
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Related U.S. Application Data

- [63] Continuation of Ser. No. 137,376, Oct. 14, 1993, Pat. No. 5,371,876, which is a continuation of Ser. No. 698,318, May 10, 1991, abandoned.
- [51] **Int. Cl.⁶** **G06F 12/02**
- [52] **U.S. Cl.** **395/430; 395/479; 395/413; 395/419; 364/DIG. 1**
- [58] **Field of Search** **364/200 MS File, 364/900 MS File; 395/400, 425**

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,153,937	5/1979	Poland	364/706
4,290,104	9/1981	Holtey et al.	395/400
4,374,417	2/1983	Bradley et al.	395/400
4,441,155	4/1984	Fletcher et al.	395/400
4,443,847	4/1984	Bradley et al.	395/425
4,608,632	8/1986	Kummer	395/425
4,763,333	8/1988	Byrd	371/66
4,799,145	1/1989	Goss et al.	395/700
4,831,522	5/1989	Henderson et al.	395/425
4,862,349	4/1989	Foreman et al.	395/700
5,034,915	7/1991	Styma et al.	395/275
5,053,990	10/1991	Kreifels et al.	395/425
5,117,492	5/1992	Nash	395/400
5,126,808	6/1992	Montalvo et al.	357/23.5
5,134,580	7/1992	Bertram et al.	395/650
5,136,713	8/1992	Bealkowski et al.	395/700
5,142,680	8/1992	Ottman et al.	395/700
5,210,875	5/1993	Bealkowski et al.	395/700

OTHER PUBLICATIONS

- Markus A. Levy, "Designing with Flash Memory", *Circuit Cellar Ink*, Dec. 1990, pp. 50-58.
- Jerry Jex, "Flash Memory BIOS For PC and Notebook Computers", *IEEE*, 1990, pp. 692-695.
- Waite, et al., "Soul of CPM", *Howard W. Sams and Co.*, 1983, pp. 2-7, 177-182 and 279-322.

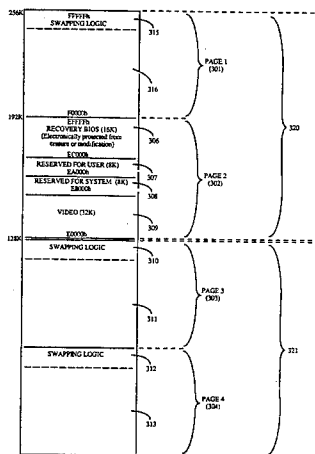
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[57] **ABSTRACT**

A computer system wherein a paging technique is used to expand the useable non-volatile memory capacity beyond a fixed address space limitation. The computer system of the preferred embodiment includes a flash memory component for storing non-volatile code and data including a system BIOS in the upper 128K of memory. The useful BIOS memory space is effectively increased while maintaining the address boundary of the upper 128K region. The address space of the non-volatile memory device is logically separated into distinct pages of memory (Pages 1-4). Using the apparatus and techniques of the present invention, Page 1, Page 3 and Page 4 may be individually swapped into the address space originally occupied by Page 2 (the swappable page area). In the preferred embodiment, Page 2 is held static and thus is not used as a swap area. Each of the swappable pages, Page 1, Page 3, and Page 4, contain processing logic called swapping logic used during the swapping or paging operation. The swapping logic operates in conjunction with paging hardware to effect the swapping of pages into the swappable page area. The high order processor address lines are input by a page decoder. The page decoder is used to modify the address actually presented to the non-volatile memory device. A page register provides a means by which the processor may select a page in non-volatile memory. In an alternative embodiment of the present invention, several different forms of configuration or identification information may be stored in a page of non-volatile memory.

14 Claims, 11 Drawing Sheets



OTHER PUBLICATIONS

Waite et al., "CP/M Bible", 1983, pp. 5-22 and 100.

Brett Glass, "The IBM PC BIOS", *Byte*, Apr. 1989, pp. 303-310.

Gus Venditto, "Pipeline", *PC Magazine* vol. 9, No. 3, Feb. 1990, pp. 1-3.

Bill Machrone, "Bill Machrone", *PC Magazine*, vol. 9, No.

7, Apr. 1990, pp. 1-2.

Gus Venditto, "Intel's flash memory poised to give laptops their next great leap", *PC Magazine* vol. 9, No. 14, Aug. 1990, pp. 1-3.

John H. Wharton, "FLASH! memory technology marches on", *Microprocessor Report*, Aug. 1990, pp. 1-4.

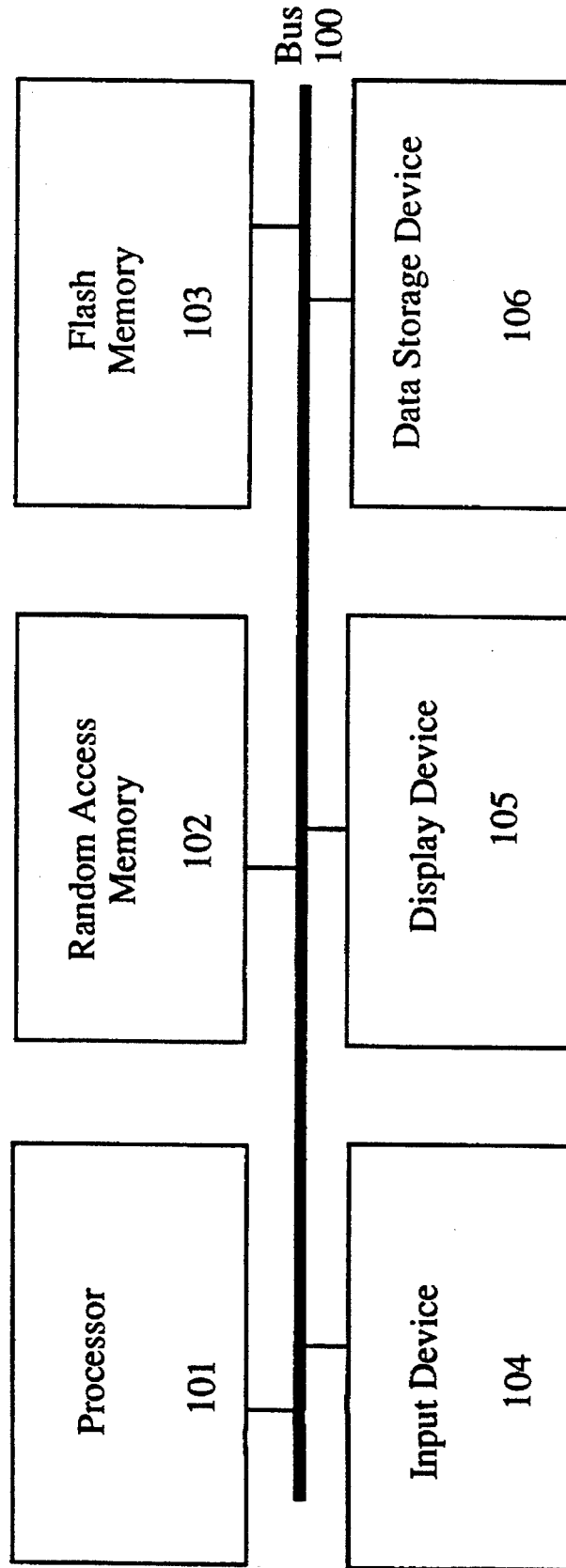


Figure 1

FIGURE 2

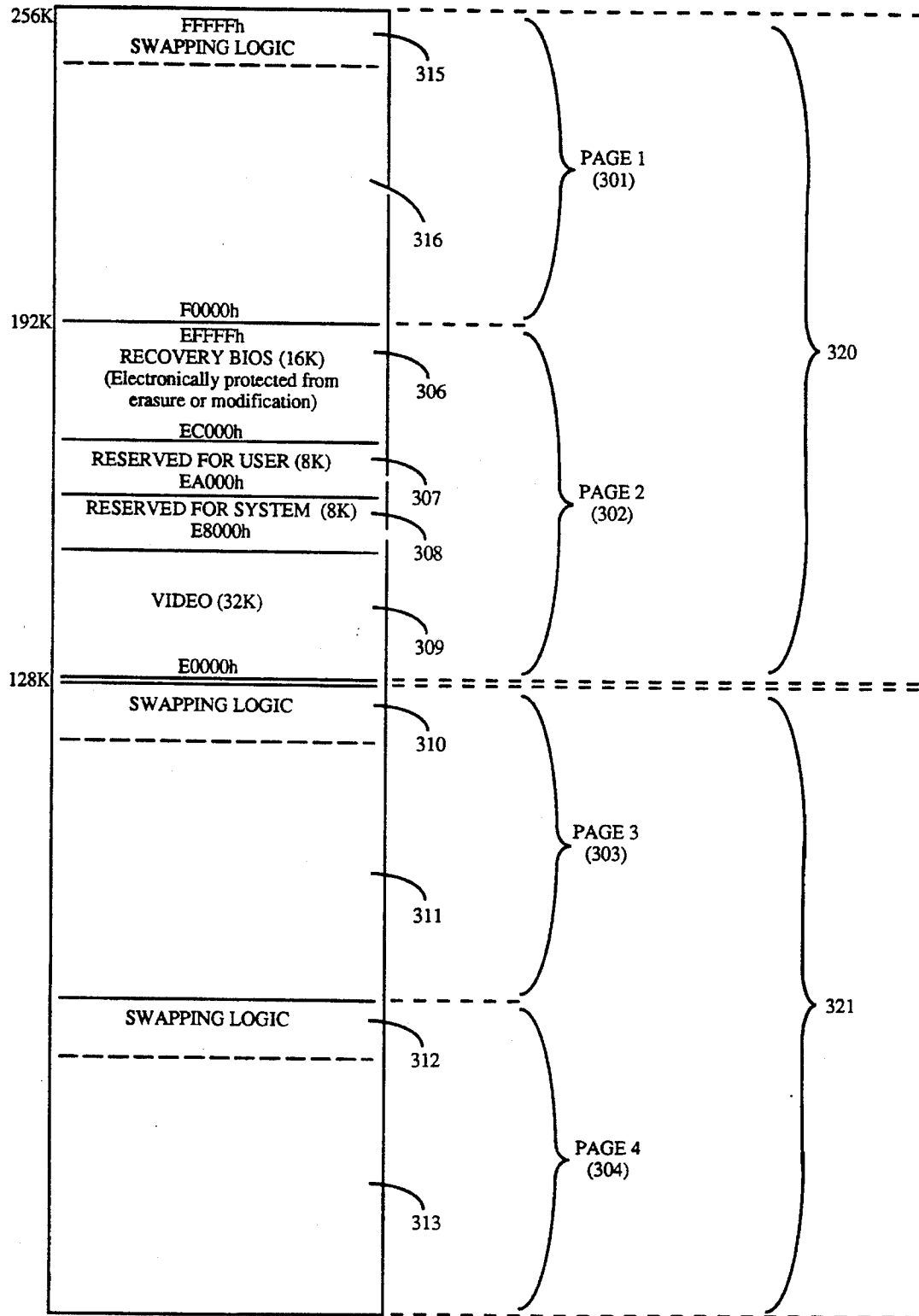


FIGURE 3A

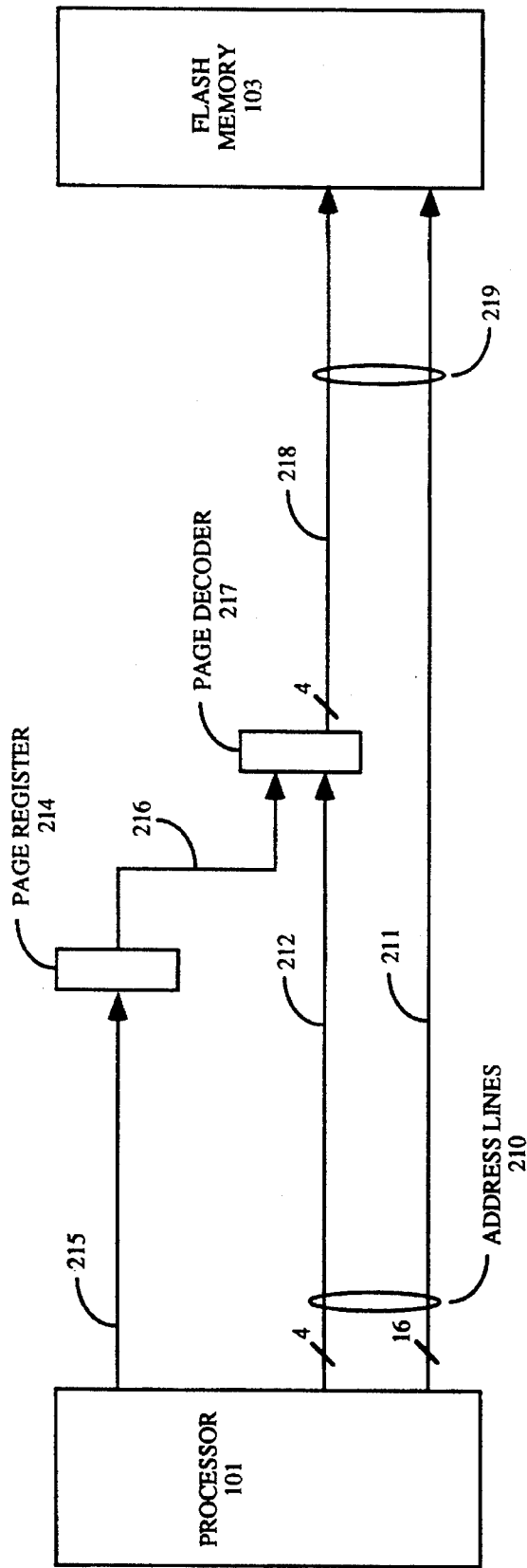


FIGURE 3B

PAGE	PROCESSOR ADDRESS	NON-VOLATILE MEMORY ADDRESS
1	F0000h - FFFFFh (64K)	F0000h - FFFFFh (64K)
2 (STATIC)	E0000h - EFFFFh (64K)	E0000h - EFFFFh (64K)
3	F0000h - FFFFFh (64K)	OTHER ADDRESS RANGE (i.e. D0000h - DFFFFh)
4	F0000h - FFFFFh (64K)	OTHER ADDRESS RANGE (i.e. C0000h - CFFFFh)
N/A	E0000h - EFFFFh (64K)	E0000h - EFFFFh (64K)
N/A	00000h - DFFFFh (64K)	00000h - DFFFFh (64K)

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