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United States Patent [19]

Fujishima et al.

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[54] **SEMICONDUCTOR MEMORY DEVICE FOR SIMPLE CACHE SYSTEM**

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[73] Assignee: **Mitsubishi Denki Kabushiki Kaisha**, Tokyo, Japan

[21] Appl. No.: **564,657**

[22] Filed: **Aug. 9, 1990**

Related U.S. Application Data

[63] Continuation of Ser. No. 266,601, Nov. 3, 1988, abandoned.

[30] **Foreign Application Priority Data**

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Dec. 17, 1987 [JP] Japan 62-322126

[51] **Int. Cl.**[5] **G06F 12/00**; G06F 12/08; G06F 13/00; G11C 7/00

[52] **U.S. Cl.** **395/425**; 365/230.03; 365/63; 365/49; 364/DIG. 1; 364/243.41

[58] **Field of Search** ..... 365/49, 230.03, 63; 364/200 MS File, 900 MS File, 243.4, 243.41, 964, 964.2; 395/425

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,168,541	9/1979	DeKarske	365/49
4,219,883	8/1980	Kobayashi et al.	365/49 X
4,577,293	3/1986	Matick et al.	365/49
4,656,626	4/1987	Yudichak	365/49
4,669,043	5/1987	Kaplinsky	364/200
4,731,758	3/1988	Lam et al.	365/189.05
4,754,433	6/1988	Chin et al.	365/189.02
4,845,677	7/1989	Chappell et al.	365/189.02
4,872,138	10/1989	Ciacci	365/49
4,926,385	5/1990	Fujishima et al.	365/230.03
4,953,073	8/1990	Moussouris et al.	364/200
5,014,240	5/1991	Suzuki	365/49
5,111,386	5/1992	Fujishima et al.	395/425

OTHER PUBLICATIONS

Asakura et al., "An Experimental 1Mb Cache DRAM with ECC", *1989 Symposium on VLSI Circuits* (May 25-27, 1989), pp. 43-44.

Asakura et al., "An Experimental 1-Mbit Cache DRAM with ECC", *IEEE Journal of Solid-State Circuits*, vol. 25, No. 1 (Feb. 1990), pp. 5-10.

Hidaka et al., "The Cache DRAM Architecture: A DRAM with an On-Chip Cache Memory", *IEEE Micro* (Apr. 1990) pp. 15-24.

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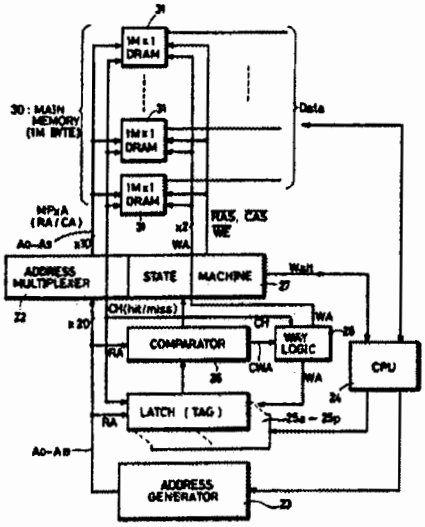
[57] **ABSTRACT**

A semiconductor memory device comprises a DRAM memory cell array comprising a plurality of dynamic type memory cells arranged in a plurality of rows and columns, and an SRAM memory cell array comprising static type memory cells arranged in a plurality of rows and columns. The DRAM memory cell array is divided into a plurality of blocks each comprising a plurality of columns. The SRAM memory cell array is divided into a plurality of blocks each comprising a plurality of columns, corresponding to the plurality of blocks in the DRAM memory cell array. The SRAM memory cell array is used as a cache memory. At the time of cache hit, data is accessed to the SRAM memory cell array. At the time of cache miss, data is accessed to the DRAM memory cell array. On this occasion, data corresponding to one row in each of the blocks in the DRAM memory cell array is transferred to one row in the corresponding block in the SRAM memory cell array.

19 Claims, 12 Drawing Sheets



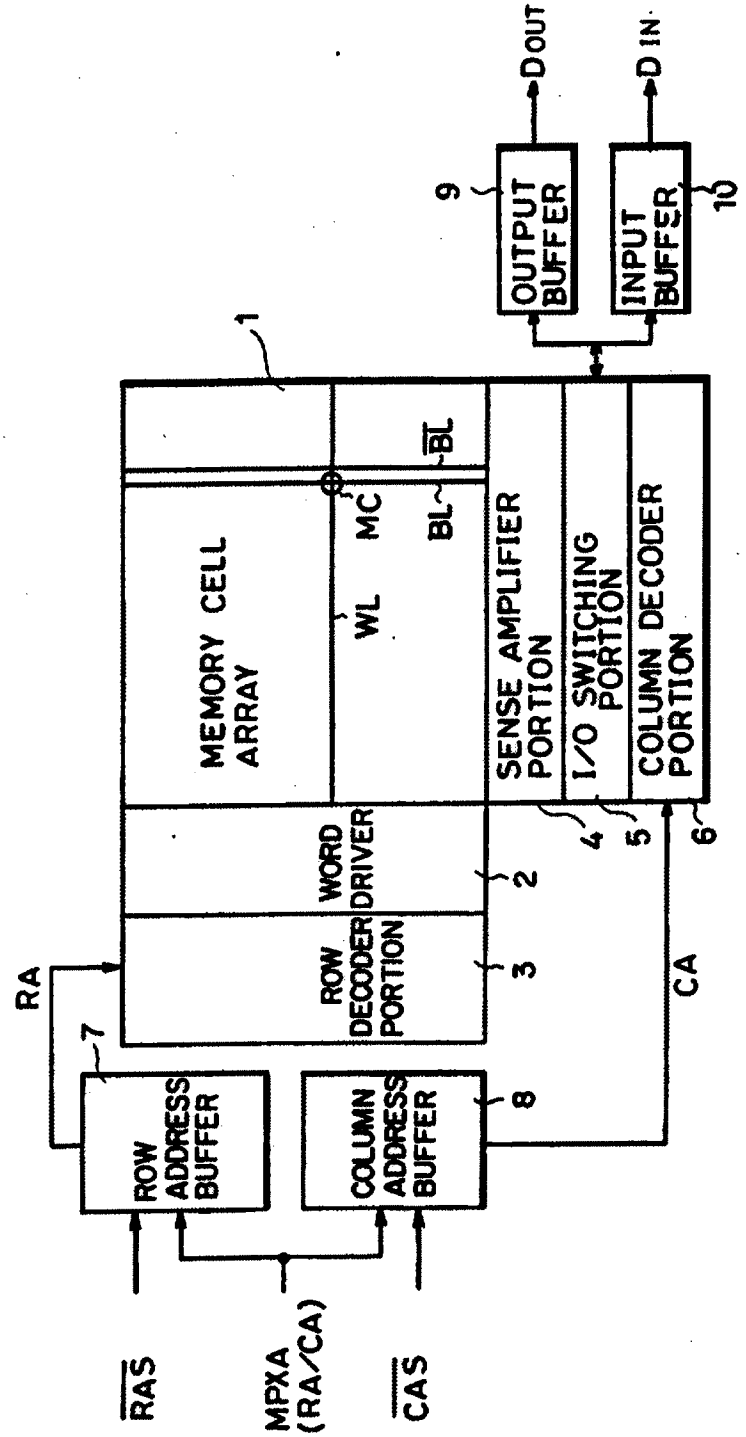


FIG.1 PRIOR ART

FIG.2A PRIOR ART

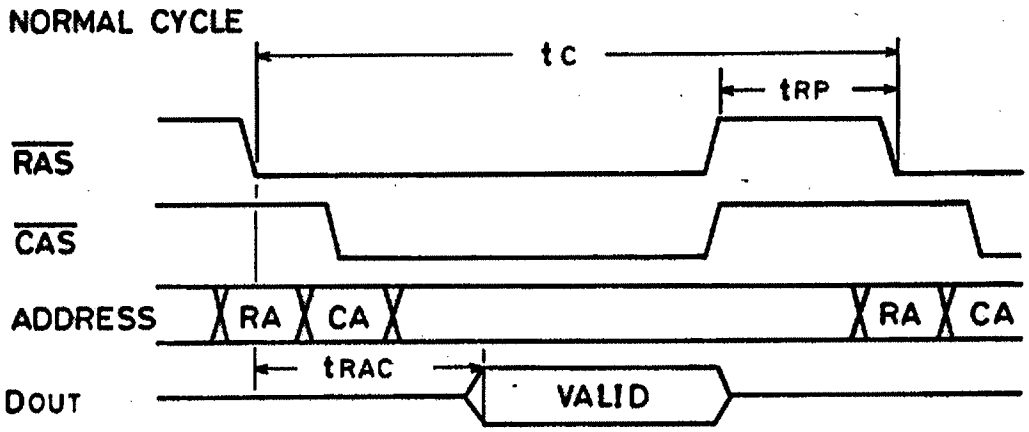


FIG.2B PRIOR ART

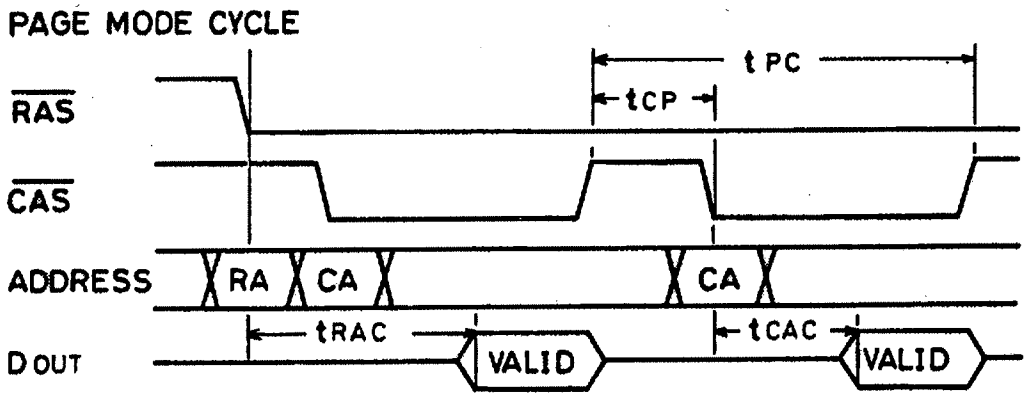


FIG.2C PRIOR ART

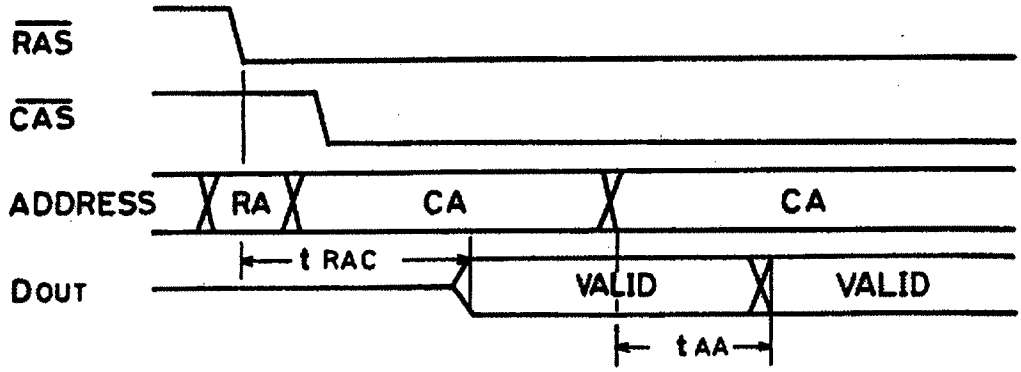
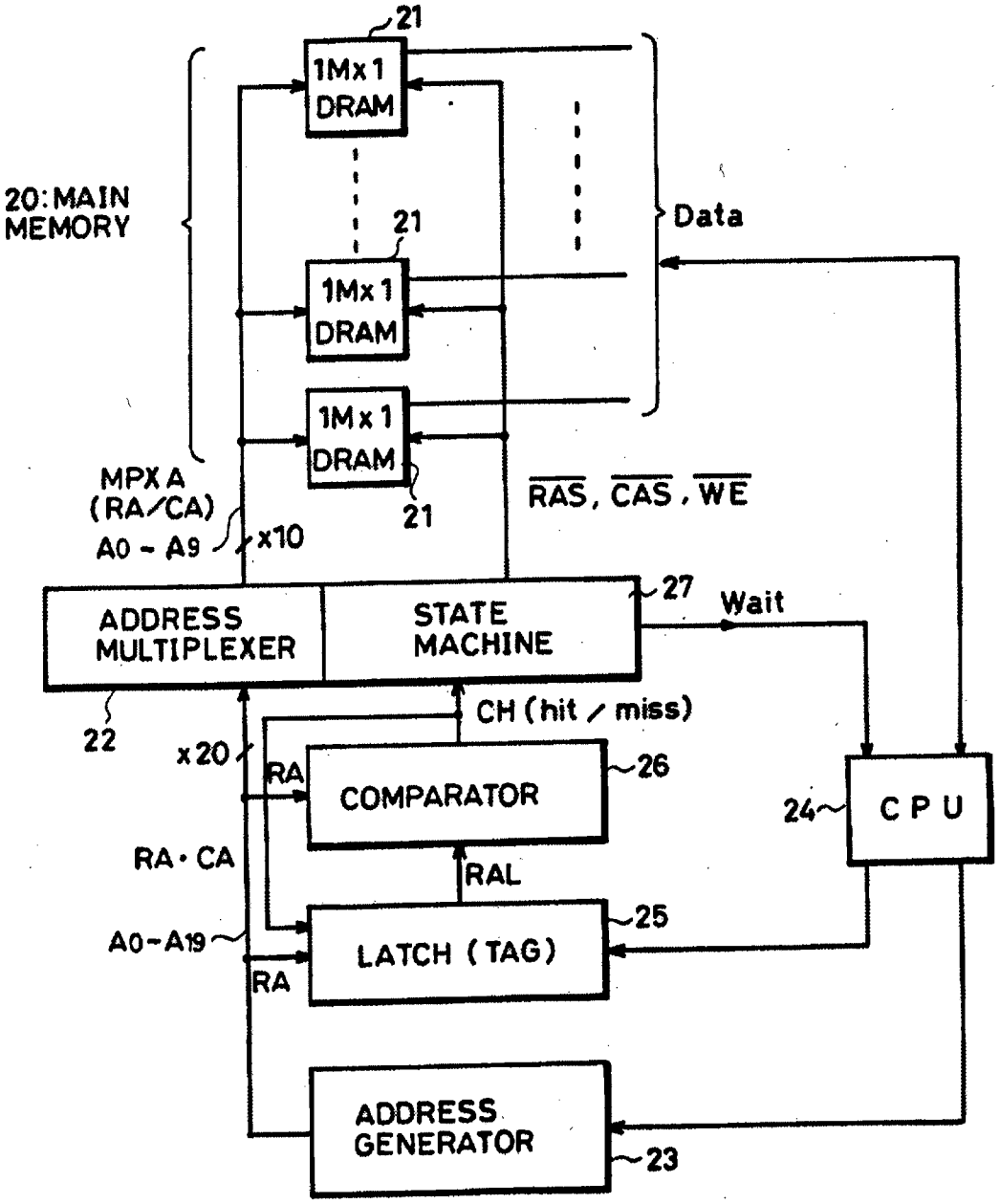


FIG. 3 PRIOR ART



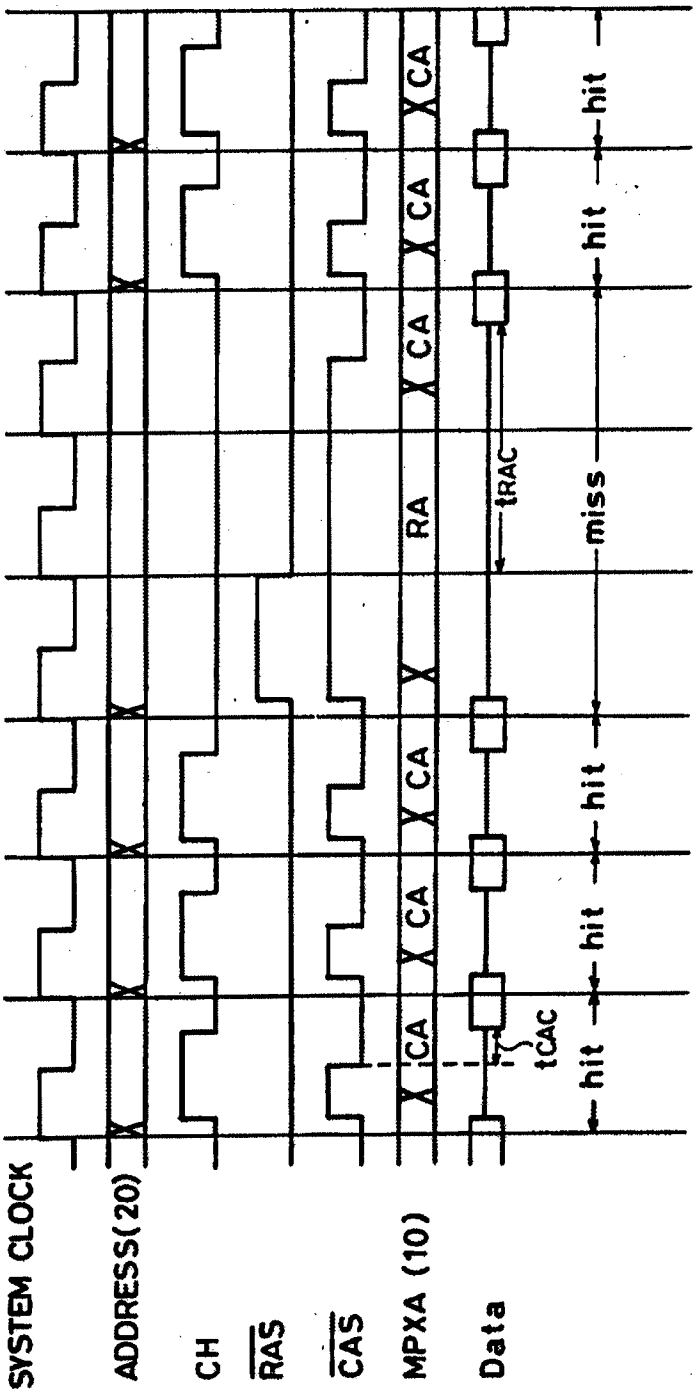


FIG.4 PRIOR ART

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