

- [54] **SOLID STATE DISK DRIVE UNIT HAVING ON-BOARD BACKUP NON-VOLATILE MEMORY**
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- [52] U.S. Cl. .... **395/750; 395/182.04; 395/471; 395/431**
- [58] Field of Search ..... **395/400, 425**

OTHER PUBLICATIONS

Amaru, Christopher, "Solid-state SCSI—affordable luxury." Digital Review, v. 9, N. 13 p. 27(2), Jul. 13, 1992.  
 Chen, Peter M. et al, "Storage Performance—Metrics and Benchmarks." Proc. of the IEEE, Aug. 1993, v. 81, Issue 8, pp. 1151–1165.

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[57] **ABSTRACT**

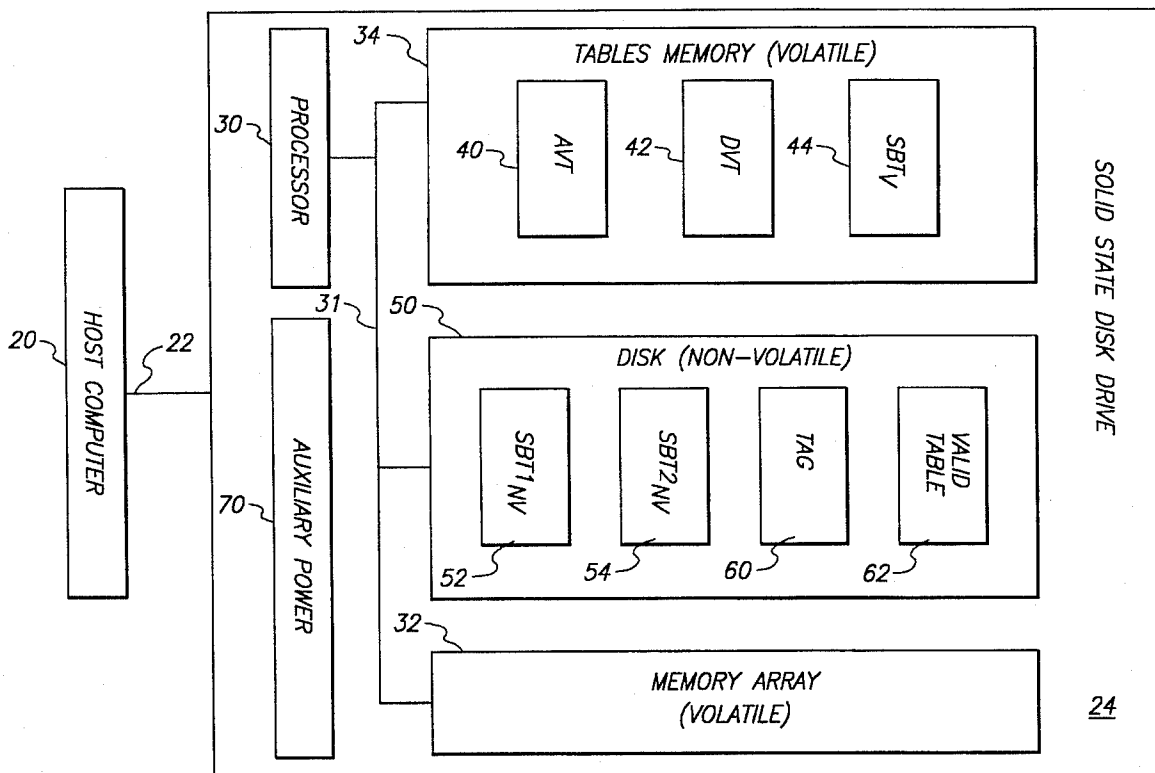
Disclosed is a solid state disk drive, including a volatile, electronic RAM, memory and a non volatile, magnetic disk. The drive continuously saves unique data stored in the memory back to the disk. Additionally, the drive includes a number of tables and bit fields, in both volatile electronic memory and disk, for generally keeping track of what data has been restored from disk to memory, what data in the memory has been modified since it was restored from disk, and what modified data in the memory has been saved back to disk. In the event of a primary power outage, the drive first saves the volatile tables onto disk, and then saves the volatile, modified data onto disk, while using auxiliary power. If, however, auxiliary power is lost before any or all of the modified data is saved on disk, the saved tables provide information which enables the drive to distinguish the valid from the invalid data on disk.

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,394,732	7/1983	Swenson .....	395/425
4,506,323	3/1985	Pusic et al. ....	395/425
4,811,203	3/1989	Hamstra .....	395/425
5,034,915	7/1991	Sturma et al. ....	395/425
5,197,026	3/1993	Butler .....	365/104
5,379,415	1/1995	Papenberg et al. ....	395/575
5,396,637	3/1995	Harwell et al. ....	395/750
5,418,925	5/1995	DeMoss et al. ....	395/425

27 Claims, 22 Drawing Sheets



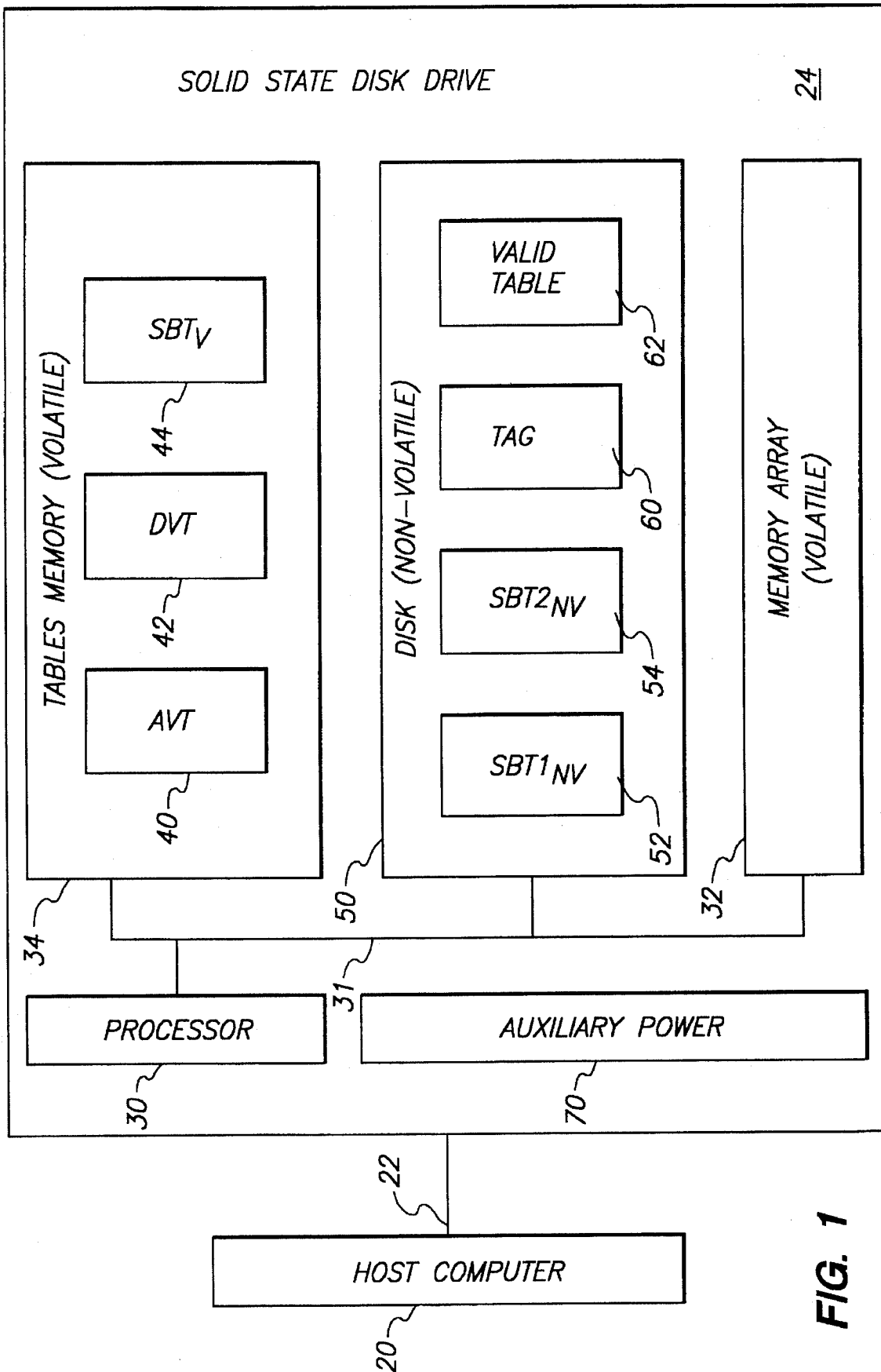


FIG. 1

*DISK 50  
(NON-VOLATILE)*

ADDR.	DATA	DISK TAGS
0	DATA	*
1	DATA	*
2	DATA	*
3	DATA	*
4	DATA	*
5	DATA	*
6	DATA	*
...	...	...
(N-2)	DATA	*
(N-1)	DATA	*

*MEMORY ARRAY 32  
(VOLITILE)*

ADDR.	DATA
0	*
1	*
2	*
3	*
4	*
5	*
6	*
...	...
(N-2)	*
(N-1)	*

**FIG. 2A** (AT T1)

*DISK 50  
(NON-VOLATILE)*

ADDR.	SBT nv 52	SBT nv 54	TAG 60	TBL. VAL. 62
0	*	*	*	*
1	*	*		
2	*	*		
3	*	*		
4	*	*		
5	*	*		
6	*	*		
...	...	...		
(N-2)	*	*		
(N-1)	*	*		
CNTR	*	*		

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*TABLES MEMORY 34  
(VOLITILE)*

ADDR.	AVT 40	DVT 42	SBTV 44
0	*	*	*
1	*	*	*
2	*	*	*
3	*	*	*
4	*	*	*
5	*	*	*
6	*	*	*
...	...	...	...
(N-2)	*	*	*
(N-1)	*	*	*

**FIG. 3A** (AT T1)

*DISK 50  
(NON-VOLATILE)*

ADDR.	DATA	DISK TAGS
0	DATA	1
1	DATA	1
2	DATA	1
3	DATA	1
4	DATA	1
5	DATA	1
6	DATA	1
...	...	...
(N-2)	DATA	1
(N-1)	DATA	1

*MEMORY ARRAY 32  
(VOLITILE)*

ADDR.	DATA
0	*
1	*
2	*
3	*
4	*
5	*
6	*
...	...
(N-2)	*
(N-1)	*

**FIG. 2B** (AT T2)

*DISK 50  
(NON-VOLATILE)*

ADDR.	SBT nv 52	SBT nv 54	TAG 60	TBL. VAL. 62
0	0	0	1	1
1	0	0		
2	0	0		
3	0	0		
4	0	0		
5	0	0		
6	0	0		
...	...	...		
(N-2)	0	0		
(N-1)	0	0		
CNTR	0	1		

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*TABLES MEMORY 34  
(VOLITILE)*

ADDR.	AVT 40	DVT 42	SBTV 44
0	0	0	0
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
...	...	...	...
(N-2)	0	0	0
(N-1)	0	0	0

**FIG. 3B** (AT T2)

*DISK 50  
(NON-VOLATILE)*

ADDR.	DATA	DISK TAGS
0	DATA	1
1	DATA	1
2	DATA	1
3	DATA	1
4	DATA	1
5	DATA	1
6	DATA	1
...	...	...
(N-2)	DATA	1
(N-1)	DATA	1

*MEMORY ARRAY 32  
(VOLITILE)*

ADDR.	DATA
0	DATA
1	*
2	*
3	*
4	*
5	*
6	*
...	...
(N-2)	*
(N-1)	*

**FIG. 2C** (AT T3)

*DISK 50  
(NON-VOLATILE)*

ADDR.	SBT nv 52	SBT nv 54	TAG 60	TBL. VAL. 62
0	0	0	1	1
1	0	0		
2	0	0		
3	0	0		
4	0	0		
5	0	0		
6	0	0		
...	...	...		
(N-2)	0	0		
(N-1)	0	0		
CNTR	0	1		

90 92

*TABLES MEMORY 34  
(VOLITILE)*

ADDR.	AVT 40	DVT 42	SBTV 44
0	1	1	0
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
...	...	...	...
(N-2)	0	0	0
(N-1)	0	0	0

**FIG. 3C** (AT T3)

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