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**Lee et al.**

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(54) **HYBRID SSD USING A COMBINATION OF SLC AND MLC FLASH MEMORY ARRAYS**  
(75) Inventors: **Charles C. Lee**, Cupertino, CA (US);  
**David Q. Chow**, San Jose, CA (US);  
**Abraham Chih-Kang Ma**, Fremont, CA (US);  
**I-Kang Yu**, Palo Alto, CA (US);  
**Ming-Shiang Shen**, Taipei Hsien (TW)

6,230,233	B1	5/2001	Lofgren et al.
6,275,894	B1	8/2001	Kuo et al.
6,321,478	B1	11/2001	Klebes
6,324,620	B1 *	11/2001	Christenson et al. .... 711/112
6,418,009	B1 *	7/2002	Brunette ..... 361/306.3
6,547,130	B1	4/2003	Shen
6,636,929	B1	10/2003	Frantz et al.
6,718,407	B2	4/2004	Martwick
6,880,024	B2	4/2005	Chen et al.
7,103,765	B2	9/2006	Chen
7,228,299	B1 *	6/2007	Harmer et al. .... 707/3
7,257,714	B1	8/2007	Shen
2001/0043174	A1	11/2001	Jacobsen et al.
2002/0166023	A1	11/2002	Nolan et al.
2003/0046510	A1	3/2003	North
2003/0163656	A1	8/2003	Ganton
2004/0148482	A1	7/2004	Grundy et al.
2004/0255054	A1	12/2004	Pua et al.
2005/0102444	A1	5/2005	Cruz

(73) Assignee: **Super Talent Electronics, Inc.**, San Jose, CA (US)

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**G06F 13/00** (2006.01)  
(52) **U.S. Cl.** ..... **711/103**; 711/E12.083  
(58) **Field of Classification Search** ..... None  
See application file for complete search history.

(56) **References Cited**  
U.S. PATENT DOCUMENTS

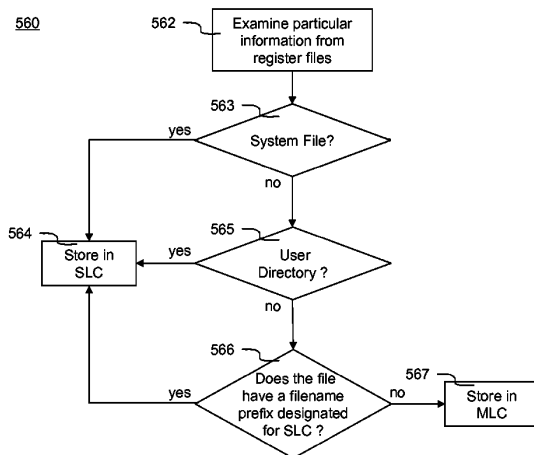
5,623,552	A	4/1997	Lane
5,907,856	A	5/1999	Estakhri et al.
5,959,541	A	9/1999	DiMaria et al.
6,000,006	A	12/1999	Bruce et al.
6,012,636	A	1/2000	Smith
6,069,920	A	5/2000	Schulz et al.
6,081,858	A	6/2000	Abudayyeh et al.
6,125,192	A	9/2000	Bjorn et al.
6,193,152	B1	2/2001	Fernando et al.
6,202,138	B1	3/2001	Estakhri et al.

Primary Examiner — Pierre-Michel Bataille  
Assistant Examiner — Sean D Rossiter  
(74) *Attorney, Agent, or Firm* — Roger H. Chu

(57) **ABSTRACT**

Hybrid solid state drives (SSD) using a combination of single-level cell (SLC) and multi-level cell (MLC) flash memory arrays are described. According to one aspect of the present invention, a hybrid SSD is built using a combination SLC and MLC flash memory arrays. The SSD also includes a micro-controller to control and coordinate data transfer from a host computing device to either the SLC flash memory array of the MLC flash memory array. A memory selection indicator is determined by triaging data file based on one or more criteria, which include, but is not limited to, storing system files and user directories in the SLC flash memory array and storing user files in the MLC flash memory array; or storing more frequent access files in the SLC flash memory array, while less frequent accessed files in the MLC flash memory array.

**20 Claims, 14 Drawing Sheets**



U.S. PATENT DOCUMENTS

2005/0120146	A1	6/2005	Chen et al.	2006/0206702	A1	9/2006	Fausak	
2005/0160213	A1	7/2005	Chen	2006/0242395	A1	10/2006	Fausak	
2005/0193161	A1	9/2005	Lee et al.	2006/0271731	A1*	11/2006	Kilian et al.	711/108
2005/0246243	A1	11/2005	Adams et al.	2007/0113267	A1	5/2007	Iwanski et al.	
2005/0251617	A1*	11/2005	Sinclair et al.	2008/0104309	A1*	5/2008	Cheon et al.	711/103
2005/0268082	A1	12/2005	Poisner	2008/0112238	A1*	5/2008	Kim et al.	365/200
2006/0065743	A1	3/2006	Fruhauf	2008/0126680	A1*	5/2008	Lee et al.	711/103
2006/0075174	A1	4/2006	Vuong	2009/0100244	A1*	4/2009	Chang et al.	711/172
2006/0106962	A1	5/2006	Woodbridge et al.	2009/0248965	A1*	10/2009	Lee et al.	711/103
2006/0161725	A1	7/2006	Lee et al.	2010/0082883	A1*	4/2010	Chen et al.	711/103

\* cited by examiner

**FIG. 1**

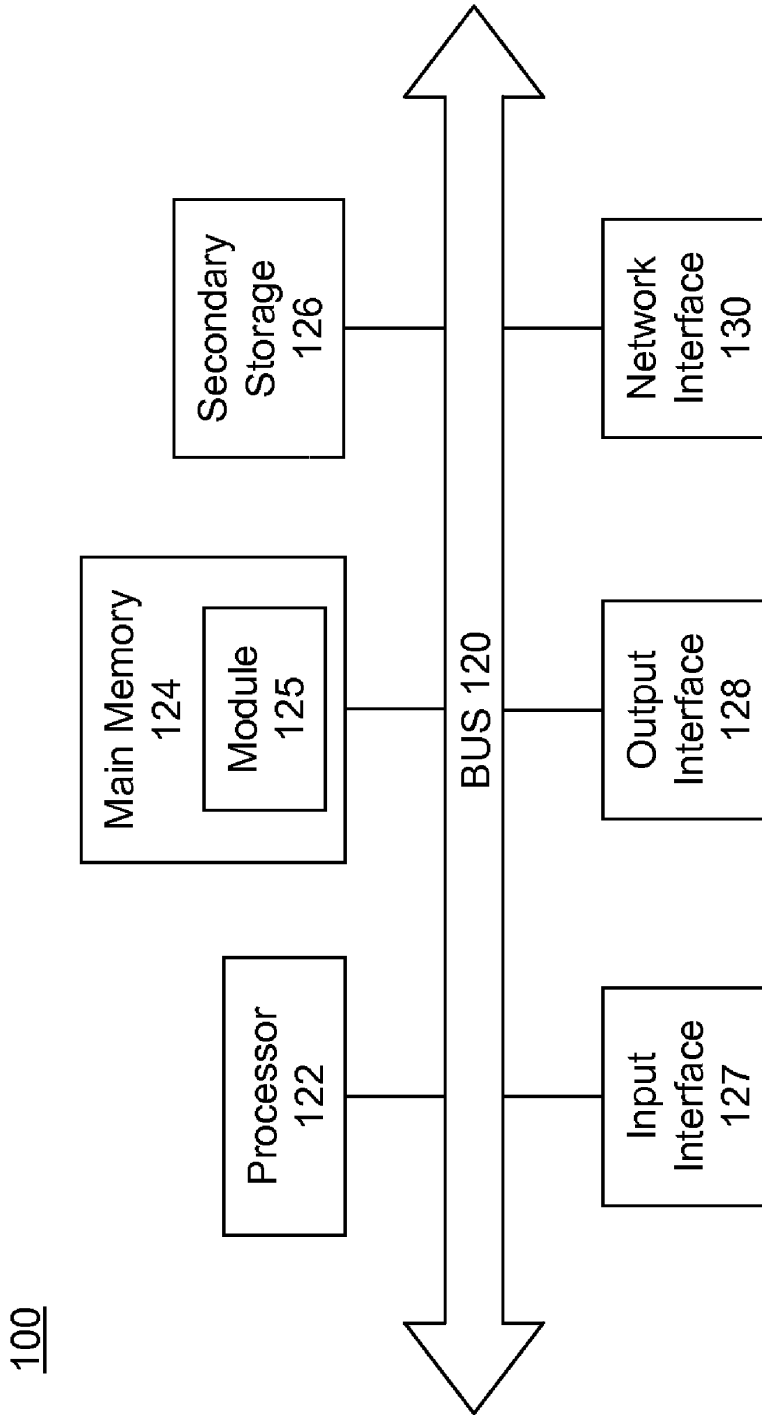


FIG. 2

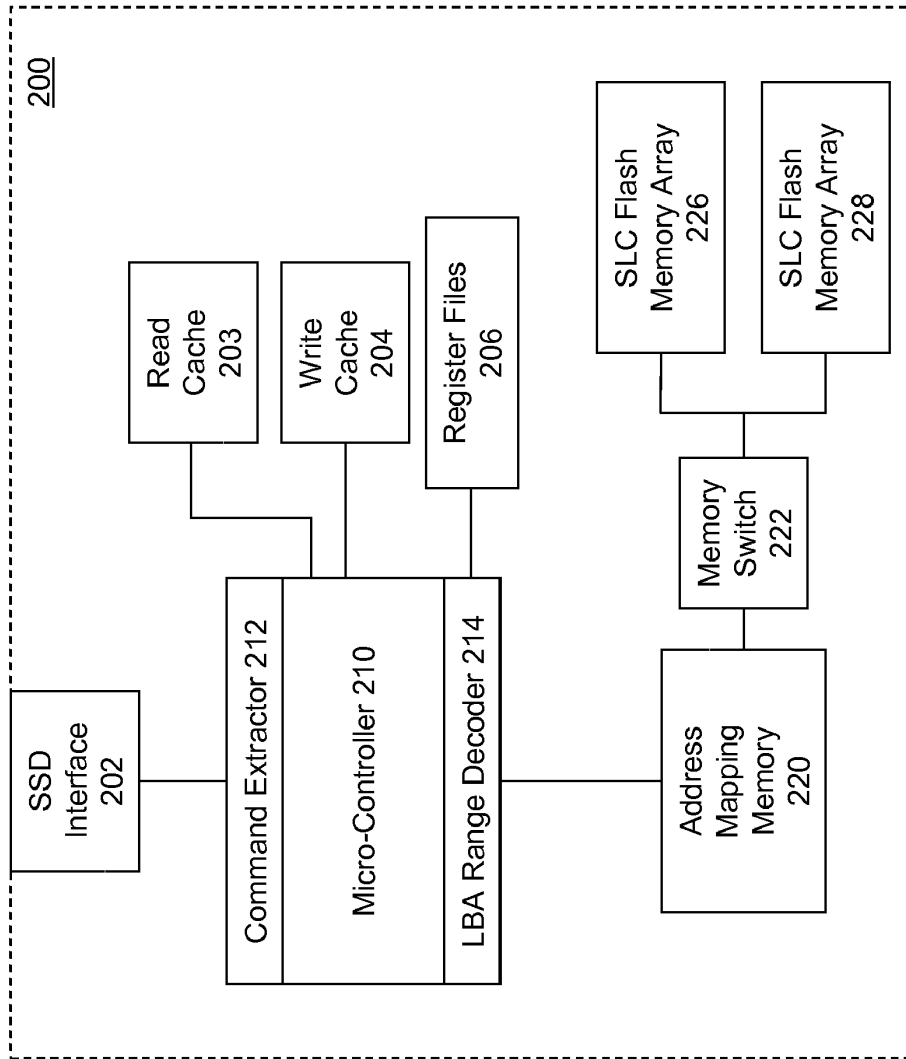
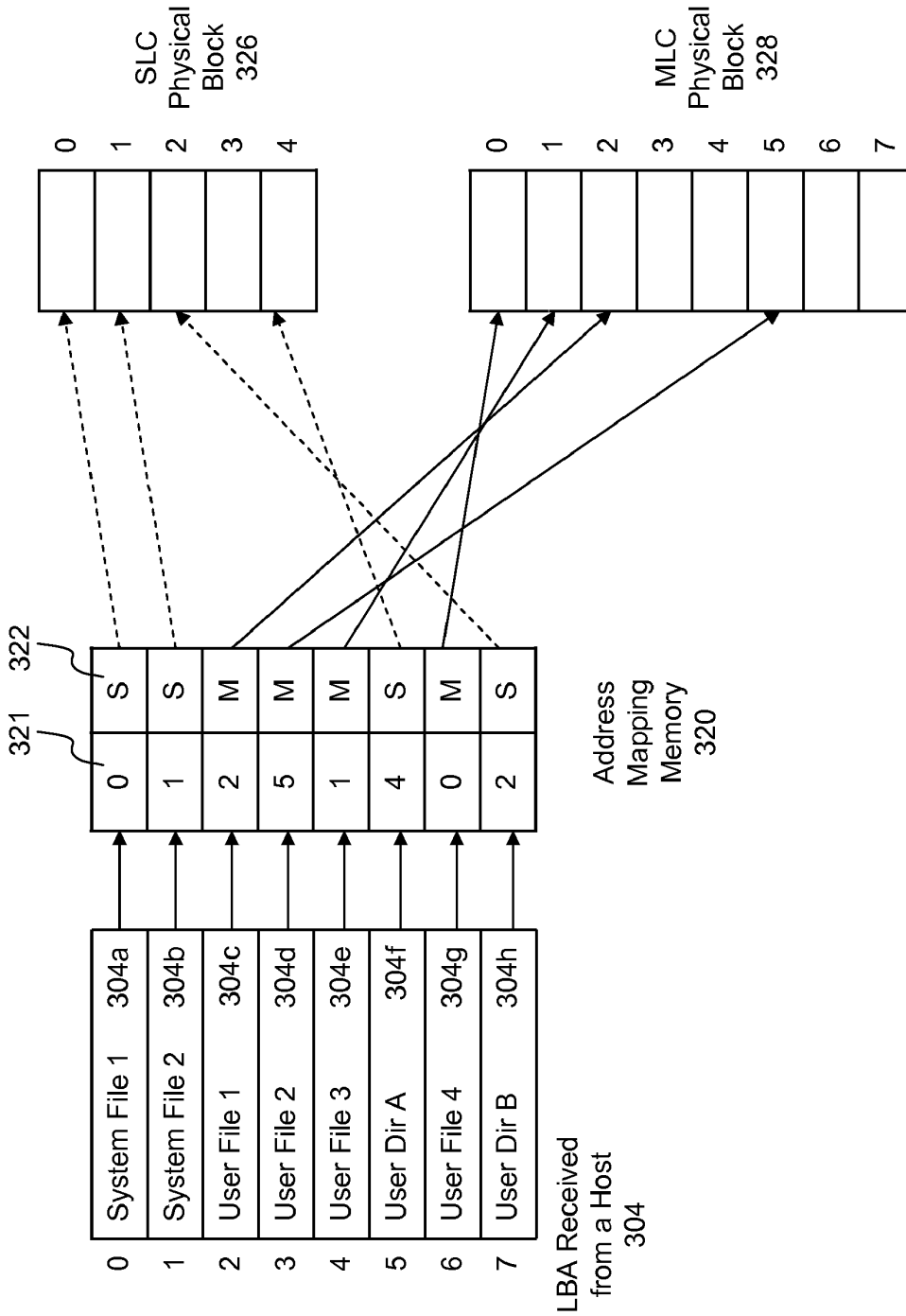


FIG. 3



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