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(12) **United States Patent**
**Dye**

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(54) **MEMORY CONTROLLER INCLUDING EMBEDDED DATA COMPRESSION AND DECOMPRESSION ENGINES**

(75) Inventor: **Thomas A. Dye**, Austin, TX (US)

(73) Assignee: **Interactive Silicon, Inc.**, Austin, TX (US)

( * ) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Under 35 U.S.C. 154(b), the term of this patent shall be extended for 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **08/916,464**

(22) Filed: **Aug. 8, 1997**

**Related U.S. Application Data**

(60) Continuation of application No. 08/463,106, filed on Jun. 5, 1995, now abandoned, which is a division of application No. 08/340,667, filed on Nov. 16, 1994, now Pat. No. 6,002,411.

(51) **Int. Cl.**[7] ..... **G06F 13/00**

(52) **U.S. Cl.** ..... **711/170**; 711/159; 711/160; 711/165; 711/155; 710/68; 709/247; 345/202; 345/521; 382/232

(58) **Field of Search** ..... 395/341, 888, 395/133, 159; 711/203, 170, 160, 133, 134, 136, 155, 159, 165; 709/247; 345/521, 202, 509; 710/68; 714/763, 764; 382/232

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 4,008,460 | * | 2/1977 | Bryant et al. | 395/463 |
| 4,688,108 | * | 8/1987 | Cotton et al. | 358/261.1 |
| 4,881,075 | * | 11/1989 | Weng | 341/87 |
| 4,929,946 | * | 5/1990 | O'Brien et al. | 341/87 |

(List continued on next page.)

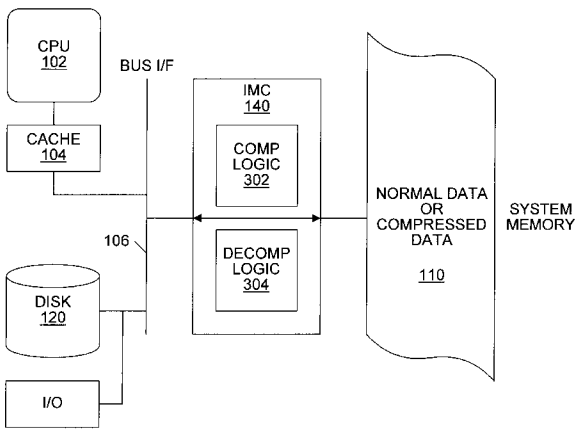
* cited by examiner

*Primary Examiner*—Eddie P. Chan
*Assistant Examiner*—Hong Kim
(74) *Attorney, Agent, or Firm*—Conley, Rose & Tayon, PC; Jeffrey C. Hood

(57) **ABSTRACT**

An integrated memory controller (IMC) which includes data compression and decompression engines for improved performance. The memory controller (IMC) of the present invention preferably sits on the main CPU bus or a high speed system peripheral bus such as the PCI bus and couples to system memory. The IMC preferably uses a lossless data compression and decompression scheme. Data transfers to and from the integrated memory controller of the present invention can thus be in either two formats, these being compressed or normal (non-compressed). The IMC also preferably includes microcode for specific decompression of particular data formats such as digital video and digital audio. Compressed data from system I/O peripherals such as the hard drive, floppy drive, or local area network (LAN) are decompressed in the IMC and stored into system memory or saved in the system memory in compressed format. Thus, data can be saved in either a normal or compressed format, retrieved from the system memory for CPU usage in a normal or compressed format, or transmitted and stored on a medium in a normal or compressed format. Internal memory mapping allows for format definition spaces which define the format of the data and the data type to be read or written. Software overrides may be placed in applications software in systems that desire to control data decompression at the software application level. The integrated data compression and decompression capabilities of the IMC remove system bottle-necks and increase performance. This allows lower cost systems due to smaller data storage requirements and reduced bandwidth requirements. This also increases system bandwidth and hence increases system performance. Thus the IMC of the present invention is a significant advance over the operation of current memory controllers.

**97 Claims, 19 Drawing Sheets**



U.S. PATENT DOCUMENTS


| | | | | |
|---|---|---|---|---|
| 5,237,460 | * | 8/1993 | Miller et al. | 395/888 |
| 5,247,638 | * | 9/1993 | O'Brien et al. | 395/888 |
| 5,247,646 | * | 9/1993 | Osterlund et al. | 395/888 |
| 5,353,425 | * | 10/1994 | Matamy et al. | 711/144 |
| 5,357,614 | * | 10/1994 | Pattisam et al. | 395/250 |
| 5,396,343 | * | 3/1995 | Hanselman | 358/426 |
| 5,420,696 | * | 5/1995 | Wegeng et al. | 358/468 |
| 5,455,577 | * | 10/1995 | Slivka et al. | 341/51 |
| 5,479,587 | * | 12/1995 | Campbell et al. | 358/1.17 |
| 5,483,622 | * | 1/1996 | Zimmerman et al. | 358/1.15 |
| 5,504,842 | * | 4/1996 | Gentile | 358/1.15 |
| 5,548,742 | * | 8/1996 | Wang et al. | 711/128 |
| 5,559,978 | * | 9/1996 | Spilo | 711/203 |
| 5,563,595 | | 10/1996 | Strohacker | 341/106 |
| 5,584,008 | * | 12/1996 | Shimada et al. | 711/114 |
| 5,602,976 | * | 2/1997 | Cooper et al. | 358/1.17 |
| 5,606,428 | * | 2/1997 | Hanselman | 358/404 |
| 5,652,878 | * | 7/1997 | Craft | 707/1 |
| 5,696,912 | * | 12/1997 | Bicevskis et al. | 395/308 |
| 5,696,926 | * | 12/1997 | Culbert et al. | 711/203 |
| 5,699,539 | * | 12/1997 | Garber et al. | 711/2 |
| 5,708,763 | * | 1/1998 | Peltzer | 395/115 |
| 5,812,817 | * | 9/1998 | Hovis et al. | 711/173 |
| 5,828,877 | | 10/1998 | Pearce et al. | 395/670 |

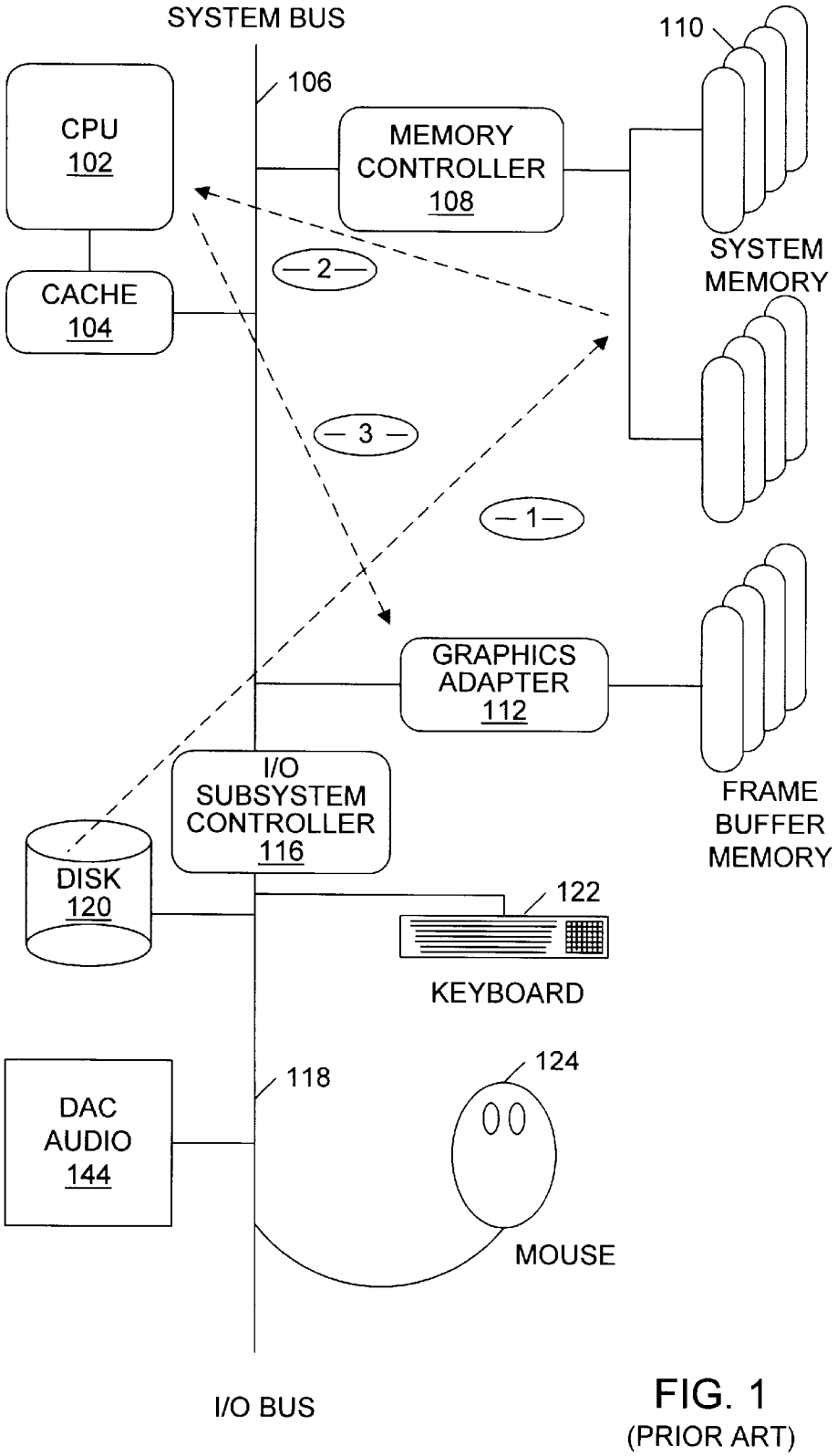



FIG. 1
(PRIOR ART)

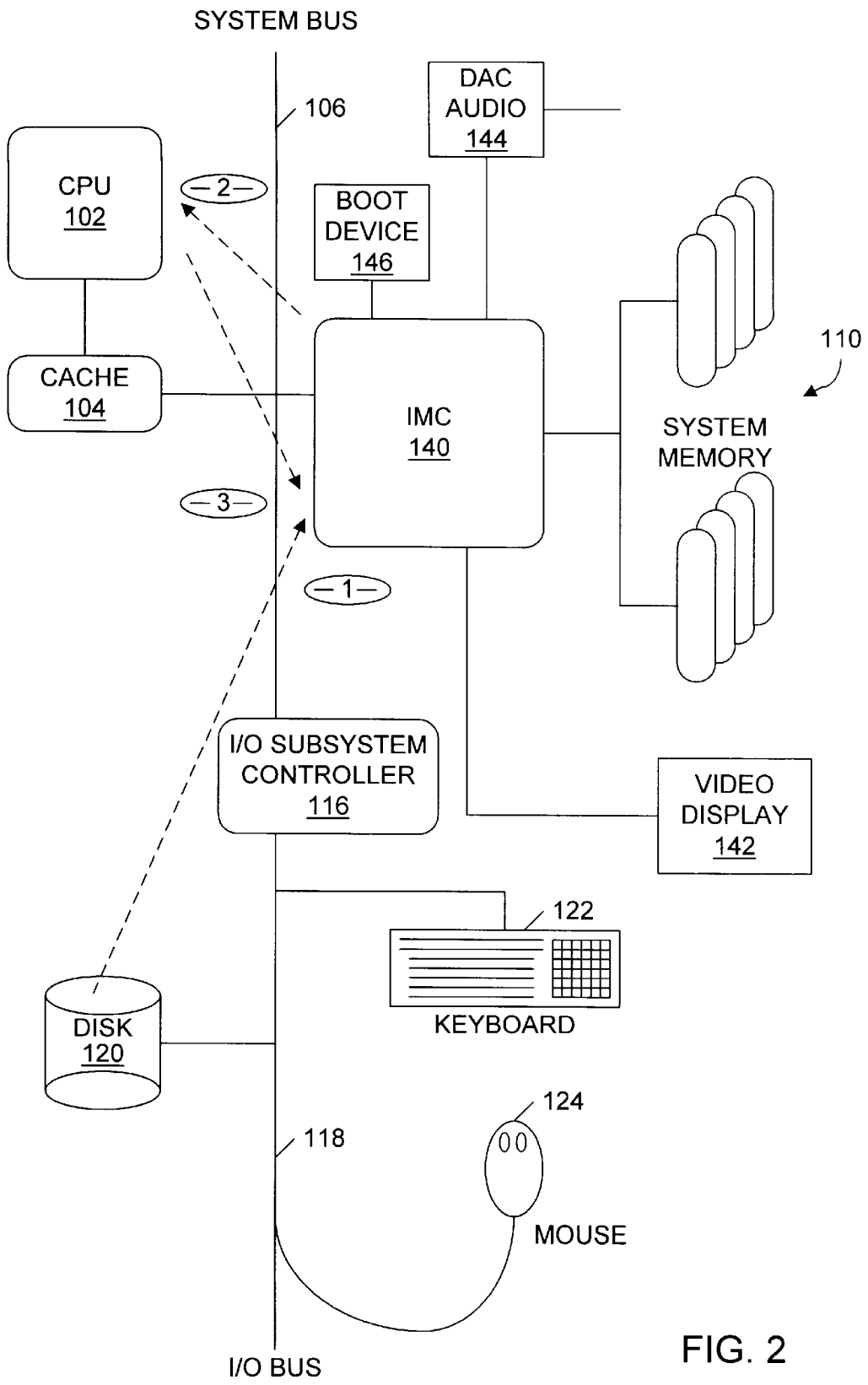



FIG. 2

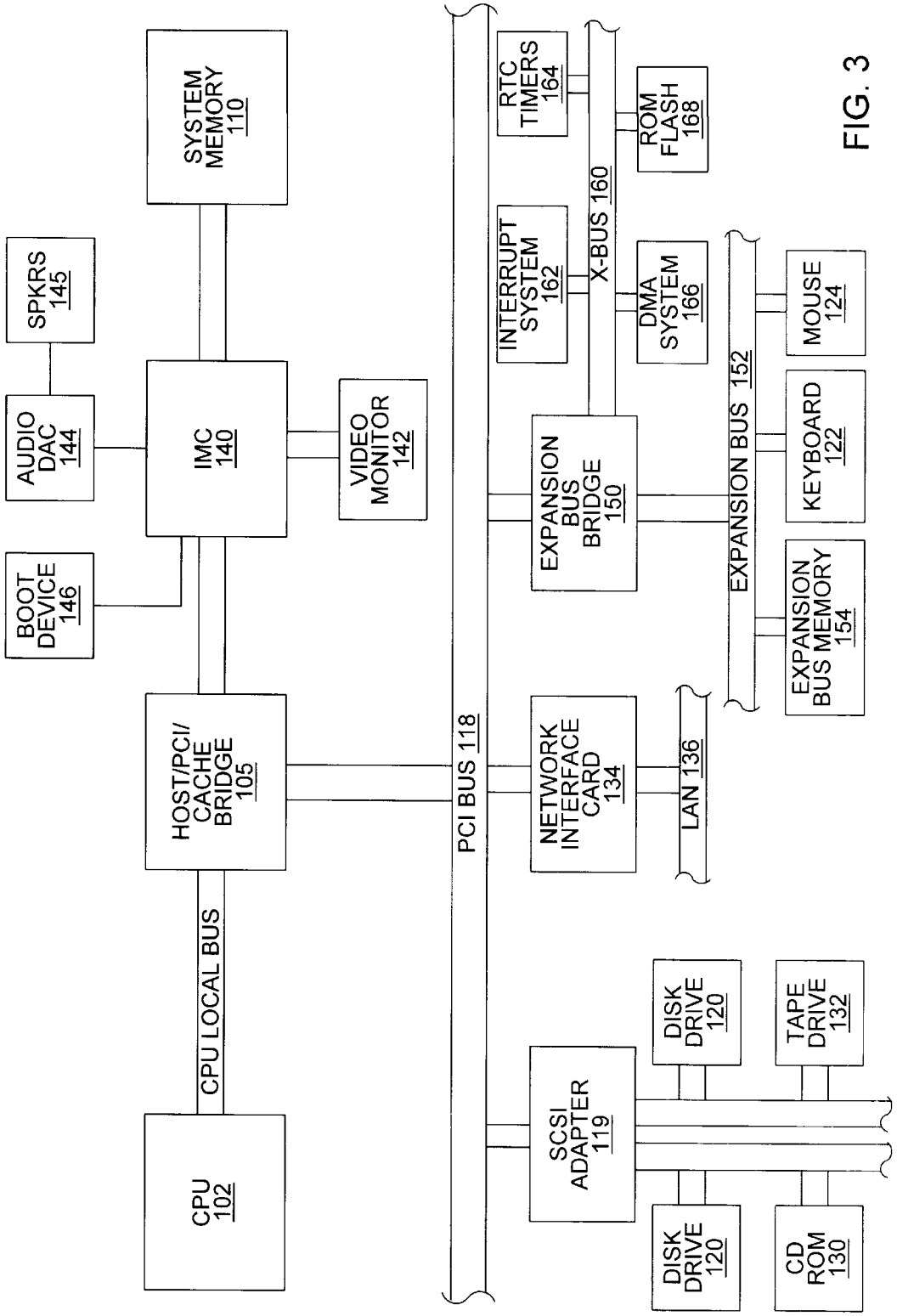



FIG. 3

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