

**(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.<sup>7</sup>** ..... **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

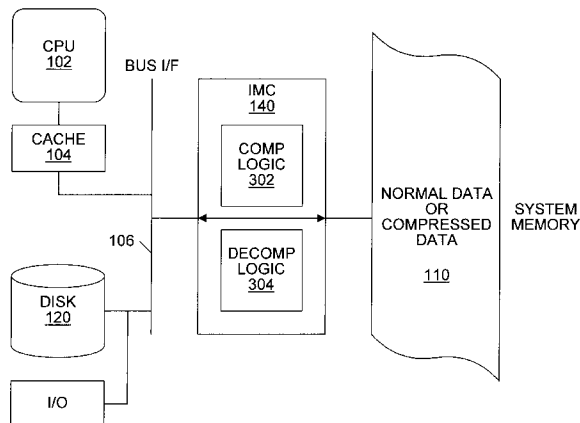
*Assistant Examiner*—Hong Kim

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

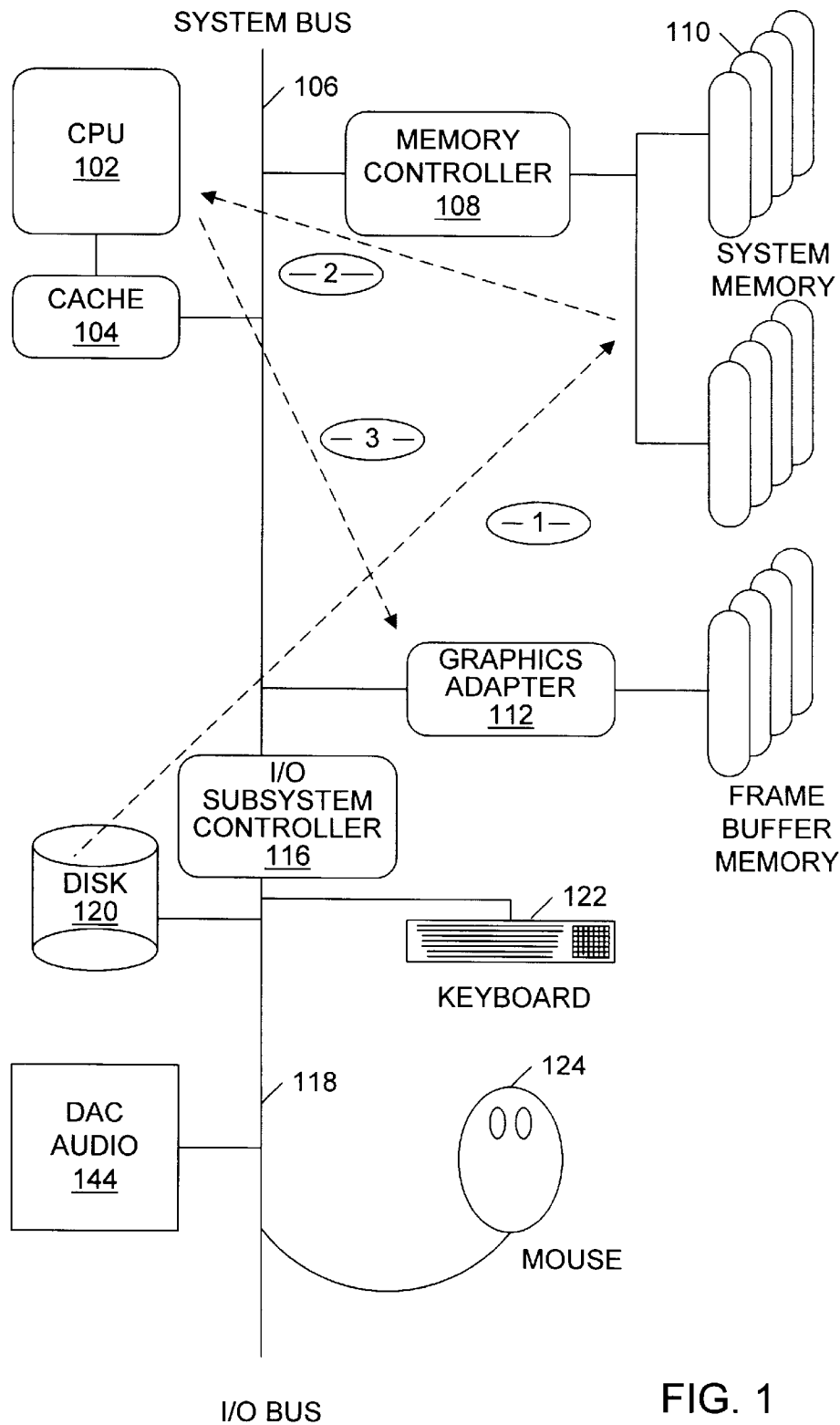


FIG. 1  
(PRIOR ART)

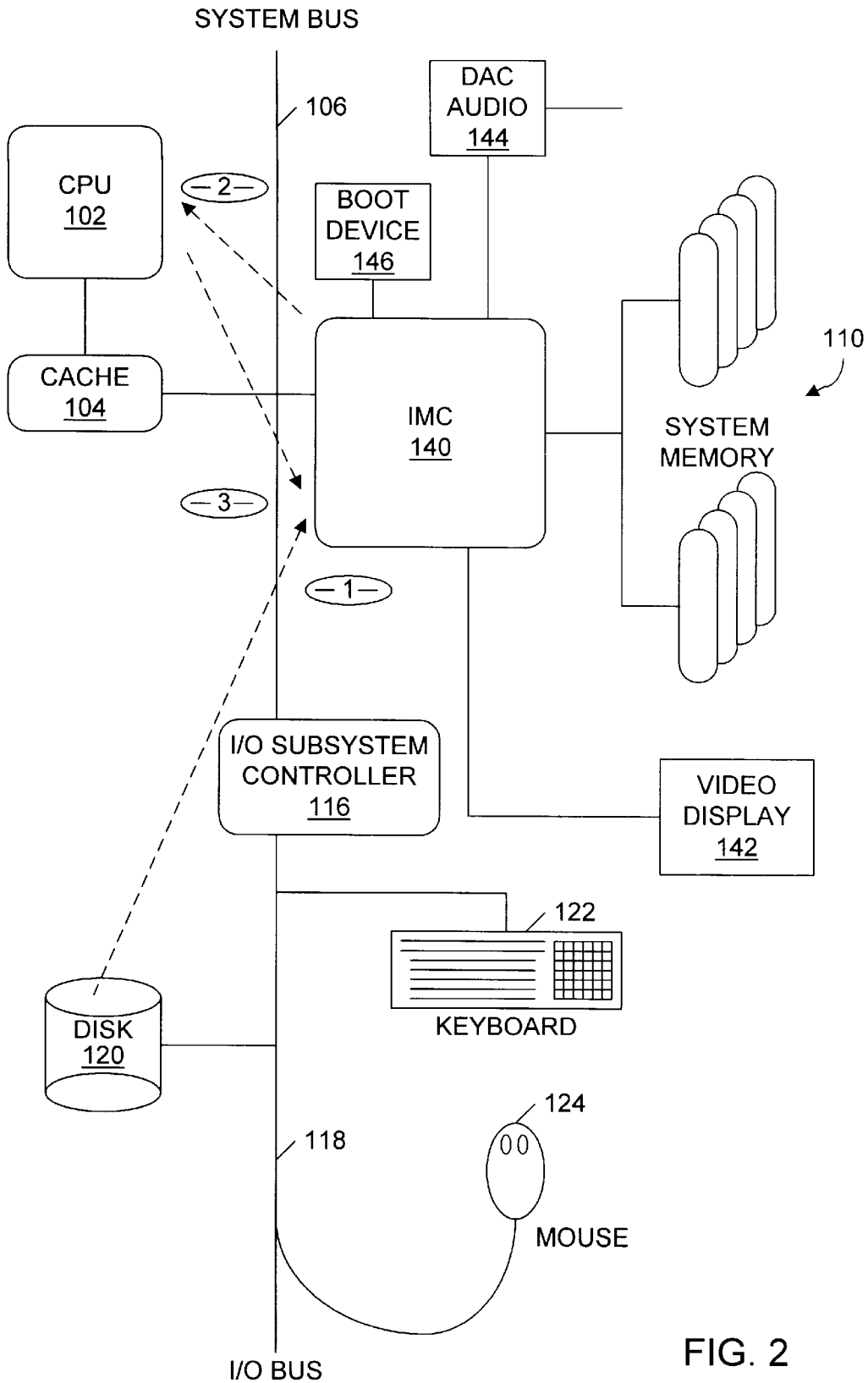


FIG. 2

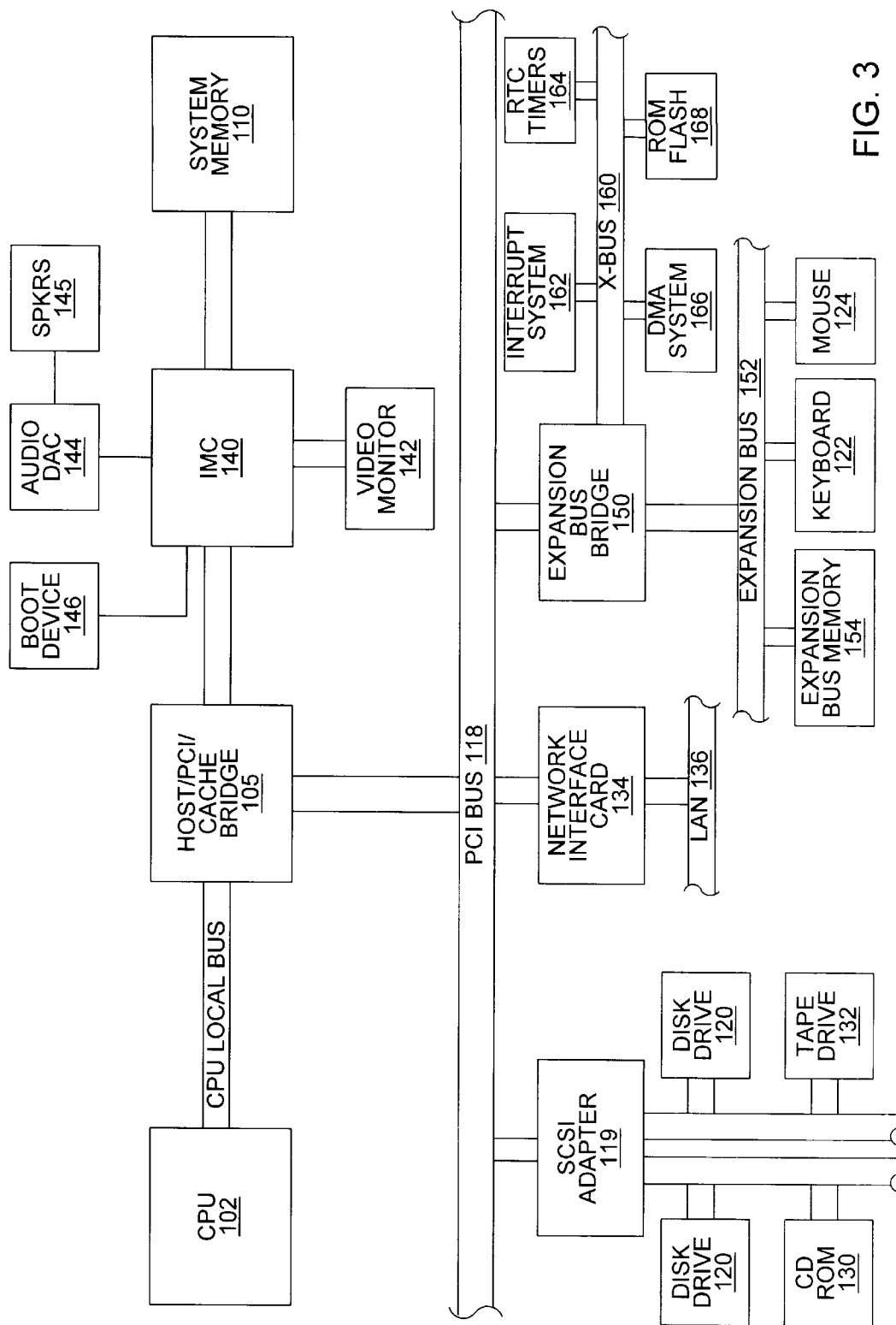


FIG. 3

# Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

## Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

## Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

## Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

## API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

## LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

## FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

## E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.