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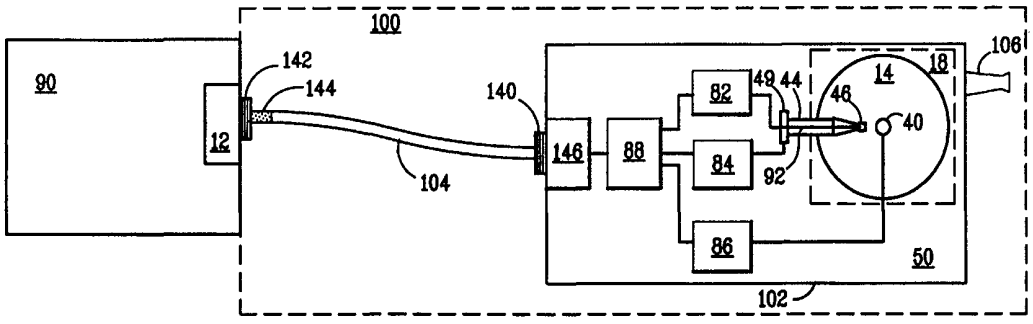

(57) Abstract

A data storage device (100) according to the present invention has a data storage medium (14), such as a removable magnetic storage medium; a read/write head (46) that writes digital data to, and reads digital data from, the data storage medium; and an electrical interface (104), coupled to the data storage medium, that can be selectively coupled to a first communication port of a first digital appliance or to a second communication port of a second digital appliance. The data storage device receives digital data generated by the first digital appliance via the electrical interface, stores the received digital data in the data storage medium as stored digital data, and transfers the stored digital data to the second digital appliance via the electrical interface. The invention is particularlly suitable for use where the first digital appliance is a digital camera having a compact flash interface port.

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APPARATUS AND METHOD FOR DIRECT CONNECTION OF A MASS STORAGE DRIVE TO A DIGITAL APPLIANCE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority from U.S. Provisional Application Serial No. 60/078,192, filed March 16, 1998, the contents of which are hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention relates in general to data storage devices. More particularly, the present invention relates to directly connecting a data storage device to a digital appliance to provide a direct communications path for digital data transferred between the digital appliance and the data storage device.

BACKGROUND OF THE INVENTION

The application of digital technology is rapidly being applied to a host of consumer appliances. For example, the digital camera is widely expected to become a major application of digital technology. The digital camera employs a microprocessor and other supporting circuitry to convert an analog image into a set of digital pixels, thereby forming a digital image. The digital pixels are stored in a memory area of the camera for later retrieval and processing. The digital images can then be downloaded to a personal computer (PC) or a notebook computer for viewing and editing.

A conventional digital camera has a central processing unit (CPU) which

functions as a control unit, an image photographing unit, a data converting and compressing unit, a memory controller which functions as an interface, a data memory which is a storage medium, a first in first out (FIFO) circuit, and a communication port.

The CPU controls operations of the components of the camera. The image photographing unit, which is typically implemented as a charge coupled device, converts a detected image into analog signals. The data converting and compressing unit converts the analog signals into digital signals which represent the image data, and compresses and encodes the image data. The image data is written into a data memory through the FIFO circuit by operation of the memory controller. The data memory is typically a standard flash memory PC card or other nonvolatile memory and is typically constructed in accordance with the PCMCIA (Personal Computer Memory Card International Association) standard. The image data can be read out from the data memory through the FIFO circuit by operation of the memory controller. A communication port is provided to download image data directly to a PC.

Flash memory is the most common form of digital image storage space in a digital camera. When the memory area becomes full, the memory area must be cleared before more pictures can be taken. In the earliest digital cameras to arrive in the marketplace, the flash memory modules were not removable. Those cameras require that the camera be connected to a PC or notebook computer to download the images. Newer cameras provide a removable flash memory module. Accordingly, when such a memory module is full, it can be replaced with an empty memory module. The user is then free to take additional pictures and postpone the download to a later time. Unfortunately, although the flash memory modules are removable, they are also relatively expensive. As a result, a user is likely to purchase only one or two additional memory modules, which still limits the user's picture taking capability.

Thus, at present, digital camera images are stored in the internal memory (*e.g.*, flash memory, RAM, etc.) of the camera which, when it becomes full, requires downloading through a port (*e.g.*, serial, parallel, SCSI) to a PC. This is not convenient to the user if a PC is not readily available. Transfer of images over a serial port is very slow.

A digital camera is only one example that uses flash memory to provide a removable storage solution. Other digital information appliances, such as smart phones, personal digital assistants, and the like, similarly rely on flash memory to provide a removable storage solution.

Therefore, there is a need in the art for a data storage device that can be selectively coupled to any of a plurality of digital appliances to provide low cost and efficient digital data transfer between the digital appliances and the data storage device.

SUMMARY OF THE INVENTION

A data storage device according to the present invention comprises a data storage medium, such as a removable magnetic storage medium; a read/write head that writes digital data to, and reads digital data from, the data storage medium; and an electrical interface, coupled to the data storage medium, that can be selectively coupled to a first communication port of a first digital appliance or to a second communication port of a second digital appliance. The data storage device receives digital data generated by the first digital appliance via the electrical interface, stores the received digital data in the data storage medium as stored digital data, and transfers the stored digital data to the second digital appliance via the electrical interface.

The invention is particularly suitable for use where the first digital appliance is a digital camera having a compact flash interface port. Nonetheless, the data storage device of the present invention can be adapted to transfer digital data between digital appliances and the data storage medium regardless of the type of communications port the digital appliance has, or the protocol it supports. For example, where either of the communications ports is an ATA, SSFDC, parallel, USB, PCMCIA, or SCSI port, the electrical interface can include an ATA, SSFDC, parallel, USB, PCMCIA, or SCSI interface. Similarly, the electrical interface can also include a protocol adapter to enable the transfer of data between the digital appliance and the data storage medium where the digital appliance and the data storage medium support different protocols.

The data storage device can also include a housing with an optional mounting member coupled to the housing so that a user can, for example, mount the data storage device to a camera tripod, or clip the device to his shirt pocket or belt.

In particular, a data storage device for storing digital data generated by a digital appliance having a flash memory interface port comprises a data storage medium; a read/write head adapted to write digital data to, and read digital data from, the data storage medium; and an electrical interface coupled to the data storage medium and adapted to be coupled to the flash memory interface port of the digital appliance. The data storage device is adapted to receive the digital data from the digital appliance via the electrical interface, and to store the received digital data in the data storage medium. Preferably, the flash memory interface comprises a compact flash interface and the electrical interface comprises an ATA interface.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other aspects of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings. For the purpose of illustrating the invention, there is shown in the drawings embodiments that are presently preferred, it being understood, however, that the invention is not limited to the specific methods and instrumentalities disclosed. In the drawings:

Figure 1 shows a preferred embodiment of a portable disk drive;

Figure 2 shows a preferred embodiment of a data storage device particularly suitable for use with a digital camera;

Figure 3 is a table of pin assignments for converting from a Compact Flash interface connector to an IDE interface;

Figure 4 shows a preferred embodiment of a data storage device including an16/8 bit converter;

Figure 5 is a table of pin assignments for an 8-bit ATA connector ; and

Figure 6 shows another preferred embodiment of a data storage device according to the present invention.

DESCRIPTION OF EXEMPLARY EMBODIMENTS AND BEST MODE

The present invention relates to directly connecting a data storage device to a digital appliance, such as a digital camera, to provide a direct communications path for digital data transferred between the digital appliance and the data storage device.

Figure 1 is a schematic diagram of a storage drive 50 for storing and retrieving information for a host device 90. Host device 90 may be one of a number of various types of computer based digital appliances such as a digital camera, personal computer, handheld computer, or any other digital appliance that generates or receives digital data. Host device 90 communicates with drive 50 via a bus 91 by sending commands to write or read digital information to or from data storage medium 14. Bus 91 can be any of the various buses such as parallel, generic serial, USB, SCSI, and so on.

Data storage medium 14 may be any of the various digital data storage media such as magnetic, optical, or magneto-optical. Optionally, medium 14 may be fixed in drive 50, or alternatively removable from drive 50. Where medium 14 is removable from drive 50, medium 14 may be encased in an outer shell 18 to protect medium 14 from damage. In a preferred embodiment of the present invention, data storage medium 14 is a nonvolatile, removable, magnetic medium, such as a magnetic disk, included in a portable data storage drive, such as a "CLIK!" drive (Iomega Corporation, Roy, Utah).

Drive 50 comprises a controller 88 that provides an interface with host device 90 as well as controlling the overall operation of drive 50. Controller 88 is preferably a microprocessor-based controller. Drive 50 also comprises a read channel 82 for conditioning signals read from medium 14, an actuator controller 84 for providing servo control and tracking, a motor controller 86 for controlling the spin rate of medium 14 via a spindle motor 40, and an actuator assembly for reading the data from medium 14.

The actuator assembly comprises a read/write head 46 that is connected to a distal end of the actuator assembly. The actuator assembly also comprises a suspension arm 44 and an actuator 49 that cooperate to move the read/write head 46 over the surface of medium 14 for reading and writing digital information. Read/write head 46 is electrically coupled to read channel 82 by way of electrical conductor 92.

Actuator 49 comprises an electro-magnetic motor, preferably a voice coil motor, stepper motor, or the like. Moreover, actuator 49 may comprise a linear or rotary motion. Linear motion actuators are generally referred to as linear actuators; whereas, rotary motion actuators are generally referred to as rotary actuators.

Figure 2 shows a preferred embodiment of a data storage device according

to the present invention. As shown in Figure 2, data storage device 100 includes a drive 50, such as described above in connection with Figure 1, and an electrical interface 104 and electrical interface to connect drive 50 to digital camera 90. Electrical interface 104 can be any electrical interface capable of carrying bus 91, but in a preferred embodiment, electrical interface 104 is a cable.

Digital cameras commonly use flash memory to store digital image data generated when a digital photograph is taken. Typically, digital camera 90 includes a flash memory module that connects to digital camera 90 via a flash memory interface 12, such as a Compact Flash interface. Electrical interface 104 includes a Compact Flash connector 142 on one end of the cable to connect electrical interface 104 to digital camera 90. The user simply removes the Compact Flash module and connects the Compact Flash connector of electrical interface 104 into Compact Flash interface 12. Drive 50, however, includes an ATA interface port 146. Consequently, electrical interface 104 also includes an ATA connector 140 on the other end of the cable.

Preferably, data storage device 100 also comprises a protective housing 102 with an optional mounting member 106. Mounting member 106 can be a clip, for example, to enable the user to clip data storage device 100 onto a belt or shirt pocket while using digital camera 10, or to mount data storage device 100 onto a camera tripod.

Figure 3 provides a pinout for a standard Compact Flash interface 12 and for an ATA, or IDE, interface 16. Thus, Figure 3 shows the conversion from Compact Flash to IDE that is necessary to make digital storage device 100 appear to digital camera 90 as nothing more than a flash memory module within digital camera 90. Data is written directly, as it is generated, to data storage medium 14 in data storage device 100 by operation of controller 88 via electrical interface 104 and communication port 12. In this way, data storage device 100 enables the direct transfer of digital data from digital camera 90 to data storage medium 14 without the use of a personal computer (PC) or other external data transfer device.

Data storage device 100 is adapted to receive digital data from digital camera 90, and to store the received digital data in data storage medium 14. To enable data storage device 100 to appear to digital camera 90 as if it were a flash memory module, data storage

device 100 interprets and responds to all ATA flash commands as if it were flash memory in accordance with the American National Standards Institute ATA flash specification (ANSI X3T13/1153D, Revision 7, Information Technology - ATA Attachment-4 with Packet Interface Extension (ATA/ATAPI-4), October 1996).

Digital appliance 90 initiates the transfer of data between digital appliance 90 and data storage device 100. As image data is generated, it is provided to data storage device 100 through a FIFO circuit (not shown) by operation of controller 88. Each image transfer intended for the memory of digital appliance 90 is directly provided to data storage device 100 for storage in data storage medium 14. Data storage device 100 interprets and responds to commands of digital appliance 90 as if it were a memory of digital appliance 90.

To use the data storage device of the present invention, a user couples data storage device 100 directly to digital appliance 10 (*e.g.*, digital camera) and uses digital appliance 10 to control the transfer of image data, for example, to a disk, (*e.g.*, a CLIK! disk), in much the same way as a Compact Flash™. As will be explained in greater detail below, the same connector 142 with the appropriate adapter 144 can be used to couple data storage device 100 to a computer with a PCMCIA ATA interface to access the image data stored in data storage medium 14. When data storage device 100 is connected to a digital camera, the digital camera acts like a host and uses the ATA standard. Similarly, when data storage device 100 is connected to a computer, the computer, because it has an ATA interface, acts like a host to data storage device 100.

As shown in Figure 4, data storage device 100 can also include an optional input-output (i/o) board 124. Drive 50 is connected to i/o board 124 via an IDE bus 130. I/o board 124 has an external host connector 132. Figure 5 shows the pinout for host connector 132. Host connector 132 has 34 pins with an overall shield. Pins are assigned by even numbers on one side of the connector and odd numbered pins on the opposing side of the connector. The table shown in Figure 5 provides the pin assignments for host connector 132 (column labeled D3) and the required Host usage of the pins (column labeled Host Interface).

Preferably, electrical interface 104 comprises an ATA interface 146. ATA

interface 146 can be either a standard ATA interface or a nonstandard ATA interface. In a preferred embodiment, ATA interface 146 is a nonstandard ATA interface that uses eight bits (rather than 16) for status and data transfers. The use of an 8-bit ATA interface allows reduces the number of pins required for the connectors and permits electrical interface 104 to include a smaller cable.

To ensure that the 8-bit ATA interface is transparent to digital appliances, i/o board 124 performs a 16/8 bit conversion. A register (at address 0x3F4, aliased at 0x3F5) is used to maintain a check syndrome on all data transfers. Write operations to 0x3F4 or 0x3F5 cause the syndrome to be initialized to all "ones", while reads of 0x3F4 or 0x3F5 return the contents of the check syndrome. The syndrome value is 10 bits wide and is accessed in two read cycles. A first read of 0x3F4 returns the upper 2 bits and the next read returns the lower 8 bits of the syndrome value.

Accesses to a data register at address 0x1F0 are performed an even number of times since odd and even accesses transfer either the upper or lower 8-bits of a 16-bit value. To facilitate operation with some PCMCIA implementations, the lower address bit is ignored during the read or write cycle immediately following a read or write of the data register. This will allow the host to access even/odd byte lanes via the least significant address line. Since reads of address 0x1F1 will reference either the lower byte of data or access the ERROR register depending upon the address used in the previous cycle, the user must insure that data transfers are 16-bit aligned and are consecutive.

Figure 5 is a table of the pin assignments for a preferred embodiment of a connector used with ATA interface 146. The host connector has 34 pins with an overall shield. Pins are assigned by even numbers on one side of the connector and odd numbered pins on the other side of the connector. Figure 5 shows the pin assignments of the connector, and the required host usage of the pins. Note the presence of only eight data lines (*i.e.*, pins 4-9 & 11-12).

Data storage device 100 also preferably includes a power source 20, which is preferably detachable and portable, such as a battery pack. Either a standard battery (*e.g.*, 9 volt or AA alkaline) or more preferably, a rechargeable battery, is provided as a power supply. Thus, there is no additional power drain on the digital appliance.

Optionally, a power switch (not shown) is provided so that the power source can be manually turned off to save power when not in use.

Data storage device 100 also optionally includes an indicator lamp (not shown), which is preferably a multi-color LED or a plurality of LEDs that indicates the status of a data transfer. For example, the indicator lamp can be a two color LED that turns red if data storage medium 14 does not have enough unused or free storage space remaining to store the contents of the camera (*i.e.*, disk full), and the LED turns green after a successful transfer of the data from digital appliance 10 (*i.e.*, transfer successful). Additional LED indicator lamps can be incorporated to indicate other statuses such as "on going transfer" or "unsuccessful transfer." The indicator lamp is separate from any indicator lamps that may be present on the power source (*e.g.*, battery pack indicator LEDs).

Figure 6 shows another aspect of data storage device 100 according to the present invention. As shown in Figure 6, the same electrical interface 104 used to directly connect data storage device 100 to digital camera 90, can also be used to directly connect data storage device 100 to a PC 50 (*e.g.*, a notebook computer) using a protocol adapter 125, or other digital appliance 60, 70, etc. In this way, data received from a first digital appliance ("received digital data") and stored on data storage medium 14 ("stored digital data") can be transferred, viewed, or edited on a second digital appliance. The present invention is more economically feasible than flash memory, and data transfer between the digital appliance and a PC is much faster with the present invention than with flash memory.

As shown in Figure 6, data storage device 100 is first coupled to a first digital appliance (*e.g.*, digital appliance 40). Data storage device 100 receives, via electrical interface 104, the digital data generated by digital appliance 40, and stores the received digital data in data storage medium 14. Data storage device 100 is then coupled to a second digital appliance (*e.g.*, digital appliance 50). On command from digital appliance 50, data storage device 100 transfers the stored digital data to digital appliance 50 via electrical interface 104.

In general, electrical interface 104 can be any interface that provides a bus

for the transfer of digital data between data storage medium 14 and digital appliances 40, 50, 60, 70. Similarly, electrical interface 104 can support any protocol and provide an interface between digital storage medium 14 and any communications port 41, 51, 61, 71, regardless of the protocol the communications port supports.

In general, digital appliances 40, 50, 60, 70 can have different communications port interfaces and support different protocols. To ensure that data storage device 100 can be selectively coupled (*i.e.*, coupled based on a user's selection) to digital appliances having communications ports that support different protocols, electrical interface 104 can be selectively coupled to any communication port that supports any protocol by selecting the appropriate interfaces and protocol adapters to be included in electrical interface 104. For example, if digital appliance 40 is a digital camera and communications port 41 is a compact flash port that supports ATA protocol, electrical interface 104 can include an ATA interface.

Similarly, if digital appliance 50 is a desk top computer and communications port 51 is a SCSI interface port, electrical interface 104 can include a SCSI interface 115 and an ATA-to-SCSI protocol adapter 125. On the other hand, if digital appliance 60 is a notebook computer having a PCMCIA interface port 61, electrical interface 104 can include a PCMCIA interface 116 and an ATA-to-PCMCIA protocol adapter 127. If digital appliance 70 is a PC printer and communications port 71 is a parallel port, electrical interface 104 can include a parallel port interface 117 and an ATA-to-parallel protocol adapter 127. Similarly, electrical interface 104 can be selectively coupled to other communications ports, such as USB ports or SSFDC ports using the appropriate USB or SSFDC interfaces and protocol adapters. Thus, electrical interface 104 is basically a modular means for providing communication between a digital appliance and data storage medium 14. The user merely selects which interfaces and protocol adapters to include in electrical interface 104 based on the communications ports and protocols supported by the digital appliances to which the user wishes to couple data storage device 100.

It should be noted that although the portable device of the described embodiments is preferably a digital camera, the present invention is not limited thereto. For example, the present invention can be applied to a smart phone, personal digital

assistants, and notebook computers. Any digital data, such as sound data, can be downloaded and saved by the present invention, not just digital image data.

We claim:

1. A data storage device for storing digital data generated by a digital appliance having a flash memory interface port, the data storage device comprising:

a data storage medium;

a read/write head adapted to write digital data to, and read digital data from, the data storage medium; and

an electrical interface coupled to the data storage medium and adapted to be coupled to the flash memory interface port of the digital appliance,

wherein the data storage device is adapted to receive the digital data from the digital appliance via the electrical interface, and to store the received digital data in the data storage medium.

2. The data storage device of claim 1, wherein the data storage medium is a magnetic storage medium.

3. The data storage device of claim 1, wherein the data storage medium is removable.

4. The data storage device of claim 1, wherein the flash memory interface comprises a compact flash interface.

5. The data storage device of claim 1, wherein the electrical interface comprises an ATA interface.

6. The data storage device of claim 1, further comprising:

a housing, coupled to the electrical interface; and

a mounting member coupled to the housing.

7. A data storage device comprising:

a data storage medium;

a read/write head that writes digital data to, and reads digital data from, the data storage medium; and

an electrical interface, coupled to the data storage medium, that can be selectively coupled to a first communication port of a first digital appliance or to a second communication port of a second digital appliance,

wherein the data storage device receives digital data generated by the first digital appliance via the electrical interface, stores the received digital data in the data storage medium as stored digital data, and transfers the stored digital data to the second digital appliance via the electrical interface.

8. The data storage device of claim 7, wherein the data storage medium is a magnetic storage medium.

9. The data storage device of claim 7, wherein the data storage medium is removable.

10. The data storage device of claim 7, wherein the first digital appliance is a digital camera and the first communication port is a compact flash interface port.

11. The data storage device of claim 7, wherein at least one of the first communication port and the second communication port is an ATA port and the electrical interface comprises an ATA interface.

12. The data storage device of claim 7, wherein at least one of the first communication port and the second communication port is an SSFDC port and the electrical interface comprises an SSFDC interface.

13. The data storage device of claim 7, wherein at least one of the first communication port and the second communication port is a parallel port and the electrical interface comprises a parallel port interface.

14. The data storage device of claim 7, wherein at least one of the first communication port and the second communication port is a USB port and the electrical interface comprises a USB interface.

15. The data storage device of claim 7, wherein at least one of the first communication port and the second communication port is a PCMCIA port and the electrical interface comprises a PCMCIA interface.

16. The data storage device of claim 7, wherein the electrical interface comprises a protocol adapter.

17. The data storage device of claim 16, wherein the protocol adapter is an ATA to PCMCIA adapter.

18. The data storage device of claim 16, wherein the protocol adapter is an ATA to SCSI adapter.

19. The data storage device of claim 16, wherein the protocol adapter is an ATA to parallel port adapter.

20. The data storage device of claim 7, further comprising:
a housing, coupled to the electrical interface; and
a mounting member coupled to the housing.

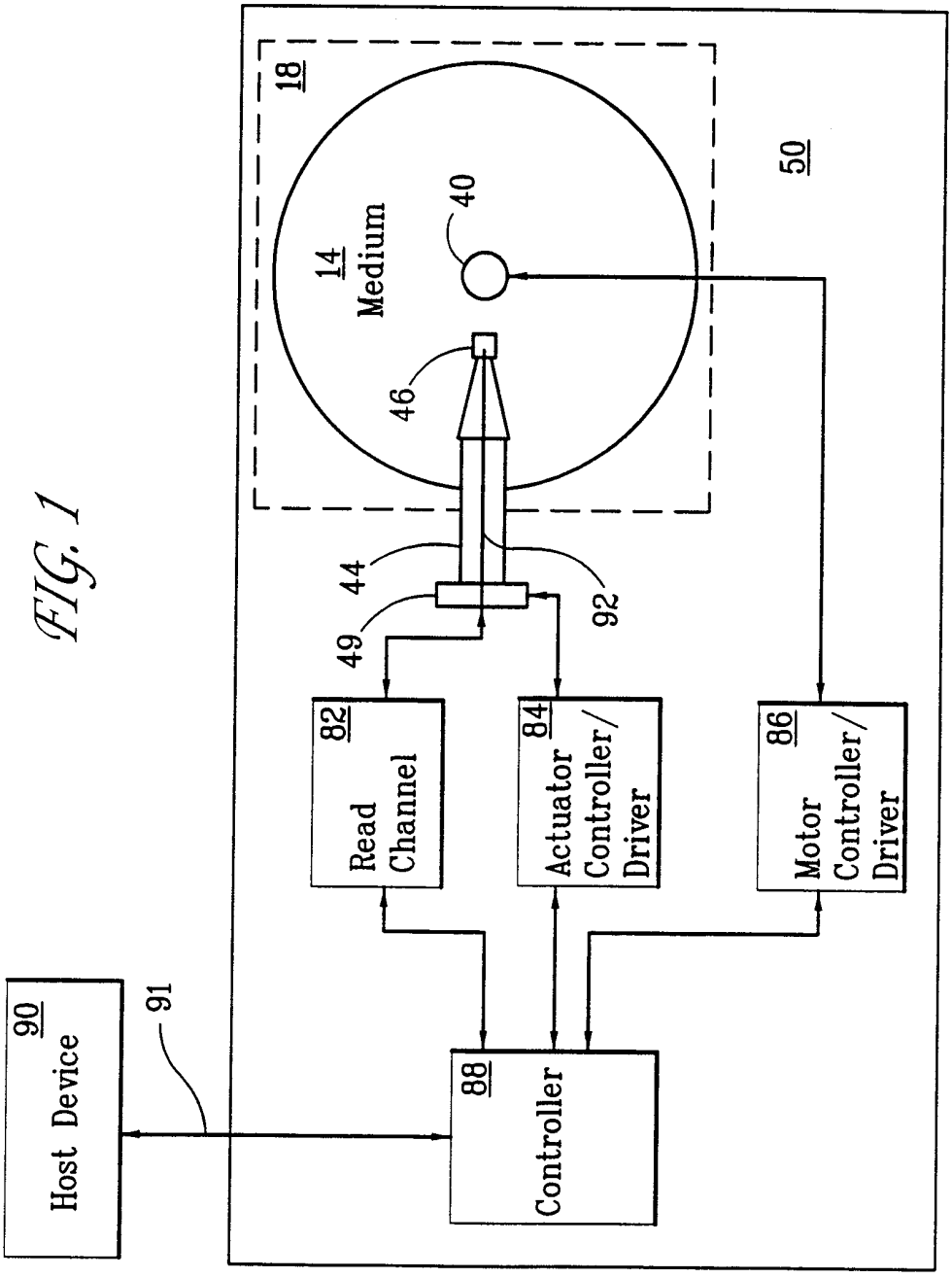
18
50
14
Medium
40
46
44
92
49
82
Read Channel
84
Actuator Controller/ Driver
86
Motor Controller/ Driver
90
Host Device
91
88
Controller

FIG. 1

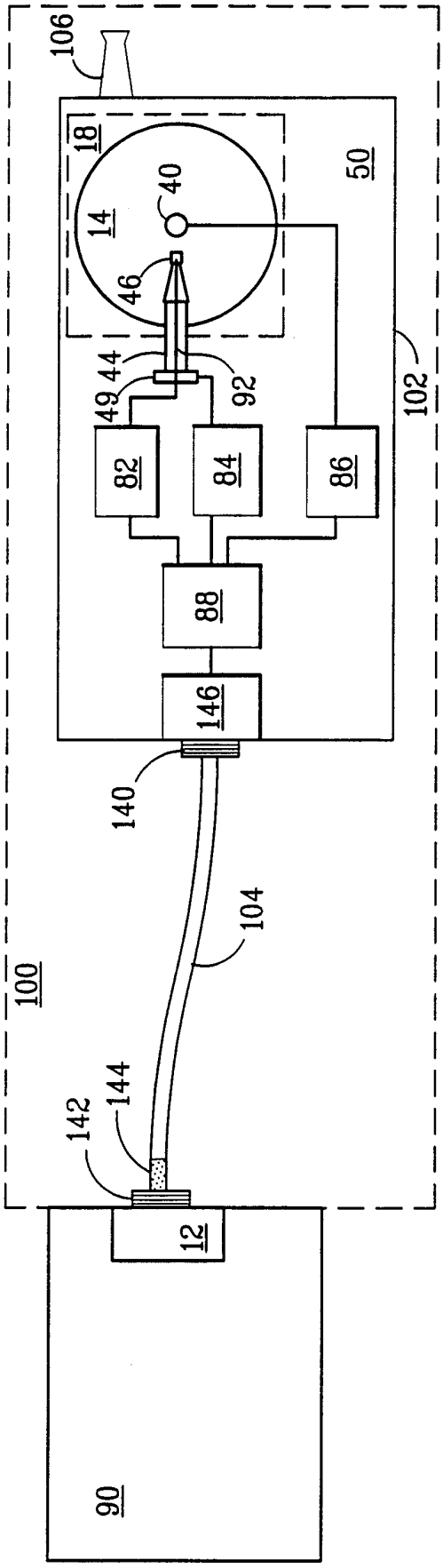
106
18
50
40
14
46
44
49
92
102
82
84
86
88
146
140
104
100
142
144
12
90

FIG. 2

IDE Interface		Compact Flash Interface	
Pin #	Signal Name	Pin #	Signal Name
1	RESET-	41	RESET
2	GROUND	1	GROUND
3	DD7	6	D07
4	DD8	47	D08
5	DD6	5	D06
6	DD9	48	D09
7	DD5	4	D05
8	DD10	49	D10
9	DD4	3	D04
10	DD11	27	D11
11	DD3	2	D03
12	DD12	28	D12
13	DD2	23	D02
14	DD13	29	D13
15	DD1	22	D01
16	DD14	30	D14
17	DD0	21	D00
18	DD15	31	D15
19	GROUND	25	CD1- GROUND
20	KEYPIN	no connect	
21	DMARQ	no connect	
22	GROUND	26	CD2- GROUND
23	IOW-	35	IOW-
24	GROUND	33	VS1- GROUND
25	IOR-	34	IORD-
26	GROUND	26	CD2- GROUND
27	IORDY	42	IORDY
28	CSEL	39	CSEL-
29	DMACK	no connect	
30	GROUND	25	CD1- GROUND
31	INTRQ	37	IREQ-
32	reserved	no connect	
33	DA1	19	A01
34	PDIAG	46	PDIAG-
35	DA0	20	A00
36	DA2	18	A02
37	CS0-	7	CS0-
38	CS1-	32	CS1-
39	DASP-	45	DASP-
40	GROUND	50	GROUND

FIG. 3

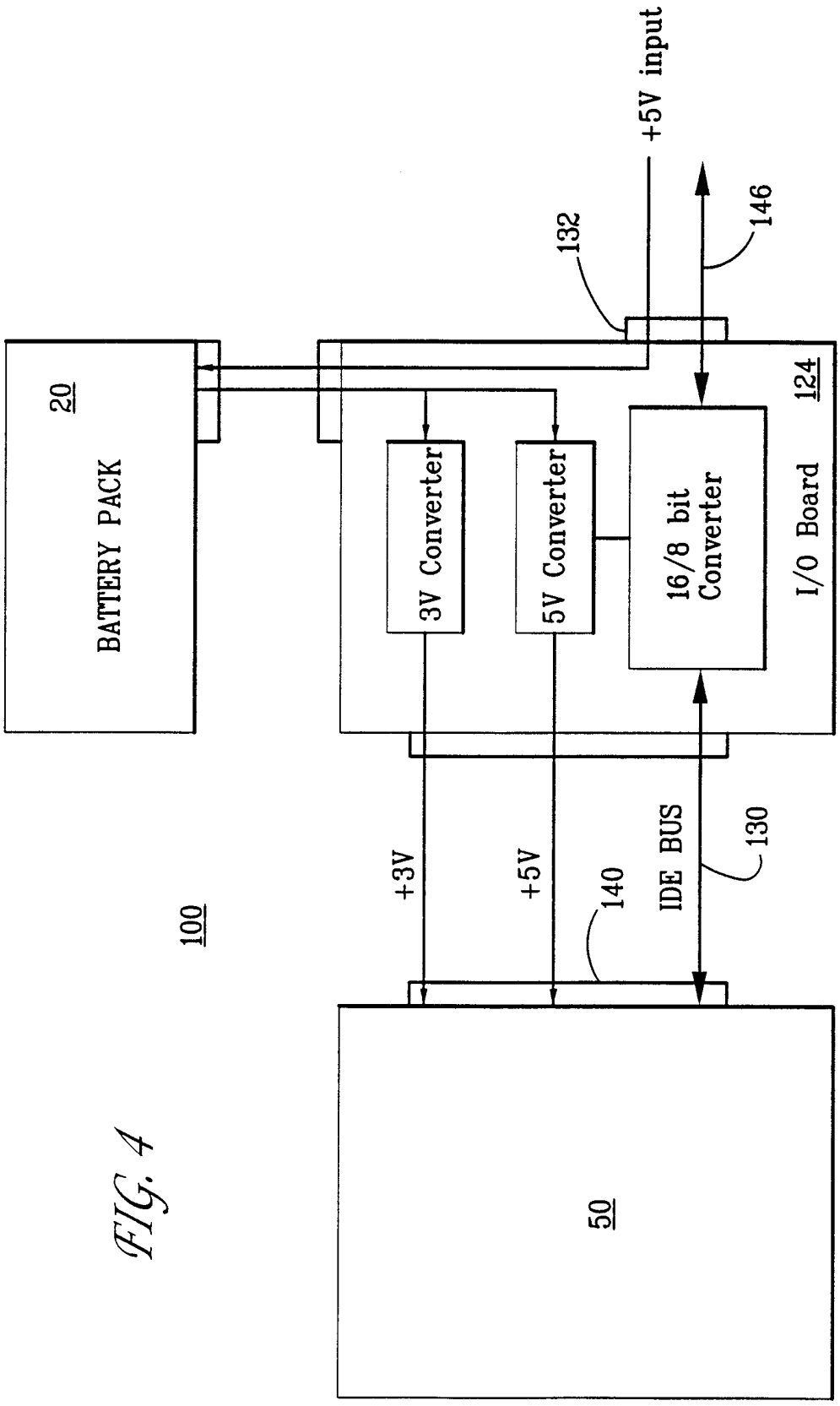
+5V input
132
146
20
BATTERY PACK
3V Converter
5V Converter
16/8 bit Converter
I/O Board
124
+3V
+5V
140
IDE BUS
130
100
50

FIG. 4

Pin#	D3	Host Interface
1	GND	GND
2	GND	GND
3	RESET-	RESET-
4	Data4	Data4
5	Data3	Data3
6	Data5	Data5
7	Data2	Data2
8	Data6	Data6
9	Data1	Data1
10	GND	GND
11	Data0	Data0
12	Data7	Data7
13	GND	GND
14	DIRQ	DIRQ
15	IOW-	IOW-
16	CS1-	CS1-
17	IOR-	IOR-
18	CS0-	CS0-
19	A0	A0
20	A1	A1
21	A2	A2
22	D3_EN	D3_EN
23	5VIN	5VIN
24	5VIN	5VIN
25	GND	GND
26	GND	GND
27	N/C	<Reserved>
28	N/C	<Reserved>
29	BATT+	<Reserved>
30	BATT+	<Reserved>
31	+5V	<Reserved>
32	+3.3V	<Reserved>
33	GND	GND
34	GND	Drain Wire GND

FIG. 5

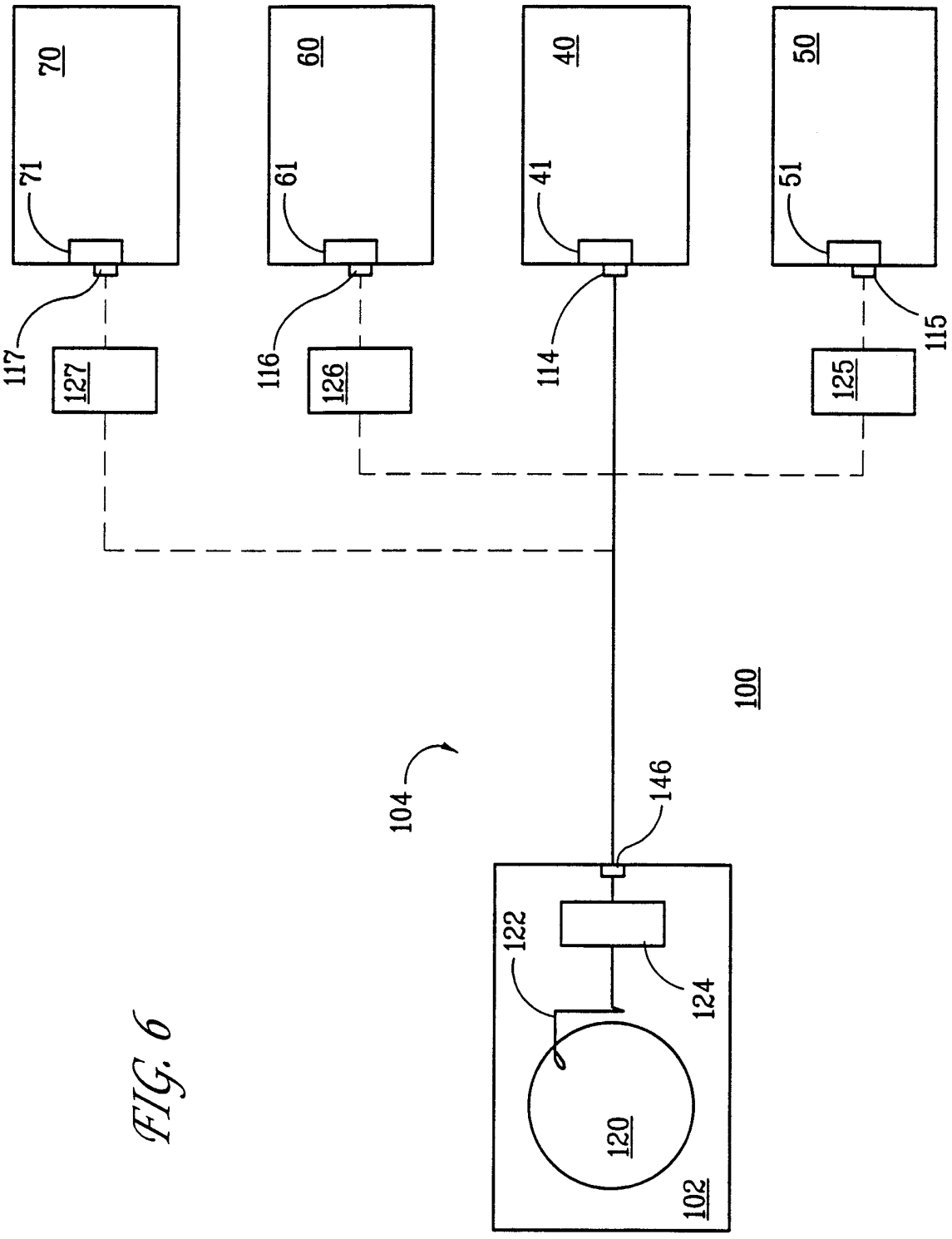
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FIG. 6

INTERNATIONAL SEARCH REPORT

	International Application No PCT/US 99/05560

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G06F13/38 G11B31/00 H04N1/21 G06F1/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G11B G06F H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 018, no. 409 (P-1779), 29 July 1994 (1994-07-29) & JP 06 119422 A (NIKON CORP), 28 April 1994 (1994-04-28) abstract ---	1-6
X	US 5 475 441 A (SMITH DAVID A ET AL) 12 December 1995 (1995-12-12) column 6, line 46 - line 65; claims 1-3; figure 6 ---	1-6
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 July 1999	27/07/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Brunet, L

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/05560

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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