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Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

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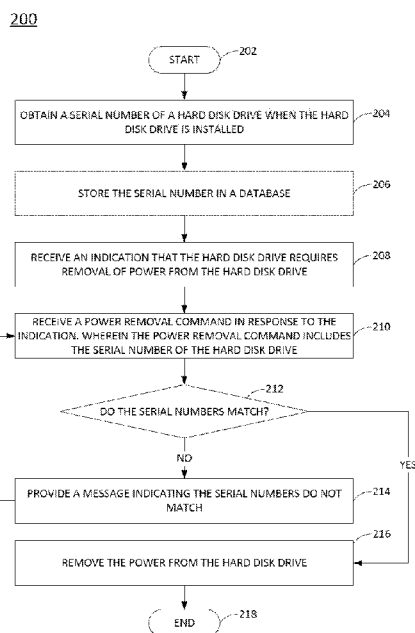
(54) Title: HARD DISK DRIVE POWER REMOVAL

FIG. 2

(57) **Abstract:** In one example, a technique is described in which a serial number of a hard disk drive is obtained when the hard disk drive is installed; an indication that the hard disk drive requires removal of power is received; a power removal command is received in response to the indication, wherein the power removal command includes the serial number of the hard disk drive; the serial number in the power removal command is verified that it matches the serial number of the hard disk drive and the power is removed from the hard disk drive when the serial number in the power removal command matches the serial number of the hard disk drive.

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HARD DISK DRIVE POWER REMOVAL

BACKGROUND

[0001] Occasionally hard disk drives may be powered down due to a failure or for maintenance. Many times, there may be many different hard disk drives within a computer, a cloud storage service, or a server farm. Commands may be sent to remove power from a hard disk drive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] FIG. 1 is a block diagram of an example system of the present disclosure;

[0003] FIG. 2 is an example flowchart of a method for hard disk drive power removal; and

[0004] FIG. 3 is an example high-level block diagram of a computer suitable for use in performing the functions described herein.

DETAILED DESCRIPTION

[0005] The present disclosure broadly discloses techniques for hard disk drive power removal. Hard disk drives may need to be powered down due to a failure or for maintenance. Many times, there may be different hard disk drives within a computer or a server farm. However, when a user sends a command to remove power from a hard disk drive in response to an indication that the hard disk drive needs to be powered down due to a failure or for maintenance, the user can send the command to the wrong hard drive.

[0006] For example, a user or technician may send a command to a hard disk drive in bay number two when the hard disk drive that failed was actually in bay number one. As a result, the wrong hard disk drive may be powered off resulting in lost data or corruption of data.

[0007] Examples of the present disclosure provide commands for hard disk drive power removal using a serial number of the hard disk drive. For example, to help ensure the correct hard disk drive is powered down, the command may require that the user or technician to include a serial number of the hard disk

drive. The system may then check the serial number of the hard disk drive included in the power removal command with the serial number of the hard disk drive in the selected bay. If the serial numbers match, the hard disk drive may then be powered down. If the serial numbers do not match, then an error message may be returned to the user.

[0008] FIG. 1 illustrates an example system 100 of the present disclosure. In one example, the system 100 includes a processor 104. In one example, the processor 104 may be in communication with an expander 106 that allows the processor 104 to communicate with and control a plurality of different hard disk drives 108₁ to 108_n, also referred to collectively as hard disk drives 108 or individually as a hard disk drive 108. In one example, the expander 106 may be a physical device, e.g., a Serial Attached SCSI (SAS) Expander, or may be implemented virtually by machine readable instructions.

[0009] Each one of the hard disk drives 108 may be coupled to a different bay or port, e.g., bay 1 to bay n. Each one of the hard disk drives 108 may be powered independently. In other words, the power may be removed asynchronously from a hard disk drive 108₁ in a system that includes a plurality of different hard disk drives 108_n and are controlled by a single controller and independently powered. Thus, when the hard disk drive 108₁ fails or requires maintenance, the hard disk drive 108₁ that has failed may be powered down without removing power to the other hard disk drives 108₂ to 108_n that are functioning properly.

[0010] In one example, the expander 106 and the hard disk drives 108 may be located within a common housing of the processor 104. In another example, the expander 106 and the hard disk drives 108 may be located in a remote network 110, e.g., in the "cloud." The remote network 110 may be an Internet Protocol (IP) network that can be accessed via the Internet. For example, the hard disk drives 108 may be part of a cloud network storage service or a storage farm that is located remotely from the processor 104.

[0011] It should be noted that FIG. 1 has been simplified for ease of explanation. For example, the remote network 110 may include additional network elements that are not shown, such as for example, additional access

networks between the remote network 110 and the processor 104, firewalls, border elements, gateways, and the like.

[0012] In one example, the system 100 may also include a database (DB) 112 for storing information. In one example, the DB 112 may be any electronic means of storing data for later retrieval. In one example, the DB 112 may be part of the processor 104 or may be a separate storage device. In one example, the DB 112 may be co-located with the processor 104 or may be located remotely in the remote network 110.

[0013] In one example, each one of the hard disk drives 108 may have a unique serial number (SN#). When a new hard disk drive 108 is installed, the hard disk drive 108 may have the serial number read by, polled by, or obtained by the expander 106. The serial number may be stored in the DB 112. The DB 112 may store a list of serial numbers for the plurality of different hard disk drives 108.

[0014] In one example, when a hard disk drive 108 fails, a notification may be sent to a user or a technician via the processor 104 and shown on a display. The notification may be an email, a pop-up message, an instant message, and the like. The notification can include a message indicating that a particular hard disk drive 108 has failed, is not functioning properly or requires maintenance.

[0015] In response, the user or technician may be required to remove power from the failing hard disk drive 108 such that the failing hard disk drive 108 can be repaired. In previous methods, the user would simply send a command to power down the hard disk drive 108 by specifying a bay number connected to the alleged hard disk drive 108 that was failing. No verification would be performed to ensure that the specified bay number contained the correct hard disk drive 108. Many times, this would lead to the wrong hard disk drive 108 being powered down resulting in errors or lost data.

[0016] In one example of the present disclosure, the command to remove power may require the user to include the serial number of the hard disk drive 108 that needs to be powered down. For example, a user may get a notification that hard disk drive 108₂ is not functioning properly. In response, the user may send a command via a display and processor 104 to power down the hard disk

drive 108₂. The command includes the serial number of the hard disk drive 108₂, e.g., 12345. In one example, the expander 106 may obtain the serial number of the hard disk drive 108₂ and the processor 104 may compare the serial number received in the command from the user and the serial number obtained by the expander 106 from the hard disk drive 108₂. The processor 104 may verify that the correct hard disk drive 108 is being powered down by comparing the serial numbers. If the serial numbers match, then the hard disk drive 108₂ may be powered down.

[0017] In one example, a user may accidentally provide the wrong serial number, e.g., 23456 in the command to power down the hard disk drive 108₂. Thus, when the processor 104 performs the verification by comparing the serial number 23456 received in the command from the user and the serial number 12345 obtained by the expander 106 from the hard disk drive 108₂, the processor 104 may detect a mismatch. As a result, an error message may be sent to the user indicating that a mismatch was detected and require the user to re-enter the command with the correct serial number or suggest the user re-check the serial number of the hard disk drive 108₂.

[0018] In another example, the hard disk drive 108₂ may have completely failed and may be unresponsive. When the hard disk drive 108₂ is non-responsive, the processor 104 may check the DB 112 to obtain the serial number of the hard disk drive 108₂ that was obtained and stored when the hard disk drive 108₂ was initially installed or configured. The processor 104 may compare the serial number received in the command with the serial number obtained in the DB 112 and determine if there is a match. If there is a match, the processor 104 may execute the command to power down the hard disk drive 108₂. If there is a mismatch, the processor 104 may return an error message to the user via a display.

[0019] In another example, a user may be using storage services of the hard disk drives 108 in the cloud, e.g., the remote network 110. A user may detect a problem with storing data and notify another user, such as a service provider of the cloud storage. The service provider may then determine which hard disk drive 108, e.g., hard disk drive 108₃, is associated with the user and send a

power removal command to the hard disk drive 108₃. Previously, the service provider may have been required to only provide the bay number. Thus, if the service provider accidentally sent the power removal command to bay 1 rather than bay 3, the wrong hard disk drive 108₁ may be powered down causing data to be lost for another user.

[0020] However, examples of the present disclosure would require the service provider to provide the serial number of the hard disk drive 108₃ in addition to specifying that the hard disk drive 108₃ is located in bay 3. As a result, the processor 104 would verify that the serial number received from the power removal command matches the serial number of the hard disk drive 108₃, e.g., either obtained by the expander 106 from the hard disk drive 108₃ or from the DB 112 if the hard disk drive 108₃ is non-responsive, before removing the power from the hard disk drive 108₃.

[0021] In one example, the command may be any type of command or protocol used to communicate with and/or control operation of a hard disk drive 108. In one example, the command may be a small computer system interface (SCSI) enclosure services protocol command. The SCSI enclosure services protocol command may be modified to require the user to include a serial number of the hard disk drive 108 when issuing a power removal command to the hard disk drive 108.

[0022] It should be understood that the techniques of the present disclosure may be implemented in hardware, software or a combination thereof. The processor 104 may be any electronic device for executing machine readable instructions.

[0023] FIG. 2 illustrates a flowchart of a method 200 for hard disk drive power removal. In one example, the method 200 may be performed by the processor 104 or a computer as illustrated in FIG. 3 and discussed below.

[0024] At block 202 the method 200 begins. At block 204, the method 200 obtains a serial number of a hard disk drive when the hard disk drive is installed. For example, as part of the installation and configuration protocol, the expander may poll the hard disk drive to obtain the serial number of the hard disk drive automatically. The serial number may then be stored for later reference. The

serial number may be automatically obtained for each hard disk drive that is initially installed or when a new hard disk drive is replaced with a new hard disk drive in a particular bay or connection.

[0025] At optional block 206, the method 200 stores the serial number in a database. In one example, a database may be used to store a list of serial numbers for a plurality of different hard disk drives. In one example, the database may be co-located with a computer or a server for performing the functions described herein or may be located remotely from the computer or the server.

[0026] At block 208, the method 200 receives an indication that the hard disk drive requires removal of power from the hard disk drive. In one example, the indication may be a message sent to a user or a technician that the hard disk drive is failing, malfunctioning, requires maintenance, and the like. The indication may be sent as an email, a pop-up message, an instant message, and the like.

[0027] At block 210, the method 200 receives a power removal command in response to the indication, wherein the power removal command includes the serial number of the hard disk drive. In one example, in response to the indication, the user or technician may be required to power down the malfunctioning hard disk drive asynchronously such that the hard disk drive can be repaired or replaced. In one example, the user or technician may be required to enter the serial number of hard disk drive in the power removal command in addition to the physical location of the hard disk drive, e.g., the bay number, port number, connection number, and the like. For example, the user or technician may look up the serial number of the hard disk drive in a list that is maintained. For example, the user or a service provider of the storage services may keep an additional list of serial numbers for all the hard disk drives that are installed at each location or bay with each unique serial number being associated with a respective one of the hard disk drives.

[0028] At block 212, the method 200 determines whether the serial numbers match. For example, if the hard disk drive is still responsive despite the malfunction or failure, the method 200 may poll the hard disk drive for the serial

number of the hard disk drive that is failing. The method 200 may then compare the serial number received from the power removal command and the serial number obtained from the hard disk drive.

[0029] In another example, if the hard disk drive is non-responsive, the method 200 may obtain the serial number of the hard disk drive from the database that stored the serial number upon installation of the hard disk drive previously at optional block 206. Based upon the comparison if the serial numbers do not match, then the method 200 proceeds to block 214. At block 214, the method 200 provides a message indicating that the serial numbers do not match. The method 200 may then return to block 210 to repeat blocks 210 and 212.

[0030] Returning back to block 212, based on the comparison if the method 200 determines that the serial numbers match, the method 200 proceeds to block 216. At block 216, the method 200 removes the power from the hard disk drive. In one example, the power may be removed asynchronously. In other words, in a system comprising a plurality of different hard disk drives that are powered individually or independently, but controlled via a single controller, the power is removed only from the hard disk drive that is failing or requires maintenance while maintaining power to the remaining hard drives. At block 218, the method 200 ends.

[0031] As a result, the examples of the present disclosure may improve the functioning of an application server or a computer. For example, commands to remove power to a hard disk drive in a particular bay may include a serial number of the hard disk drive to ensure the proper hard disk drive is being turned off that could not otherwise be verified without the improvements provided by the present disclosure. In other words, hard disk drive technology controls may be improved by providing a computer that is modified with the ability to automatically verify the power is being removed from the correct hard disk drive based on the serial number of the hard disk drive, as disclosed by the present disclosure.

[0032] It should be noted that although not explicitly specified, one or more blocks, functions, or operations of the method 200 described above may include

a storing, displaying and/or outputting step as required for a particular application. In other words, any data, records, fields, and/or intermediate results discussed in the methods can be stored, displayed, and/or outputted to another device as required for a particular application. Furthermore, blocks, functions, or operations in FIG. 2 that recite a determining operation, or involve a decision, do not necessarily require that both branches of the determining operation be practiced. In other words, one of the branches of the determining operation can be deemed as an optional step.

[0033] FIG. 3 depicts a high-level block diagram of a computer that can be transformed to into a machine that is dedicated to perform the functions described herein. In one example, the techniques of the present disclosure may improve the operation and functioning of a computer to validate a hard disk drive, as disclosed herein.

[0034] As depicted in FIG. 3, the computer 300 comprises a hardware processor element 302, e.g., a central processing unit (CPU), a microprocessor, or a multi-core processor, a memory or a storage 304, e.g., random access memory (RAM) and/or read only memory (ROM), a module 305 for hard disk drive power removal, and various user input/output devices 306, e.g., storage devices, including but not limited to, a tape drive, a floppy drive, a hard disk drive or a compact disk drive, a receiver, a transmitter, a speaker, a display, a speech synthesizer, an output port, an input port and a user input device, such as a keyboard, a keypad, a mouse, a microphone, and the like. Although only one processor element is shown, it should be noted that the computer may employ a plurality of processor elements. Furthermore, although only one computer is shown in the figure, if the method(s) as discussed above is implemented in a distributed or parallel manner for a particular illustrative example, i.e., the blocks of the above method(s) or the entire method(s) are implemented across multiple or parallel computers, then the computer of this figure is intended to represent each of those multiple computers. Furthermore, one or more hardware processors can be utilized in supporting a virtualized or shared computing environment. The virtualized computing environment may support one or more virtual machines representing computers, servers, or other

computing devices. In such virtualized virtual machines, hardware components such as hardware processors and computer-readable storage devices may be virtualized or logically represented.

[0035] It should be noted that the present disclosure can be implemented by tangible, non-transitory machine readable instructions and/or in a combination of machine readable instructions and hardware, e.g., using application specific integrated circuits (ASIC), a programmable logic array (PLA), including a field-programmable gate array (FPGA), or a state machine deployed on a hardware device, a computer or any other hardware equivalents, e.g., computer readable instructions pertaining to the method(s) discussed above can be used to configure a hardware processor to perform the blocks, functions and/or operations of the above disclosed methods. In one example, instructions and data for the present module or process 305 for hard disk drive power removal, e.g., machine readable instructions can be loaded into memory 304 and executed by hardware processor element 302 to implement the blocks, functions or operations as discussed above in connection with the exemplary method 200. Furthermore, when a hardware processor executes instructions to perform “operations”, this could include the hardware processor performing the operations directly and/or facilitating, directing, or cooperating with another hardware device or component, e.g., a co-processor and the like, to perform the operations.

[0036] The processor executing the machine readable instructions relating to the above described method(s) can be perceived as a programmed processor or a specialized processor. As such, the present module 305 for hard disk drive power removal, including associated data structures, of the present disclosure can be stored on a tangible or physical (broadly non-transitory) computer-readable storage device or medium, e.g., volatile memory, non-volatile memory, ROM memory, RAM memory, magnetic or optical drive, device or diskette and the like. More specifically, the computer-readable storage device may comprise any physical devices that provide the ability to store information such as data and/or instructions to be accessed by a processor or a computing device such as a computer or an application server.

[0037] It will be appreciated that variants of the above-disclosed and other features and functions, or alternatives thereof, may be combined into many other different systems or applications. Various presently unforeseen or unanticipated alternatives, modifications, variations, or improvements therein may be subsequently made by those skilled in the art which are also intended to be encompassed by the following claims.

What is claimed is:

1. A method, comprising:
 - obtaining, by a processor, a serial number of a hard disk drive when the hard disk drive is installed;
 - receiving, by the processor, an indication that the hard disk drive requires removal of power from the hard disk drive;
 - receiving, by the processor, a power removal command in response to the indication, wherein the power removal command includes the serial number of the hard disk drive;
 - verifying, by the processor, that the serial number in the power removal command matches the serial number of the hard disk drive that was obtained;
 - and
 - removing, by the processor, the power from the hard disk drive when the serial number in the power removal command matches the serial number of the hard disk drive.
2. The method of claim 1, wherein the obtaining automatically includes obtaining the serial number as part of a hard disk drive installation.
3. The method of claim 1, wherein the serial number that is obtained is stored in a database with a plurality of different serial numbers of a plurality of different hard disk drives.
4. The method of claim 3, wherein the verifying further comprises:
 - obtaining, by the processor, the serial number of the hard disk drive from the database when the hard disk drive is non-responsive.
5. The method of claim 1, wherein the indication comprises a message that the hard disk drive has failed or requires maintenance.

6. The method of claim 1, wherein the power removal command comprises a small computer system interface enclosure services protocol command.
7. The method of claim 1, wherein the removing the power comprises asynchronously removing the power from the hard disk drive in a system comprising a plurality of hard disk drives, wherein each one of the plurality of hard disk drives is controlled via a single controller of the processor and independently powered.
8. The method of claim 1, further comprising:
 - providing, by the processor, a message indicating that the serial number in the power removal command is incorrect when the serial number in the power removal command does not match the serial number of the hard disk drive that was obtained.
9. A computer system comprising:
 - a processor;
 - an expander coupled to the processor; and
 - a plurality of hard disk drives coupled to the expander, wherein each one of the plurality of hard disk drives provides a respective serial number when connected to the expander, wherein an indication is sent to the processor when one of the plurality of hard disk drives requires removal of power causing the processor to execute an instruction set to:
 - receive a power removal command in response to the indication, wherein the power removal command includes the respective serial number of the one of the plurality of hard disk drives;
 - verify that the serial number in the power removal command matches the respective serial number of the one of the plurality of hard disk drives that was provided when connected to the expander; and
 - remove the power from the one of the plurality of hard disk drives when the serial number in the power removal command matches the serial number of the one of the plurality of hard disk drives.

10. The computer system of claim 9, further comprising:
a database in communication with the processor, wherein the respective serial number that is provided is stored in the database with a plurality of different serial numbers of the plurality of different hard disk drives.
11. The computer system of claim 10, wherein the instruction to verify further comprises instructions to:
obtain the respective serial number of the one of the plurality of hard disk drives from the database when the one of the plurality of hard disk drives is non-responsive.
12. The computer system of claim 9, wherein the indication comprises a message that the hard disk drive has failed or requires maintenance.
13. The computer system of claim 9, wherein the power removal command comprises a small computer system interface enclosure services protocol command.
14. The computer system of claim 9, wherein the instruction set further comprises instructions to:
provide a message indicating that the serial number in the power removal command is incorrect when the serial number in the power removal command does not match the serial number of the hard disk drive that was obtained.
15. A non-transitory machine-readable storage medium storing instructions executable by a processor, the machine-readable storage medium comprising:
instructions to obtain a serial number of a hard disk drive when the hard disk drive is installed;
instructions to receive an indication that the hard disk drive requires removal of power from the hard disk drive;
instructions to receive a power removal command in response to the

indication, wherein the power removal command includes the serial number of the hard disk drive;

instructions to verify that the serial number in the power removal command matches the serial number of the hard disk drive that was obtained;
and

instructions to remove the power from the hard disk drive when the serial number in the power removal command matches the serial number of the hard disk drive.

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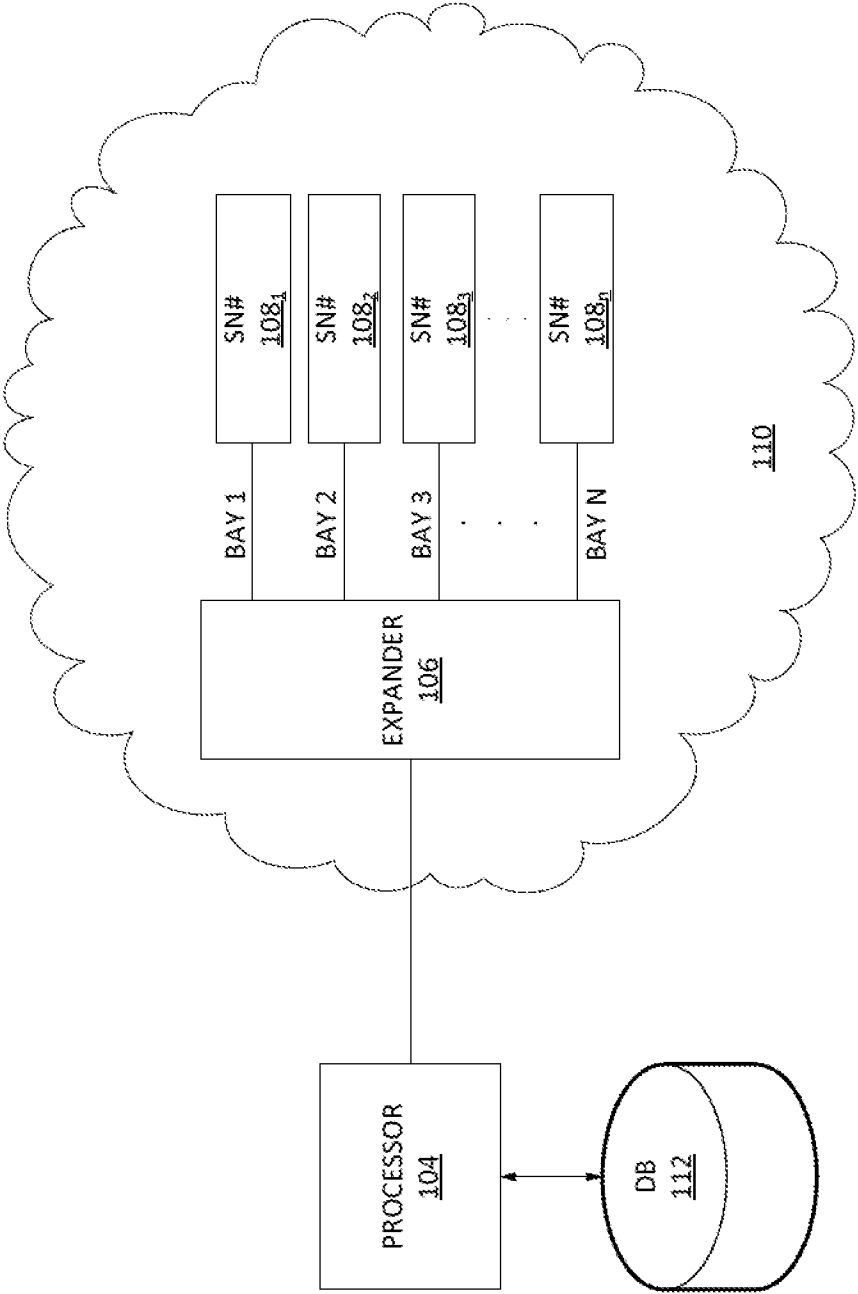


FIG. 1

200

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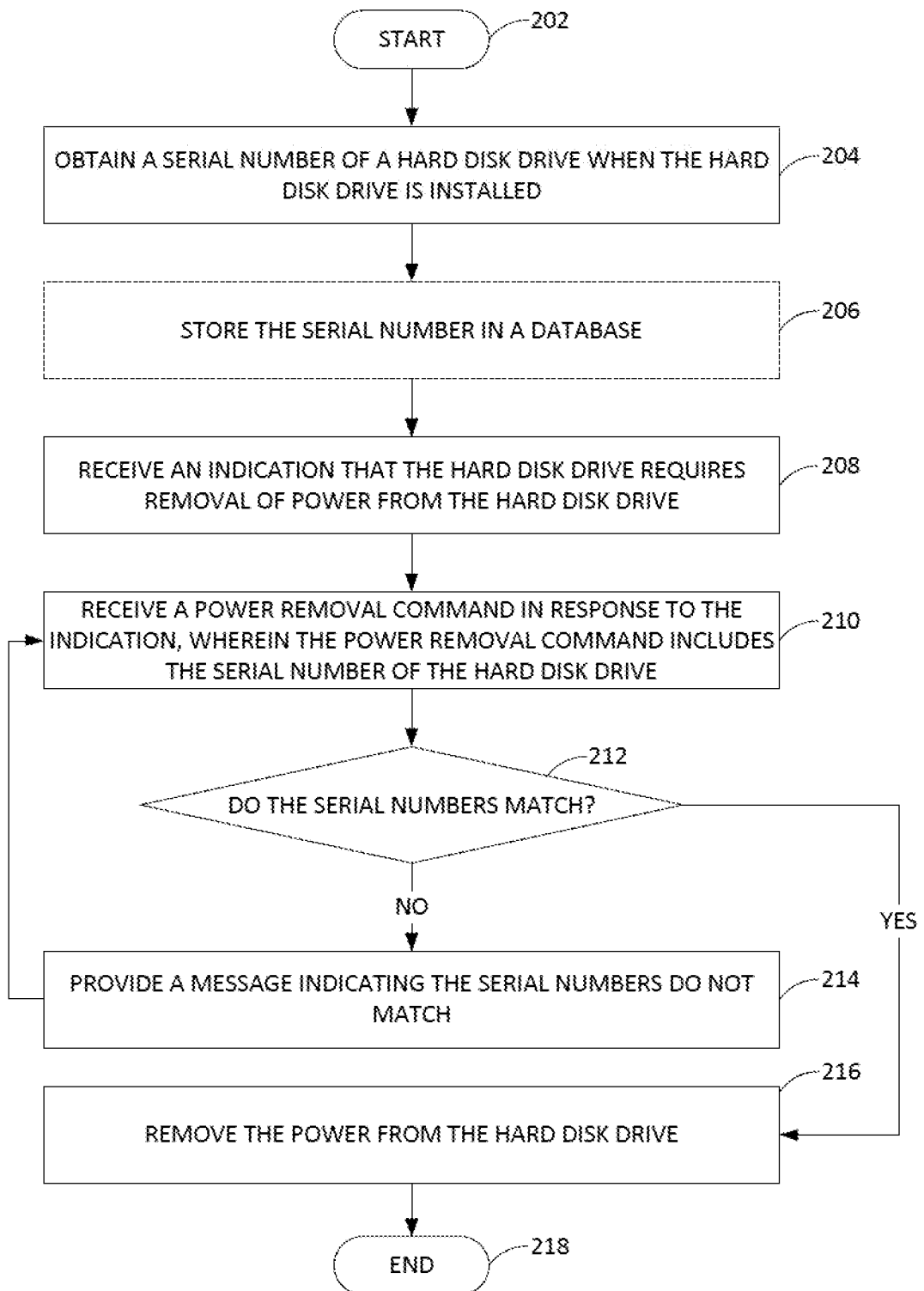


FIG. 2

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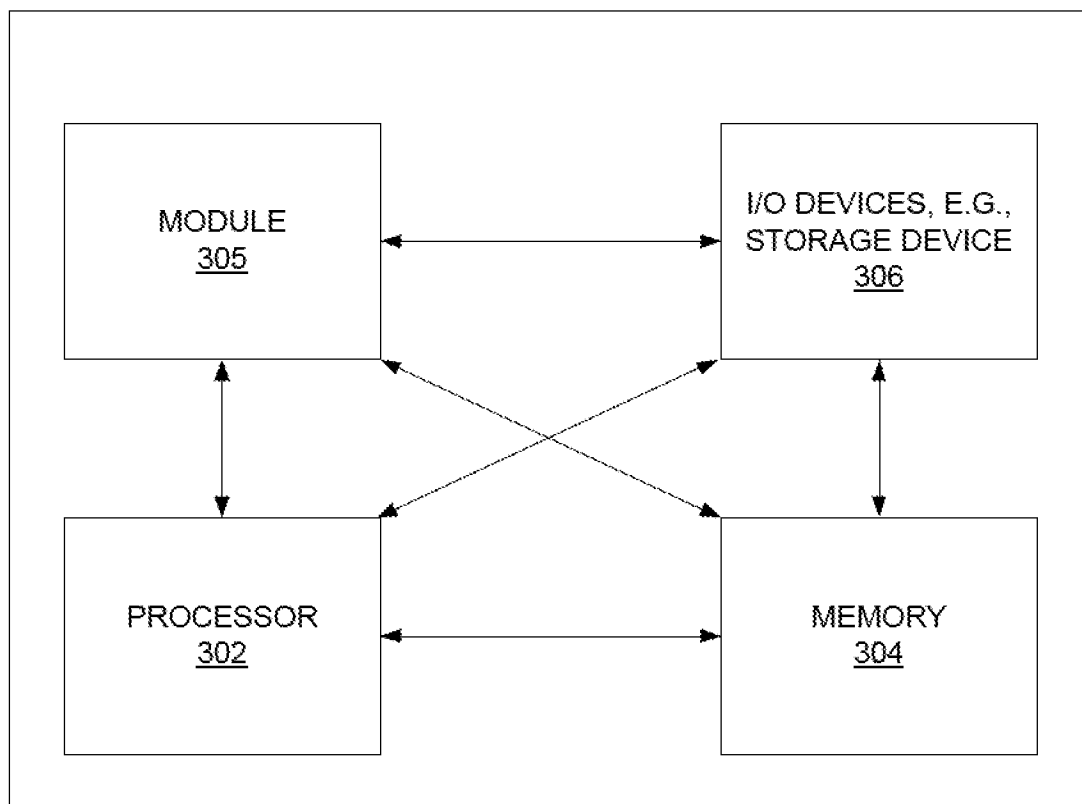
300

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/013432**A. CLASSIFICATION OF SUBJECT MATTER****G06F 1/26(2006.01)i**

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)

G06F 1/26; G06F 3/06; G11C 7/10; G06F 3/00; G11B 19/02; G11B 19/00; G06F 21/00

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & keywords: hard disk drive, serial number, removal of power, indication, match, fail, maintenance

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 09-101866 A (NEC ENG. LTD.) 15 April 1997 See paragraphs [0021]-[0033]; claims 1-2; and figure 1.	1-15
Y	US 2006-0034131 A1 (ATSUHIRO ONO et al.) 16 February 2006 See paragraphs [0035]-[0043]; claims 10, 13; and figures 2-3.	1-15
A	JP 2007-193711 A (CHUGOKU ELECTRIC POWER CO., INC.) 02 August 2007 See paragraphs [0058]-[0063]; claims 1-2; and figures 6-7.	1-15
A	US 2009-0300717 A1 (SRIKANTH MANDAVA) 03 December 2009 See paragraphs [0036]-[0037]; and figure 5.	1-15
A	JP 2001-101763 A (TOSHIBA CORP.) 13 April 2001 See paragraphs [0036]-[0064]; and figures 1-3.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

26 October 2015 (26.10.2015)

Date of mailing of the international search report

26 October 2015 (26.10.2015)

Name and mailing address of the ISA/KR

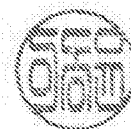
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Republic of Korea

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/013432

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