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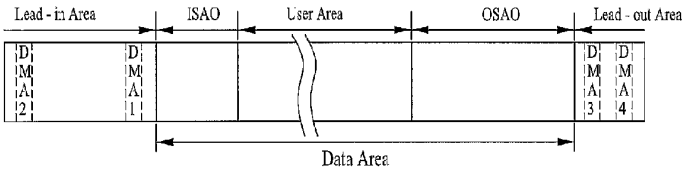


(57) Abstract: A write once optical recording medium and a method and apparatus for storing and recovering defect management information to and from the write once optical recording medium are provided. The recording medium includes at least one recording layer, and a data area on the recording layer. The data area includes at least one spare area and a user data area. The spare area contains at least one replacement cluster, each of the replacement clusters storing therein address information of a corresponding defective cluster.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

# WRITE ONCE OPTICAL DISC, AND METHOD AND APPARATUS FOR RECOVERING DISC MANAGEMENT INFORMATION FROM THE WRITE ONCE OPTICAL DISC

## Technical Field

The present invention relates to a write once optical disc and a method and apparatus for recovering disc management information from the write once optical disc.

## Background Art

Optical discs are used widely as optical media for recording large sized data. Among the optical discs, recently a new high-definition digital video disc (HD-DVD) type of recording media, such as a Blu-ray disc, is under development. High definition video data and high definition audio data can be written and stored on such a Blu-ray disc for a long time. The Blu-ray disc, the next generation HD-DVD technology, can store much more data than the currently available DVDs.

Generally, the Blu-ray disc has a 1.2mm thickness and a 12cm diameter with a 0.1mm thick optical transmission layer accessible with a bluish violet laser having a 405nm wavelength, which is much finer than the currently available DVD that uses a red laser having a 650nm wavelength.

Various draft standards for the Blu-ray disc are under

preparation. In this regard, various draft standards for a Blu-ray disc write once (BD-WO) are under preparation in succession to a Blu-ray disc re-writable (BD-RE). A BD-WO is a write once Blu-ray optical disc that allows only one time recording on its area, whereas a BD-RE is a rewritable Blu-ray optical disc that allows recording, erasing and repeated recording of its area.

FIG. 1 illustrates a structure of a recording area of a BD-RE, schematically. The Blu-ray disc in FIG. 1 has one recording layer provided with, starting from an inner circumference of the disc, a lead-in area, a data area, a lead-out area. The data area has an inner spare area (ISA0) and an outer spare area (OSA0) respectively in the inner and outer circumferential parts of the data area, and a user area in the middle part of the data area for the user's data writing/recording.

If a defective area in the data area of the BD-RE is detected in the middle of data writing, a replacement writing operation is carried out in which the data in the defective area is transferred to the spare area. Then, as management information on the defective area, information on the positions and the like of the defective area and on the used replacement area is written in defect management areas (DMA1, DMA2, DMA3, and DMA4) of the lead-in/out areas, for management of defects.

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However, since the writing on a particular area is possible only once in the write once optical disc, it is important to manage well position information indicating whether or not an area has a data written thereon, position information indicating the location of the disc area to which data can be written, defective area information indicating the location of defective areas, and the like. In the consolidated standards for write once optical discs such as BD-WOs under development, establishment of consolidated standards would be needed for methods of providing defect management information and recovering the defect management information in case the defect management information is damaged or has not yet been written. If data are written on a disc without recovering the lost disc management information, many problems would arise such as writing data based on incorrect prior management information and obtaining an incorrect position of the recordable area on the disc.

It is not admitted that any of the information in this specification is common general knowledge, or that the person skilled in the art could be reasonably expected to have ascertained, understood, regarded it as relevant or combined it in anyway at the priority date.

**Disclosure of Invention**

Accordingly, described herein is a write once optical recording medium, and a method and apparatus for storing and recovering disc management information to and from the

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optical disc that substantially obviate one or more of the problems due to limitations and disadvantages of the related art.

Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

Described herein (but not claimed) is a recording medium comprising at least one recording layer; and a data area on the at least one recording layer, the data area including at least one spare area and a user data area, the at least one spare area containing at least one replacement cluster, each of the at least one replacement cluster containing address information of a corresponding defective cluster.

According to a first aspect of the present invention, there is provided a recording medium comprising:

a data area including a spare area and a user data area, the spare area including one or more replacement areas each of which replaces a defective area existing in the user data area and contains address information of the defective area; and

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a temporary defect management area assigned to at least one of a lead-in area of the recording medium and the spare area for temporarily storing defect management information, the temporary defect management area storing an (n)th temporary defect list management information reconstructed from an (n-1)th temporary defect list information recorded in the temporary defect management area and the address information contained in the one or more replacement areas.

Described herein (but not claimed) is a method of managing disc management information on a recording medium including a data area, the data area including at least one spare area and a user data area, the at least one spare area containing at least one replacement cluster, the method comprising (a) storing, in each of the at least one replacement cluster, address information of a corresponding defective cluster.

According to another aspect of the present invention, there is provided a method for recovering management information from a recording medium having a spare area and a user data area, the recording medium including a temporary defect management area for storing therein temporary disc definition structure (TDDS) information, the method comprising steps of:

reproducing an (n-1)th TDDS information from the recording medium;

determining if a certain area following an area indicated by the (n-1)th TDDS information has recording;

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determining position information associated with the certain area if the certain area has recording; and

reconstructing an (n)th TDDS information based on the determined position information.

According to yet another aspect of the present invention, there is provided a method for recovering management information from a recording medium having a spare area and a user data area, the recording medium including a temporary defect management area for storing therein temporary defect list (TDFL) information, the method comprising steps of:

reproducing an (n-1)th TDFL information from the temporary defect management area;

reproducing address information of a defective area replaced by a replacement area located in the spare area and address information of the replacement area from the replacement area; and

reconstructing an (n)th TDFL information based on the reproduced address information.

Also described herein (but not claimed) is an apparatus for managing disc management information on a recording medium including a data area, the data area including at least one spare area and a user data area, the at least one spare area including at least one replacement cluster, the apparatus comprising a recording/reproducing unit for recording and reproducing data to and from the recording medium; and a

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control unit for controlling the recording/reproducing unit to store, in each of the at least one replacement cluster, address information of a corresponding defective cluster.

According to still another aspect of the present invention, there is provided an apparatus for recovering management information from a recording medium having a spare area and a user data area, the recording medium including a temporary defect management area for storing therein temporary disc definition structure (TDDS) information, the apparatus comprising:

a pick-up configured to record/reproduce data to/from the recording medium directly; and

a microcomputer operatively coupled to the pickup and configured to control the pickup to reproduce an (n-1)th TDDS information from the recording medium; configured to determine if a certain area following an area indicated by the (n-1)th TDDS information has recording; means for determining position information associated with the certain area if the certain area has recording; and configured to reconstruct an (n)th TDDS information based on the determined position information.

According to another aspect of the present invention, there is provided an apparatus for recovering management information from a recording medium having a spare area and a user data area, the recording medium including a temporary

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defect management area for storing therein temporary defect list (TDFL) information, the apparatus comprising:

a pick-up configured to record/reproduce data to/from the recording medium directly; and

a microcomputer operatively coupled to the pickup and configured to control the pickup to reproduce an (n-1)th TDFL information from the temporary defect management area; configured to control the pickup to reproduce address information of a defective area replaced by a replacement area located in the spare area and address information of the replacement area from the replacement area; and configured to reconstruct an (n)th TDFL information based on the reproduced address information.

It is to be understood that both the foregoing description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention claimed.

As used herein, except where the context requires otherwise the term "comprise" and variations of the term, such as "comprising", "comprises" and "comprised", are not intended to exclude other additives, components, integers or steps.

**Brief Description of Drawings**

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated

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in and constitute a part of this application, illustrate embodiment (s) of the invention and together with the description serve to explain the principle of the invention.

In the drawings:

FIG. 1 illustrates a structure of a writing area on a BD-RE, schematically;

FIG. 2 illustrates a structure of a write once optical disc in accordance with the present invention;

FIG. 3 illustrates temporary disc management information storable on the write once optical disc of FIG. 2 in accordance with the present invention;

FIG. 4 illustrates a recording unit structure of a replacement area in a spare area of the write once optical disc of FIGs. 2 and 3 in accordance with the present invention;

FIG. 5 illustrates the contents of temporary disc management information storable on the write once optical disc of FIGs. 2 and 3 in accordance with the present invention;

FIG. 6 illustrates a method of recovering disc management information of a write once optical disc in accordance with a first embodiment of the present invention;

FIG. 7 illustrates a method of determining a recorded or unrecorded area on a write once optical disc in accordance with the present invention;

FIG. 8 illustrates the contents of lost temporary defective area information of the write once optical disc of FIGs. 2 and 3 in accordance with the present invention;

FIG. 9 illustrates a method of recovering temporary disc management information applicable to a write once optical disc in accordance with a second embodiment of the present invention;

FIG. 10 illustrates a method of recovering temporary defective area information applicable to a write once optical disc in accordance with the second embodiment of the present invention; and

FIG. 11 illustrates an optical disc recording/reproducing apparatus according to the present invention.

**Best Mode for Carrying Out the Invention**

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. For convenience of description, a case of a write once Blu-ray disc (BD-WO) will be described as an example.

Along with this, even though the inventor selects general terms used widely in describing the present invention as far as possible, the inventor selects the terms in particular cases at the inventor's discretion, when a meaning of the term is described in detail in a relevant description part of the present application. Therefore, the present invention should be understood by any meanings of the terms as defined by the inventor, if present.

<Definitions of Optical Disc and Disc Management Information>

FIG. 2 illustrates the structure of a write once optical disc such as a BD-WO in accordance with an embodiment of the present invention. The disc of FIG. 2 is a single layer disc having one recording layer, but the present invention is applicable to multi-layer write once optical disc such as a dual layer BD-WO.

Referring to FIG. 2, the recording layer of the disc includes a lead-in area, a data area, and a lead-out area. The data area includes inner and outer spare areas ISA0 and OSA0 for replacing defective areas for physical defect management. The lead-in area includes first and second DMAs (DMA1 and DMA2) whereas the lead-out area includes third and fourth DMAs (DMA3 and DMA4). Temporary Defect Management Areas (TDMAs) are also provided for temporarily storing and managing defective area information. When no more data is to be written on the write once optical disc or in response to a command from a host or system, data stored in the TDMA are transferred to a DMA for more permanent storage. Generally, in view of the importance of defect management, each of the DMAs carries the same management data for redundancy purposes.

In general, in the case of a rewritable optical disc, since writing/erasure can be repeated as many times as desired, a large sized DMA is not needed. However, this is not the case with a write once optical disc. In the case of a

write once optical disc, once data are written to a recordable area, data cannot be written again to that area. As a result, a larger management area and/or an efficient management area structure and method are required for defect management.

As shown in FIG. 2, the TDMAs include a TDMA1 assigned to the lead-in area and having a fixed size, and a TDMA2 assigned to the outer spare area OSA0 and having a size varied in accordance with the size of the spare area. For instance, if the size of the OSA0 is N*256 clusters, then the size (P clusters) of the TDMA2 is as follows: P = (N*256)/4.

As disc management information, one or more Temporary Defect Lists (TDFLs) and one or more Temporary Disc Definition Structures (TDDSs) are written in each of the TDMA1 and TDMA2. Therefore, the disc management information according to the present invention means information written to the TDFLs and TDDSs, in a narrow sense.

If a defective area is found in the data area or a spare area, a process is carried out for transferring data from the defective area to a spare area. The TDFL is information for managing such a series of processes by using a defective area list, and is written out in 1 ~ 4 cluster size depending on the size of the defective area list (in case the disc is a single layer disc). The TDDS is written

out in one cluster size and includes a Disc Definition Structure (DDS) information and disc use state information (track information or space bit map (SBM)) in a narrow sense as shown in FIG. 3.

In the present application, terms "TDDS" and "TDDS information" are used interchangeably, and terms "TDFL" and "TDFL information" are used interchangeably.

An Optimum Power Calibration Area (OPC Area) is assigned to the lead-in area for finding an optimum writing power, and has the structure and purpose, which are the same as the related art optical disc.

The contents of each TDDS will be described in more detail and in comparison to the structure of the related art re-writable optical disc by referring to FIG. 3.

As shown in FIG. 3, in the case of the re-writable optical disc, the DDS occupies approximately 60bytes, a very small portion of one cluster (which has 32 sectors), and the rest of the one cluster is set in zero padding. However, in the present invention, in addition to the area (e.g., 60bytes) 60a used as the DDS area in the related art re-writable optical disc, the rest 60b of the one sector is used as the DDS in the write once optical disc. Accordingly, the TDDS of the present invention is composed of the entire one sector (2048bytes) used to store the DDS and the rest 60c of one cluster used to store disc use state information

(track information or space bit map (SBM)).

As part of the DDS, information required for managing the write once optical disc according to the present invention includes the following information, but may include other information as needed in the process of standard establishment.

At first, for supporting a plurality of different writing methods, the DDS includes a recording mode flag 62 for indicating a particular recording mode/method. For instance, the recording mode flag 62 having a value of '0000 0000b' represents a sequential recording, and the recording mode flag 62 having a value of '0000 0001b' represents a random recording. The DDS further includes 'First PSN of latest TDFL,' 'Last PSN of the used OPC,' and 'First usable spare cluster in ISA0/OSA0' and 'First PSN of (n-1)th TDDS' for each of the spare areas. PSN means physical sector number.

Next, in the remaining thirty-one sectors (60c) of the one cluster of the TDDS, the disc use state information of the present invention is recorded. The disc use state information is information varied with the use of the disc, and particularly, in the case of the write once optical disc, such information is required for the accurate search of an additional recordable area obtained by sorting the entire disc area into written/unwritten areas. Although FIG.

3 discloses using the front first sector of one cluster as the DDS area and the rest of the 31 sectors of the one cluster as the area for storing the disc use state information, the present invention encompasses using the front 31 sectors of the one cluster as the area for storing the disc use state information, and the last 32nd sector of the one cluster as the DDS area.

As mentioned above, the disc use state information can be, e.g., either the track information or SBM. If the recording mode flag 62 indicates a sequential recording, then the track information is stored in the area 60c as the disc use state information. But if the recording mode flag 62 indicates a random recording, the SBM is recorded in the area 10c as the disc use stage information.

The track information is one kind of information on the disc use state, and is applicable to the disc having the sequential recording applied thereto. In the related art write once optical discs such as a CD and a DVD, the use state information is known as track information for CDs, and RZone, Fragment, or recording range for DVDs. All these various terms will be called as 'track information' as a common name in the present invention, and should be understood as that meaning.

The SBM (Space Bitmap) is another kind of information indicating the disc use state, and is applicable to the

disc having the random recording according to the present invention. The SBM is applicable to the entire area of the disc, wherein one bit is assigned to every smallest recording unit (e.g., one cluster in the case of a BD-WO), which is represented with '1b' if the cluster is a written area, and '0b' if the cluster is an unwritten area (or vice versa). Thus, upon reading the SBM information, the positions of the present written areas and unwritten areas of the write once optical disc can be known easily.

An example of the track information is indicated as 64 and is illustrated on the right side part of FIG. 3 schematically. The track information indicates a last recorded position of a data for each track in the disc, and the track information can include information on a Last Recorded Address (LRA) that indicates the address of the last recorded area in the user area.

The TDDS and TDFL as discussed above are needed to conduct defect management of the write once optical disc. However, situations arise when the recording of the TDDS and/or TDFL may fail, e.g., a power failure. For such situations, the present invention provides a disc structure and a method and apparatus for recovering disc management information such as a TDDS and/or TDFL. Such a disc structure will be discussed now.

FIG. 4 shows an example of a replacement cluster R in a

spare area (e.g., ISA0 or OSA0 in FIG. 2) of a write once optical disc such as a BD-WO according to the present invention. As shown in FIG. 4, when a defect is found in the user area or a spare area of the write once optical disc, user data intended for or written in the cluster having this defect are written to an available area of the spare area. This available area is referred to herein as a replacement cluster d, and the cluster having the defect is referred to herein as a defective cluster D. A cluster is a unit of recording and includes one or more sectors as known.

The replacement cluster d includes an address area 21, a user control data area 22, and a replacement user data area 24. The address area 21 stores the address information of the replacement cluster d, e.g., the first PSN of the replacement cluster d. Other information may be stored in the address area 21. The address information of the defective cluster D, e.g., the first PSN of the defective cluster D, is stored in a certain area of the replacement cluster d, and this certain area can be, e.g., either the address area 21 or the user control data area 22. The user control data area 22 also stores therein control data for the replacement cluster d. The replacement user data area 24 stores the user data intended for or written to the defective cluster D.

Using the disc structure of FIG. 4, a method of recovering disc management information in accordance with a first embodiment of the present invention will be discussed referring to FIGs. 5-8. Lost disc/defect management information, i.e., information intended to recover, is indicated with the dashed lines in FIGs. 5 and 8.

As shown in FIG. 5, the write once optical disc such as the disc of FIGs. 2 and 3 stores a plurality of TDFLs (#n-1, #n,...) and a plurality of TDDSs (#n-1, #n,...) in a TDMA such as a TDMA1. Each of the TDFLs and TDDSs has the structure as discussed in the present application. In this example, assume that an (n)th TDDS 32 is lost and that defects are present at A, B, C clusters in the data area and as a result, and user data are written respectively at 'a', 'b', and 'c' clusters in the spare area (ISA0) in place of the A, B, C clusters.

To recover the lost (n)th TDDS 30, referring to FIG. 6, when the write once optical disc is loaded into a system including a recording/reproducing device (e.g., the system shown in FIG. 11 to be discussed later), the (n-1)th TDDS 30 (in FIG. 5) that is properly recorded on the BD-WO is read (step 601). Once the (n-1)th TDDS is obtained, positions of the last recorded areas of the disc at the time the (n-1)th TDDS is written can be known. For instance, from the (n-1)th TDDS, the last PSN of the used

OPC in the lead-in area can be determined, the disc use state information [track information (LRA use) or SBM] for the data area can be obtained, and the first useable spare cluster in the spare area ISA0/OSA0 can be obtained.

If it is determined that the next TDDS ((n)th TDDS 32) needs to be recovered (step 602), then certain applicable areas of the disc are checked to obtain information needed to reconstruct the (n)th TDDS (step 603). More specifically, the area following each of the last recorded areas indicated by the (n-1)th TDDS is checked to see if there is any recording in that area. This checking can be implemented by using an RF signal test to be discussed later referring to FIG. 7. The location or address at which such recording in the area following each of the last recorded areas indicated by the (n-1)th TDDs ends, is then determined and used to reconstruct the (n)th TDDS (step 604). And the reconstructed (n)th TDDs is recorded as the (n)th TDDS 32 in the TDMA1 (step 604) and this completes the recovery of the lost (n)th TDDS according to the present invention. The step 602 can be progressed automatically or upon a request from a user or a host.

FIG. 7 illustrates the RF signal test that is used to determine whether an area of a disc is a recorded area or an unrecorded area according to the present invention. As shown in FIG. 7, the location of the recorded/unrecorded

(written/unwritten) areas on the disc can be determined using an RF signal. Generally, an RF signal can be detected from a written/recorded area of the disc, whereas a little or no RF signal can be detected from an unwritten/unrecorded area of the disc. Therefore, by detecting the RF signal, the end address of the written area, which is what the (n)th TDDS intended to identify, can be detected.

The process as shown in FIG. 7 is carried out for each of certain areas of the disc to obtain the information needed to reconstruct the lost TDDS information (steps 6031, 6032, and 6033 in FIG. 6). For example, the last PSN of the used OPC can be determined by checking the RF signal from the lead-in area, the disc use state information [track information (LRA use) or SBM] can be obtained by checking the RF signal from the data area, and the first useable spare cluster can be obtained by checking the RF signal from the spare area ISA0/OSA0.

Next, a method of recovering an (n)th TDFL in accordance with the first embodiment of the present invention will be described with reference to FIGS. 5-8.

An example of the structure of the (n-1)th TDFL 40 in FIG. 5 is shown in FIG. 8. In the example of FIGs. 5 and 8, the (n-1)th TDFL 40 includes three entries 51 containing the first PSN of each of the defective clusters A, B, C and the

first PSN of each of the replacement clusters a, b, c corresponding respectively to the defective clusters A, B, C. In other words, due to the defects in the clusters A, B, C in the data area, user data are written respectively to the clusters a, b, c in the spare area (ISA0) in place of the clusters A, B, C. Information on such defective and replacement clusters is then managed and stored as entries in the (n-1)th TDFL 40.

At a later recording time, assume that a defect is found at the cluster D in the data area. Then data intended for or written to the cluster D are written at the cluster d in the spare area (ISA0) in place of the cluster D. However, due to a failure in writing the (n)th TDFL to indicate this replacement writing, the system or host knows nothing about this replacement writing. As such, a method of recovering the (n)th TDFL is needed and is described as follows according to the present invention.

As shown in FIG. 6, when the disc is loaded in the system, reproducible properly recorded TDDS and TDFL are read (step 601), namely, the (n-1)th TDDS 30 and the (n-1)th TDFL 40 in FIG. 5. In the case of the above example, it is possible to obtain the three entries for the defective clusters A, B and C from the (n-1)th TDFL shown in FIG. 8, and a position information 50 of the first usable spare cluster (50) in the ISA0/OSA0 from the (n-1)th TDDS as shown in FIG. 5. The

position information 50 of the first usable spare cluster as obtained from the (n-1)th TDDS, in this example, indicates the position or the starting address of the replacement cluster d.

Next, the existence of any recording in the area following the first usable spare cluster 50 indicated by the (n-1)th TDDS is determined (step 6033 in the step 603). That is, the system checks if there is any recording in the cluster d area. This checking is done by using the RF signal test discussed above in connection with FIG. 7. Depending on the system, the step 6033 can be progressed automatically or upon a request from a host or the like (step 602). In the case of the above example, it is determined that the cluster d has recording.

For the recovery of the (n)th TDFL, however, a full entry is required, which includes the position information of the defective cluster D corresponding to the replacement cluster d. But this position information is not obtainable merely by determining whether or not the replacement cluster d has recording therein using the RF signal test. Therefore, in order to obtain the position information of the defective cluster D, the present invention utilizes the position information of the defective D cluster recorded at a particular area of the reproducible replacement cluster d, as discussed above in connection with FIG. 4. For instance,

the first PSN of the defective cluster D is recorded in either the address area 21 or the user control data area 22 of the replacement cluster d.

Therefore, in the above example, upon reading the user control data area (or the address area) of the replacement cluster d, the position information on the defective cluster D, a defective area, can be known. And this information is used to reconstruct the last full entry 52 of the (n)th TDFL as shown in FIG. 8. In this example, the last full entry 52 of the (n)th TDFL can be reconstructed with the first PSN of the replacement cluster d obtained from the step 6033 and the first PSN of the defective cluster D corresponding to the replacement cluster d, which was obtained from the user control data area (or the address area) of the replacement cluster d. Then the entire (n)th TDFL can be reconstructed with the three entries 51 from the (n-1)th TDFL and the recovered last entry 52.

Upon writing the (n)th TDFL recovered as discussed above in the TDMA area such as the TDMA1, the recovery process of the TDFL is completed (step 604).

The terms 'first PSN' and 'last PSN' will be described in more detail. One recording unit written on the disc (a cluster in the case of BD-WO) has a plurality of sectors, and the first PSN is the start address of the first sector,

and the last PSN is the start address of the last sector. Therefore, if the direction of the use of the disc is in the direction of the PSN increase, the position of a particular recording unit can be known from the 'first PSN' of the cluster (i.e., the start address of the first sector of the cluster), and if the direction of the use of the disc is in the direction of the PSN decrease (like the OPC area), the position of a particular recording unit can be known from the 'last PSN' of the cluster (i.e., the start address of the last sector of the cluster). According to the present invention, 'position information' can mean the 'first PSN' and/or the 'last PSN,' but is not limited to such and can means other ways of indicating a particular location or position.

Referring to FIGs. 9 and 10, a method of recovering disc management information in accordance with a second embodiment of the present invention, which suggests recovering lost disc management information (e.g., (n)th TDDS and (n)th TDFL) from an area recorded at the last time on the disc, will be now discussed. FIG. 9 illustrates the processing steps for recovering an (n)th TDDS and FIG. 10 illustrates the processing steps for recovering an (n)th TDFL.

To recover a lost (n)th TDDS, as shown in FIG. 9, when a write once optical disc such as the disc of FIGs. 2 and 3

is loaded in the system including the recording/reproducing device, last recorded positions of applicable areas (e.g., spare area, data area, lead-in area, etc.) on the disc are determined (step 901). This can be accomplished by using the RF signal test discussed above in connection with FIG. 7. Next, the (n-1)th TDDS is read from the TDMA (step 902). Then the position information obtained at the step 901 is compared to the position information obtained at the step 902 (step 903). If there is any discrepancy between the two pieces of position information, then the discrepancy information and the (n-1)th TDDS are used to reconstruct the lost (n)th TDDS (step 904), in the manner similar to the first embodiment discussed above. For instance, the discrepancy information should indicate the real last recorded locations of the disc (at the time of the (n)th TDDS) and this information is used to update or change the different pieces information stored in the (n-1)th TDDS, to compose the (n)th TDDs. But if there is no discrepancy detected at the step 903, then the system presumes there is no (n)th TDDS and the process ends.

Depending on the system, there may be a case in which the position information obtained from the last recorded areas on the disc is taken directly as the (n)th TDDS without the comparison step 903. Such a case may arise when there is no (n-1)th TDDS, or the reliability of data reproduced from

the (n-1)th TDDS is questionable or low.

Therefore, in the method of recovering an (n)th TDDS in accordance with the second embodiment of the present invention, a finally recorded area on a disc is determined at first, and then the (n)th TDDS is recovered using the finally recorded area location information.

To recover an (n)th TDFL, as shown in FIG. 10, when the disc is loaded in the system, recorded areas in a spare area of the disc are reproduced (step 1001), from which position information on each of the replacement clusters and position information on each of the defective clusters corresponding to the replacement clusters are obtained (step 1002). This can be accomplished if the disc structure of FIG. 4 is used, which stores the position information of the replacement cluster and the position information of the corresponding defective cluster both within the replacement cluster. These two pieces of position information constitute the latest entry in the (n)th TDFL. Then any entry from the recorded (n-1)th TDFL is detected (step 1003). All the detected entries from the step 1003 are then compared with the composed entry from the step 1002. If there is any discrepancy, the discrepancy information and the entries from the (n-1)th TDFL are used to compose the (n)th TDFL (step 1005). That is, if there is a discrepancy, then the composed entry from the step

1002 is added cumulatively to the entries of the (n-1)th TDFL to reconstruct the (n)th TDFL. This process is used because generally the present TDFL should always contain information on all defective areas on the disc. If there is no discrepancy detected at the step 1004, then the system presumes there is no (n)th TDFL and the process ends. Depending on the system, there may be a case in which the two pieces of position information from the replacement cluster are taken directly as the (n)th TDFL without the comparison step 1004. Such a case may arise when there is no (n-1)th TDFL, or the reliability of data reproduced from the (n-1)th TDFL is questionable or low.

Therefore, in the method of recovering an (n)th TDFL in accordance with the second embodiment of the present invention, position information is determined from the replacement area in the spare area at first, newest entry information is obtained from the position information, and the (n)th TDFL is reconstructed using the entry information.

FIG. 11 illustrates an optical disc recording/reproducing apparatus according to the present invention. This apparatus or other suitable apparatus or system can be used to implement the structure of the disc and the methods of storing and recovering the disc management information such as TDFL and TDDS as discussed above.

Referring to FIG. 11, the optical disc

recording/reproducing apparatus includes a recording/reproducing unit 10 for recording and reproducing data to/from the optical disc and a controller 20 for controlling the recording/reproducing unit 10. All the elements of the recording/reproducing apparatus are operatively coupled. The controller 20 transmits a command for recording or reproducing to/from areas on the disc, to the recording/reproducing unit 10. The recording/reproducing unit 10 records or reproduces data to/from the disc according to the commands of the controller 20. The recording/reproducing unit 10 includes an interface unit 12, a pick-up unit 11, a data processor 13, a servo unit 14, a memory 15 and a microcomputer 16. The interface unit 12 communicates with external devices such as the controller 20. The pick-up unit 11 records or reproduces data to/from the optical disc directly. The data processor 13 receives a reproduction signal from the pick-up unit 11, restores a preferred signal, modulates a signal proper to the optical disc, and transmits the signal. The servo unit 14 controls the pick-up unit 11 to read the signal from the optical disc or to record the signal to the optical disc. The memory 15 stores temporarily data and various information including disc management information as needed. The microcomputer 16 controls the components of the recording/reproducing unit 10 and can implement or

control the processing steps of the methods of recovering the TDFL and TDDS according to the present invention.

According to the first and second embodiments of the present invention, the recovery of the (n)th TDDS and the (n)th TDFL can be progressed at the same time or separately at different times.

**Industrial Applicability**

The recovery of lost disc management information (particularly TDDS and TDFL) from the information on the finally recorded area(s) on the disc and prior TDDS/TDFL information, prevents occurrence of an error caused by the loss of the management information, thereby allowing a more effective use of the disc.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A recording medium comprising:

a data area including a spare area and a user data area, the spare area including one or more replacement areas each of which replaces a defective area existing in the user data area and contains address information of the defective area; and

a temporary defect management area assigned to at least one of a lead-in area of the recording medium and the spare area for temporarily storing defect management information, the temporary defect management area storing an (n)th temporary defect list management information reconstructed from an (n-1)th temporary defect list information recorded in the temporary defect management area and the address information contained in the one or more replacement areas.

2. A method for recovering management information from a recording medium having a spare area and a user data area, the recording medium including a temporary defect management area for storing therein temporary disc definition structure (TDDS) information, the method comprising steps of:

reproducing an (n-1)th TDDS information from the recording medium;

determining if a certain area following an area indicated by the (n-1)th TDDS information has recording;

determining position information associated with the certain area if the certain area has recording; and

reconstructing an (n)th TDDS information based on the determined position information.

3. A method for recovering management information from a recording medium having a spare area and a user data area, the recording medium including a temporary defect management area for storing therein temporary defect list (TDFL) information, the method comprising steps of:

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reproducing an (n-1)th TDFL information from the temporary defect management area;

reproducing address information of a defective area replaced by a replacement area located in the spare area and address information of the replacement area from the replacement area; and

reconstructing an (n)th TDFL information based on the reproduced address information.

4. The method of claim 3, wherein the step of reconstructing the (n)th TDFL information comprising:

comparing the reproduced address information with entry information contained in the (n-1)th TDFL information.

5. The method of claim 4, wherein the step of reconstructing the (n)th TDFL information comprises:

if the reproduced address information is discrepant with the entry information, adding entry information having the reproduced address information to the (n-1)th TDFL information.

6. The method of any one of claims 3 to 5, wherein in the step of reproducing the address information, the address information of the defective area is reproduced from an address area of the replacement area.

7. The method of any one of claims 3 to 6, wherein the address information of the defective area is a first physical sector number of the defective area.

8. The method of any one of claims 3 to 7, further comprising a step of:

recording the reconstructed (n)th TDFL information onto the temporary defect management area.

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9. An apparatus for recovering management information from a recording medium having a spare area and a user data area, the recording medium including a temporary defect management area for storing therein temporary disc definition structure (TDDS) information, the apparatus comprising:

a pick-up configured to record/reproduce data to/from the recording medium directly; and

a microcomputer operatively coupled to the pickup and configured to control the pickup to reproduce an (n-1)th TDDS information from the recording medium; configured to determine if a certain area following an area indicated by the (n-1)th TDDS information has recording; means for determining position information associated with the certain area if the certain area has recording; and configured to reconstruct an (n)th TDDS information based on the determined position information.

10. An apparatus for recovering management information from a recording medium having a spare area and a user data area, the recording medium including a temporary defect management area for storing therein temporary defect list (TDFL) information, the apparatus comprising:

a pick-up configured to record/reproduce data to/from the recording medium directly; and

a microcomputer operatively coupled to the pickup and configured to control the pickup to reproduce an (n-1)th TDFL information from the temporary defect management area; configured to control the pickup to reproduce address information of a defective area replaced by a replacement area located in the spare area and address information of the replacement area from the replacement area; and configured to reconstruct an (n)th TDFL information based on the reproduced address information.

11. The apparatus of claim 10, further comprising:

a data processor configured to receive and restore a reproduction signal from the recording medium, or modulate a signal proper to the recording medium; and

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a servo configured to control the optical pickup to read/record a signal from/to the recording medium,

wherein the microcomputer is operatively coupled to the data processor and the servo, and configured to control the pickup, the data processor and the servo so as to reproduce the (n-1)th TDFL information from the temporary defect management area, reproduce the address information from the replacement area, and reconstruct the (n)th TDFL information based on the (n-1)th TDFL information and the reproduced address information.

12. The apparatus of claim 10 or 11, further comprising:

a controller configured to transmit, to the apparatus, a command for recording/reproducing data to/from the recording medium.

13. The apparatus of any one of claims 10 to 12, wherein the microcomputer is configured to reconstruct the (n)th TDFL information by comparing the reproduced address information with entry information contained in the (n-1)th TDFL information.

14. The apparatus of claim 13, wherein the microcomputer is configured to reconstruct the (n)th TDFL information by adding entry information having the reproduced address information to the (n-1)th TDFL information if the reproduced address information is discrepant with the entry information.

15. The apparatus of any one of claims 10 to 14, wherein the address information of the defective area is reproduced from an address area of the replacement area.

16. The apparatus of any one of claims 10 to 15, wherein the address information of the defective area is a first physical sector number of the defective area.

17. The apparatus of any one of claims 10 to 16, wherein each of the defective area and the replacement area has a size of at least one cluster.

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18. The apparatus of any one of claims 10 to 17, wherein the microcomputer is configured to control the pickup to record the reconstructed (n)th TDFL information onto the temporary defect management area.

19. The apparatus of any one of claims 10 to 18, wherein the microcomputer is configured to control the pickup to reproduce data from the recording medium based on the reconstructed (n)th TDFL information.

20. The apparatus of any one of claims 10 to 19, wherein the microcomputer is configured to control the pickup to record a copy of TDFL information recorded in the temporary defect management area onto a defect management area of the recording medium when no more data is to be written on the recording medium.

# FIG. 1
# Related Art

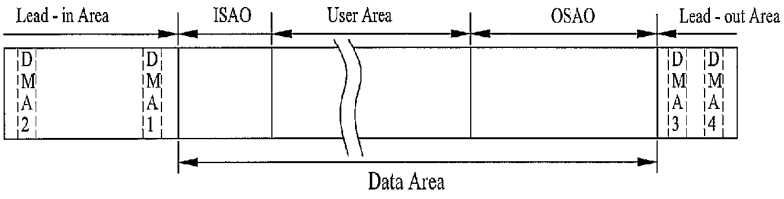


FIG. 2

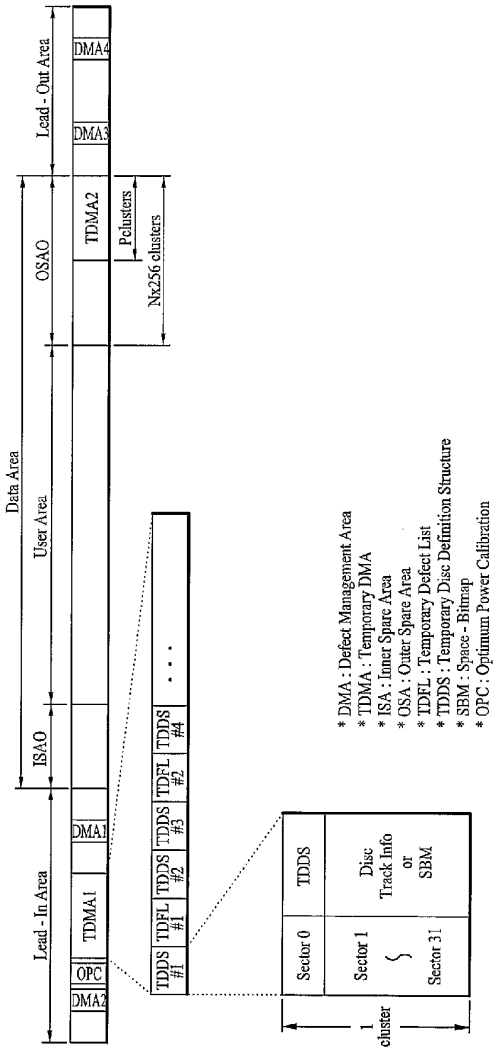

Lead - In Area
Data Area
User Area
Lead - Out Area
ISA0
OSA0
DMA2
OPC
TDMA1
DMA1
TDDS #1
TDFL #1
TDDS #2
TDDS #3
TDFL #2
TDDS #4
. . .
TDMA2
DMA3
DMA4
Pclusters
Nx256 clusters
1 cluster
Sector 0
TDDS
Sector 1
~
Sector 31
Disc Track Info or SBM
* DMA : Defect Management Area
* TDMA : Temporary DMA
* ISA : Inner Spare Area
* OSA : Outer Spare Area
* TDFL : Temporary Defect List
* TDDS : Temporary Disc Definition Structure
* SBM : Space - Bitmap
* OPC : Optimum Power Calibration

FIG. 3

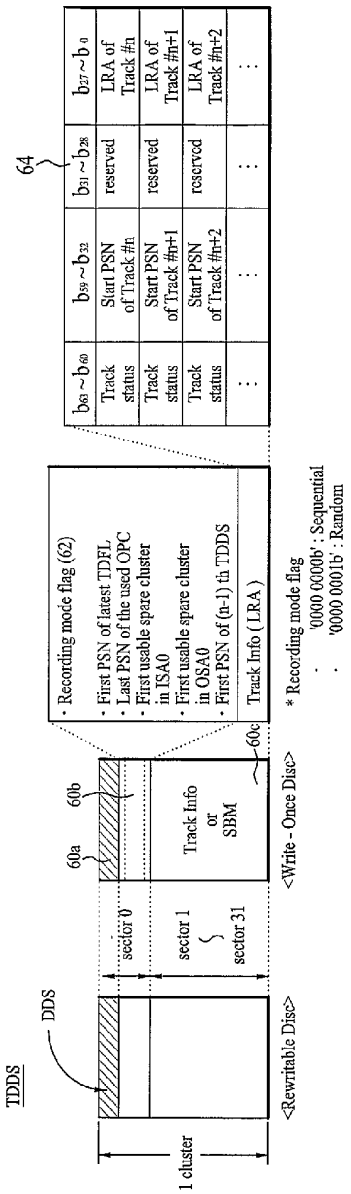
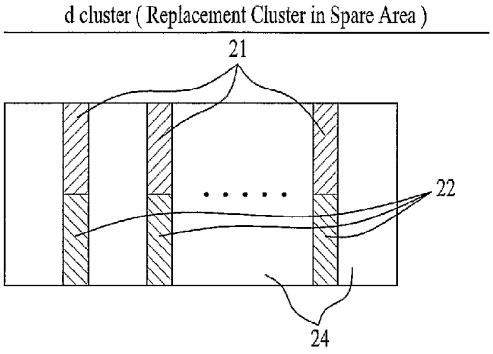

TDDS
DDS
1 cluster
sector 0
sector 1
sector 31
60a
60b
Track Info or SBM
60c
<Rewritable Disc>
<Write - Once Disc>
· Recording mode flag (62)
· First PSN of latest TDFL
· Last PSN of the used OPC
· First usable spare cluster in ISA0
· First usable spare cluster in OSA0
· First PSN of (n-1) th TDDS
Track Info ( LRA )
* Recording mode flag
· '0000 0000b' : Sequential
· '0000 0001b' : Random
64
b63 ~ b60
b59 ~ b32
b31 ~ b28
b27 ~ b0
Track status
Start PSN of Track #n
reserved
LRA of Track #n
Track status
Start PSN of Track #n+1
reserved
LRA of Track #n+1
Track status
Start PSN of Track #n+2
reserved
LRA of Track #n+2

FIG. 4




* Defective cluster(D) is replaced with Replacement cluster(d)

FIG. 5

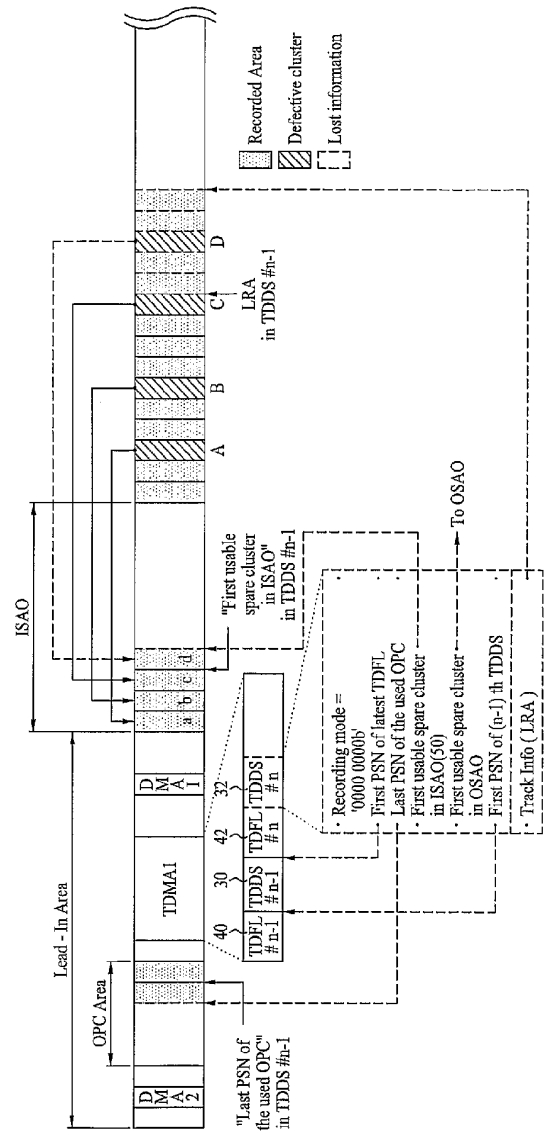

Recorded Area
Defective cluster
Lost information
LRA in TDDS #n-1
ISAO
"First usable spare cluster in ISAO" in TDDS #n-1
To OSAO
Recording mode = '0000 0000b'
First PSN of latest TDFL
Last PSN of the used OPC
First usable spare cluster in ISA0(50)
First usable spare cluster in OSAO
First PSN of (n-1) th TDDS
Track Info (LRA)
Lead - In Area
OPC Area
TDMA1
DMA2
DMA1
TDFL # n-1
TDDS # n-1
TDFL # n
TDDS # n
"Last PSN of the used OPC" in TDDS #n-1

FIG. 6

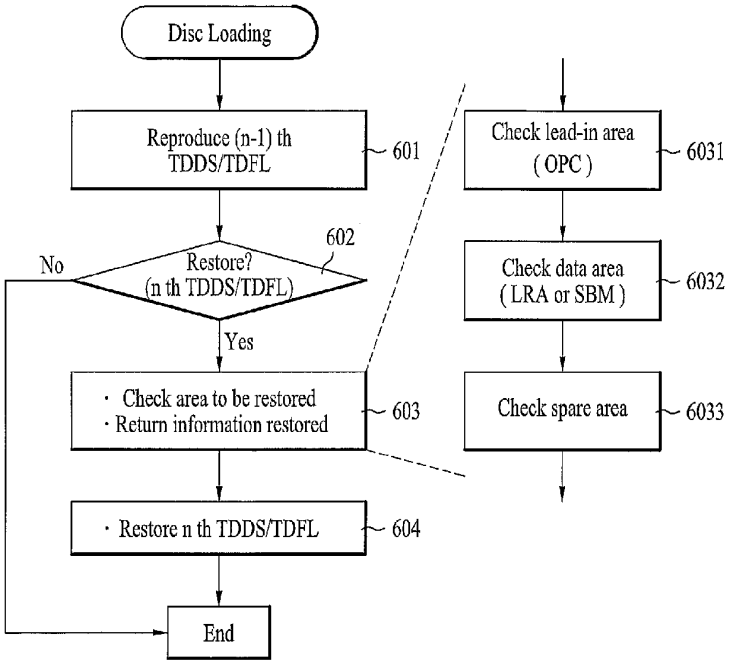

Disc Loading
Reproduce (n-1) th TDDS/TDFL
601
Restore? (n th TDDS/TDFL)
602
No
Yes
· Check area to be restored
· Return information restored
603
· Restore n th TDDS/TDFL
604
End
Check lead-in area ( OPC )
6031
Check data area ( LRA or SBM )
6032
Check spare area
6033

FIG. 7

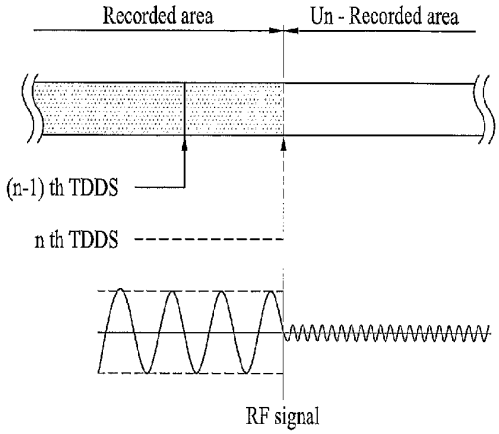


FIG. 8

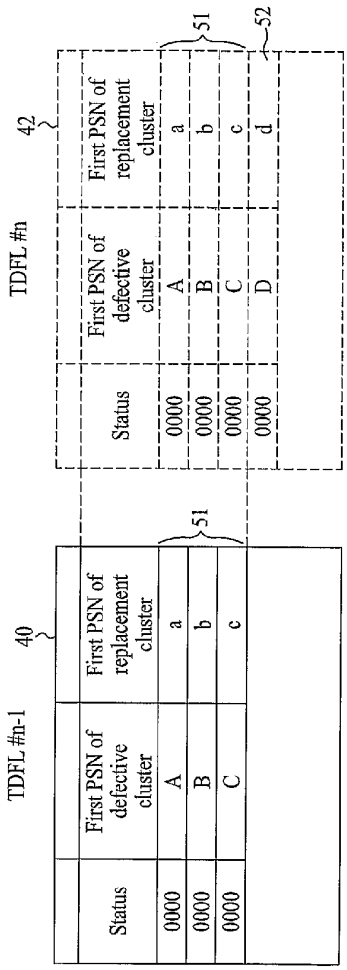

TDFL #n-1
40
Status
First PSN of defective cluster
First PSN of replacement cluster
0000
A
a
0000
B
b
0000
C
c
51
TDFL #n
42
Status
First PSN of defective cluster
First PSN of replacement cluster
0000
A
a
0000
B
b
0000
C
c
0000
D
d
51
52

FIG. 9

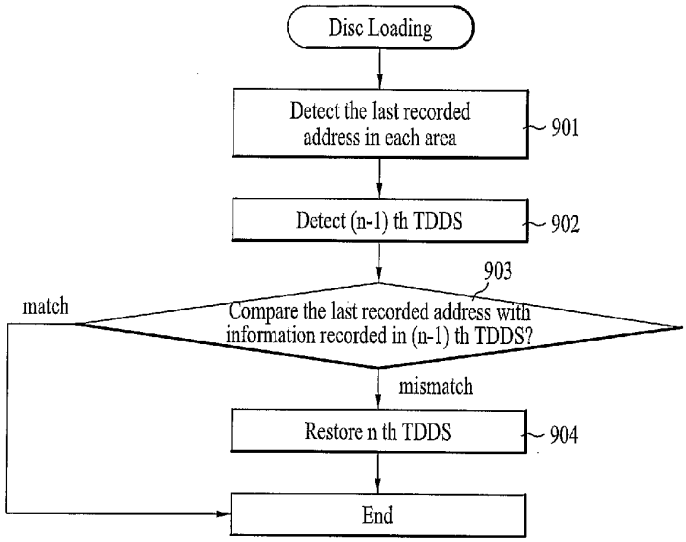

Disc Loading
Detect the last recorded address in each area
901
Detect (n-1) th TDDS
902
903
Compare the last recorded address with information recorded in (n-1) th TDDS?
match
mismatch
Restore n th TDDS
904
End

FIG. 10

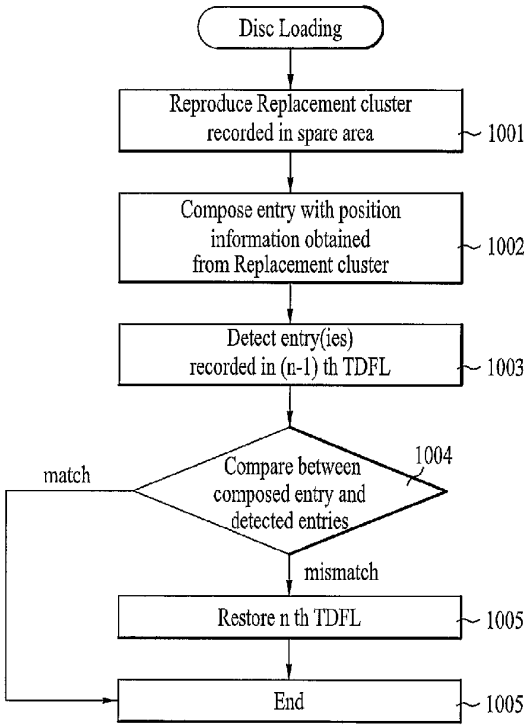
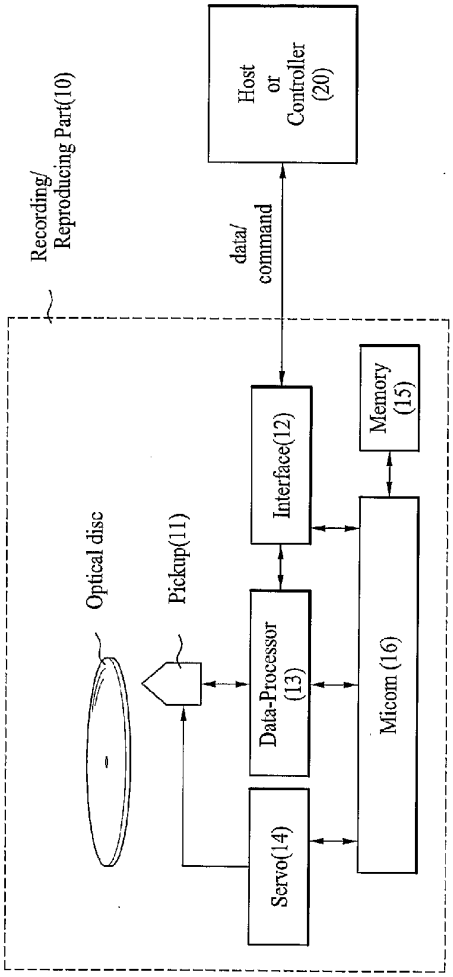

Disc Loading
Reproduce Replacement cluster recorded in spare area
1001
Compose entry with position information obtained from Replacement cluster
1002
Detect entry(ies) recorded in (n-1) th TDFL
1003
Compare between composed entry and detected entries
1004
match
mismatch
Restore n th TDFL
1005
End
1005

FIG. 11


Host or Controller (20)
data/ command
Recording/ Reproducing Part(10)
Memory (15)
Interface(12)
Optical disc
Pickup(11)
Data-Processor (13)
Micom (16)
Servo(14)