SPECIFICATION

AN OPTICAL DISK AND AN OPTICAL DISK RECORDING/REPRODUCTION DEVICE

FIELD OF THE INVENTION

The present invention relates to an optical disk and an optical disk recording/reproduction device. Specifically, the present invention relates to an optical disk in which sector address information pit arrays are disposed between land tracks and groove tracks in a wobbling manner, and an optical disk recording/reproduction device for such an optical disk.

PRIOR ART

Optical disks have excellent removability/portability and random access performance and therefore have been acquiring a broader range of applications in various information equipment fields, e.g., personal computers. As a result, there has been an increasing demand for increasing the recording capacitance of optical disks. Rewritable optical disks require sector-by-sector management of recording and reproduction of data. Therefore, in the production of such disks, address information for each sector is often formed in the form of pits while guide grooves are formed for tracking control purposes. In currently prevalent rewritable optical disks, concave and convex tracks of 1 - 1.6 μm (each width accounting for about 50%) are formed in a spiral shape on a disk substrate. A thin film composed of a recording material (e.g., Ge, Sb, and Te in the case of phase-change type optical disks) is formed on the surface of the tracks by methods such as sputtering.

The disk substrate is mass-duplicated in the form of substrates of polycarbonate, etc. by using a stamper which is formed from a master disk in which concave grooves and pits for sector addresses and the like are cut by radiating a light beam. For optical disks having the above configuration, a light beam is radiated on either a concave track or a convex track with a predetermined recording power so as to form marks on the recording film, thereby recording information, and a light beam is radiated on either a concave track or a convex track with a predetermined reproduction power so as to detect light reflected from the recording film, thereby reproducing information.

In recent years, the capacity of information data dealt with in various fields has further increased, so that optical disks are also desired to have increased capacity. Although it is possible to increase the recording density by narrowing the width of each track (hereinafter referred to as the "track pitch"), it is necessary to reduce the track pitch to 1/2 of the conventional track pitch in order to realize a recording density twice as high as the conventional recording density. However, any production method would have a large difficulty in forming a stamper having convex and concave tracks with a stable width which is a half of the track pitch and to duplicate such a disk. On the other hand, there has been proposed a method for increasing the recording density by recording/reproducing information on both the concave tracks and convex tracks. According to this method, a recording density twice as high as the conventional recording density can be realized without changing the width of the concave and convex tracks.

In the case of optical disks in which information is recorded on both convex and concave tracks, providing sector addresses for identifying sectors separately for each track would require forming two addresses or concave tracks at the same time, which would require the use of two or more laser beams and therefore a complex apparatus. Therefore, an intermediate address method has been proposed in which addresses are formed so as to be on both a concave track and a convex track of the optical disk (Japanese Laid-Open Patent Publication No. 6-176404). According to this method, each address on the disk is provided so as to be centered around a boundary line between a convex track and a concave track, with a width substantially equal to that of the concave track, so that the concave track and the convex track share the same address. As a result of this, cutting of the master disk can be facilitated. In this case, however, two tracks are present for the same address when viewed from the recording/reproduction device, and therefore it is necessary to clearly distinguish between them somehow.

Hereinafter, a conventional optical disk and a conventional optical disk recording/reproduction device based on the above-mentioned intermediate address method will be described with reference to the figures.

Figure 38 is a schematic diagram showing a conventional optical disk having a sector structure. In Figure 38, 200 denotes a disk; 201 denotes a track; 202 denotes a sector; 203 denotes a sector address region; and 204 denotes a data region. Figure 39 is a magnified view of a sector address region and a schematic diagram showing a conventional intermediate address. In Fig-

ure 39, 206 denotes address pits; 207 denotes recording marks; 208 denotes a groove track; 209 denotes a land track; and 210 denotes a light spot.

Herein, the groove track 208 and the land track 209 have the same track pitch Tp. Each address pit 206 is disposed so that the center thereof is shifted by Tp/2 along the radius direction of the disk from the center of the groove track 208.

Figure 40 is a block diagram showing the conventional tracking control and the signal processing of reading signals on an optical disk.

Reference numeral 200 denotes a disk; 201 denotes a track; 210 denotes a light spot; and 211 denotes a disk motor for rotating the disk 200. Reference numeral 212 denotes an optical head for optically reproducing signals on the disk 200. The optical head 212 is composed of a laser diode 213, a collimate lens 214, an object lens 215, a half mirror 216, a photosensitive section 217, and an actuator 218. Reference numeral 220 denotes a tracking error signal detection section for detecting a tracking error signal indicating the amount of dislocation between the light spot 210 and the track 201 along the radius direction. The tracking error signal detection section 220 is composed of a differential circuit 221 and a LPF (Low Pass Filter) 222. Reference numeral 223 denotes a phase compensation section for generating a drive signal for driving the optical head from a tracking error signal; 224 denotes a head driving section for driving the actuator 218 in the optical head 212 in accordance with

the drive signal; 225 denotes an addition circuit for signals from the photosensitive section 217; 226 denotes a waveform equivalent section for preventing interference between signs of a reproduced signal; 227 is a data slice section for digitalizing the reproduced signal at a predetermined slice level; 228 denotes a PLL (Phase Locked Loop) for generating a clock which is in synchronization with the digitalized signal; 229 is an AM detection section for detecting AMs (Address Marks); 230 is a demodulator for demodulating the reproduced signal; 231 denotes a switcher for separating the demodulated signal into data and an address; 232 is a CRC (Cyclic Redundancy Check) determination section for determining errors in the address signal; 233 is an error correction section for correcting errors in the data signal; 234 denotes an address reproduction section composed of elements 225 to 232; and CRC is an error detection code which is generated from an address number and an ID number.

First, positioning control is performed along the focusing direction of the light spot 210, but the description of general focusing control is omitted.

Hereinafter, the tracking control operation will be described. Laser light radiated from the semiconductor laser diode 213 is collimated by the collimate lens 214, and is converged on the disk 200 via the object lens 215. The laser light reflected from the disk 200 returns to photosensitive sections 217a and 217b via the half mirror 216, whereby the distribution of light amount is detected as an electric signal, which is determined by the relative positions of the light spot 210 and the

track 201 on the disk. In the case of using the two-divided photosensitive sections 217a and 217b, a tracking error signal is detected by detecting a difference between the photosensitive sections 217a and 217b by means of the differential circuit 221 and extracting a low-frequency region of the differential signal by means of the LPF 222. In order to ensure that the light spot 210 follows the track 201, a drive signal is generated in the phase compensation section 223 such that the tracking error signal becomes 0 (i.e., the photosensitive sections 217a and 217b have the same light amount distribution), and the actuator 218 is moved by the head driving section 224 in accordance with the drive signal, thereby controlling the position of the object lens 215.

On the other hand, when the light spot 210 follows the track 201, the amount of reflected light reduces at the recording marks 207 and the address pits 206 on the track owing to interference of light, thereby lowering the output of the photosensitive section 217, whereas the amount of reflected light increases where pits do not exist, thereby increasing the output of the photosensitive section 217. The total light amount of the output of the photosensitive section corresponding to the recording mark 207 and address pits 206 are derived by the addition circuit 225, led through the waveform equivalent section 226, and digitalized at a predetermined slice level at the data slice section 227, i.e., converted into a signal sequence of "0" and "1". Data and a read clock are extracted from this digitalized signal by the PLL 228. The demodulator 230 demodulates the recorded data which has been modulated, and converts it into a data format which allows external processing.

If the demodulated data is a signal in the data region, the errors in the data are corrected in the error correction section **233**, whereby a data signal is obtained. On the other hand, if the AM detection section **229** detects an AM signal for identifying the address portion in a signal sequence that is constantly output from the PLL **228**, the switcher **231** is switched so that the demodulated data is processed as an address signal. The CRC determination section **232** determines whether or not the address signal which has been read includes any errors; if no error is included, the address signal is output as address data.

Figure **41** shows the states of a reproduced signal (RF signal) and a tracking error signal (TE signal) when the light spot **210** passes the sector address region **203** in the above-described configuration. Although the light spot **210** is located in the center of the track in the data region **204**, a drastic dislocation occurs between the light spot **210** and the address pits **206** immediately after the light spot **210** enters the sector address region **203**, thereby greatly fluctuating the level of the TE signal. The light spot **210** cannot rapidly follow the address pits **206** but gradually comes closer to the address pits **206**, as indicated by the broken line. However, since the sector address region **203** is short, the data region **205**, which is a grooved region, is reached before the light spot **210** manages to completely follow the address pits **206**, so that a tracking control is performed so that the off-tracking **Xadr** state is eliminated in the grooved region. Moreover, since a portion of the light spot **210** is on the address pits **206**, an RF signal as shown in Figure **41** is obtained. The RF signal ampli-

tude **Aadr** varies in accordance with the distance between the light spot **210** and the address pits **206**. Specifically, **Aadr** decreases as the distance becomes larger, and increases as the distance becomes smaller.

However, in accordance with the sector address having the configuration shown in Figure **39**, the distance between the light spot and the address pits may also vary in the sector address region in the case where the center of the light spot is dislocated from the center of the track in the data region. As a result, there is a problem in that, although the amplitude of the reproduced signal in the address pit region would increase if the light spot shifted closer to the address pits, the amplitude of the reproduced signal in the address pit region would decrease if the light spot shifted away from the address pits, thereby resulting in an insufficient reading of the address.

There is also a problem in that, since the light spot is dislocated from the address pits in the sector address region, a large fluctuation in level, which does not indicate the actual track offset amount, occurs in the tracking error signal. Since the tracking control is performed by employing such a tracking error signal, a tracking offset occurs after the light spot passes the sector address section.

There is also a problem in that, since the same address pits are allocated to a land track and its adjoining groove track, it is impossible to identify whether or not a track which is currently being followed is a land track or a groove track.

In view of the above-mentioned problems, the present invention has an objective of providing an optical disk having a novel address pit arrangement in sector address sections such that insufficient reading of address signals due to tracking offset is reduced and the tracking offset after passing a sector address is reduced, the optical disk further enabling identification of land tracks and groove tracks, and an optical disk recording/reproduction device for such an optical disk.

DISCLOSURE OF THE INVENTION

An optical disk according to the present invention includes a first track having a spiral shape and a second track having a spiral shape, the first track and the second track adjoining each other, and information being recorded on or reproduced from the first track and the second track. The optical disk includes an address region including a first address block formed so as to be on both the first track and the second track adjoining the first track on an inner periphery side, and a second address block formed so as to be on both the first track and the second track adjoining the first track on an outer periphery side.

In one embodiment, the optical disk is a land/groove recording/reproduction type including a plurality of sectors having a sector address region and a data region, wherein the sector address region includes a plurality of address blocks, at least two of the plurality of address blocks that adjoin each other along a circumference direction being disposed so as to be shifted toward opposite sides with respect to a track center, and each of the plurality of address blocks

includes within the sector address region a portion indicating an address number for identifying the plurality of sectors from one another and a portion indicating an ID number for identifying the plurality of address blocks from one another.

In one embodiment, the at least two address blocks that adjoin each other are located so as to be shifted from the track center, toward an inner periphery side or an outer periphery side, by about a half of a track pitch along a radius direction.

In one embodiment, the portion indicating the address number has a data pattern which is common to the plurality of address blocks within the same sector address region.

In one embodiment, each of the plurality of address blocks has non-pit data in a beginning portion and an end portion thereof.

In one embodiment, the length of the non-pit data is larger than a disk rotation accuracy of a laser cutting process in the production of a master disk.

In one embodiment, the first one of the plurality of address blocks includes a reproduction clock synchronization signal portion which is longer than a reproduction clock synchronization signal portion of any other address block.

In one embodiment, the sector address region includes a block composed of information not related to

the identification of the address numbers, and the block is disposed so as to be shifted from the track center, toward an inner periphery side or an outer periphery side, by about a half of a track pitch along a radius direction.

In one embodiment, an interspace is provided, along the circumference direction, between the at least two address blocks that adjoin each other.

In one embodiment, in the sector address region, the address blocks are located along the circumference direction in such a manner that phases of pit patterns constituting the address blocks match each other on both sides of one track.

An optical disk recording/reproduction device for an optical disk of a land/groove recording/reproduction type according to the present invention includes a plurality of sectors having a sector address region and a data region, wherein the sector address region of the optical disk includes a plurality of address blocks, at least two of the plurality of address blocks that adjoin each other along a circumference direction being disposed so as to be shifted toward opposite sides with respect to a track center, and each of the plurality of address blocks includes a portion indicating an address number for identifying the plurality of sectors from one another and a portion indicating an ID number for identifying the plurality of address blocks from one another within the sector address region. The recording/reproduction device includes an optical head for radiating a light beam on the optical disk and receiving light reflected from the

optical disk so as to output a reproduced signal, and an address signal reproduction section for reading the address number and the ID number when reproducing the sector address of the optical disk.

In one embodiment, the optical disk recording/reproduction device further includes an address correction section for correcting the address number which is read from each address block in accordance with the ID number by employing a signal indicating land reproduction or groove reproduction.

In one embodiment, the optical disk recording/reproduction device further includes a memory for storing the address number read by the address signal reproduction section as associated with the ID number read by the address signal reproduction section, a comparator for comparing two or more address numbers respectively associated with two or more specific ID numbers against each other so as to detect whether or not the two or more address numbers match each other, and a judgment section for determining whether a track on which the light beam for reproduction is a land track or a groove track based on an output of the comparator.

It is preferable that the optical disk recording/reproduction device further includes an address correction section for correcting the address number stored in the memory in accordance with the ID number.

In one embodiment, the optical disk recording/reproduction device further includes a tracking error signal detection section for detecting a tracking error

signal indicating a locational offset amount between a track and a light spot, a timing generation section for generating a gate pulse signal synchronized with each address block of the sector address region, an outer periphery value sample/hold section for sampling and holding the levels of the tracking error signals for the address blocks disposed on an outer periphery side in synchronization with the gate pulse signal, an inner periphery value sample/hold section for sampling and holding the levels of the tracking error signals for the address blocks disposed on an inner periphery side in synchronization with the gate pulse signal, a differential circuit for obtaining a difference between a value in the outer periphery value sample/hold section and a value in the inner periphery value sample/hold section; a gain conversion section for converting an output of the differential circuit into a signal having a predetermined level, and a tracking offset correction circuit for performing a tracking correction using an output from the gain conversion section.

In one embodiment, the optical disk recording/reproduction device further includes a reflected light amount signal detection section for detecting the amount of reflected light from the optical disk, a timing generation section for generating a gate pulse signal synchronized with each address block of the sector address region, an outer periphery value sample/hold section for sampling and holding the signal levels of the reflected light for the address blocks disposed on an outer periphery side in synchronization with the gate pulse signal, an inner periphery value sample/hold section for sampling and holding the signal levels of the

reflected light for the address blocks disposed on an inner periphery side in synchronization with the gate pulse signal, a differential circuit for obtaining a difference between a value held in the outer periphery value sample/hold section and a value held in the inner periphery value sample/hold section, a gain conversion section for converting an output of the differential circuit into a signal having a predetermined level, and a tracking offset correction circuit for performing a tracking correction using an output from the gain conversion section.

Another optical disk according to the present invention includes a first track having a spiral shape and a second track having a spiral shape, the first track and the second track adjoining each other, and information being recorded on or reproduced from the first track and the second track, wherein the optical disk includes an address block formed so as to be on both the first track and the second track, and a track identification mark formed on either the first track or the second track.

In one embodiment, the address regions are located in accordance with a CAV format or a ZCAV (ZCLV) format.

Another optical disk according to the present invention includes a first track having a spiral shape and a second track having a spiral shape, the first track and the second track adjoining each other, and information being recorded on or reproduced from the first track and the second track, wherein the optical disk includes

an address region including an address block formed so as to be on both the first track and the second track, and a first track identification mark formed so as to be on both the first track and the second track adjoining the first track on an inner periphery side, and a second track identification mark formed so as to be on both the first track and the second track adjoining the first track on an outer periphery side, wherein the first track identification mark and the second track identification mark are identical.

Another optical disk according to the present invention includes a first track having a spiral shape and a second track having a spiral shape, the first track and the second track adjoining each other, and information being recorded on or reproduced from the first track and the second track, wherein the optical disk includes an address region including an address block formed so as to be on both the first track and the second track, and a track identification mark formed in a control information region of either the first track or the second track.

The optical disk recording/reproduction device is an optical disk recording/reproduction device capable of recording information on and reproducing information from one optical disk according to the present invention, and includes track designation means for selecting the first track or the second track for which information is to be recorded, and track identification mark reproduction means for reading a track identification mark, wherein the track identification mark reproduction means reads the track identification mark of a currently reproduced

track and identifies the currently reproduced track to be either the first track or the second track depending on whether or not the track identification mark is present so as to output a track identification signal, and the track designation means switches between selecting the first track and selecting the second track in accordance with the track identification signal.

The optical disk recording/reproduction device is an optical disk recording/reproduction device capable of recording information on and reproducing information from one optical disk according to the present invention, and includes track designation means for selecting the first track or the second track for which information is to be recorded, address reproduction means for reading the first address block and the second address block formed so as to be on the first track and the second track adjoining the first track, and track identification means for identifying a currently reproduced track to be either the first track or the second track based on the first address block and the second address block reproduced by the address reproduction means, wherein the track identification means identifies the currently reproduced track to be either the first track or the second track based on a difference between the two addresses reproduced by the address reproduction means so as to output a track identification signal, and the track designation means switches between selecting the first track and selecting the second track in accordance with the track identification signal.

The optical disk recording/reproduction device is an optical disk recording/reproduction device capable of

recording information on and reproducing information from one optical disk according to the present invention, and includes track designation means for selecting the first track or the second track for which information is to be recorded, track identification mark reproduction means for reading a track identification mark formed so as to be on both the first track and the second track adjoining the first track, and track identification means for identifying a currently reproduced track to be either the first track or the second track based on two track identification marks reproduced by the track identification mark reproduction means,

wherein the track identification means identifies the currently reproduced track to be either the first track or the second track based on a difference between the two track identification marks reproduced by the track identification mark reproduction means, so as to output a track identification signal, and the track designation means switches between selecting the first track and selecting the second track in accordance with the track identification signal.

It is an optical disk recording/reproduction device capable of recording information on and reproducing information from one optical disk according to the present invention, and includes track designation means for selecting the first track or the second track for which information is to be recorded, data reproduction means for reading a track identification mark provided in the control information region, track polarity determination means for determining the polarity of a reproduced track, and track selection signal correction means for correcting a track selection signal from the

track designation means, wherein the data reproduction means reproduces the track identification mark in the control information region when the reproduction of the optical disk is started, the track polarity determination means determines whether the selection of tracks is correct or not based on the track identification mark of the reproduced track and the track selection signal from the track designation means so as to output a track polarity determination signal, and the track selection signal correction means corrects the track selection signal from the track designation means based on the track polarity determination signal so as to select the first track or the second track.

In one embodiment, a method for identifying a track on the optical disk according to the present invention is characterized in that a plurality of address blocks provided within one address region are read in order to detect whether or not at least two address blocks match each other, thereby identifying a currently reproduced track to be either the first track or the second track.

In accordance with the above-mentioned constitution, sector addresses having address blocks which are disposed so as to wobble with respect to the center of each track along the radius direction are provided. As a result, insufficient reading of address signals due to tracking offset can be reduced and the tracking offset after passing a sector address can be reduced.

Moreover, it is possible to identify a currently reproduced track to be either a land track or a groove

track.

Furthermore, it is possible to detect an off-track signal indicating the actual tracking offset amount between the light spot and a track based on a difference between reflected light amount signals or tracking error signals obtained at address blocks wobbling between an inner track and an outer track. It becomes possible to accurately follow tracks by correcting the tracking error signal using this off-track signal.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic view showing an optical disk according to Example 1 of the present invention.

Figure 2 is a diagram showing the location of address blocks in an optical disk according to Example 1 of the present invention.

Figure 3 is a block diagram showing an optical disk recording/reproduction device according to an example of the present invention.

Figure 4 is a configuration diagram showing a track identification circuit employed in the optical disk recording/reproduction device according to the present invention.

Figure 5 is a schematic view showing an optical disk according to Example 2 of the present invention.

Figure 6 is a diagram describing the format of sector addresses in an optical disk according to Exam-

ple 2 of the present invention.

Figure **7A** is a diagram showing the configuration of sector address regions.

Figure **7B** is a diagram describing a RF signal and a TE signal in a sector address region.

Figures **8A** and **8B** are diagrams describing a tracking offset of a light spot and a RF signal.

Figures **9A** and **9B** are diagrams showing the location of address blocks in an optical disk according to another example of the present invention.

Figures **10A** and **10B** are diagrams showing the location of address blocks in an optical disk according to another example of the present invention.

Figure **11** is a diagram showing the location of address blocks in an optical disk according to still another example of the present invention.

Figure **12** is a diagram showing the location of address blocks in an optical disk according to still another example of the present invention.

Figure **13** is a block diagram showing an optical disk recording/reproduction device according to an example of the present invention.

Figure **14** is a diagram showing the location of address blocks in an optical disk according to still

another example of the present invention.

Figure 15 is a diagram describing the operation of an address correction section.

Figure 16 is a block diagram showing an optical disk recording/reproduction device according to another example of the present invention.

Figure 17A is a block diagram showing a land/groove identification section.

Figure 17B is a block diagram showing another land/groove identification section.

Figure 18 is a block diagram showing an optical disk recording/reproduction device according to another example of the present invention.

Figure 19 is a diagram showing changes in the TE signal in response to off-tracking.

Figure 20 is a timing diagram of a timing generation section.

Figure 21 is a block diagram showing the location of address blocks in an optical disk according to another example of the present invention.

Figure 22 is a diagram showing changes in an AS signal in response to off-tracking.

Figure 23 is a diagram showing the location of

address blocks in an optical disk according to still another example of the present invention.

Figure **24A** is a diagram showing two address blocks which should be formed.

Figure **24B** is a diagram showing two address blocks which are formed in actuality.

Figure **25A** is a diagram showing a case where pit data of one of two adjoining address blocks overlaps with the other address block.

Figure **25B** is a diagram showing a case where pit data of one of two adjoining address blocks does not overlap with the other address block.

Figure **26A** is a diagram showing the location of address blocks in an optical disk according to still another example of the present invention. Figure **26B** is a diagram showing the location of data within those address blocks.

Figure **27** is a diagram showing the location of address blocks in an optical disk according to still another example of the present invention.

Figure **28** is a block diagram showing an optical disk recording/reproduction device according to still another example of the present invention.

Figure **29** is a diagram showing the configuration of a track identification mark reproduction circuit.

Figure 30 is a diagram showing the location of address blocks in an optical disk according to still another example of the present invention.

Figure 31 is a block diagram showing an optical disk recording/reproduction device according to still another example of the present invention.

Figure 32 is a diagram showing the configuration of a track identification mark reproduction circuit employed in the optical disk recording/reproduction device according to the present invention.

Figure 33 is a diagram showing the configuration of a track identification circuit employed in the optical disk recording/reproduction device according to the present invention.

Figure 34 is a diagram showing the location of address blocks in an optical disk according to still another example of the present invention.

Figure 35 is a block diagram showing an optical disk recording/reproduction device according to still another example of the present invention.

Figure 36 is a diagram showing the configuration of a track polarity determination circuit employed in the optical disk recording/reproduction device according to the present invention.

Figure 37 is a diagram showing the configuration of a track selection signal correction circuit employed

in the optical disk recording/reproduction device according to the present invention.

Figure 38 is a diagram showing the track structure of a conventional optical disk.

Figure 39 is a schematic diagram showing a sector address in a conventional optical disk.

Figure 40 is a block diagram showing a conventional optical disk recording/reproduction device.

Figure 41 is a diagram describing a RF signal and TE signal in a conventional example.

BEST MODES FOR CARRYING OUT THE INVENTION

Hereinafter, examples of the present invention will be described with reference to the figures.

(Example 1)

Figure 1 shows the outlook of an optical disk **401** according to Example 1 of the present invention. Two spiral-shape tracks **404** are provided on the optical disk **401**: a convex track (i.e., land track) **402** and a concave track (i.e., groove track) **403**.

The recording and/or reproduction of information is conducted for both tracks **402** and **403**. One round of each track is divided into one or more address regions **405** and one or more data regions **406**. In the case where one round of each track is divided into a plurality of sectors, one address region **405** and one data re-

gion **406** are assigned to each sector. In this case, each address region **405** is also referred to as a sector address region.

The optical disk **401** includes a substrate and various films (not shown) formed on the substrate. These films include a known recording film for recording information, a known reflective film, a known protection film, and the like. The optical disk **401** can be of a type obtained by attaching two substrates to each other, each substrate having an information recording face. This applies to any one of the optical disks described in the following examples.

Figure **2** shows the address regions **405** of the optical disk **401** in more detail. As shown in Figure **2**, one address region **405** showing the address of its corresponding track (or sector) is allocated to each of tracks **403a**, **402a**, **403b**, and **402b**.

In order to indicate the address of the groove track **403a**, a pair of address blocks **411a** and **801a** are provided in the address region **405**, the address blocks **411a** and **801a** consisting of identical pit arrays. In order to indicate the address of the groove track **403b**, a pair of address blocks **411b** and **801b** are provided, the address blocks **411b** and **801b** consisting of identical pit arrays. In order to indicate the address of the groove track **403c**, a pair of address blocks **411c** and **801c** are provided, the address blocks **411c** and **801c** consisting of identical pit arrays. The information indicated by the pit pattern (i.e., pit array) of the address block is different depending on the track (or

sector).

As seen from Figure 2, the pair of address blocks **411b** and **801b**, for example, are located so as to be shifted in opposite directions with respect to the center **408** of the groove track **403b**. The amount of shift is about a half of a track pitch Tp. In the present example, the track pitch Tp is prescribed to be in the range of about 0.3 to about 1.6 μm.

Specifically, the address block **411b** is formed so as to be centered around a boundary line **409** between the groove track **403b** and the land track **402b**, which adjoins the outer periphery of the groove track **403b**, the address block **411b** thus being on both the groove track **403b** and the land track **402b**. The address block **801b** is formed so as to be centered around a boundary line **407** between the groove track **403b** and the land track **402a**, which adjoins the inner periphery of the groove track **403b**, the address block **801b** thus being on both the groove track **403b** and the land track **402a**. In other words, the two address blocks **411b** and **801b** are formed so as to be shifted toward the outer periphery and the inner periphery, respectively, from the center **408** of the groove track **403b** by about 1/2 Tp. Herein, it is assumed that the groove tracks, land tracks, and the address blocks **411b** and **801b** all have the same width. Moreover, the two address blocks **411b** and **801b**, which are formed in the same address region **405** on the groove track **403b**, for example, contain the same address information. Furthermore, the two address blocks are successively disposed along the track direction (i.e., the circumference direction of the optical disk) so that they will be

successively reproduced. Two address blocks are similarly formed in any other address region not shown in the figure.

In accordance with the above configuration, a laser light spot which has moved along the center **408** of the track **403b** on the left side of Figure **2**, for example, passes over both address blocks **411b** and **801b** in the address region **405**, and thereafter continues to move along the center **408** of the track **403b** on the right side of Figure **2**.

The address regions **405** of the optical disk shown in Figure **2** are formed in accordance with the CAV or ZCAV (ZCLV) format. Accordingly, the address regions **405** of adjoining tracks are aligned along the radius direction of the disk. As a result, the two address blocks **411b** and **801c**, which correspond to the adjoining groove tracks **403b** and **403c**, respectively, are formed in the address region **405** of the land track **402b**. Herein, the data region **406** is identified by the first address block **411a** or **411b**, whose data is first reproduced within the address region.

As a result, when the data in the groove track **403b** is reproduced, the information in the two address blocks **411b** and **801b** in the address region **405**, which have the same value, is reproduced. When the data in the land track **402b** is reproduced, the information in the two address blocks **411b** and **801c** in the address region **405**, which have different values, is reproduced. Although these tracks share the same address block **411b**, it is possible to determine whether the currently repro-

duced track is a groove track or a land track depending on whether the content of the address block **801b** or **801c** reproduced after the address block **411b** coincides with the content of the address block **411b**.

Figure **2** describes a disk in which the first address block is disposed on the boundary line **409** between the groove track **403b** and the land track **402b** adjoining the outer periphery of the groove track **403b** and the second address block is disposed on the boundary line **407** between the groove track **403b** and the land track **402a** adjoining the inner periphery of the groove track **403b**. However, the same effect can be attained by a disk in which the first address block is disposed on the boundary line **407** between the groove track **403b** and the land track **402a** adjoining the inner periphery of the groove track **403b** and the second address block is disposed on the boundary line **409** between the groove track **403b** and the land track **402b** adjoining the outer periphery of the groove track **403b**.

A case was described in which two address blocks provided for identifying data regions on the groove track contain the same address information, but the same effect can be attained in the case where two address blocks provided for identifying data regions on the land track contain the same address information.

Figure **3** is a diagram showing an optical disk recording/reproduction device according to the present invention. Although the descriptions in the present specification will be centered around the reproduction of information recorded on an optical disk, it will be

appreciated that the present invention is applicable to the recording of information on an optical disk. For conciseness, the "optical disk recording/reproduction device" in the present specification is defined to include not only a recording/reproduction device having a recording function but also a reproduction only device and a recording only device. In other words, the term "optical disk recording/reproduction device" will be employed so as to encompass both an "optical disk recording/reproduction device" by the narrow sense of the word and an "optical disk recording device" and an "optical disk reproduction device" by the narrow sense of the word.

The optical disk recording/reproduction device of the present example is suitable for recording or reproducing information on the optical disk **401** shown in Figure 2. In the following description, a CPU **601** will be described as the track designation means; an address reproduction circuit **603** will be described as an address reproduction means; and a track identification circuit **901** will be described as a track identification means.

In Figure 3, the optical disk **401** is attached to a motor **611**, whereby it is rotated. An optical head **610** converges laser light on an information recording face of the optical disk **401**. A head amplification circuit **606** converts the intensity of light reflected from the information recording side of the optical disk **401** into a voltage, which is amplified to become a signal at a predetermined level. A digitalization circuit **605** converts a reproduced analog signal into a digital

signal. A linear motor **609** is provided for quickly moving the optical head **610** to a target track. The operation of the linear motor **609** is controlled by a liner motor control circuit **607**. A data reproduction circuit **612** demodulates the signal digitalized by the digitalization circuit **605** in synchronization with a clock, and transfers the obtained data. An ID reproduction circuit **602** is composed of: an address reproduction circuit **603** for reproducing an address (address information) from the signal digitalized by the digitalization circuit **605**; the track identification circuit **901** for identifying the land track **403** from the groove track **402** and identifying the land track **402** from the groove track **403**; and a register **902** which is provided for combining a first address reproduced by the address reproduction circuit **603** and a track identification signal **b** obtained from the track identification circuit **901** into one address **a**. A focus/tracking control circuit **608** performs focusing control for maintaining the focus of the laser light on the information recording face and tracking control for maintaining the focus of the laser light in the center of a track of the disk. In order to access a target track, the CPU **601** moves the optical head **610** to the vicinity of the target track by means of the linear motor control circuit **607**, further moves the optical head **610** onto the target track by means of the tracking control circuit **608** through a track jump, and selects either a land track or a groove track by designating the tracking polarity.

Figure **4** is a diagram showing the configuration of the track identification circuit **901** for generating a track identification signal **b** based on two addresses **e**

reproduced from the optical disk **401** shown in Figure **2**. Reference numeral **1001** denotes a register for retaining a first address; **1002** denotes a register for retaining a second address; **1003** denotes a comparator for comparing the two addresses; and **1004** denotes a flip-flop for retaining the comparison result.

Hereinafter, an address reproduction operation by the optical disk recording/reproduction device shown in Figure **3** will be described with reference to Figures **3** and **4**.

When receiving the logical address of a track in which data is desired to be recorded or reproduced, the CPU **601** issues a seek command to the linear motor control circuit **607**, and drives the linear motor **609** so as to move the optical head **610** to the vicinity of the target track. Next, the CPU **601** issues a track jump command or a track selection command, which is in accordance with whether the track is a land track or a groove track to the focus/tracking control circuit **608**, whereby the optical head **610** arrives at the target track. The focus/tracking control circuit **608** selects the tracking control polarity and jumps the optical head **610** by half a track when receiving a track selection command, so that focusing and tracking to the target track are attained.

Reflected light from the optical disk **401** is converted into currents by a plurality of optical detectors in the optical head **610**, and are converted into voltages as reproduced signals corresponding to the respective optical detectors by the head amplification circuit **606**. The reproduced signals are subjected to

various calculations depending on the purpose for which they are used, whereby a reproduction signal indicating information, a tracking error signal, and a focusing error signal are generated. The tracking error signal and the focusing error signal are supplied to the focusing/tracking control circuit **608** so as to be employed for the focusing and tracking of the optical head **610**. The reproduced signal indicating information is digitalized by the digitalization circuit **605**.

In accordance with this optical disk recording/reproduction device, a logical address for identifying a data region is composed of: the address block **411** (reproduced by the address reproduction circuit **603**) common to the land track **402** and the groove track **403**; and the track identification signal **b** (composed of 1 bit) for identifying the land track **402** and the groove track **403**, in which the most significant bit is a value obtained from the track identification signal **b** and the other addresses are addresses obtained from the address region.

The track identification circuit **901** is composed of the two registers **1001** and **1002**, the comparator **1003**, the flip-flop **1004**, delay elements **1005**, **1006**, and **1007**. The track identification circuit **901** takes the two addresses **e** into the registers **1001** and **1002** in accordance with gate pulse signals obtained by delaying the address detection signal **d** by predetermined time periods. The two addresses **e** are compared by the comparator **1003**. Specifically, the address detection signal **d** is delayed by predetermined time periods by the three delay elements **1005**, **1006**, and **1007** so as to give gate pulse

signals for the registers **1001** and **1002** and the flip-flop **1004**. In accordance with the above-described circuit, the track identification signal **b** is generated so as to indicate a groove track when the two address blocks **411** and **801** coincide with each other, and a land track when the two addresses are different.

The register **902** in Figure 3 retains the first address reproduced by the address reproduction circuit **603**. By combining the first address and the most significant bit of the address of the data obtained from the track identification signal **b**, the address **a** for identifying the data region is obtained.

The data reproduction circuit **612** compares the address **a** reproduced in the ID reproduction circuit **602** and the address supplied from the CPU **601**, and, if the addresses match, reproduces data after a predetermined period of time from the reproduction of the address.

Finally, if the reproduced address **a** is determined to be different from the address supplied from the CPU **601**, the target track is sought again. Herein, if only the most significant bit of these addresses are different, a half-track jump is made, and the track selection signal, which selects the tracking polarity, is inverted. In the above-described example, the case where only the most significant bits of the addresses are different corresponds to a case in which the addresses common to the land track and the groove track match but either a land track or a groove track is wrongly selected. In order to correct this situation, the tracking selection signal is inverted, so that the tracking

polarity is switched.

When reproducing the data in a groove track of the optical disk **401** shown in Figure **2** by the above-described device, the laser light scans approximately the center **408** of that groove track, and the information in two address blocks within one address region that have the same value (e.g., **411b** and **801b**) is reproduced. On the other hand, when reproducing the data in a land track, the laser light scans approximately the center **410** of that land track, and the information in two address blocks having different values (e.g., **411b** and **801c**) within one address region is reproduced. Thus, information in different pairs of addresses is reproduced from the address region depending on whether a currently reproduced track is a land track or a groove track. As a result, it becomes possible to identify the currently reproduced track to be either the land track **402** or the groove track **403** based on the reproduced signal only. Therefore, irrespective of the correspondence between groove configurations (i.e., groove track or land track) and tracking polarities, recording or reproduction can be performed for a desired track by only using the reproduced signal.

In accordance with the above-described optical disk recording/reproduction device, the tracking polarity can be automatically switched based only on the reproduced signal, utilizing differences in two addresses. Therefore, it is possible to perform one, common type of tracking regardless of the characteristics of the disk and the optical disk recording/reproduction device. As a result, compatibility among optical disks in which

information is recorded on both land tracks and groove tracks can be improved.

(Example 2)

Figure 5 shows an optical disk according to Example 2 of the present invention.

In accordance with a predetermined physical format, a plurality of sectors 4 are successively disposed on a disk 1 along a track 2. Each sector 4 is composed of a sector address region 5 indicating the position of that sector on the disk and a data region 6 for actually recording data.

Figure 6 shows a logical format of a sector address adopted by the optical disk 1 of the present example. In the optical disk 1 of the present example, four address blocks 16 to 19 are provided within one sector address. In Figure 6, the address blocks 16 to 19 are indicated as ID1 to ID4, respectively. Each address block includes a VFO 11, an AM (Address Mark) 12, an address number 13 of the sector, an overlapping sequential number (ID number) 14, and a CRC (Cyclic Redundancy Check) 15.

The VFO 11 is a reproduction clock synchronization signal portion, which has a continuous repetition data pattern for enabling an address signal to be securely reproduced from the address region in spite of possible fluctuation in the rotation speed of the disk. The recording/reproduction device locks a PLL (Phase Locked Loop) to this repetition data pattern so as to generate a clock for reading data. The AM 12 is composed of a

specific code pattern for indicating the start point of the address data. The address number **13** is a data pattern indicating the position of the sector on the disk. The ID number **14** indicates the location order of each address block in the relevant address region; this number may also be referred to as "repetition number". The CRC is an error detection code which is generated from the address number and the ID number. The error detection code can be any code other than CRC, e.g., Reed Solomon's code, as long as reading errors of the address number and the ID number can be detected. Each address block can contain additional information as well as the information shown in Figure **6**.

Figure **7A** is a diagram showing the location of address blocks within a sector address region of the optical disk of the present example. While two address blocks were provided in each address region in the previous example, there are four address blocks provided in each address region according to the present example. However, the number of address blocks to be provided in each address region is not limited to four.

Figure **7A** shows a land track **22** and groove tracks **21** and **23** adjoining the land track **22**. Four address blocks **ID1** to **ID4** are disposed in the a sector address region **5** provided between data regions **6** and **7** so as to alternately wobble with respect to the center of the track. Specifically, in the case where the track width (or the track pitch) of one track is **Tp** whether it is a land track or a groove track, the address blocks **ID1** to **ID4** are shifted by **Tp/2** from the center of the track along the radius direction so as to be disposed alter-

nately on the inner periphery side and the outer periphery side. Address pits 25 are formed in each of the address blocks ID1 to ID4. Recording marks 26 are formed in the data regions 6 and 7. According to the present example, the width of the address pits 25 (i.e., size along the direction of the disk radius) is in the range of 0.1 to 0.6 μm. The recording marks 26 according to the present example are formed on a recording film.

The address pits 25 are usually formed when forming the groove tracks 21 and 23. In the case where the groove tracks and the address pits are formed by a laser cutting method, the laser light spot for cutting is moved toward right in Figure 7A as it forms the groove track 21 in the data region 6. Thereafter, the laser light spot is moved toward right in Figure 7A as it forms the address blocks 16, 17, 18, and 19 in the sector address region 5 in this order. Specifically, in the data region 6, laser light is continuously emitted so that a groove track of a predetermined width is formed, and laser light is intermittently emitted in accordance with the desired address pits in the sector address region 5 so as to be shifted from the groove track by Tp/2 along the radius direction. Although the address blocks ID1 and ID3 are disposed so as to be shifted upward with respect to the address blocks ID2 to ID4 in Figure 7A, it is also applicable to dispose the address blocks ID1 and ID3 so as to be shifted downward with respect to the address blocks ID2 to ID4 in the figure.

Figure 7B shows the respective waveforms of a reproduced signal (RF signal) and a tracking error signal (TE signal) when the light spot 24 reproduces the sector

address region 5. In general, the amplitude of the RF signal takes a value which is substantially in proportion with the area which the light spot 24 occupies in the address pit 25. Therefore, when the light spot 24 is at the center of the track, the light spot 24 illuminates the same area of the address block ID1 or ID3 and the address block ID2 or ID4 although in different directions with respect to the address pits 25. Thus, the RF signal has substantially the same amplitude, as shown in the figure.

In the data regions 6 and 7, which are composed of grooves, the TE signal takes values which are in proportion with the amount of offset between the light spot 24 and the track groove. Similarly, in the sector address region 5 composed of pits, the TE signal takes values which are in proportion with the amount of offset between the light spot 24 and the address pits 25 (although the output level of the TE signal is different, for the same offset amount, between the groove portions and the pit portions). Accordingly, the resultant TE signal has different polarities depending on the location of the address block as shown in Figure 7B.

Figures 8A and 8B show the states of the RF signal in a sector address region when the light spot is in off-track states. Figure 8A shows the RF signal in the sector address region 5 in the case where the light spot 24 is shifted toward the inner periphery of the track. Figure 8B shows the RF signal in the case where the light spot 24 is shifted toward the outer periphery of the track. In Figure 8A, the RF signal has a large amplification in the address blocks ID1 and ID3 since the

light spot 24 passes near the address blocks 16 and 18, and the RF signal has a small amplification in the address blocks ID2 and ID4 since the light spot 24 passes at a distance from the address blocks 17 and 19. Therefore, the address signal becomes difficult to read in ID2 and ID4. However, at least one but only one address block is required to be properly read in one sector address. In the example shown in Figure 8A, the RF signal amplitude is large in ID1 and ID3, thereby making it easy to read the address, so that the reading for the sector address as a whole is satisfactory.

Similarly in Figure 8B, the RF signal amplitude is small in ID1 and ID3, thereby making it difficult to read the address, but the RF signal amplitude is conversely large in ID2 and ID4, thereby making it easy to read the address. In other words, the address readability in the sector addresses does not decrease irrespective of whether the light spot becomes off-track toward the inner periphery side or the outer periphery side from the track center.

As will be appreciated, the same address readability is attained for both the land tracks and the groove tracks.

Furthermore, as in Figure 7B, the level of the TE signal alternately shifts, i.e., to be positive or negative, for every address block. However, by wobbling the address blocks, the frequency of level shifts increases. Specifically, the frequency of level shifts of the TE signal is 20 kHz or more, which is considerably higher than the control band in which the light spot can

follow the target track, in view of the time (100 μsec or less) period usually required for passing through a sector address region. Therefore, the light spot will never respond to such level shifts of the TE signal. Moreover, since the mean value of level shifts is substantially zero, offsets of the light spot due to a DC component are unlikely to occur. As a result, the sector address regions have little influence on the tracking control section, and the disturbance in the tracking control immediately after passing through a sector address region can be reduced.

Although the present example described a case where 4 address blocks are provided for 1 sector address, similar effects of improving the address readability against off-tracking can be provided in the case where the number of address blocks is two or more.

In the case where an even number of address blocks are disposed equally on the inner periphery side and the outer periphery side, there is provided an effect of preventing disturbance in the tracking control after passing through an address region. In the case where an odd number of address blocks are provided, a DC component due to the level shifts of the TE signal is generated, but it has substantially no influence because it has a higher frequency than the tracking control band. It is desirable to provide an even number of address blocks equally on the inner periphery side and the outer periphery side in terms of both address readability and tracking control stability.

(Example 3)

Next, an optical disk according to Example 3 of the present invention will be described.

Figures **9A** and **9B** show the location of information blocks in sector address regions according to the present example. The optical disk of the present example has the same configuration as that shown in Figure **7A** except that it includes additional information blocks **107**, **108**, and **109** containing additional information which is not address number information in the sector region **5**. Reference numerals **#100** and **#101** denote track address numbers.

The address blocks **16** to **19** each contain address information for identifying an address number from an ID number. It is preferable to dispose the additional information blocks **107** to **109** so as to be shifted by a width of about **Tp/2** from the center of the track along the radius direction, as in the case of address blocks **16** to **19**. In the case where the additional information blocks are shorter in length than the address blocks, or where it is impossible to divide the additional information into two, the additional information block **107** is disposed either on the inner periphery side or the outer periphery side as shown in Figure **9A**. On the contrary, in the case where the additional information block is relatively long, the additional information can be divided into identifiable block units **108** and **109** as shown in Figure **9B**, which are disposed so as to be alternately shifted on the inner periphery side and the outer periphery side of the track.

By adopting the above-mentioned configuration, it

is possible to improve address information and additional information readability against off-tracking, and stability of tracking control during and after passing through a sector address region even in the case where additional information is added to the sector address region, as in the previous examples.

Although additional information is disposed at the end (i.e., right side in the figure) of each sector address region according to the present example, it can also be disposed in another position.

(Example 4)

Next, an optical disk according to Example 4 of the present invention will be described.

Figures **10A** and **10B** show the location of address blocks in sector address regions according to the present example. In Figures **10A** and **10B**, **110** and **112** denote groove tracks; **111** denotes a land track; **113**, **114**, **115**, **116**, **117**, **118**, **119**, and **120** denote address blocks; and **24** denotes a light spot.

First, a method for forming tracks and address pits will be described. Tracks and pits are formed by radiating cutting laser light onto a rotating master disk. A continuous groove is obtained when the laser light is continuously radiated, which becomes a track (i.e., groove track in the present example). Pits are formed by discontinuously radiating the laser light by turning it on and off at a predetermined interval. In other words, in the case of a disk having sector addresses, tracks and address pits are formed in each round of

the disk by controlling the radiation of the cutting laser light in the groove portions and the address pit portions while moving the cutting laser light along the radius direction by a track pitch for every turn of the master disk.

Tracks and address pits are formed by a similar method in order to realize the wobbled address pits according to the present invention. However, the address pits are disposed so as to be either on the inner periphery side or the outer periphery side of the track, so that the cutting laser light must be turned on and off while shifting the center of the cutting laser light by **Tp/2** along the radius direction for each address block. Alternatively, the track grooves and address pits can be formed by employing a set of three laser light beams, i.e., laser light for forming track grooves, laser light for forming address pits on the inner periphery side, and laser light for forming the address pits on the outer periphery side, each laser light being turned on and off in predetermined positions.

In Figures **10A** and **10B**, the groove track **110** (on the left side of the figure) and the address blocks **113**, **114**, **115**, and **116** are first formed in this order. Then, after the master disk has made one complete turn, the groove track **112** and the address blocks **117**, **118**, **119**, and **120** are formed in this order. Since the rotation accuracy and the like of the master disk have some fluctuation, the positions of address blocks including the same ID number (e.g., address blocks **113** and **117**) do not necessary coincide along the circumference direction. If their positions are at an offset of **ΔX** as shown in

Figure 10A, there is a possibility that the reproduced (RF) signal may not be accurately detected when reproducing data in the land track 111 because the end of the address block 117 and the beginning of the address block 114 overlap with each other by ΔX. Therefore, by disposing the address blocks so as to be at an interval of Xm with one another along the circumference direction, the interval Xm being equal to or greater than the disk rotation accuracy during cutting, the overlapping of adjoining address blocks can be prevented, thereby ensuring the reproducibility of an address signal.

The interval Xm equal to or greater than the disk rotation accuracy during cutting is set to be a value in the range of 0 to 1.0 μm, for example. The interval Xm can be varied in accordance with the distance from the center of the disk.

(Example 5)

Next, an optical disk according to Example 5 of the present invention will be described.

Figure 11 shows the location of address blocks in sector address regions of an optical disk according to the present example. In Figures 11, 150 and 152 denote groove tracks; 151 denotes a land track; 153, 154, 155, and 156 denote address blocks; and 157 to 164 denote address pits constituting the address blocks. When performing a cutting, the grooves and address pits are successively formed. In the groove track 150, the pits of the address blocks 153 and 154 are formed in synchronization with a standard clock for cutting, so that the interval between address pits in the address

blocks **153** and **154** along the time axis when reproducing data from the groove track **150** will be a multiple of an information reading clock period Tw (e.g., about 5 to 100 ns). In other words, not only a pit interval **T10** within the same address block but also a pit interval **T11** between different address blocks will become a multiple of Tw in theory.

However, in practice, the position of the address block for the next groove track **152** is purposely shifted along the circumference direction in order to prevent the overlapping of address blocks due to rotation fluctuation during the cutting, as described in Example 4. Even in this case, if **ΔX** is set at an arbitrary value, a time interval **T14** from the pit **163** of the address block **155** to the pit **160** of the address block **154** may not be a multiple of Tw because it is not synchronized with a reference clock during cutting.

When the time interval **T14** is not a multiple of Tw, some time is required for readjusting the phase of the data reading clock in the PLL at the VFO located in the beginning of the address block **154**.

In order to solve such a problem, the address pits can be disposed with their phases matched so that the time interval **T12** of the offset **ΔX** approximately becomes a multiple of Tw. Thus, **T14** also approximately becomes a multiple of Tw, whereby the time required for the PLL synchronization in the address block **154** when reproducing the data in the land track **151** can be reduced.

(Example 6)

Next, an optical disk according to Example 6 of the present invention will be described.

Figure 12 shows the location of address blocks in sector address regions in an optical disk according to the present example. In Figure 12, 130 and 132 denote groove tracks; 131 denotes a land track; 133, 134, 135, 136, 137, 138, 139, and 140 denote address blocks; 24 denotes a light spot; 141 denotes a VFO; 142 denotes an AM; 143 denotes an address number; 144 denotes an ID number; 145 denotes a CRC; and 146 and 147 denote dummy data regions.

In the present example, as shown in Figure 12, dummy data regions 146 and 147 are disposed at the beginning and the end of each address block, the dummy data regions 146 and 147 containing data which has nothing to do with the identification of address signals. Herein, the VFO 141, the AM 142, the address number 143, the ID number 144, and the CRC 145 are the same as those described in Example 2. By providing the dummy data regions 146 and 147, the beginning of an address block is prevented from overlapping with the end of its previous address block even when a locational fluctuation occurs for the address blocks along the circumference direction.

The pit pattern of the dummy data can be arbitrary selected. For example, by ensuring that the dummy data has the same pit pattern as the VFO 141 in the beginning of each address information region, the VFO region will appear to be longer, thereby providing an advantage of ensuring the generation of the data reading

clock. The length of each of the dummy data regions 146 and 147 can be any value as long as the dummy data region does not overlap with a region which is actually required for the identification of the address signal.

It is also applicable to dispose a dummy data region only in the end of each address block.

(Example 7)

Next, an example of an optical disk recording/reproduction device according to the present invention will be described.

Figure 13 is a block diagram showing an optical disk recording/reproduction device capable of reading sector addresses in the optical disk shown in Figure 7A. In Figure 13, 31 denotes a disk; 32 denotes a disk motor; 33 denotes an optical head; 34 denotes an address reproduction section composed of an addition circuit 35, a waveform equivalent section 36, a data slice section 37, a PLL 38, a demodulator 39, an AM detection section 40, a switcher 41, and a CRC determination section 42; 43 denotes an error correction section; and 44 denotes an address correction section.

Figure 14 shows the configuration of sector addresses of an optical disk for which recording/reproduction of information with the present optical disk recording/reproduction device is performed. The optical disk has the same configuration as that of the optical disk shown in Figure 7A. In Figure 14, a land track 52 and groove tracks 51 and 53 interposing the land track 52 are illustrated. In a sector address region 5

provided between the data regions 6 and 7, four address blocks 54 to 57 are disposed so as to alternately wobble with respect to the track center. In this example, it is assumed that the track number increases by 1 for every complete round of the track; a groove track 51 has an address #100; a land track 52 has an address #101; and a groove track 53 has an address #101. The values (e.g., #100) in each address block represents a value (address) set in the address number 13 in that address block.

An operation of reading a signal from the sector address region 5 shown in Figure 14 by using the optical disk recording/reproduction device shown in Figure 13 will be described.

First, the optical head 33 radiates laser light onto the optical disk 31, whereby the intensity of the light reflected from the optical disk 31 is detected. A reproduced signal (RF signal) is generated based on the amount of reflected light. The same operation of extracting an address number and an ID number from an RF signal for each address block as described in the description of conventional techniques is performed by means of the waveform equivalent section 36, the data slice section 37, the PLL 38, the demodulator 39, the AM detection section 40, the switcher 41, and the CRC determination section 42.

When the light spot 24 reproduces data in the groove track 51, the address signals obtained in the sector address regions are, respectively, (#100, 1), (#100, 2), (#100, 3), (#100, 4), where (address number, ID number). These values are input to the address

correction section **44**. The address correction section **44** detects an address based on an input address number and an input ID number.

Figure **15** shows sets of signals input to the address correction section **44** when reproducing data in a groove track and when reproducing data in a land track. The address blocks **54**, **55**, **56**, and **57**, which include the same address number, are disposed so as to wobble on the inner periphery side and the outer periphery side with respect to the center the groove track **51**. Therefore, the address numbers of **ID1** to **ID4**, obtained when reproducing the data in the groove track **51**, all take the same value (i.e., **#100** herein). Accordingly, the read-out address number (**#100**) can be output intact from the address correction section **44** as a final address value.

On the other hand, when the light spot **24** reproduces data in the land track **52**, the address signals obtained in the sector address regions are, (#101, 1), (#100, 2), (#101, 3), (#100, 4), which are input to the address correction section **44** in this order. Since it is known from the location pattern of address blocks shown in Figure **14** that the address number indicated in **ID1** and **ID3** is smaller by 1 than the actual address number, the address correction section **44** adds 1 to the address number **#101** read from **ID2** and **ID4** to obtain an address number **#101**. Since the address number **#101** read from **ID1** and **ID3** coincides with the actual address value, it is used intact as the address number. Thus, a final address value **#101** is output. By inputting a signal (L/G signal) which indicates whether data in a groove track is being reproduced or data in a land track is being reproduced to

the address correction section **44**, the above-mentioned address correction can be achieved.

Thus, in accordance with the optical disk recording/reproduction device of the present example, the address correction section **44** is provided which is capable of correcting a read-out address number (e.g., **#100**) based on an ID number which is read out substantially simultaneously (e.g., 2) provided that it is previously known whether data in a groove track is being reproduced or data in a land track is being reproduced so as to derive a correct sector address value (e.g., #101). As a result, it becomes possible to manage the sector addresses of an optical disk located as in Figures **7A**, **7B**, and **14**.

In this example, the address numbers of the land track and the groove track are the address number indicated in **ID1**. Since substantially all of the four addresses **ID1** to **ID4** are properly read when reading sector addresses, it is preferable to, if the value of **ID1** was properly obtained, use that value as the track address. In other words, it is more practical to set the track address of the land track **52** to be **#101** because this will eliminate the need of correcting an address number read out from **ID1**, although it is also applicable to set the track address of the land track **52** to be **#100**. Another advantage of equal readability regardless of land tracks or groove tracks will be provided by **ID1** indicating the track address number itself in the case where the VFO of **ID1** is prescribed to be longer than those of other address blocks so as to enhance the readability of **ID1**.

In the above example, a case was described in which one sector is provided for one track. However, in the case of a disk of a format such that a number N of sectors are included in one track, the sector number consecutively increasing, address #100 will be adjoined by address (#100 + N). Accordingly, the address correction section outputs a corrected value by adding N to a read-out address value when reproducing data in a land track. Thus, it becomes possible to derive address values for both land tracks and groove tracks in the same manner described above.

Furthermore, in the case where a number N of sectors are included in one track such that the address number takes discontinuous values, it is possible to calculate a corrected value in accordance with the specific format of the sector addresses based on the address number and the sector number which are read from each address block.

Furthermore, although a case was described in which the same address number is read out when reproducing data in a groove track, it is also applicable to configure the optical disk so that the same address number is read out when reproducing data in a land track.

Although the same address number was disposed on the inner periphery side and the outer periphery side of one track, it is also possible to correct a read-out address number based on an ID number if the location pattern of ID numbers and address blocks is known.

(Example 8)

Next, another example of an optical disk recording/reproduction device according to the present invention will be described.

Figure 16 is a block diagram showing an optical disk recording/reproduction device according to the present example. In Figure 16, 31 denotes a disk; 32 denotes a disk motor; 33 denotes an optical head; 34 denotes an address reproduction section composed of an addition circuit 35, a waveform equivalent section 36, a data slice section 37, a PLL 38, a demodulator 39, an AM detection section 40, a switcher 41, and a CRC determination section 42; 43 denotes an error correction section; and 61 denotes a land/groove identification section.

Figure 17A is a block diagram showing the configuration of the land/groove identification section 61. Reference numeral 62 denotes memory 1; 63 denotes memory 2; 64 denotes memory 3; 65 denotes memory 4; 66 denotes comparator 1; 67 denotes comparator 2; 68 denotes comparator 3; 69 denotes comparator 4; and 70 denotes a judgement section.

An operation of land/groove identification by the above-described optical disk recording/reproduction device, performed based on address signals obtained from sector address sections in which address blocks are disposed as shown in Figure 10, will be described. First, the optical head 33 radiates laser light onto the disk 31, whereby a reproduced signal (RF signal) is detected based on the amount of reflected light. The same operation of extracting an address number and an ID

number from an RF signal for each address block as described in the description of conventional techniques is performed by means of the waveform equivalent section **36**, the data slice section **37**, the PLL **38**, the demodulator **39**, the AM detection section **40**, the switcher **41**, and the CRC determination section **42**.

The address signals read by the light spot **24** scanning the sector address region **5** are sequentially input to the land/groove identification section **61** as pairs of (address number, ID number). In the land/groove identification section **61**, the read-out address numbers are stored intact in the memories **62**, **63**, **64**, and **65** corresponding to the respective input ID numbers. Specifically, an address number in ID number 1 is stored in memory 1 (**62**); an address number in ID number 2 is stored in memory 2 (**63**); and so on.

With reference to Figure **14**, when reproducing data in the groove track **51**, **#100** is stored in memory 1; **#100** is stored in memory 2; **#100** is stored in memory 3; and **#100** is stored in memory 4. Comparator 1 (**66**) in Figure **17A** compares the address numbers in memory 1 (**62**) and memory 2 (**63**) so as to determine whether or not the two address numbers coincide, and transfers the result to the judgment section **70**. Similarly, comparator 2 (**67**) compares the address numbers in memory 2 (**63**) and memory 3 (**64**); comparator 3 (**68**) compares the address numbers in memory 3 (**64**) and memory 4 (**65**); and comparator 4 (**69**) compares the address numbers in memory 4 (**65**) and memory 1 (**62**). The comparators 2 to 4 transfer their respective results to the judgment section **70**.

In this example, comparators 1 to 4 are all expected to output a result "coincided" for a groove track, due to the location pattern of the address blocks as shown in Figure 14. The judgement section 70 judges that the currently reproduced track is a groove track when the outputs of all the comparators coincide. On the other hand, while the light spot 24 is reproducing data in the land track 52 shown in Figure 14, #101 is stored in memory 1 (62); #100 is stored in memory 2 (63); #101 is stored in memory 3 (64); and #100 is stored in memory 4 (65). As a result, the outputs of comparators 1 to 4 all become "not coincided". Thus, comparators 1 to 4 are all expected to output a result "not coincided" for a land track, due to the location pattern of the address blocks as shown in Figure 14; in this case, the currently reproduced track is judged to be a land track.

As described above, it is possible to determine whether a currently reproduced track is a land track or a groove track by examining whether or not address numbers corresponding to predetermined ID numbers coincide. In the case of the location pattern of address blocks according to the present example, the currently reproduced track is determined to be a groove track if at least one of the results from comparator 1 (66), comparator 2 (67), comparator 3 (68), and comparator 4 (69) is "coincided". The currently reproduced track is determined to be a land track if at least one result is "not coincided". In other words, it is not necessary for all the address blocks to be read accurately. The land/groove identification is possible as long as information in at least one of the address blocks ID1 and ID3 on the inner periphery side and information in at

least one of the address blocks **ID2** and **ID4** on the outer periphery side can be read out as address signals.

Moreover, the land/groove identification is also possible when an address correction section **71** is incorporated as shown in Figure **17B**. In this case, **#101** is input to memory 1 (**62**); **#100** is input to memory 2 (**63**); **#101** is input to memory 3 (**64**); and **#100** is input to memory 4 (**65**). Therefore, the outputs of the comparators 1 to 4 all become "coincided" when reproducing data in a land track. Thus, the track is determined to be a land track when all the comparators output "coincided". On the other hand, when reproducing data in a groove track, the outputs of the comparators 1 to 4 all become "not coincided". Thus, the track is determined to be a groove track when all the comparators output "not coincided".

The identification as to land/groove is impossible in the case where address signals can be read only from the address blocks **ID1** and **ID3** on the inner periphery side or only from the address blocks **ID2** and **ID4** on the outer periphery side. In such cases, a signal (L/G OK signal) indicating that the judgement section **70** is incapable of judging can be output. Since sector addresses are read at a rate of once in every few milliseconds in accordance with the disk rotation, in general, there is only a very small probability for the land/groove identification to be disabled for all the sector addresses over a long period of time. Therefore, the land/groove identification is practically possible by the above operation.

If an address which actually indicates a false address but was erroneously judged as correct by the CRC judgment section is input to the land/groove identification section, the outputs of the comparators will include both "coincided" and "not coincided". In such cases, too, a signal (L/G OK signal) indicating that the judgement section **70** is incapable of judging can be output.

It will be appreciated that by inputting the land/groove identification signal (L/G signal) from the land/groove identification section **61** to the address correction section **44** of Example 7 shown in Figure **13**, the land/groove identification and outputting of an address value can be simultaneously performed based on one sector address.

(Example 9)

Next, still another example of an optical disk recording/reproduction device according to the present invention will be described.

Figure **18** is a block diagram showing an optical disk recording/reproduction device according to the present example. In Figure **18**, **31** denotes a disk; **32** denotes a disk motor; **33** denotes an optical head; **34** denotes an address reproduction section; **81** denotes a tracking error signal detection section composed of a differential circuit **82** and a LPF (Low Pass Filter) **83**; **84** denotes a phase compensation section; **85** denotes a head driving section; **90** denotes a timing generation section; **91** denotes an outer periphery value sample/hold section; **92** denotes an inner periphery value sample/hold section; **93** denotes an addition circuit; and **94** denotes

a gain conversion circuit.

An operation of detecting an off-tracking amount between a light spot and a track in a sector address region having address blocks disposed as shown in Figure 14, performed by the above-described optical disk recording/reproduction device, will be described.

First, the optical head 33 in Figure 18 radiates laser light onto the disk 31 and detects a reproduced signal (RF signal) based on the amount of reflected light. The operation of extracting an address number and an ID number for each address block as described in the description of conventional techniques is performed by the address reproduction section 34.

Figure 19 is a schematic diagram showing change in the tracking error signal (TE signal) in a sector address region 5 during an off-track state. The level of the TE signal shifts substantially in proportion with the distance between the light spot and the address pits, and the direction of level shifts is determined by the relative positions of the light spot and the address pits, as described in Example 2. Herein, it is assumed that the TE signal takes a negative value when the light spot 24 passes over address pits 25 on the outer periphery side and takes a positive value when the light spot 24 passes over address pits 25 on the inner periphery side. When the light spot 24 follows line (a) of a track 2, the level shifts VTE1 and VTE3 of the TE signal take small negative values because the distance between the light spot 24 and the address pits 25 is relatively small in ID1 and ID3. In this case, the level

shifts **VTE2** and **VTE4** of the TE signal take large positive values because the distance between the light spot **24** and the address pits **25** is relatively large in **ID2** and **ID4**. As a result, a TE signal shown in (**a**) of Figure **19** is obtained. When the light spot **24** follows line (**b**) of the track **2**, the level shift amount is the same in all of **ID1** to **ID4** because the distances between the light spot **24** and the address pits **25** in **ID1** to **ID4** are the same. As a result, a TE signal shown in (**b**) of Figure **19** is obtained. When the light spot **24** follows line (**c**) of the track **2**, a TE signal shown in (**c**) of Figure **19** is obtained. As seen from Figure **19**, the levels of **VTE1** (or **VTE3**) and **VTE2** (or **VTE4**) vary depending on which position of the track **2** the light spot **24** moved over, so that the off-tracking amount can be deduced based on a difference between level shifts. In other words, the off-tracking amount can be obtained in accordance with the equation Voftr = **VTE1** - **VTE2**. If the light spot **24** follows the center line (**b**) of the track **2**, **VTE1** - **VTE2** = 0 in the sector address region **5**; if the light spot **24** follows the line (**a**) of the track **2**, **VTE1** - **VTE2** < 0 in the sector address region **5**; and if the light spot **24** follows the line (**c**) of the track **2**, **VTE1** - **VTE2** > 0 in the sector address region **5**. Thus, the direction and amount of off-tracking can be obtained.

Next, the operation of the timing generation section **90** in Figure **18** will be described. Figure **20** is a timing diagram showing gate pulse signals (**GT0** to **GT2**) in the timing generation section **90**. Since read-out address signals are input from the address reproduction section **34** to the timing generation section **90**, the timing generation section **90** generates a gate pulse

signal **GT1** which is in synchronization with address blocks on the outer periphery side and a gate pulse signal **GT2** which is in synchronization with address blocks on the inner periphery side, based on the received address signals. The gate pulse signal **GT1** becomes a signal for sampling a signal in the outer periphery value sample/hold section. The gate pulse signal **GT2** becomes a signal for sampling a signal in the inner periphery value sample/hold section.

First, (a) of Figure **20** shows a case where **ID1** was successfully read. The timing with which **ID2**, **ID3**, and **ID4** appear can be known if **ID1** is successfully read. Accordingly, the signal **GT0**, which includes a gate pulse in synchronization with the end of **ID1**, is generated. In this case, gate pulse signals **GT2** and **GT1** are generated for the address block **ID3** on the inner periphery side and the address block **ID2** on the outer periphery side, respectively (**ID2** can also be **ID4**). Accordingly, the timing generation section **90** generates the gate pulse signal **GT1** so as to lag behind the gate pulse signal **GT0** by time **T1**, and generates the gate pulse signal **GT2** so as to lag behind the gate pulse signal **GT0** by time **T2**.

Next, (b) of Figure **20** is a timing diagram showing the case where **ID2**, but not **ID1**, was successfully read. A gate pulse **GT0** is generated which is in synchronization with the end of **ID2**. In this case, gate pulse signals **GT2** and **GT1** are generated for the address block **ID3** on the inner periphery side and the address block **ID4** on the outer periphery side, respectively. Accordingly, the timing generation section **90** generates the gate pulse signal **GT1** so as to lag behind the gate

pulse signal **GT0** by time **T2**, and generates the gate pulse signal **GT2** so as to lag by time **T1**.

Next, (c) of Figure **20** shows the case where gate pulse signals to be sampled and held are generated in synchronization with a further gate pulse signal which is in synchronization with the sector address region. Assuming that **GT0** is the further gate pulse signal, which rises immediately before each sector address region, gate pulse signals **GT2** and **GT1** are generated for the address block **ID1** on the inner periphery side and the address block **ID2** on the outer periphery side, respectively. Accordingly, the timing generation section **90** generates the gate pulse signal **GT1** so as to lag behind the gate pulse signal **GT0** by time **T4**, and generates the gate pulse signal **GT2** so as to lag behind the gate pulse signal **GT0** by time **T3**.

By using the gate pulse signals **GT1** and **GT2** generated by the timing generation section **90**, with reference to (a) of Figure **20**, for example, the level **VTE2** of the TE signal in the address block **ID2** on the outer periphery side is stored in the outer periphery value sample/hold section **91** in synchronization with the gate pulse signal **GT1**, and the level **VTE3** of the TE signal in the address block **ID3** on the inner periphery side is stored in the inner periphery value sample/hold section **92** in synchronization with the gate pulse signal **GT2**. As a result, a value (**VTE1** - **VTE2**) is output from the differential circuit **93**. Since this value corresponds to the off-tracking amount, it can be further converted into an off-track signal (OFTR signal) by adjusting its level to the level of the TE signal by the

gain conversion section **94**. In the actual tracking control system, a state may occur in which the light spot is not actually in the track center, owing to offset components, etc. generated in the tracking error signal detection section **81**, the phase compensation section **84**, and the head driving section **85**, although the TE signal is controlled to be zero. Accordingly, by applying the OFTR signal for correcting the offset in the tracking control system as shown in Figure **18**, it becomes possible to position the light spot in the track center. The same applies to **(b)** and **(c)** of Figure **20**.

The gate pulse signal **GT2** is to be generated in synchronization with one of the address blocks on the inner periphery side, rather than a specific one of the address blocks; the gate pulse signal **GT1** is to be generated in synchronization with one of the address blocks on the outer periphery side, rather than a specific one of the address blocks. Although it's not necessary to adjust time **T1** and time **T2** at exact time intervals so as to synchronize the gate pulse signals with specific address pit positions in the address block, it is preferable that the pit arrangement patterns in the respective address blocks are measured with the same period (e.g., the VFO region).

Although the information in only one address block on the inner periphery side and only one address block on the outer periphery side is sampled and held in the present example, a more average value can be detected by detecting an off-track signal by using a mean value of a plurality of address blocks on the inner periphery side and a mean value of a plurality of address blocks on the

outer periphery side, even if the tracks are locally warped.

(Example 10)

Next, still another example of an optical disk recording/reproduction device according to the present invention will be described.

Figure 21 is a block diagram showing the device according to the present example. In Figure 21, 31 denotes a disk; 32 denotes a disk motor; 33 denotes an optical head; 34 denotes an address reproduction section; 81 denotes a tracking error signal detection section; 84 denotes a phase compensation section; 85 denotes a head driving section; 90 denotes a timing generation section; 91 denotes an outer periphery value sample/hold section; 92 denotes an inner periphery value sample/hold section; 93 denotes a differential circuit; 94 denotes a gain conversion circuit; and 100 denotes a reflected light amount signal detection section composed of an addition circuit 101 and a LPF (Low Pass Filter) 102.

In Figure 21, elements 31, 32, 33, 34, 81, 84, 85, 90, 91, 92, and 93 perform the same operation described in Example 9. While a TE signal is sampled and held in order to detect an off-tracking amount in Example 9, the detection of the off-tracking amount in Example 10 is performed by sampling and holding a reflected light amount signal (AS signal) detected by the reflected light amount signal detection section 100.

In the reflected light amount signal detection section 100, the outputs of a two-divided photosensitive

elements of the optical head **33** are summed up in the addition circuit **101**, and the added signal is led through the LPF **102** (having a band in a few dozen kHz to a few 100 kHz, which is higher than the tracking control band but lower than the RF signal) in order to remove the high-frequency component thereof. As a result, an AS signal is detected as a signal indicating an average reflected light amount.

Figure **22** shows the change in the AS signal with respect to the offset amount between the light spot and a track. As described in Example 2, the RF signal shifts as shown in Figure **7A**, **8A** or **8B** depending on where the light spot **24** passes through. Since the AS signal indicates an average level of the RF signal, AS signals as shown in **(a)**, **(b)**, and **(c)** in Figure **22** will result, respectively, for lines **(a)**, **(b)**, **(c)** in Figure **22** which the light spot **24** follows. Therefore, by sampling and holding **VAS1**, **VAS2**, and the like in synchronization with the address blocks on the inner periphery side and the address blocks on the outer periphery side and obtaining a difference therebetween (**VAS1 - VAS2**) as in Example 9, a signal corresponding to the off-tracking amount can be detected. Gate pulse signals **GT1** and **GT2** for the sampling and holding are generated by the timing generation section **90** as shown in Example 9. However, as for the timing of gate pulse signal generation, it is preferable to employ an AS signal derived from the VFO portion, the AM portion, or a specially provided pit portion because a more accurate detection will be enabled by sampling AS signals at portions in address blocks having the same pit pattern.

Moreover, it is applicable to employ an offtrack signal (OFTR signal) detected by using the AS signal for correcting the offset in the tracking control system as in Example 9.

Although the AS signal employed herein is obtained by leading the RF signal through the LPF, it is also applicable to employ the lower envelope level (i.e., the side having a smaller reflected light amount) of the RF signal (i.e., **VRF3** and **VRF4** in Figure **22**).

(Example 11)

Next, still another example of an optical disk according to the present invention will be described.

The address blocks in the sector address regions in the optical disk of the present example has substantially the same schematic location shown in Figure **10A**. However, instead of incorporating a margin (**ΔX1**) between adjoining address blocks, the optical disk of the present example adopts a data pattern such that the end pattern of each address block is not in the form of pits and that the beginning pattern of the subsequent address block is also not in the form of pits, as shown in Figure **23**. In particular, the beginning pattern of each address block includes non-pit data (having a length of **ΔX1**) longer than the rotation accuracy (**ΔX**) in the cutting of the master disk.

While distances between address block are wasted in the case of Figure **10B**, where address blocks are disposed so as to be shifted with respect to one another along the circumference direction, the optical disk of

the present example overcomes that problem.

The advantages of the optical disk of the present example will be described in detail with reference to Figures **24A**, **24B**, **25A**, and **25B**. In the data pattern of the address blocks shown in Figures **24A** and **24B**, the end pattern of each address block is in the form of pits, and the beginning pattern of the subsequent address block is also in the form of pits. Specifically, Figure **24A** shows a pit configuration designed to result in the case of such a data pattern. In Figure **24A**, the end pits of the address block **113** and the beginning pits of the address block **114** are formed so as to have predetermined lengths along the respective center lines thereof. However, in practice, the end pits of the address block **113** and the beginning pits of the address block **114** may be formed in a continuous manner shown in Figure **24B** when address pits are formed while shifting the location of the laser light spot in the sector address region **5** along the radius direction in the cutting process of the master disk. This is because the laser light is radiated onto the optical disk even while shifting the laser light spot for cutting from the address block **113** to the address block **114** along the radius direction. As a result, as shown in Figure **24B**, pits having an unexpected configuration may result, thereby making it difficult to properly reproduce data.

This problem can be solved by cutting the address pits on the inner periphery side and the address pits on the outer periphery side by using separate laser light beams. However, the use of such a method would complicate the structure of the cutting apparatus.

Figures **25A** and **25B** show the operation of reading pits in the case where the light spot **24** scans the land track **111** for reproducing the data therein. Figure **25A** shows a sector address region in the case where the pit pattern in portions connecting address blocks is not particularly defined. In the sector address region of Figure **25A**, adjoining address blocks **114** and **117** overlap with each other by a length corresponding to the cutting accuracy **ΔX** along the circumference direction, and the beginning of the address block **114** is pit data. In such a state, where non-pit data of the end of the address block **117** overlaps with the pit data of the beginning of the address block **114** as shown in Figure **25A**, reproducing data in the address block **117** while moving the light spot **24** along the center line of the land track **111** would result in data error in the address block **117**. This is because the pit data in the beginning of the address block **114** causes a misjudgment that the end of the address block **117** has pit data.

On the other hand, Figure **25B** shows a sector address region of the optical disk of the present example. The optical disk includes non-pit data in the beginning and the end of each address block. In the case of Figure **25B**, where the beginning of the address block **114** is not pit data, no data error occurs in the address block **117** even if the non-pit last data of the address block **117** overlaps with the non-pit data in the beginning of the address block **114** because the reproduced signal is non-pit data. Although the number of non-pit data in the beginning of the address block **114** cannot be correctly detected, the beginning of an address block is generally a VFO region, so that not all the data are

required to be read. No problems will occur in reading address blocks if the address data portion is resynchronized in the AM region following the VFO region and the address number and CRC are properly recognized.

Thus, by ensuring that the beginning pattern and the end pattern of each sector address block are non-pit data as shown in Figure **25B**, insufficient formation of pits between wobbling address blocks during the cutting of the master disk and reading errors of address data during reproduction of sector addresses due to overlapping of address blocks can be prevented, while also eliminating wasteful gaps.

(Example 12)

Next, still another example of an optical disk according to the present invention will be described.

Figure **26A** shows the location of address blocks of the optical disk of the present example, which is similar to Example 2: **110** and **112** denote groove tracks; **111** denotes a land track; **113**, **114**, **115**, **116**, **117**, **118**, **119**, and **120** denote address blocks; and **24** denotes a light spot. Figure **26B** shows the location of data in the respective address blocks. The address block **117** in **ID1** is composed of the following data: VFO1 (**300**), AM (**301**), address number (**302**), ID number (**303**), and CRC1 (**304**). The address block **114** in **ID2** is composed of the following data: VFO2 (**305**), AM (**306**), address number (**307**), ID number (**308**), and CRC2 (**309**).

The optical disk of the present example differs from the optical disk of Example 2 in that the length of

VFO1 of the address block **117** is prescribed to be 1.5 times to 3 times longer than the VFO of address blocks in **ID2**, **ID3**, and **ID4** according to the present example.

When a sector address region is irradiated by the light spot **24**, data in **ID1** and data in **ID2** are reproduced in this order. The data region **6** is composed of a track groove, but the sector address region **5** is composed of a mirror face having address pits formed therein. Therefore, as shown in Figures **8A** and **8B**, the d.c. signal component (DC level) of the reproduced signal (RF signal) varies between the data region **6** and the sector address region **5**. As a result, the level of the RF signal drastically shifts immediately after the light spot **24** has moved from the data region **6** to the sector address region **5**. In order to accurately read the data in spite of such level shifts, it is necessary to improve the reproduction circuit. However, even by improving the reproduction circuit, the influence of level shifts of the RF signal cannot be completely eliminated in the interface between the data region **6** and the sector address region **5**. Therefore, it takes more time to lock the PLL in **ID1** in order to match the phases of the data reading clock and the data (VFO1). In **ID2** and after, it becomes faster to lock the PLL in the VFO because the influence of the level shifts of the RF signal decreases.

In the case where the data lengths of all the address blocks are made equal, the lengths of the VFOs in **ID2** to **ID4** must coincide with the length of VFO required in **ID1**, so that the VFOs in **ID2** to **ID4** become longer than necessary, resulting in waste of space. Therefore, according to the present example, only the length of the

VFO in ID1 is made longer than the VFOs in ID2, ID3, and ID4, thereby making it possible to optimize the lengths of the VFOs required for the respective address blocks. As a result, it becomes possible to eliminate redundant data and to maintain readability of addresses.

Since the difference between the length of VFO1 (300) in ID1 and VFO2 (305) in ID2 is small relative to the data length of one sector address region, there is substantially no influence on the average value of the tracking error signal in the sector address region described in Example 1.

(Example 13)

Next, still another example of an optical disk according to the present invention will be described with reference to Figure 27. Figure 27 shows an address region 405. An address block 411 provided in the address region 405 is recorded so as to be centered around a boundary line 409 between a groove track 403 and a land track 402 on the outer periphery side, the address block 411 thus being on both the groove track 403 and the land track 402, and it takes a different value in each address region. Since the address block 411 is included in common in the address regions of the land track 402 and the groove track 403 adjoining each other, the data regions are to be identified by the same address block 411. A track identification mark 412 is for identifying the land track 403 from the groove track 402 and identifying the land track 402 from the groove track 403, both of which have the same address block 411, and is disposed in the center of either track (i.e., 408 or 410). Herein, the track identification mark 412 is

provided on the track center **408** of the groove track **403**.

As a result, the track identification mark **412** is reproduced when reproducing data in the groove track **403**, and the track identification mark **412** is not reproduced when reproducing data in the land track **402**. Although the tracks **402** and **403** have the same address block **411**, it is possible to identify whether a currently reproduced track is a land track or a groove track depending on whether or not the track identification mark **412** is subsequently reproduced.

In Figure **27**, the track identification mark **412** is located after the address block **411**, so as to be more easily and accurately detected in accordance with a gate pulse signal generated based on the address block **411**. In other words, it is ensured that the track identification mark **412** is reproduced after the address block **411** in the reproduced signal.

Since the reproduced signal differs depending on the track as described above, it is possible to identify the land track **402** from the groove track **403** based on the reproduced signal alone. Therefore, irrespective of the correspondence between groove configurations and tracking polarities, recording or reproduction can be performed for a desired track by only using the reproduced signal.

Although the track identification mark **412** is recorded on the groove track **403** in the above example, it will be appreciated that the same effect can also be attained by recording the track identification mark **412** on the land track **402**.

Figure 28 is a diagram showing the configuration of an optical disk recording/reproduction device according to another example of the present invention. The optical disk recording/reproduction device shown in Figure 28 records or reproduces information on the optical disk shown in Figure 27. In the following description, a CPU 601 will be described as a track designation means, and a track identification mark reproduction circuit 604 will be described as a track identification mark reproducing means.

In Figure 28, the circuitry shown by 601 and 605 to 612 perform the same operation as that described in Example 1.

An ID reproduction circuit 602 is composed of an address reproduction circuit 603 for reproducing an address block 411 based on a signal digitalized by a digitalization circuit 605 and the track identification mark reproduction circuit 604 for reproducing a track identification mark 412.

Figure 29 is a diagram showing the configuration of the track identification mark reproduction circuit 604 for reproducing the track identification mark 412 from an optical disk having address regions shown in Figure 27. Reference numeral 701 denotes a flip-flop, and 702 denotes a delay element. Signal b is a track identification signal. Signal c is a reproduced signal which has been digitalized. Signal d is a gate pulse signal based on a reproduced address.

Each logical address for identifying a data

region is expressed by an address which is common to the land track **402** and the groove track **403** (reproduced by the address reproduction circuit **603**) and a 1-bit track identification mark for identifying the land track **402** from the groove track **403**.

Figure **29** shows the track identification mark reproduction circuit **604** in the case where the track identification mark **412** is composed of 1 bit. The track identification mark reproduction circuit **604** is composed of the flip-flop **701** and the delay element **702** so that the address detection signal **d** representing that the previous address has been successfully reproduced is delayed by a predetermined amount of time by the delay element **702** and the reproduced signal **c** is taken into the flip-flop **701** during the gate period thereof. In accordance with this circuit, the track identification mark **412** (composed of 1 bit) is reproduced after a predetermined amount of time from the reproduction of the address. Herein, the most significant bit of the logical address is obtained based on whether or not the track identification mark **412** is present. In the case where the reproduced track identification mark **412** is composed of a plurality of bits, a track identification signal can be generated by comparison with a predetermined mark representing the land track **402** or the groove track **403**, the signal being utilized as the most significant bit of the address.

The data reproduction circuit **612** compares the address reproduced by the ID reproduction circuit **602** and the address supplied from the CPU **601**, and, if the addresses match, reproduces data after a predetermined

period of time from the reproduction of the address.

Finally, if the reproduced address is determined to be different from the address supplied from the CPU **601**, the target track is sought again. Herein, if only the most significant bit of these addresses are different, a half-track jump is made, and the track selection signal, which selects the tracking polarity, is inverted. In the above-described example, the case where only the most significant of the addresses are different corresponds to a case in which the addresses common to the land track and the groove track match but either a land track or a groove track is wrongly selected. In order to correct this situation, the tracking selection signal is inverted, so that the tracking polarity is switched.

When reproducing the data in a groove track of the optical disk shown in Figure **27** by the above apparatus, the laser light scans approximately the center **408** of that groove track, and the address block **411** and the track identification mark **412** are reproduced. On the other hand, when reproducing the data in a land track, the laser light scans approximately the center **410** of that land track, and only the address is reproduced. Thus, the reproduced signal in the address region differs depending on the reproduced track. As a result, it becomes possible to identify the land track **402** and the groove track **403** based on the reproduced signal only. Therefore, irrespective of the correspondence between groove configurations and tracking polarities, recording or reproduction can be performed for a desired track by only using the reproduced signal.

In accordance with the above-described optical disk recording/reproduction device, the tracking polarity can be automatically switched based on the reproduced signal in relation to the track identification mark. Therefore, it is possible to perform one, common type of tracking regardless of the characteristics of the disk and the optical disk recording/reproduction device. As a result, compatibility among optical disks in which information is recorded on both land tracks and groove tracks can be improved.

(Example 14)

Figure 30 shows address regions 405 of still another example of an optical disk according to the present invention. The present example is characterized in that track identification marks 1101a, 1101b, 1101c, 1102a, 1102b, and 1102c are provided, as well as address blocks 411a, 411b, and 411c, in the address regions 405 of the optical disk.

The address regions 405 shown in Figure 30 are formed in accordance with the CAV or ZCAV (ZCLV) format, in which the address regions of adjoining tracks are aligned along the radius direction of the disk. The address blocks 411a and 411b for identifying subsequent data regions are provided in the address regions 405. The address block 411b is provided so as to be centered around a boundary line 409 between a groove track 403b and a land track 402b, the address block 411b being on both the groove track 403b and the land track 402b; different addresses are provided for different address regions. Since the address block 411b is located in the middle of the groove track 403b and the land track 403b,

the same address block **411b** is provided for the data regions **406** of the groove track **403b** and the land track **402b** adjoining each other in this disk. The two track identification marks **1101b** and **1102b** are formed so as to be shifted toward the outer periphery and the inner periphery, respectively, from the center **408** of the groove track **403b** by about 1/2 of the track width. Herein, it is assumed that the two track identification marks **1101b** and **1102b**, present in the same address region **405**, have the same value. Moreover, the two track identification marks are disposed in sequential positions along the track direction so that they will be sequentially reproduced. Similarly, two track identification marks **1101a**, **1102a**, **1101c**, and **1102c** are similarly provided for groove tracks **403a** and **403c** located on the inner periphery side and the outer periphery side of the groove track **403b**. Herein, the two track identification marks present in a given address region **405** are assigned with a value different from that of the track identification marks in an adjoining address region **405**. For example, the same mark 1 (indicated by oblique lines descending toward left in Figure **30**) is employed for the track identification marks **1101a** and **1102a**, **1101c**, and **1102c** on the groove tracks **403a** and **403c**, but mark 2 (indicated by oblique lines descending toward right in Figure **30**), which is different from mark 1, is employed for the track identification marks **1101b** and **1102b** on the adjoining groove track **403b**. Herein, it is assumed that the track identification marks are each formed as data of 1 bit (i.e., 0 or 1), and that pits alternately representing 0 and 1 are provided for adjoining address regions along the radius direction. Specifically, a pit of 1 bit is provided, as the track identification

marks **1101b** and **1102b**, for the groove track **403b**; however, no pits are provided, as the track identification marks **1101a** and **1102c**, for the groove tracks adjoining the groove track on the inner periphery side and the outer periphery side. In the optical disk **401** shown in Figure **30**, the track identification marks **1101** and **1102** are all located after the address blocks **411**, so as to be more easily and accurately detected in accordance with a gate pulse signal generated based on the address blocks **411**. In other words, it is ensured that the track identification marks **1101** and **1102** are reproduced after the address blocks **411** in the reproduced signal.

As a result, the two track identification marks having the same value (i.e., **1101b** and **1102b**) in the address regions **405** are reproduced when reproducing data in the groove track **403b**, and the track identification marks having different values (i.e., **1101b** and **1102c**) in the address regions **405** are reproduced when reproducing data in the land track **402b**. Although the tracks **403b** and **402b** have the same address block **411b**, it is possible to identify whether a currently reproduced track is a land track or a groove track depending on whether the subsequently reproduced track identification mark matches or not.

Figure **30** describes a disk in which the first track identification marks **1101a**, **1101b**, and **1101c** are disposed on the boundary line **409** between the groove track **403b** and the land track **402b** adjoining the outer periphery of the groove track **403b** and the second track identification marks **1102a**, **1102b**, and **1102c** are disposed on the boundary line **407** between the groove track **403b**

and the land track **402a** adjoining the inner periphery of the groove track **403b**. However, the same effect can be attained by a disk in which the first track identification marks are disposed on the boundary line **407** between the groove track **403b** and the land track **402a** adjoining the inner periphery of the groove track **403b** and the second track identification marks are disposed on the boundary line **409** between the groove track **403b** and the land track **402b** adjoining the outer periphery of the groove track **403b**.

A case was described in which two track identification marks provided in the address region on a groove track have the same value, but the same effect can be attained in the case where two track identification marks provided in the address region on a land track have the same value.

Figure **31** is a diagram showing the configuration of an optical disk recording/reproduction device according to another example of the present invention. The optical disk recording/reproduction device of the present example records or reproduces information on the optical disk shown in Figure **30**. In the following description, a CPU **601** will be described as a track designation means; a track identification mark reproduction circuit **1201** will be described as a track identification mark reproduction means; and a track identification circuit **1202** will be described as a track identification means.

In Figure **31**, the circuitry shown by **601** and **605** to **612** perform the same operation as that described in Example 1.

An ID reproduction circuit **602** is composed of an address reproduction circuit **603** for reproducing information in an address block **411** based on a signal digitalized by a digitalization circuit **605**, the track identification mark reproduction circuit **1201** for reproducing the track identification marks **1101** and **1102**, and the track identification circuit **1202** for identifying the land track **402** from the groove track **403**.

Figure **32** is a diagram showing the configuration of the track identification mark reproduction circuit **1201** for reproducing the track identification marks **1101** and **1102** from the optical disk **401** shown in Figure **30**. Reference numeral **1701** denotes a flip-flop; **1302**, **1303**, **1304**, and **1305** each denote a delay element.

Figure **33** is a diagram showing the configuration of the track identification circuit **1202** for generating track identification signal **b** from the two track identification marks **1101** and **1102** reproduced from the optical disk **401** shown in Figure **30**. Reference numeral **1401** denotes a flip-flop for retaining the value of the first track identification mark **1101** composed of 1 bit; **1402** denotes a flip-flop for retaining the value of the second track identification mark **1102** composed of 1 bit; **1403** denotes a comparator for comparing the two track identification marks; and **1404** denotes a flip-flop for retaining the value of a track identification signal. Gate pulse signals for taking in the two track identification marks **1101** and **1102** and a gate pulse signal for taking in the comparison result of the two track identification marks **1101** and **1102** are generated by delaying an address

detection signal **d** at **1405**, **1406**, and **1407** by predetermined time periods.

Each logical address for identifying a data region is expressed by an address which is common to the land track **402** and the groove track **403** (reproduced by the address reproduction circuit **603**) and a 1-bit track identification signal **b** for identifying the land track **402** from the groove track **403** (e.g., the most significant 1 bit).

Figure **32** shows the track identification mark reproduction circuit **1201** in the case where the track identification marks **1101** and **1102** are each composed of 1 bit. The track identification mark reproduction circuit **1201** is composed of the flip-flop **1301** and the delay elements **1302** and **1303** so that the address detection signal **d** is delayed by predetermined amounts of time by means of the delay elements **1702** and **1703** and the digitalized reproduced signal **c** is taken into the flip-flop **1701** during the periods of the gate pulse signal. In accordance with this circuit, the two track identification marks **1101** and **1102** composed of 1 bit are reproduced after predetermined amounts of time from the reproduction of the address.

The track identification circuit **1202** shown in Figure **33** is composed of the three flip-flops **1401**, **1402**, and **1404**, the comparator **1403**, and delay elements **1405**, **1406**, and **1407**. The first track identification mark reproduced by the track identification mark reproduction circuit **1201** is taken into the flip-flop **1401**. The second track identification mark is taken into the flip-

flop **1402**. The two track identification marks are compared by the comparator **1403**, in accordance with gate pulse signals obtained by delaying the address detection signal **d** by predetermined time periods by means of the delay elements **1405**, **1406**, and **1407**, respectively, the comparison result being retained in the flip-flop **1404**. Specifically, the gate pulse signals obtained by delaying the address detection signal **d** by predetermined time periods by means of the delay elements **1405**, **1406**, and **1407**, respectively, are applied to the clock terminals of the flip-flops **1401**, **1402**, and **1404**. The above circuitry generates a track identification signal which identifies a currently reproduced track to be a groove track when the two track identification marks match or a land track when the two track identification marks do not match. The track identification signal defines the most significant bit of the address of each data region.

When reproducing the information in the address regions of the optical disk shown in Figure **30** by using the above apparatus, the laser light scans approximately the center **408** of the groove track **403b**, so that the address block **411b** and the track identification marks **1101b** and **1102b** having the same value is reproduced. On the other hand, the laser light scans approximately the center **410** of the land track **402b**, so that the address block **411b** and the track identification marks **1101b** and **1102c** having different values are reproduced. Thus, the reproduced signal for the reproduced track identification mark differs depending on the track. As a result, it becomes possible to identify the currently reproduced track to be either the land track **402** or the groove track **403** based on the reproduced signal only.

Therefore, irrespective of the correspondence between groove configurations (i.e., groove track or land track) and tracking, recording or reproduction can be performed for a desired track by only using the reproduced signal.

In accordance with the above-described optical disk recording/reproduction device, the tracking polarity can be automatically switched based on the reproduced signal in relation to the two track identification marks. Therefore, it is possible to perform one, common type of tracking regardless of the characteristics of the disk and the optical disk recording/reproduction device. As a result, compatibility among optical disks in which information is recorded on both land tracks and groove tracks can be improved.

(Example 15)

Another example of an optical disk according to the present invention will be described.

Figure 34 shows address regions 405 and a control information region 1502 of the optical disk according to the present example. In Figure 34, 402 denotes a land track; 403f denotes a groove track; 405 denotes address regions; 411 denotes an address block; and 1501 denotes a track identification mark.

The address block 411 provided in the address regions 405 is recorded so as to be centered around a boundary line 409 between a groove track 403 and a land track 402, the address block 411 being on both the groove track 403 and the land track 402, and it a different

address is provided in every address region. The data regions of the adjoining land track **402** and groove track **403** are to be identified by the same address block **411**. The track identification mark **1501** is provided in a specific position of the predetermined control information region **1502** of either the land track **402** or the groove track **403**, so as to be on a track center **408** or **410**. The track identification mark **1501** is for identifying whether the track on which the track identification mark **1501** is provided is the land track **402** or the groove track **403**, and differs depending on whether it is provided on a land track or a groove track. Herein, the track identification mark **1501** is composed of 1 bit.

As a result, if a track identification mark representing a groove track is reproduced in a currently reproduced track, it is known that the polarity of the currently performed tracking is intended for reproducing data in a groove track. If a track identification mark representing a land track is reproduced, it is known that the polarity of the currently performed tracking is intended for reproducing data in a land track. Thus, by reproducing the track identification mark **1501** from the reproduced signal only and detecting its pattern, the correspondence between the groove configuration of the currently reproduced track and a tracking polarity can be obtained.

In the optical disk **401** shown in Figure **34**, the track identification mark **1501** is located in the data region **406** after the address block **411**, so as to be more easily and accurately detected in accordance with a gate

pulse signal generated based on the address blocks **411**. In other words, it is ensured that the track identification mark **1501** is reproduced after the address blocks **411** in the reproduced signal. It will be appreciated that, although the track identification mark **1501** is recorded in a data region on the groove track **403** in Figure **34**, the same effect can be expected by recording the track identification mark **1501** in a data region on the land track **402**.

(Example 16)

Figure **35** is a diagram showing the configuration of an optical disk recording/reproduction device according to still another example of the present invention. The optical disk recording/reproduction device shown in Figure **35** records or reproduces information on the optical disk shown in Figure **34**. In the following description, a CPU **601** will be described as a track designation means; a track polarity determination circuit **1601** will be described as a track polarity determination means; and a track selection signal correction circuit **1602** will be described as a track selection signal correction means.

In Figure **35**, elements **601** and **605** to **612** perform the same operation as that described in Example 1.

When reproducing data in a track in which a control information region **1502** is provided, the track polarity determination circuit **1601** identifies the currently reproduced track to be either a land track or a groove track by extracting a track identification mark **1501** from the reproduced signal from a data

reproduction circuit **612**. The track polarity determination circuit **1601** determines whether or not selection of a track is correctly performed by obtaining the correspondence between the designated track selection signal and the groove configuration (i.e., land or groove) of the track, and generates a tracking determination signal. The track selection signal correction circuit **1602** corrects the track selection signal from the CPU **601** depending on whether the tracking selection, as derived from the track polarity determination circuit **1601**, is correct or not.

Figure **36** is a diagram showing an exemplary configuration of the track polarity determination circuit **1601** for determining whether or not tracking selection is correctly performed based on a track identification mark **1501** (reproduced signal **h**) in the control information region **1502** of the optical disk shown in Figure **34** and a track selection signal **i** from the CPU **601**. Reference numeral **1701** denotes an exclusive OR gate; **1702** denotes a flip-flop; and **1703** denotes a delay element.

Figure **37** is a diagram showing an exemplary configuration of the track selection signal correction circuit **1602** for correcting the track selection signal **i** from the CPU **201** based on the track selection determination signal **g**, which is a result derived from the track polarity determination circuit **1601** indicating whether the tracking selection is correct or not. Reference numeral **1801** denotes an exclusive OR gate.

An operation which is performed when an optical disk is mounted in the optical disk record-

ing/reproduction device having the above-described configuration will be described below.

When an optical disk is mounted, the recording/reproduction device reproduces a control information region **1502** of a particular track on which the track identification mark **1501** is provided. At this time, the CPU **601** outputs a track polarity identification signal **k** to the track polarity determination circuit **1601**. When the logical address of a track including a control information region **1502** in which the track identification mark **1501** is provided is supplied to the CPU **601**, the CPU **601** issues a command for a linear motor control circuit **607** to seek for a target track, and drives a linear motor **609** so as to move an optical head **610** to the vicinity of the target track. Next, the CPU **601** outputs a track jump command and the track selection signal **i**, which is in accordance with whether the track is a land track or a groove track, to a focus/tracking control circuit **608** so as to arrive at the target track. When the track selection instruction is supplied, the focus/tracking control circuit **608** conducts a half-track jump by switching the tracking control polarity, whereby focusing and tracking for the target track are attained.

It is assumed that the logical address for identifying a data region is represented by an address common to the land track **402** and the groove track **403** (reproduced by an address reproduction circuit **603**) and a track selection signal composed of 1 bit for identifying a groove track from a land track (e.g., the most significant 1 bit).

The data reproduction circuit **612** compares the address reproduced by the ID reproduction circuit **602** and the address supplied from the CPU **601** and, if the addresses match, reproduces data after a predetermined period of time from the reproduction of the address. When a disk has been mounted, the control information region **1502** of a track which is provided with the track identification mark **1501** is reproduced.

Figure **36** shows the track polarity determination circuit **1601** in the case where the track identification mark **1501** is composed of 1 bit. For example, when the track identification mark **1501** (reproduced signal **h**) indicates "1", the track identification mark **1501** is recorded on the groove track **402**, and when the track identification mark **1501** indicates "0", the track identification mark **1501** is recorded on the land track **402**. When the CPU **601** selects the groove track **403**, "1" is output as the track selection signal **i**, and "0" is output when the land track **402** is desired to be selected. The exclusive OR gate **1701** shown in Figure **36** detects a track selection error when the track selection signal **i** is different from the reproduced track identification mark **1501** (reproduced signal **h**). In other words, the track selection is wrong when it is determined based on the track identification mark **1501** that a land track is actually being tracked (i.e., when the track identification mark is "0") although a groove track is being selected (i.e., the track identification mark is "1") by the track selection signal **i**. By taking an exclusive OR of the two signals, such an error is detected. The track polarity determination signal **k** from the CPU **601** and the address detection signal **d** from the

address reproduction circuit **603** are used as gate pulse signals for taking into the flip-flop **1702** a determination result as to whether or not the track selection is correct. The delay element **1703** delays the address detection signal **d** by a predetermined amount of time in order to generate the gate pulse signal used for taking in the signal indicating whether or not the track selection is correct.

The track selection signal correction circuit **1602** in Figure **37** performs a correction based on the track polarity determination signal **g** in the case where the wrong tracking is being performed as known by the track selection signal **i**. When the wrong track is being selected, "1" appears in the track polarity determination signal; in such cases, the track selection signal **i** is inverted and supplied to the focus/tracking control circuit **608**. This inversion operation is performed by the exclusive OR gate **1801** in Figure **37**. Since the data in a track in which the track identification mark **1501** is provided is reproduced when a disk is mounted or when the drive is activated, and since the matching/mismatching of the track selection signal from the CPU **601** and the tracking polarity is stored in the flip-flop **1702** in the track polarity determination circuit **1601**, a correction based on the track polarity determination signal **g** is performed for the tracking selection in the subsequent reproduction/recording of data. As a result, correct tracking is always performed.

Therefore, in an optical disk in which at least one track identification mark **1501** is provided in the control information regions **1502** as shown in Figure **34**,

the correspondence between the respective polarities of groove tracks and land tracks and the track selection signal output from the CPU **601** is previously obtained, so that recording or reproduction can be performed for a desired track irrespective of the correspondence between groove configurations and tracking polarities. Moreover, since correction of tracking polarities is possible by providing a track identification mark **1501** in only one track, a larger recording capacitance can be obtained than in the case where a track identification mark is provided in every address region.

In accordance with the above-described optical disk recording/reproduction device, the tracking polarity can be automatically switched based on the reproduced signal in relation to the track identification marks. Therefore, it is possible to perform one, common type of tracking regardless of the characteristics of the disk and the optical disk recording/reproduction device. As a result, compatibility among optical disks in which information is recorded on both land tracks and groove tracks can be improved.

It will be appreciated that all of the above Examples can also be applied to phase change type optical disks or magneto-optical disks.

Although optical disks having two or four address blocks in each sector address region were described in the above-described examples, the number of address blocks in each sector address region can be increased to three, or five or more to improve the address reading accuracy and determination accuracy of land/groove.

INDUSTRIAL APPLICABILITY

Thus, in accordance with the present invention, a plurality of address blocks are provided within one sector address region of an optical disk which allows recording/reproduction on both land tracks and groove tracks, the address blocks being disposed so as to alternately wobble with respect to the center of each track along the radius direction, i.e., toward the inner periphery side or the outer periphery side. As a result, sector addresses can be securely read even when the light spot is off-tracked, and the disturbance in the tracking control due to level shifts of the tracking error signal in the sector address regions can be reduced. Thus, an optical disk which is unlikely to cause reading errors of address signals can be provided.

Moreover, in accordance with an optical disk recording/reproduction device employing the above optical disk, when information in wobbling address blocks is reproduced, the read-out address numbers are corrected in accordance with the overlapping sequential number (ID number), depending on whether the track is a land track or a groove track. As a result, a different address number can be read for each address block in one sector address, whereby an accurate address value can be obtained.

Moreover, in accordance with an optical disk recording/reproduction device employing the above optical disk, when data in wobbling address blocks is reproduced, it is determined whether or not the address numbers for the respective overlapping sequential numbers of the address blocks on the inner periphery side match the

address numbers for the respective overlapping sequential numbers of the address blocks on the outer periphery side. As a result, it becomes possible to identify the current track to be either a land track or a groove track.

Furthermore, by detecting a difference between a tracking error signal or a reflected light amount signal in the address blocks on the inner periphery side and a tracking error signal or a reflected light amount signal in the address blocks on the outer periphery side, the true off-tracking amount between the light spot and the track can be detected. By correcting for a tracking error signal by using this off-tracking amount, a tracking control system is realized such that the light spot can be always positioned in a track center.

Furthermore, since a tracking signal offset is symmetrically generated while the laser light spot passes through addresses, the tracking during the address reproduction becomes stable.

CLAIMS

1. An optical disk comprising a first track having a spiral shape and a second track having a spiral shape, the first track and the second track adjoining each other, and information being recorded on or reproduced from the first track and the second track,

wherein the optical disk comprises an address region including:

a first address block formed so as to be on both the first track and the second track adjoining the first track on an inner periphery side, and

a second address block formed so as to be on both the first track and the second track adjoining the first track on an outer periphery side.

2. An optical disk of a land/groove recording/reproduction type comprising a plurality of sectors having a sector address region and a data region,

wherein the sector address region includes a plurality of address blocks, at least two of the plurality of address blocks that adjoin each other along a circumference direction being disposed so as to be shifted toward opposite sides with respect to a track center, and

each of the plurality of address blocks includes within the sector address region a portion indicating an address number for identifying the plurality of sectors from one another and a portion indicating an ID number for identifying the plurality of address blocks from one another.

3. An optical disk according to claim 2, wherein the at least two address blocks that adjoin each other are

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located so as to be shifted from the track center, toward an inner periphery side or an outer periphery side, by about a half of a track pitch along a radius direction.

4. An optical disk according to claim 2, wherein the portion indicating the address number has a data pattern which is common to the plurality of address blocks within the same sector address region.

5. An optical disk according to claim 2, wherein each of the plurality of address blocks has non-pit data in a beginning portion and an end portion thereof.

6. An optical disk according to claim 5, wherein the length of the non-pit data is larger than a disk rotation accuracy of a laser cutting process in the production of a master disk.

7. An optical disk according to claim 2, wherein the first one of the plurality of address blocks includes a reproduction clock synchronization signal portion which is longer than a reproduction clock synchronization signal portion of any other address block.

8. An optical disk according to claim 2, wherein the sector address region includes a block composed of information not related to the identification of the address numbers, and

the block is disposed so as to be shifted from the track center, toward an inner periphery side or an outer periphery side, by about a half of a track pitch along a radius direction.

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9. An optical disk according to claim 2, wherein an interspace is provided, along the circumference direction, between the at least two address blocks that adjoin each other.

10. An optical disk according to claim 2, wherein, in the sector address region, the address blocks are located along the circumference direction in such a manner that phases of pit patterns constituting the address blocks match each other on both sides of one track.

11. An optical disk recording/reproduction device for an optical disk of a land/groove recording/reproduction type including a plurality of sectors having a sector address region and a data region,

wherein the sector address region of the optical disk includes a plurality of address blocks, at least two of the plurality of address blocks that adjoin each other along a circumference direction being disposed so as to be shifted toward opposite sides with respect to a track center, and each of the plurality of address blocks includes a portion indicating an address number for identifying the plurality of sectors from one another and a portion indicating an ID number for identifying the plurality of address blocks from one another within the sector address region, and

wherein the recording/reproduction device comprises:

an optical head for radiating a light beam on the optical disk and receiving light reflected from the optical disk so as to output a reproduced signal, and

an address signal reproduction section for reading the address number and the ID number when reproducing the sector address of the optical disk.

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12. An optical disk recording/reproduction device according to claim 11 further comprising an address correction section for correcting the address number which is read from each address block in accordance with the ID number by employing a signal indicating land reproduction or groove reproduction.

13. An optical disk recording/reproduction device according to claim 11 further comprising:

a memory for storing the address number read by the address signal reproduction section as associated with the ID number read by the address signal reproduction section,

a comparator for comparing two or more address numbers respectively associated with two or more specific ID numbers against each other so as to detect whether or not the two or more address numbers match each other, and

a judgment section for determining whether a track on which the light beam for reproduction is a land track or a groove track based on an output of the comparator.

14. An optical disk recording/reproduction device according to claim 11 further comprising a tracking error signal detection section for detecting a tracking error signal indicating a locational offset amount between a track and a light spot,

a timing generation section for generating a gate pulse signal synchronized with each address block of the sector address region,

an outer periphery value sample/hold section for sampling and holding the levels of the tracking error signals for the address blocks disposed on an outer

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periphery side in synchronization with the gate pulse signal,

an inner periphery value sample/hold section for sampling and holding the levels of the tracking error signals for the address blocks disposed on an inner periphery side in synchronization with the gate pulse signal,

a differential circuit for obtaining a difference between a value in the outer periphery value sample/hold section and a value in the inner periphery value sample/hold section,

a gain conversion section for converting an output of the differential circuit into a signal having a predetermined level, and

a tracking offset correction circuit for performing a tracking correction using an output from the gain conversion section.

15. An optical disk recording/reproduction device according to claim 11 further comprising:

a reflected light amount signal detection section for detecting the amount of reflected light from the optical disk,

a timing generation section for generating a gate pulse signal synchronized with each address block of the sector address region,

an outer periphery value sample/hold section for sampling and holding the signal levels of the reflected light for the address blocks disposed on an outer periphery side in synchronization with the gate pulse signal,

an inner periphery value sample/hold section for sampling and holding the signal levels of the reflected light for the address blocks disposed on an inner periph-

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ery side in synchronization with the gate pulse signal,

a differential circuit for obtaining a difference between a value held in the outer periphery value sample/hold section and a value held in the inner periphery value sample/hold section,

a gain conversion section for converting an output of the differential circuit into a signal having a predetermined level, and

a tracking offset correction circuit for performing a tracking correction using an output from the gain conversion section.

16. An optical disk comprising a first track having a spiral shape and a second track having a spiral shape, the first track and the second track adjoining each other, and information being recorded on or reproduced from the first track and the second track,

wherein the optical disk comprises:

an address block formed so as to be on both the first track and the second track, and

a track identification mark formed on either the first track or the second track.

17. An optical disk according to claim 1, wherein the address regions are located in accordance with a CAV format or a ZCAV (ZCLV) format.

18. An optical disk comprising a first track having a spiral shape and a second track having a spiral shape, the first track and the second track adjoining each other, and information being recorded on or reproduced from the first track and the second track,

wherein the optical disk comprises an address region

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including:

an address block formed so as to be on both the first track and the second track, and

a first track identification mark formed so as to be on both the first track and the second track adjoining the first track on an inner periphery side, and

a second track identification mark formed so as to be on both the first track and the second track adjoining the first track on an outer periphery side,

wherein the first track identification mark and the second track identification mark are identical.

19. An optical disk comprising a first track having a spiral shape and a second track having a spiral shape, the first track and the second track adjoining each other, and information being recorded on or reproduced from the first track and the second track,

wherein the optical disk comprises an address region including:

an address block formed so as to be on both the first track and the second track, and

a track identification mark formed in a control information region of either the first track or the second track.

20. An optical disk recording/reproduction device capable of recording information on and reproducing information from the optical disk according to claim 16, the optical disk recording/reproduction device comprising:

track designation means for selecting the first track or the second track for which information is to be recorded, and

track identification mark reproduction means for

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reading a track identification mark,

wherein the track identification mark reproduction means reads the track identification mark of a currently reproduced track and identifies the currently reproduced track to be either the first track or the second track depending on whether or not the track identification mark is present, so as to output a track identification signal, and

the track designation means switches between selecting the first track and selecting the second track in accordance with the track identification signal.

21. An optical disk recording/reproduction device capable of recording information on and reproducing information from the optical disk according to claim 1, the optical disk recording/reproduction device comprising:

track designation means for selecting the first track or the second track for which information is to be recorded,

address reproduction means for reading the first address block and the second address block formed so as to be on the first track and the second track adjoining the first track, and

track identification means for identifying a currently reproduced track to be either the first track or the second track based on the first address block and the second address block reproduced by the address reproduction means,

wherein the track identification means identifies the currently reproduced track to be either the first track or the second track based on a difference between the two addresses reproduced by the address reproduction means, so as to output a track identification signal, and

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the track designation means switches between selecting the first track and selecting the second track in accordance with the track identification signal.

22. An optical disk recording/reproduction device capable of recording information on and reproducing information from the optical disk according to claim 18, the optical disk recording/reproduction device comprising:

track designation means for selecting the first track or the second track for which information is to be recorded,

track identification mark reproduction means for reading a track identification mark formed so as to be on both the first track and the second track adjoining the first track, and

track identification means for identifying a currently reproduced track to be either the first track or the second track based on two track identification marks reproduced by the track identification mark reproduction means,

wherein the track identification means identifies the currently reproduced track to be either the first track or the second track based on a difference between the two track identification marks reproduced by the track identification mark reproduction means, so as to output a track identification signal, and

the track designation means switches between selecting the first track and selecting the second track in accordance with the track identification signal.

23. An optical disk recording/reproduction device capable of recording information on and reproducing information from the optical disk according to claim 19, the optical

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disk recording/reproduction device comprising:

track designation means for selecting the first track or the second track for which information is to be recorded,

data reproduction means for reading a track identification mark provided in the control information region,

track polarity determination means for determining the polarity of a reproduced track, and

track selection signal correction means for correcting a track selection signal from the track designation means,

wherein the data reproduction means reproduces the track identification mark in the control information region when the reproduction of the optical disk is started, the track polarity determination means determines whether the selection of tracks is correct or not based on the track identification mark of the reproduced track and the track selection signal from the track designation means so as to output a track polarity determination signal, and the track selection signal correction means corrects the track selection signal from the track designation means based on the track polarity determination signal so as to select the first track or the second track.

24. An optical disk recording/reproduction device according to claim 13 further comprising an address correction section for correcting the address number stored in the memory in accordance with the ID number.

25. A method for identifying a track on an optical disk according to claim 1, wherein a plurality of address

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blocks provided within one address region are read in order to detect whether or not at least two address blocks match each other, thereby identifying a currently reproduced track to be either the first track or the second track.

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