Description

BACKGROUND OF THE INVENTION

This invention relates to optical recording and reproducing device for recording information on and reproducing it from an optical disk, and more particularly to optical heads thereof provided with a servo mechanism for correcting the tilting of the optical axis of the light beam with respect to the recording surface of the optical disk.

Optical disk recording and reproducing devices are now widely used as information storage. In such devices, information is stored on spiral tracks formed on an optical disk, and is recorded and read by a laser light beam focused on the disk by an optical head. In order to ensure that the light beam is converged correctly on the track, the optical heads must be provided with servo mechanisms for correcting the focusing and tracking errors thereof. Further, they must be provided with a tilt servo mechanism; namely, if the optical axis of the light beam radiated from the optical head is not at right angles with the information recording surface of the optical disk, an aberration called coma may result, which may occasion crosstalk between the adjacent tracks; in order to prevent comas, the optical heads must be provided with a servo mechanism for correcting the tilting of the light beam from the direction at right angles with the recording surface of the optical disk.

Referring now to Figs. 1 through 7, let us describe in some detail the structure and operation of an optical head provided with a conventional servo mechanism for correcting the tilting of the light beam as well as those for correcting the focusing and tracking errors.

Fig. 1 shows an overall organization of an optical head device of an optical disk recording and reproducing device; the optical head device utilizes the twin spot method and the astigmatic method (described below) for detecting the tracking and the focusing error, respectively. A laser diode 1 constitutes a light source for emitting a divergent pencil of rays 2. The emitted pencil of rays 2 is separated by a diffraction grating 3 into three pencils of rays 2a, which are reflected by a beam splitter 4, collimated into parallel pencils of rays 2b by a collimating lens 7, and converged by a converging lens 5 at spots 9a, 9e, and 9f, respectively, along a track 8 on an optical disk 6. The disk 6 is rotated by a motor 60 and comprises a transparent substrate 6a and a recording surface 6b on which information recording tracks 8, 8a and 8b are formed. The rays of light reflected at the spots 9a, 9e and 9f along the track 8 are directed via the converging lens 5 and collimating lens 7 to the beam splitter 4 to be separated from the emitting pencils of rays 2b and to fall upon a photodetector 10 as three reflected pencils of rays 2c. The beam splitter 4 comprises, in addition to a partially silvered surface for separating the reflected rays 2c from the emitted pencil of rays 2a, a grating whose grating interval varies gradually within the opening thereof so as to give an astigmatic abberation (astigmatism) to the reflected rays 2c that are diffracted light of first order.

Fig. 2 shows a vertical section of the converging lens 5. As shown in the figure, the converging lens 5 comprises a lens portion 5a for converging the emitted and reflected pencils of rays 2b and 2c, a flange portion 5b for supporting the converging lens portion 5a, and an attachment portion 5c for mounting the lens portion 5a to actuators 5d and 5e (described below) via the flange portion 5b. These portions 5a through 5c of the converging lens 5 are formed as a single integral piece.

By the way, Fig. 3 shows a slightly modified organization of an optical head device wherein the collimator lens 7 of the device of Fig. 1 is not utilized; otherwise, the optical disk device of Fig. 3 is similar to that of Fig. 1 both in its organization and method of operation, wherein like reference numerals represent like or corresponding parts.

As shown in Fig. 4, the photodetector 10 comprises a central portion partitioned into four cells A through D, and a pair of lateral cells E and F; the central pencil in the emitted rays 2b which falls on and reflected at the information reading spot 9a on the track 8 falls, after passing through the converging lens 5, the collimating lens 7, and the beam splitter 4, on the central portion consisting of cells A through D as the central information carrying pencil of rays 20a (shown by a shaded circle in the figure), while the lateral pencils in the emitted rays 2b falling on and reflected at the spots 9e and 9f falls, after passing through the converging lens 5, the collimating lens 7, and the beam splitter 4, on the lateral cells E and F as the pencils of rays 20e and 20f for determining the tracking error. The tracking and focusing errors are adjusted by the tracking actuator 5e and the focusing actuator 5d, respectively, in response to the signals generated by the circuit shown in Fig. 4, on the principles of the twin spot method and the astigmatic aberration method, respectively, as described below.

The tracking error may be caused by the fact that the center of the optical disk 6 is deviated from the center of rotation of the motor 60 due to the mounting error, etc.; such tracking error is detected and adjusted by the twin spot method as follows:

The pencil of rays 2 emitted from the laser diode 1 is separated by the diffraction grating 3 into three pencils of rays (i.e. a central pencil and a pair of lateral pencils of rays) which are converged on spots 9a, 9e and 9f along an information recording track 8 as described above. Since the information is carried by the central pencil of rays 20a reflected from the central light spot 9a, the spot 9a should be positioned precisely on the track 8; thus, the line connecting the

converging light spots 9a, 9e and 9f is slightly inclined with respect to the direction of the track 8. The pencils of rays reflected diffusively at spots 9e and 9f are converged via the converging lens 5, the collimating lens 7 (which is omitted in the case of the device of Fig. 3), and the beam splitter 4, on the cells E and F of the photodetector 10, as lateral pencils of rays 20e and 20f. The subtractor 13 calculates the difference between the outputs of the two lateral photodetector cells E and F, and the phase compensation circuit 14 outputs in response to the differential output of the subtractor 13 a tracking error signal V_{AT} coresponding to the tracking error, i.e. the deviation of the information reading spot 9a from the track 8 in the direction X perpendicular to the direction Y of the track 8. In response to the tracking error signal V_{AT}, the tracking actuator 5e adjusts the position of the converging lens 5 in the direction X perpendicular to the track direction Y (as indicated by arrows AT in Fig. 3), so as to position the information reading spot 9a correctly on the center of the track 8.

On the other hand, the focusing error may be caused by the fact that the surface of the optical disk 6 is uneven, which may result in an undulating motion of the surface when the disk is rotated. The focusing error is detected and adjusted by the astigmatic method as follows:

As described above, the beam splitter 4 gives an astigmatism to the central pencil of rays 20a reflected from the information reading spot 9a. The photodetector 10 is positioned, in the direction Z perpendicular to the surface of the optical disk 6, at a location at which the central pencil of rays 20a falls on the central portion (i.e. the cells A through D) of the photodetector 10 as a substantially circular radiation spot of minimum blur as shown in shade in the figure, when the light spot 9a is focused precisely on the track 8. As the spot 9a on the optical disk 6 becomes too near to or too far away from the optical head (i.e., the converging lens 5) to cause a focusing error, the pencil of rays 20a on the central photodetector cells A through D is deformed into an oblong elliptic form, elongated either in the diagonal direction across the cells A and C or in the other diagonal direction perpendicular thereto across the cells B and D, as shown in dotted curves in the figure. A substractor 12, having an input coupled to the outputs of the cells A and C and the other input coupled to the outputs of the cells B and D, calculated the difference: (A + C) - (B + D), between the sum: (A + C) of the outputs of the cells A and C and the sum: (B + D) of the outputs of the cells B and D. In response to the output of the subtractor 12, the phase compensation circuit 15 outputs a focusing error signal V_{AF} corresponding to the focusing error of the spot 9a in the direction Z of the optical axis O perpendicular to the surface 6b of the optical disk 6. In response to the focusing error signal V_{AF}, the focusing actuator 5d adjusts the position of converging lens 5 in the direction Z of the optical axis O so as to correct the focusing error. Incidentally, as is well known, it is preferred that the direction of astigmatism generated by the plate-shaped beam splitter 4 forms an angle of 45 degrees with the direction Y of the tracks 8, 8a, and 8b; thus, the laser diode 1 is positioned in a direction wherein the pencil of rays 2 emitted therefrom forms an angle of 45 degrees with the direction Y of the tracks on the optical disk 6.

By the way, the sum: (A + B + C + D) of the outputs of the four central photodetector cells A through D, calculated by an adder 11, is utilized as the information reproducing signal V_{HF} in an information reproducing circuit (not shown) of the optical disk recording and reproducing device.

As described above, the focusing and the tracking error are detected by the astigmatic method and the twin spot method, respectively, whereby a single light source, i.e. the laser diode 1, is utilized both in reading out information from the optical disk 6 and in detecting the focusing and tracking errors; thus, the organization of the device for the detection of such errors is relatively simple. However, as described below in reference to Figs. 5 and 6, the conventional optical head device is in need of a separate light source for detecting the tilting of the optical head with respect to the optical disk.

The tilting of the optical axis O (see Figs. 1 and 3) of the optical head, i.e. the converging lens 5, from the direction Z perpendicular to the recording surface 6b of the optical disk 6 may be caused either by the bending of the transparent substrate 6a of the optical disk 6 or by the slanting of the rotational axis of the optical disk 6 from the direction Z. When this tilting of the optical axis of the optical head with respect to the recording surface 6b of the optical disk 6 occurs, an aberration called coma results, which may cause crosstalks from the tracks 8a and 8b adjacent to the current information reading or recording track 8 on which the information is to be recorded and reproduced by the optical head. Such crosstalks present an especially serious problem in the case of devices such as optical video disks where the information is recorded as an analog signal.

Fig. 5 shows the organization of a conventional tilt servo mechanism for correcting the tilting of the optical head with respect to the surface of the optical disk 6. A light emitting diode 30 and a pair of photodetectors 31 and 32 are mounted on the head supporting box member 33 which accomodates the above described optical head device therein; the box member 33 is rotatably supported by the support member 33a via a rotational shaft 33b. The light emitted from the light emitting diode 30 is reflected by the recording surface 6b of the disk 6 to fall on the photodetectors 31 and 32. A subtractor 34 calculates the difference of the outputs of the two photodetectors 31 and 32; in response to the differential output of the

subtractor 34, a phase compensation circuit 35 outputs to a motor 36 a signal corresponding to the amount of the tilting of the optical head with respect to the recording surface 6b of the disk 6. Thus, in response to the tilt signal from the circuit 35, the motor 36 drives the head supporting box 33 around the shaft 33b via a screw 37 to adjust the angle of the box 33 with respect to the surface of the disk 6.

The outputs of the two photodetectors 31 and 32 are equal when the optical axis of the optical head accomodated in the box 33 in perpendicular to the recording surface 6b of the disk 6. When the recording surface 6b of the disk 6 is tilted around an axis running in the direction Y of the tracks on the surface 6b, the amount of light incident on the two photodetectors 31 and 32 become uneven, as shown in Fig. 6. Thus, the output of the subtractor 38 becomes positive or negative according as the recording surface 6b of the disk is tilted in one direction or the other. Consequently, the output of the phase compensation circuit 35 corresponds to the amount of the tilting, and the box 33 is adjusted via the motor 36 in such a manner that the optical axis of the optical head accomodated in the box 33 is maintained at right angles with the recording surface 6b of the disk 6.

By the way, in the case of the devices shown in Figs. 1 and 3, the photodetector 10 is positioned at a point on the optical axis O of the converging lens 5; thus, as shown schematically in Fig. 7 (b), the light emitted from the laser diode 1 reflected by the beam splitter 4 is converged on the recording surface 6b on the disk 6, while the light reflected from the recording surface 6b of the disk 6 is converged on the photodetector 10 after passing through the beam splitter 4. However, the positions of the laser diode 1 and the photodetector 10 with respect to the beam splitter 4 may be reversed, as shown in Fig. 7 (a), so that the light emitted from the laser diode 1 which lies on the optical axis O of the converging lens 5 passes through the beam splitter 4 to be converged on the recording surface 6b on the disk 6; in such case, the light reflected from the recording surface 6b of the disk 6 and converged by the converging lens 5 is reflected by the beam splitter 4 before falling on the photodetector 10.

As described above, the conventional optical head devices are provided with a separate light source for the tilt servo mechanism, and hence have the following problems: The need for the provision of a separate light source for the tilt detection results in additional optical parts and an additional cost; further, since the space between the upper surface of the head supporting box 33 and the optical disk 6 is small, the disposition of the light emitting diode 30 and the photodetectors 31 and 32 thereon imposes a limitation on the design of the optical head device.

GB-A- 2 083 252 discloses an arrangement in which light from the main source is used for tilt detection. This, however, requires the use of a complex optical system.

JP-A- 58-208939 reflecting the subject matter of the preamble of claim 1 also discloses a system in which light from the main source is used for tilt detection. This also requires the use of a complicated optical system.

The present invention sets out to provide a device which makes use of the main light source in a simple, and therefore, more economical and efficient fashion.

SUMMARY OF THE INVENTION

It is a primary object of this invention therefore to provide an optical head device provided with a tilt servo mechanism whereby a separate light source for tilt detection is unnecessary, so that the device can be rendered small-sized and inexpensive and the limitations imposed on the design of the device by the need for a separate light source can be removed.

It is an additional object of this invention to provide such an optical head device provided with means for utilizing, for the purpose of tilt detection, a hitherto unused portion of rays of light emitted from the light source which is provided for reproducing information.

An optical head device according to this invention comprises a light source, a converging lens, a beam splitter, and a photodetector for information reproduction, as in the case of conventional devices; it may further comprise a diffraction grating and other parts for the focusing and tracking detection. These elements have already been described above.

According to the invention there is provided an optical head device for recording and reproducing information on a recording surface of an optical disk (6), comprising:

light source means (1) for emitting rays of light;

converging lens means (5) for converging rays emitted from said light source (1) on an information track (8) on the recording surface of the optical disk (6), wherein rays of light converged on the recording surface of the optical disk (6) are reflected therefrom to form reflected rays of light;

beam splitter means (4) for separating from said rays emitted from the light source (1) said reflected rays of light that have been reflected from said recording surface of the optical disk (6) and transmitted through said converging lens means (5);

first photodetector means (10) for receiving and detecting said reflected rays of light that have passed through the converging lens means (5) and have been separated by said beam splitter means (4), thereby reproducing information recorded on said track on the optical disk (6);

means (55; 3; 90), for directing a portion of said rays of light emitted from said light source (1) to a side spot on said recording surface of the optical disk (6) situated on a side of a spot on the information recording track (8) on which the central portion of the rays

emitted from the light source (1) is converged by the converging means (5);

second photodetector means (53a,53b) for receiving and detecting said portion of the rays of light which have been directed by said directing means (53;3;90) and thereafter been reflected at said side spot on the recording surface of the optical disk (6); and

calculation means (61a,61b,62,63,35), coupled to said second photodetector means (53a,53h), for calculating from an output of said second photodetector means (53a,53b) a tilting of said recording surface of the optical disk (6) with respect to an optical axis of the converging lens means (5), said calculation means (35) outputting a signal corresponding to the calculated tilting of the recording surface of the optical disk (6);

characterised in that the said rays of light directed to a side spot of the disk (6) are rays of light which are unnecessary for recording and reproduction purposes and which are obtained without affecting the beam used for recording an reproduction; and the device comprises

actuator means (36), coupled to said calculation means (61a,61b,62,63,35), for adjusting, in response to said signal outputted from said calculation means, an attitude of said optical head device with respect to the recording surface of the optical disk (6) so that the tilting of said recording surface with respect to the optical axis of the converging lens means (5) is adjusted.

According to one aspect of this invention, the above objects are accomplished in an optical head device which further comprises a refracting means (e.g. a prism or prisms) disposed at a peripheral flange portion of the converging lens for converging the rays emitted from the light source on the recording surface of the optical disk. The refracting means refracts a peripheral portion of the light emitted from the light source and thus deflects and directs it to a spot on the recording surface of the disk that is situated to a side of the spot on which the central portion of the rays of light emitted from the light source is converged by the converging lens. The peripheral rays thus reflected from the side spot on the recording surface of the disk are received and detected by a second photodetector which is disposed, for example, at a side of the main photodetector for information reproduction for receiving and detecting the central rays that are reflected from the recording surface of the disk. The tilting of the disk with respect to the optical axis of the converging lens of the optical head device is determined on the basis of the output of the second photodetector.

According to another aspect of this invention, the above objects are accomplished in an optical head device which comprises, in addition to a primary diffraction grating for resolving the central portion of the rays emitted from the light source into a plurality of pencils of rays, at least one secondary diffraction grating formed integrally with the primary diffraction grating at a side thereof. A peripheral portion of the light emitted from the light source and falling on the secondary diffraction grating is diffracted and thereby deflected, via the beam splitter and the converging lens, to a spot on the recording surface of the disk which is situated to a side of the spot on which the central rays passing through the primary diffraction grating are converged. The peripheral rays diffracted by the secondary diffraction grating, converged by the converging lens, and reflected at the side spot on the recording surface of the disk are detected by a second photodetector; the tilting of the disk with respect to the optical head device is determined on the basis of this second photodetector.

According to a further aspect of this invention, reflection means (i.e. a mirror or mirrors) is used to obtain rays of light for the tilt detection. The reflection means is used for reflecting a peripheral portion of the rays emitted from the light source, so as to direct it to a side spot on the recording surface of the disk via the beam splitter and the converging lens.

According to a further aspect of the invention, an optical device includes features as set out in Claim 2.

The light reflected from the side spot on the recording surface of the disk is detected by a second photodetector, and the tilting of the disk with respect to the optical head is determined on the basis of the output of the second photodetector.

It is preferred that the second photodetector comprises at least two photodetector cells, and the tilting of the disk is detected from the differential output of the two cells. The attitude of the optical head device is adjusted by an actuator such as a motor in response to the detected tilting of the disk with respect to the optical head, so that the optical axis of the converging lens of the optical head is maintained at right angles with the recording surface of the disk.

According to the above aspects of this invention, hitherto unused portions of the rays emitted from the light source are used for the tilt detection.

Preferred features of the invention are set out in Claims 2 to 19.

Thus, according to any one of the aspects of this invention, the tilt detection can be effected without utilizing a separate light source.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features which are believed to be characteristic of this invention are set forth with particularity in the appended claims. This invention itself, however, in its several aspects may best be understood from the following detailed description of the preferred embodiments taken in conjunction with the accompanying darwings, in which:

Fig. 1 is a perspective view of an optical head device comprising tracking and focusing servo mechanisms;
Fig. 2 shows a vertical section of the converging lens of the optical head device of Fig. 1 along its optical axis;
Fig. 3 is a perspective view of another optical head device which is similar to that of Fig. 1, but in which the collimating lens is not utilized;
Fig. 4 is a circuit diagram showing, together with a schematic plan view of the photodetector, the circuit for outputting the tracking and the focusing error signal together with the information reproduction signal;
Fig. 5 is a schematic side view of an optical head device provided with a conventional tilt servo mechanism;
Fig. 6 is a partial side view of the device of Fig. 5, for illustrating the principle of tilt detection;
Fig. 7 (a) and (b) show two types of the optical system of the optical head device, in which the optical axis of the laser diode coincides with that of the converging lens (shown in (a)) or is at right angles therewith (shown in (b));
Fig. 8 is a perspective view of an optical head device provided with prisms formed at two sides of the flange portion of the converging lens according to a first aspect of this invention;
Fig. 9 shows a vertical section along the direction X of the converging lens of the optical head device of Fig. 8 which is provided with the prisms;
Fig. 10 is a plan view of the converging lens of Fig. 8;
Fig. 11 is a circuit diagram of the tilt detection circuit of the optical head device of Fig. 8;
Fig. 12 (a) through (c) are partial side views of the device of Fig. 8, showing the principle of tilt detection effected by means of the partitioned photodetector cells;
Fig. 13 (a) through (c) are views similar to those of Fig. 12 (a) through (c), but showing an optical head device having a prism and a photodetector only at one side of the converging lens;
Fig. 14 (a) through (c) are also views similar to those of Fig. 12 (a) through (c), but showing an optical head device which comprises prisms and photodetectors at both sides but in which each photodetector consists of a single photodetector cell;
Fig. 15 is a circuit diagram showing the circuit for outputting a tilt detection signal in the optical head device of Fig. 14;
Fig. 16 is a schematic sectional side view of an optical head device provided with prism portions which comprise a convex surface having a light converging function;
Fig. 17 is a side view of another optical head device provided with prism portions comprising a convex surface, wherein the collimating lens is not utilized;
Fig. 18 is a schematic side view of an optical head device according to a second aspect of this invention, wherein the diffraction grating is provided with peripheral diffraction domains for diffracting the peripheral portions of the light emitted from the laser diode;
Fig. 19 shows the diffraction grating of the optical head device of Fig. 18 in greater detail, wherein (a) is a side view thereof, while (b) is a front view thereof as viewed from the direction - X, showing the grating patterns of the central peripheral domains;
Fig. 20 is a schematic side view of an optical head device similar to that of Fig. 18, wherein diffraction grating is provided with a peripheral diffraction domain whose grating interval varies gradually;
Fig. 21 (a) through (c) are partial enlarged side views of the device of Fig. 20, showing the peripheral diffraction domain of the diffraction grating in three different positions;
Fig. 22 shows a preferred form of the section of the peripheral domains of the diffraction grating of the optical head devices of Figs. 18 and 20;
Fig. 23 is a schematic side view of an optical head device according to a third aspect of this invention, which is provided with a mirror for reflecting a peripheral portion of the light emitted from the laser diode;
Fig. 24 is a schematic side view of an optical head device similar to that of Fig. 23, which is provided with a pair of mirrors for reflecting peripheral portions of the light emitted from the laser diode;
Fig. 25 shows another optical head device provide with a pair of reflecting mirrors, wherein the photodetectors for the tilt detection are disposed on the flange portion of the converging lens, whereby (a) is a side view of the optical head device whereas (b) is a plan view of the converging lens;
Fig. 26 is a side view of still another optical head device provided with a pair of reflective mirrors, wherein the photodetectors for the tilt detetion are disposed to either side of the converging lens;
Fig. 27 shows a vertical section of a cylinder accomodating the laser diode and the beam splitter, wherein an inner side surface of the cylinder is polished to form a reflective mirror;
Fig. 28 shows an embodiment of photodetector assembly including a linear position detector for the tilt detection;
Fig. 29 is a circuit diagram of the calculation circuit of the assembly of Fig. 28;
Fig. 30 is a schematic sectional side view of an optical head device
which is provided with a mirror for reflect-

ing the light emitted from the laser diode and passing through the beam splitter, for the purpose of tilt detection;

Fig. 31 is a perspective view of the optical head device of Fig. 30;

Fig. 32 shows a partial section of the device of Fig. 30 together with a diagram of the circuit for generating the tilt detection signal;

Fig. 33 is a side view of an optical head device similar to that of Fig. 30, which comprises a convex lens for collimating the light reflected by the mirror for the tilt detection;

Fig. 34 is a side view of another optical head device which is similar to that of Fig. 30, but whose mirror for tilt detection is concave; and

Fig. 35 is a side view of still another optical head device similar to that of Fig. 30, provided with an optical waveguide whose lower end surface forms a mirror.

In the drawings, like reference numerals represent like or correspodning parts, unless stated explicitely otherwise.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the accompanying drawings, the preferred embodiments of this invention are described.

A) Converging Lens with Peripheral Prism Portions

Fig. 8 shows an overall organization of an optical head device whose converging lens 5 comprises peripheral prism portions for refracting a peripheral portion of the light emitted from the laser diode 1 and thereby separating and deflecting it for the purpose of tilt detection. The device of Fig. 8 is similar to that shown in Fig. 1 except for the peripheral prismatic structure of the converging lens 5 and the tilt detection system associated therewith, whereby like reference numerals represent like or corresponding parts or portions; thus, in the following, description is made, for the most part, only of those portions which are different from the corresponding portions of the device of Fig. 1.

The central portion of the light emitted from a laser diode 1 is diffracted and resolved into three pencils of rays by a diffraction grating 3, reflected by a beam splitter 4, and collimated by a collimating lens 7, to reach the converging lens 5. As shown in Figs. 9 and 10, the converging lens 5 comprises, in addition to the central converging lens portion 5a, prism portions 55a and 55b (shaded in Fig. 10) which are situated at both sides thereof in the direction X perpendicular to the direction Y of the tracks 8, 8a, and 8b on the recording surface 6b of the optical disk 6; the peripheral rays of light incident on these prism portions 55a and 55b are refracted in the two directions away from the optical axis O of the converging lens 5 along the direction X, to form a pair of tilted peripheral pencils of rays 50a and 50b. The prism portions 55a and 55b of the converging lens 5 may be formed by shaping the flange portion 5b of the converging lens 5 of Fig. 2 into prismatic forms. On the other hand, the three pencils of rays incident on the converging lens portion 5a are converged on three spots 9a, 9e, and 9f along a track 8, to be reflected therefrom to a photodetector 10 via the converging lens 5, collimating lens 7 and the beam splitter 4; thus, on the basis of the output of the photodetector 10, which has a structure as shown in Fig. 4, the focusing and tracking error signals are obtained as well as the information reproducing signal, as described above in reference to Figs. 1 and 4.

The tilted pencils of rays 50a and 50b refracted by the prism portions 55a and 55b of the converging lens 5 fall on spots 51a and 51b situated on the recording surface 6b of the disk 6 to either side of the information reading spot 9a; the pencils of rays 50a and 50b are reflected at these spots 51a and 51b, to fall on a pair of photodetectors 53a and 53b, as reflected pencils of rays 52a and 52b. The photodetectors 53a and 53b, positioned on either side of the converging lens 5 along the direction X, are each partitioned into two cells; the photodetector 53a into cells P1 and P2, and photodetector 53b into cells P3 and P4.

As shown in Fig. 11, the outputs of the cells P1 and P2 of the photodetector 53a are coupled to a subtractor 61a which outputs the difference: P1 - P2 between the two outputs of the cells P1 and P2; on the other hand, the outputs of the cells P3 and P4 of the photodetector 53b are coupled to a subtractor 61b which outputs the difference: P3 - P4 between the two outputs P3 and P4. Thus, the adder 62 coupled to the outputs of the subtractors 61a and 61b outputs a tilt detection signal 63 equal to the sum of the two differences: (P1 - P2) + (P3 - P4). A motor 36, similar to the one described above in reference to Fig. 5, is supplied with the tilt detection signal 63 via a phase compensation circuit 35, to adjust the attitude of the head supporting box, as described above.

Fig. 12 shows the principle of tilt detection. As shown in Fig. 12 (b), the photodetectors 53a and 53b are disposed in such a manner that the amounts of light incident on the photodetector cells P1 and P3 are equal to the amounts of light incident on the cell P2 and P4, respectively, when the optical axis of the converging lens 5 is at right angles with the recording surface 6b of the disk 6. Thus, the tilt detection signal 63 outputted by the adder 62 is equal to zero when there is no tilting of the disk 6 with respect to the optical axis of the converging lens 5. When the recording surface 6b of the disk 6 is tilted into an inclination in which the outer portion of the disk 6 is raised as shown in Fig. 12 (a), the amounts of light incident on the cells P2

and P4 become greater than the amounts of light incident on the cells P1 and P3; thus, the tilt detection signal 63 become negative. On the other hand, when the recording surface of the disk 6 is tilted into an inclination in which the inner portion of the disk 6 is raised as shown in Fig. 12 (c), the amounts of light incident on the cells P1 and P3 become greater than the amounts of light incident on the cell P2 and P4; thus, the tilt detection signal 63 becomes positive. In response to the tilt detection signal 63, the motor 36 for adjusting the angle of the optical head supporting box 33 shown in Fig. 5 is driven so as to maintain the optical axis O of the converging lens 5 at right angles with the recording surface 6b of the disk 6.

In the case of the above embodiment, a pair of photodetectors 53a and 53b, each partitioned into two cells, are disposed on either side of the converging lens 5. However, as shown in Fig. 13, only one photodetector, e.g. the photodetector 53a, on one side of the converging lens 5 may be utilized. In such case, the converging lens 5 comprises a prism portion 55a only at the side at which the photodetector 53a is disposed. The tilt detection signal corresponding to the signal 63 of Fig. 11 is obtained by a subtractor coupled to the outputs of the photodetector cells P1 and P2 into which the photodetector 53a is partitioned, wherein the subtractor outputs the difference: (P1 - P2) between the outputs of the two cells P1 and P2. In the case where there is no tilting as shown in Fig. 13 (b), the tilt detection signal (P1 - P2) is equal to zero; where the outer side of the disk 6 is raised as shown in (a) of the same figure, it is negative; and where the inner side of the disk 6 is raised as shown in (c) of the same figure, it is positive. Thus, the principle of tilt detection is the same as in the case of the device of Fig. 8.

Further, as shown in Fig. 14, the photodetectors 53a and 53b may each consist of a single photodetector cell. The outputs Pa and Pb of the photodetectors 53a and 53b are coupled to a subtractor 61, which outputs the difference: (Pa - Pb) between the two outputs as the tilt detection signal 63, as shown in Fig. 15. The tilt detection signal 63 is equal to zero when there is no tilting as shown in Fig. 14 (b); it becomes positive or negative according as the disk 6 is tilted with respect to the optical axis of the converging lens 5, as shown in (a) and (c) of the same figure, respectively.

Fig. 16 shows still another modification wherein the peripheral side refracting portions 55a and 55b each have a convex surface; thus, they function not only as a prism for refracting the light incident thereon in the direction away from the optical axis of the converging lens 5, but also as a converging lens for converging the refracted pencils of rays 50a and 50b; the pencils of rays 50a and 50b are thus, after reflected at spots 51a and 51b, respectively, converged on the photodetectors 53a and 53b, as the reflected pencils of rays 52a and 52b. Since the rays 52a and 52b incident on the photodetectors 53a and 53b, respective are converged, the sensitivity of tilt detection can be enhanced.

Fig. 17 shows still further embodiment wherein the collimating lens 7 is not utilized; in this case, as in the case of the device of Fig. 3 mentioned above, the lens 5 is a converging lens of finite converging system which is capable of converging the diverging pencil of rays 2b. Since the peripheral rays of light incident on the side portions 55a and 55b of the converging lens 5 are also diverging in this case, it is preferred that these refracting portions 55a and 55b each have a convex surface so that they function both as a refracting prism and a converging lens, as in the case of the embodiment of Fig. 16.

B) Diffraction Grating with Peripheral Diffraction Domains

Fig. 18 shows an embodiment wherein the diffraction grating 3 comprises, in addition to the central or primary diffraction domain, peripheral or secondary diffraction domains for diffracting the hitherto unused peripheral rays of light emitted from the laser diode 1, for the purpose of tilt detection. The device of Fig. 18 is similar to that shown in Fig. 3, whereby like reference numerals represent like or corresponding parts; thus, the description here is limited for the most part to those portions which are different from the optical head device of Fig. 3.

The light emitted from the laser diode 1 forms a divergent pencil of rays having a Gaussian (i.e. normal) distribution of intensity whose half level angle is about 20 to 40 degrees. Of this light emitted form the laser diode 1, the central portion of the rays 2 (referred to hereinafter as the central or effective pencil of rays) shown by solid lines in the figure is utilized for the reproduction and recording of information and for obtaining the focusing and tracking error signals. The divergence angle of the effective pencil of rays 2, which is determined by an aperture limiter 16, is typically from about 10 to 15 degrees. The portions of the rays 21a and 21b (referred to hereinafter as peripheral pencils of rays) shown by dotted lines in the figure have not hitherto been utilized in optical head devices; according to this embodiment of this invention, these hitherto unused peripheral pencils of rays 21a and 21b are utilized for the purpose of tilt detection.

As shown in detail in Fig. 19, the diffraction grating 3 comprises a pair of peripheral or secondary diffraction domains 3a and 3b in addition to the central or primary diffraction domain 3c. The peripheral domains 3a and 3b, which are disposed at two sides of the central domain 3c in the direction Z, have a pattern of grating whose direction is perpendicular to that of the grating in the central domain 3c, as shown clearly in Fig. 19 (b).

The effective pencil of rays 2 emitted from the laser diode 1 and falling on the central diffraction domain 3c is resolved into three pencils of rays 2a, whose two side pencils of rays (i.e. diffracted rays of first order) are diverging in the direction Y of the tracks on the optical disk 6; thus, these central rays 2a are reflected by the beam splitter 4 and converged by the converging lens 5 on spots 9a, 9e and 9f, respectively, along an information track on the disk 6. The light reflected at these spots 9a, 9e, and 9f are converged by the converging lens 5 on the photodetector 10 after passing through the beam splitter 4. Thus, on the basis of the outputs of the photodetector 10, the reproduction and recording of information and the adjustment of the focusing and tracking errors are effected as described above in reference to Figs. 1 through 4.

On the other hand, the peripheral pencils of rays 21a and 21b incident on the peripheral diffraction domains 3a and 3b which undergo the first order diffractions are diffracted toward the optical axis O' of the laser diode 1 in the direction Z perpendicular to the recording surface of the disk 6, as shown in Fig. 18 and Fig. 19 (a). These rays 21a and 21b, after being thus changed in their propagation directions by the peripheral domains 3a and 3b of the diffraction grating 3, are reflected by the beam splitter 4 and, after passing through the opening of the aperture limiter 16, converged by the converging lens 5 on the two spots 17a and 17b on the recording surface of the disk 6 which are situated to either side of the information reading spot 9a along the direction X perpendicular to the direction Y of the tracks on the disk 6. The rays of light reflected at these side spots 17a and 17b are converged by the converging lens 5 on the two photodetectors 53a and 53b, respectively. These photodetectors 53a and 53b are partitioned into two cells; namely the photodetector 53a into cells P1 and P2, and the photodetector 53a into cells P3 and P4.

As shown in Fig. 18, the outputs of the cells P1 and P3 are coupled to an input of a subtractor 61, while those of the cells P2 and P4 are coupled to the other input of the same subtractor 61. Thus, the subtractor 61 outputs the tilt detection signal 63, which is equal to the value: (P1 + P3) - (P2 + P4). The photodetectors 53a and 53b are set in such a way that when the optical axis O of the converging lens 5 is perpendicular to the recording surface of the disk 6, the amounts of light incident on the cells P1 and P2 are equal to each other and the amounts of light incident on the cells P2 and P4 are equal to each other. Since the pencils of rays 22a and 22b reflected from the spot 17a and 17b are translated positively or negatively in the direction X according as the recording surface of the disk 6 is tilted around the direction Y, the tilt detection signal 63 is proportional to the amount of the tilting of the disk 6. Thus, the motor 36 similar to the one described above adjusts the attitude of the optical head supporting box in response to the tilt detection signal supplied thereto via a phase compensation circuit 35.

In the case of the embodiment of Fig. 18, the positions of the photodetectors 53a and 53b must be adjusted so that the output 63 of the subtractor 61 becomes equal to zero when the disk 6 is not tilted with respect to the optical axis O of the converging lens 5. Thus, the photodetectors 53a and 53b should be provided with a position adjustment mechanism which is independent of the adjustment mechanism for the photodetector 10. Fig. 20 shows an embodiment wherein the photodetector 53a for the tilt detection may be mounted on the same substrate board as the photodetector 10 for the information reproduction and for the focusing and tracking error detection.

The diffraction grating 3 of this embodiment of Fig. 20 comprises only one peripheral diffraction domain 3a in addition to the central diffraction domain 3c. As shown in greater detail in Fig. 21, the grating interval of the peripheral diffraction domain 3a decreases gradually toward the periphery in the direction Z perpendicular to the recording surface of the disk 6. Further, the diffraction grating 3 is provided with a position adjustment mechanism 3d for adjusting the position of the diffraction grating 3 along the direction Z. Let the angle of diffracted light of the first order be denoted by θ_0 when the peripheral pencil of rays 21a falls on the central portion of the peripheral domain 3a as shown in Fig. 21 (a). When the diffraction grating 3 is moved slightly downward (i.e. in the direction - Z) by the adjustment mechanism 3d to a position shown in (b) of the same figure, then the angle θ_1 of diffraction of first order becomes greater than the angle θ_0, since the pencil of rays 21a falls on a portion of the domain 3a where the grating interval is smaller. On the other hand, when the diffraction grating 3 is moved slightly upward (i.e. in the direction + Z) by the adjustment mechanism 3d to a position shown in (c) of the same figure, then the angle θ_2 of diffraction of first order becomes smaller than the angle θ_0, since the pencil of rays 21a falls on a portion of the domain 3a where the grating interval is greater.

As shown in dotted lines in Fig. 20, the pencil of rays 21a diffracted at the peripheral domain 3a of the diffraction grating 3 is reflected by the beam splitter 4 to fall on a side spot 17a on the disk 6 via the converging lens 5. The light reflected at the side spot 17a is converged by the converging lens 5, after passing through the beam splitter 4, on the photodetector 53a partitioned into two cells P1 and P2. The outputs of the cells P1 and P2 are coupled to a subtractor 61 which outputs the tilt detection signal 63 proportional to the difference: (P1 - P2) between the two outputs. The adjustment of the position in the direction X of the pencil of rays 22a reflected from the spot 17a to the photodetector 53a, for the purpose of reducing the offset of the tilt detection signal to zero, can be effect-

ed by means of the mechanism 3d which adjusts the position of the diffraction grating 3 in the direction Z. Thus, even if the photodetector 53a is mounted on the same substrate board as the photodetector 10, the adjustment of the offset of the tilt detection signal 63 which may take place at the time when the disk 6 is not tilted can be effected independently by the adjustment mechanism 3d. By forming the photodetectors 10 and 53a integrally on the same semiconductor substrate, the optical head device can be made smaller. By the way, in the above structure of the diffraction grating 3, the width of the central domain 3c in the direction Z is designed wide enough so that the effective pencil of rays 2 falls theron and passes entirely therethrough over the whole range of the adjustment of the diffraction grating 3 via the mechanism 3d in the direction Z; thus, the adjustment of the diffraction grating 3 via the mechanism 3d has no adverse effects on the recording and reproducing characteristics.

In the case of the embodiment of Fig. 20, only one peripheral diffraction domain 3a is disposed at the side of the central domain 3c. However, the same principle of grating interval variation can be applied to the case where two peripheral diffraction domains 3a and 3b are disposed at both sides of the central domain 3c in the direction Z, as in the case of the optical head device of Fig. 18.

Incidentally, the diffraction grating of peripheral diffraction domains 3a and 3b is preferred to have a form of saw-tooth shaped cross section as shown in Fig. 22, which form enhances the effectiveness of diffraction. Thus, by adopting such form, the sensitivity of tilt detection can be further improved.

C) Devices with Mirrors for Reflecting Peripheral Rays

Fig. 23 shows an embodiment which comprises a mirror 90 for reflecting and thereby deflecting a hitherto unused peripheral pencil of rays 21 for the purpose of tilt detection. In the case of this embodiment, a plane mirror 90 is disposed, for example on a side of a diffraction grating (not shown) in the direction Z perpendicular to the surface of the disk 6, instead of the peripheral diffraction domain 3a in Fig. 20, to reflect a peripheral pencil of rays 21a toward the beam splitter 4; the pencil of rays 21a thus reflected by the mirror 90 and thereafter by the beam splitter 4 falls on a spot 17a on the disk 6 via the converging lens 5. The pencil of rays 22a reflected at the spot 17a is converged by the converging lens 5 through the beam splitter 4 on the photodetector 53a partitioned into two cells P1 and P2. The subtractor 61 coupled to the outputs of the cells P1 and P2 outputs the tilt detection signal 63 proportional to the difference: (P1 - P2) between the two outputs. Except for the provision of the mirror 90 for reflecting the light for tilt detection as described above, the optical head device of Fig. 23 is similar to the device of Fig. 20, both in its organization and operation, although the diffraction grating is not shown in Fig. 23.

Fig. 24 shows an embodiment which comprises two plane mirrors 90a and 90b for reflecting peripheral pencils of rays 21a and 21b emitted from the laser diode 1. Thus, except that mirrors 90a and 90b are used instead of peripheral diffraction domains 3a and 3b, the optical head device of Fig. 24 is similar to the device of Fig. 18 both in organization and method of operation, whereby like reference numerals represent like or corresponding parts or portions. The tilt detection signal is obtained from the outputs of the cells P1 through P4, via a circuit similar to that shown in Fig. 11 or 18, as: (P1 - P2) + (P3 - P4) = (P1 + P3) - (P2 + P4).

Fig. 25 shows still another embodiment in which the cells P1 through P4 of the photodetectors 53a and 53b are disposed on the flange portion 5b of the converging lens 5. In the case of the embodiments of Figs. 23 and 24, the peripheral pencils of rays 21a and 21b for the tilt detection are radiated and converged on the optical disk 6 via the converging lens 5, and those rays which have passed again through the converging lens 5 are detected by the photodetectors 53a and 53b. However, not all the rays reflected by the disk 6 return to the converging lens 5. In the case of the embodiment of Fig. 25, the mirrors 90a and 90b are disposed at such angles that the pencils of rays 21a and 21b reflected by them eventually fall on the photodetectors 53a and 53b situated on the flange 5b of the converging lens 5. Thus, the peripheral pencils of rays 21a and 21b (whose optical axises are shown by dotted lines in the figure) emitted from the laser diode 1 are reflected by the mirrors 90a and 90b and by the beam splitter 4, to fall on the converging lens 5 forming a substantial angle with the optical axis O of the converging lens 5; thus, the pencils of rays 21a and 21b fall on spots 17a and 17b on the disk 6 which are spaced apart from the central spot 9 in the direction X perpendicular to the track direction Y. As a result, the zeroth (0th) order diffractive reflection rays 22a and 22b (whose optical axis is again shown by dotted lines in the figure) reflected at spots 17a and 17b fall on the photodetectors 53a and 53b disposed on the flange portion 5b of the converging lens 5 at either side thereof in the direction X as shown clearly in Fig. 25 (b). The tilt detection signal is obtained from the outputs of the photodetector cells P1 through P4 of the photodetectors 53a and 53b as: (P1 + P3) - (P2 + P4).

Fig. 26 shows another embodiment in which the diffracted light of first order reflected at the recording surface of the optical disk 6 is utilized for the tilt detection. Namely, on the recording surface of the disk 6 are formed a plurality of information tracks running parallel to each other in the direction Y. Thus, the re-

cording surface of the disk 6 forms a kind of reflective diffraction grating; the peripheral pencils of rays 21a and 21b emitted from the laser diode 1 and reflected and converged on spots 17a and 17b on the recording surface of the disk 6 are therefore separated into zeroth (0th) and first order diffracted rays of light, wherein the first order diffraction rays 22a' and 22b' are diffracted away from the optical axis O of the converging lens 5 in the direction X, to fall on the photodetectors 53a and 53b which are disposed to either side of the converging lens 5, at positions separated away therefrom in the direction X. Otherwise, the device of Fig. 26 is similar to that of Fig. 25.

In the case of the embodiments of Figs. 25 and 26, the pencils of rays 22a and 22b or 22a' and 22b' reflected at the spots 17a and 17b on the recording surface of the disk 6 are directed to the photodetectors 53a and 53b without being converged by the converging lens 5; since these pencils of rays 22a and 22b or 22a' and 22b' are divergent pencils, they form radiation spots of a large diameter on the photodetectors 53a and 53b. It is preferred, however, for the purpose of receiving the rays 22a and 22b or 22a' and 22b' effectively and for the purpose of detecting the tilt of the disk 6 accurately, that these pencils of rays form radiation spots which is smaller than the detection area of the cells P1 through P4 of the photodetectors 53a and 53b. For this purpose, the peripheral pencils of rays 21a and 21b are not to be converged at the spots 17a and 17b on the disk 6; the radiation spots made by the reflected pencils of rays 22a and 22b or 22a' and 22b' on the photodetectors 53a and 53b can be made smaller by collimating the pencils of rays 21a and 21b radiated on the spots 17a and 17b on the disk 6. For collimating the rays 21a and 21b on the reflection spots 17a and 17b, it suffices to make the mirrors 90a and 90b into curve convex reflective mirrors instead of plane mirrors. Then, the pencils of rays 22a and 22b or 22a' and 22b' undergoing reflective diffraction at the recording surface of the disk 6 are collimated and therefore can be detected effectively by the photodetectors 53a and 53b.

By the way, the central pencil of rays 2 must not have aberrations for the purpose of obtaining good recording and reproducing characteristics. However, even if the pencils of rays 21a and 21b for tilt detection have some amounts of aberrations, the tilt detection accuracy is not adversely affected by such aberrations. Thus, the mirrors 90a and 90b need not be formed by expensive optical abrasion process; they may be formed of inexpensive glass plates, or they may be formed of resinous plastic plates or aluminum foils. Further, instead of utilizing separate parts as described above, the mirrors 90a and 90b may be formed of portions of the inner surface of the cylinder accomodating the laser diode 1 and the beam splitter 4.

Fig. 27 shows an embodiment in which an inner side surface 90 of the cylinder 91 accomodating the laser diode 1 and the beam splitter 4 is formed into a plane and polished to reflect the peripheral pencil of rays 21 (shown by dotted lines) emitted from the laser diode 1. The structure of the cylinder 91 with polished plane inner side surfaces is applicable to the embodiments shown in Figs. 23 through 26.

Fig. 28 shows an embodiment in which a semiconductor linear position sensitive detector 19 is utilized instead of the photodetectors 53a and 53b.

In the case of the optical head devices of Figs. 23 and 24, the photodetector 10 for the information reproduction and the photodetectors 53a and 53b for the tilt detection are disposed on separate substrates in spite of the fact that they are positioned adjacent to each other; this is due to the need that the photodetectors 53a and 53b be adjusted in their positions independently of the position of the photodetector 10. Namely, in the case of these embodiments, the positions thereof in the direction X must be adjusted so that the outputs of the cells P1 and P2 of the photodetector 53a or the outputs of the cells P3 and P4 of the photodetector 53b become equal when the optical axis of the converging lens 5 is perpendicular to the recording surface of the disk 6.

In the case of the photodetector assembly 70 of Fig. 28, however, the position sensitive detector 19 for the tilt detection and the photodetector 10 for the information reproduction can be mounted on the same substrate 70a because the adjustment of the detector 19 in the direction X is unnecessary. The reason therefor is as follows:

Let the assembly 70 of Fig. 28 be disposed in the optical head device of Fig. 23 instead of the photodetectors 10 and 53a and the subtractor 61. Then, the position detector 19 outputs currents Ia and Ib from the two ends thereof whose magnitudes correspond to the central position in the direction X of the incident pencil of rays 22a from the reflection spot 17a on the disk 6. More precisely, the magnitudes of the currents Ia and Ib are such that the normalized differential outputs of the currents Ia and Ib: (Ia - Ib) / (Ia + Ib) is proportional to the displacement of the center of the incident light spot 22a in the direction X. When the spot 22a is at the center of the position detector 19, the two currents Ia and Ib are equal to each other (Ia = Ib) and hence the above normalized differential output vanishes.

Thus, fundamentally, the operational circuit 71 calculates and outputs the above value: (Ia - Ib) / (Ia + Ib) as the tilt detection signal 63; in addition thereto, it comprises means for adjusting the offset of the outputs of the detector 19. Namely, the position of the light spot 22a may be deviated from the center of the detector 19 when the disk 6 is not tilted with respect to the optical axis of the converging lens 5. In such case, Ia is not equal to Ib when there is not tilting and hence there arises an offset in the above normalized

differential output. Thus, the circuit 71 comprises a means for correcting this offset. Namely, as shown in Fig. 29, the circuit 71 comprises a variable resistor 71a, by means of which the operational amplifier 71b outputs: $A = r\cdot(Ia - Ib + \delta)$, wherein r is a constant and the value of δ is adjsuted by means of the variable resistor 71a. On the other hand, the operational amplifier 71c outputs: $B = r\cdot(Ia + Ib)$. Thus, the division circuit 71d outputs the ratio of A to B: $A/B = (Ia - Ib + \delta) / (Ia + Ib)$ as the tilt detection signal 63. Thus, by the adjustment of the value of δ by means of the variable resistor 71a, the offset of the detector 19 can be reduced to zero.

D) Devices with Mirrors for Refflecting Split Rays

Figs. 30 and 31 show an arrangement which comprises a mirror 92 for reflecting the pencil of rays 23 for the purpose of tilt detection; the pencil of rays 23 is that portion of the rays 2 emitted from the laser diode 1 which passes through the beam splitter 4 and thus is separated from the rays 2b reflected by the beam splitter 4 toward the converging lens 5 to be utilized in the information reproduction. Thus, the pencil of rays 23 emitted form the laser diode 1 and transmitted through the beam splitter 4 is reflected by the mirror 92 to fall on a side spot 17 on the recording surface 6b of the disk 6 via an opening 33a formed in the upper surface of the head supporting box 33; the pencil of rays 24 reflected by the mirror 92 falls on the spot 17 on the recording surface 6b situated to a side of the information reading spot 9 in the direction X. The light reflected at the side spot 17 falls on the photodetector 53 partitioned into two cells P1 and P2, which are disposed on the upper surface of the head supporting box 33. Incidentally, reference numerals 100 and 101 in Fig. 31 designates a pair of shafts for forwarding the optical head in the direction X.

As best shown in Fig. 31, the opening 33a and the cells P1 and P2 are positioned along the radial direction X upon the upper surface of the box 33 so that the tilting of the disk 6 in the radial direction can be detected accurately. Further, it is preferred that the opening 33a and the cells P1 and P2 are positioned as near to the converging lens 5 as possible, since the tilting of the recording surface of the disk 6 just above the converging lens 5 is to be detected by the photodetector 53. Incidentallly, head forwarding shafts 100 and 101 have been shown in Fig. 31; however, this invention is applicalbe to optical head devices which comprises a swing arm type forwarding mechanism.

Thus, as shown in Fig. 32, the tilt detection signal 63 can be obtained from the outputs of the two cells P1 and P2 via a subtractor 61 as: (P1 - P2). As shown in solid lines in the figure, the pencil of rays 24 reflected at the side spot 17 falls evenly across the two photodetector cells P1 and P2, when the optical axis O of the converging lens 5 is perpendicular to the recording surface 6b of the disk 6. However, when the disk 6 is tilted as shown by dotted lines in the figure, the pencil of rays 24 is translated in the direction X to a position indicated at 24'. On the other hand, when the disk 6 is tilted in the other direction, the pencil of rays 24 is translated in the opposite direction. Thus, the subtractor or differential amplifier 61 outputs the tilt detection signal 63 which is proportional to the tilting of the disk 6 with respect to the optical axis of the converging lens 5 of the otpical head. Thus, in response to the signal 63 supplied via the phase compensation circuit 35 the motor 35 adjusts the attitude of the box 33 to correcting the tilting of the disk with respect to the optical head.

The optical head of Figs. 30 through 32 is otherwise similar in sutructure and organization to those of Figs. 1 and 3 described above. It is noted that the principle of utilizing the rays split by the beam splitter 4 for the purpose of tilt detection by means of a mirror is also applicable to the organization of the optical head shown in Fig. 7 (a). In such case, a mirror corresponding to the mirror 92 of Fig. 30 is disposed for reflecting the pencil of rays 23 reflected by the beam splitter 4.

Fig. 33 shows another arrangement comprising a mirror 92 for reflecting the split rays. In the case of this arrangement, a convex lens 93 is disposed in the opening 33a in the box 33 for collimating the divergent pencil of rays 23 into collimated rays 24. Thus, the effectiveness and accuracy of tilt detection are enhanced in this arrangement. Otherwise, this arrangement is similar to that of Figs. 30 through 32.

Fig. 34 shows still another arrangement in which the mirror 92 for reflecting the split rays is formed into a concave form so as to collimate the diverging pencil of rays 23 into collimated rays 24. Thus, the effectiveness and accuracy of tilt detection is also enhanced in this arrangement.

Fig. 35 shows a still further arrangement which comprises an optical waveguide 94 whose lower end surface forms a reflective mirror surface 92. The upper end surface 94a may be plane; however, it is preferred to form it into a convex form as shown in the figure so as to collimate the pencil of rays 24 passing therethrough. The optical waveguide 94 may be formed, for example, of an inexpensive plastic resin bar, since only the intensity of the rays 24 are measured by the photodetector 53 and the qualities, such as aberrations, of the rays 24 do not matter in the tilt detection.

Incidentally, in the above description in reference to Figs. 33 through 35, the rays 24 are described as collimated parallel rays; however, it is not necessary that they are parallel rays. For example, when the rays 24 are converging, the sensitivity of tilt detection may further be enhanced and the cells P1 and P2 can be made smaller. Thus, the angle of convergence (or collimation) of the rays 24 falling on the disk 6 may be

selected at any preferred value.

Claims

1. An optical head device for recording and reproducing information on a recording surface of an optical disk (6), comprising:

light source means (1) for emitting rays of light;

converging lens means (5) for converging rays emitted from said light source (1) on an information track (8) on the recording surface of the optical disk (6), wherein rays of light converged on the recording surface of the optical disk (6) are reflected therefrom to form reflected rays of light;

beam splitter means (4) for separating from said rays emitted from the light source (1) said reflected rays of light that have been reflected from said recording surface of the optical disk (6) and transmitted through said converging lens means (5);

first photodetector means (10) for receiving and detecting said reflected rays of light that have passed through the converging lens means (5) and have been separated by said beam splitter means (4), thereby reproducing information recorded on said track on the optical disk (6);

means (55; 3; 90), for directing a portion of said rays of light emitted from said light source (1) to a side spot on said recording surface of the optical disk (6) situated on a side of a spot on the information recording track (8) on which the central portion of the rays emitted from the light source (1) is converged by the converging means (5);

second photodetector means (53a,53b) for receiving and detecting said portion of the rays of light which have been directed by said directing means (53;3;90) and thereafter been reflected at said side spot on the recording surface of the optical disk (6); and

calculation means (61a,61b,62,63,35), coupled to said second photodetector means (53a,53h), for calculating from an output of said second photodetector means (53a,53b) a tilting of said recording surface of the optical disk (6) with respect to an optical axis of the converging lens means (5), said calculation means (35) outputting a signal corresponding to the calculated tilting of the recording surface of the optical disk (6);

characterised in that the said rays of light directed to a side spot of the disk (6) are rays of light which are unnecessary for recording and reproduction purposes and which are obtained without affecting the beam used for recording an reproduction; and the device comprises

actuator means (36), coupled to said calculation means (61a,61b,62,63,35), for adjusting, in response to said signal outputted from said calculation means, an attitude of said optical head device with respect to the recording surface of the optical disk (6) so that the tilting of said recording surface with respect to the optical axis of the converging lens means (5) is adjusted.

2. An optical head device according to claim 1, wherein the said rays of light directed to a side spot of the disk (6) are separated from the rays of light emitted by the light source by the said beam splitter, and the beam splitter is a half mirror (4).

3. An optical head device according to claim 2, wherein a plane mirror (92) is provided for reflecting the directed rays towards the side spot of the disk and the device further comprises convex lens means (93) for collimating the portion of rays reflected by the mirror (92)

4. An optical head device according to claim 1, wherein the said rays of light directed to a side spot of the disk (6) are deflected from a peripheral region of the said rays of light emitted by the light source (1).

5. An optical head device according to claim 4, wherein the means for deflecting light is a refracting means (55a,55b) disposed in a peripheral region of the said converging lens (5).

6. An optical head device as claimed in claim 5, wherein said refracting means comprises a prism (55a,55b) formed at a flange portion of said converging lens means (5).

7. An optical head device as claimed in claim 5, wherein said refracting means comprises means (55a,55b) for converging said peripheral portion of the rays refracted by said refracting means (55a,55b).

8. An optical head device according to Claim 4, comprising:

first diffraction grating means (3c) for diffracting a central portion of the rays emitted from said light source (1), so as to resolve it into a plurality of pencils of rays; and

second diffraction grating means (3a,3b), formed integrally with said first diffraction grating means at a side thereof, for diffracting the said peripheral portion of said rays emitted from said light source means (1) so as to deflect it and direct it via the converging lens means (5) on a side spot on said recording surface of the optical disk

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selected at any preferred value.

Claims

1. An optical head device for recording and reproducing information on a recording surface of an optical disk (6), comprising:

light source means (1) for emitting rays of light;

converging lens means (5) for converging rays emitted from said light source (1) on an information track (8) on the recording surface of the optical disk (6), wherein rays of light converged on the recording surface of the optical disk (6) are reflected therefrom to form reflected rays of light;

beam splitter means (4) for separating from said rays emitted from the light source (1) said reflected rays of light that have been reflected from said recording surface of the optical disk (6) and transmitted through said converging lens means (5);

first photodetector means (10) for receiving and detecting said reflected rays of light that have passed through the converging lens means (5) and have been separated by said beam splitter means (4), thereby reproducing information recorded on said track on the optical disk (6);

means (55; 3; 90), for directing a portion of said rays of light emitted from said light source (1) to a side spot on said recording surface of the optical disk (6) situated on a side of a spot on the information recording track (8) on which the central portion of the rays emitted from the light source (1) is converged by the converging means (5);

second photodetector means (53a,53b) for receiving and detecting said portion of the rays of light which have been directed by said directing means (53;3;90) and thereafter been reflected at said side spot on the recording surface of the optical disk (6); and

calculation means (61a,61b,62,63,35), coupled to said second photodetector means (53a,53h), for calculating from an output of said second photodetector means (53a,53b) a tilting of said recording surface of the optical disk (6) with respect to an optical axis of the converging lens means (5), said calculation means (35) outputting a signal corresponding to the calculated tilting of the recording surface of the optical disk (6);

characterised in that the said rays of light directed to a side spot of the disk (6) are rays of light which are unnecessary for recording and reproduction purposes and which are obtained without affecting the beam used for recording an reproduction; and the device comprises

actuator means (36), coupled to said calculation means (61a,61b,62,63,35), for adjusting, in response to said signal outputted from said calculation means, an attitude of said optical head device with respect to the recording surface of the optical disk (6) so that the tilting of said recording surface with respect to the optical axis of the converging lens means (5) is adjusted.

2. An optical head device according to claim 1, wherein the said rays of light directed to a side spot of the disk (6) are separated from the rays of light emitted by the light source by the said beam splitter, and the beam splitter is a half mirror (4).

3. An optical head device according to claim 2, wherein a plane mirror (92) is provided for reflecting the directed rays towards the side spot of the disk and the device further comprises convex lens means (93) for collimating the portion of rays reflected by the mirror (92)

4. An optical head device according to claim 1, wherein the said rays of light directed to a side spot of the disk (6) are deflected from a peripheral region of the said rays of light emitted by the light source (1).

5. An optical head device according to claim 4, wherein the means for deflecting light is a refracting means (55a,55b) disposed in a peripheral region of the said converging lens (5).

6. An optical head device as claimed in claim 5, wherein said refracting means comprises a prism (55a,55b) formed at a flange portion of said converging lens means (5).

7. An optical head device as claimed in claim 5, wherein said refracting means comprises means (55a,55b) for converging said peripheral portion of the rays refracted by said refracting means (55a,55b).

8. An optical head device according to Claim 4, comprising:

first diffraction grating means (3c) for diffracting a central portion of the rays emitted from said light source (1), so as to resolve it into a plurality of pencils of rays; and

second diffraction grating means (3a,3b), formed integrally with said first diffraction grating means at a side thereof, for diffracting the said peripheral portion of said rays emitted from said light source means (1) so as to deflect it and direct it via the converging lens means (5) on a side spot on said recording surface of the optical disk

(6) that is situated to a side of the spots along the information track on which said pencils of rays are converged by said converging lens means (5).

9. An optical head device as claimed in claim 8 wherein said second diffraction grating means (3a,3b) comprises: a diffraction grating whose grating interval is varied gradually, and adjustment means (3d) for adjusting a position of the diffraction grating in a direction of grating interval variation.

10. An optical head device as claimed in claim 8 or 9, wherein said first and second diffraction grating means (3a, 3b) comprises diffraction gratings having a saw-tooth formed cross section.

11. An optical head device as claimed in claim 8, 9 or 10, further comprising an aperture limiter means (16) for limiting an aperture of said converging lens means for the pencils of rays into which said central portion of the rays emitted from the light source means (1) is resolved by said first diffraction grating means (3c).

12. An optical head device as claimed in any of claims 1 to 11, wherein said second photodetector means comprises a pair of photodetector cells (53a,53b), and said signal outputted from said calculation means (61a,61b,62,63,35) corresponds to a difference between two outputs of said pair of photodetector cells (53a,53b).

13. An optical head device according to claim 4 comprising:

reflection means (90) for reflecting the said peripheral portion of said rays of light emitted from said light source, thereby deflecting and directing it via said converging lens means (5), to the side spot on said recording surface of the optical disk (6).

14. An optical head device as claimed in claim 13, wherein said second photodetector means (53a,53b) comprises a pair of photodetector cells (53a,53b), and said signal outputted from said calculation means (61a,61b,62,63,35) corresponds to a difference between two outputs of said pair of photodetector cells (53a,53b).

15. An optical head device as claimed in claim 13 or 14, wherein said second photodetector means (53a,53b) is disposed next to said first photodetector means (10) to receive the peripheral rays of light reflected from the recording surface of the optical disk (6) via the converging lens means (5) and the beam splitter means (4).

16. An optical head device as claimed in claim 13 or 14, wherein said second photodetector means (53a,53b) is disposed on a flange portion of said converging lens means (5) to receive the peripheral rays of light reflected at the recording surface of the optical disk (6) directly therefrom.

17. An optical head device as claimed in claim 13 or 14, wherein said second photodetector means (53a,53b) is disposed on a side of said converging lens means (5) to receive the peripheral rays of light undergoing a reflective diffraction of first order at the recording surface of the optical disk (6).

18. An optical head device as claimed in any of claims 13 to 17, further comprising an aperture limiter means (16) for limiting an aperture of said converging lens means (5) for the central portion of the rays emitted from the light source means (1).

19. An optical head device as claimed in claim 13, wherein said second photodetector means (53a,53b) comprises a linear position detector means, disposed on a substrate on which said first photodetector means (10) is disposed, for detecting a linear position of the peripheral rays of light incident thereon after being reflected at the recording surface of the optical disk (6), the linear position detector outputting a signal corresponding to the detected linear position of the incident rays.

Patentansprüche

1. Optische Kopfvorrichtung zum Aufzeichnen und Wiedergeben von Information auf einer Aufzeichnungsfläche einer optischen Platte (6), wobei die optische Kopfvorrichtung folgendes aufweist:
eine Lichtquelleneinrichtung (1) zum Emittieren von Lichtstrahlen;
eine Sammellinseneinrichtung (5) zum Bündeln von von der Lichtquelle (1) emittierten Lichtstrahlen auf einer Informationsspur (8) auf der Aufzeichnungsfläche der optischen Platte (6), wobei auf der Aufzeichnungsfläche der optischen Platte (6) konvergent gemachte Lichtstrahlen von dieser zur Bildung reflektierter Lichtstrahlen reflektiert werden;
eine Strahlteilereinrichtung (4) zum Trennen der reflektierten Lichtstrahlen, die von der Aufzeichnungsfläche der optischen Platte (6) reflektiert und durch die Sammellinseneinrichtung (5) hindurchgeführt worden sind, von den von der Lichtquelle (1) emittierten Lichtstrahlen;
eine erste Photodetektoreinrichtung (10) zum

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Aufnehmen und Detektieren der reflektierten Lichtstrahlen, die durch die Sammellinseneinrichtung (5) hindurchgetreten sind und durch die Strahlteilereinrichtung (4) getrennt worden sind, um dadurch Information zu reproduzieren, die auf der Spur auf der optischen Platte (6) aufgezeichnet ist;
eine Einrichtung (55; 3; 90), um einen Teil der von der Lichtquelle (1) emittierten Lichtstrahlen zu einem seitlichen Punkt auf der Aufzeichnungsfläche der optischen Platte (6) zu lenken, der sich seitlich von einem Punkt auf der Informationsaufzeichnungsspur (8) befindet, an dem der zentrale Teil der von der Lichtquelle (1) emittierten Lichtstrahlen durch die Sammellinseneinrichtung (5) konvergent gemacht wird;
eine zweite Photodetektoreinrichtung (53a, 53b) zum Aufnehmen und Detektieren des Teils der Lichtstrahlen, die durch die Lenkeinrichtung (53, 3; 90) einem Lenkvorgang unterzogen worden sind und danach an dem seitlichen Punkt auf der Aufzeichnungsfläche der optischen Platte (6) reflektiert worden sind; und eine Berechnungseinrichtung (61a, 61b, 62, 63, 35), die mit der zweiten Photodetektoreinrichtung (53a, 53b) gekoppelt ist, zum Berechnen einer Neigung der Aufzeichnungsfläche der optischen Platte (6) in bezug auf eine optische Achse der Sammellinseneinrichtung (5) auf der Grundlage eines Ausgangssignals der zweiten Photodetektoreinrichtung (53a, 53b), wobei die Berechnungseinrichtung (35) ein Signal abgibt, das der berechneten Neigung der Aufzeichnungsfläche der optischen Platte (6) entspricht;
dadurch gekennzeichnet,
daß es sich bei den genannten Lichtstrahlen, die auf einen seitlichen Punkt der Platte (6) gerichtet werden, um Lichtstrahlen handelt, die für Aufzeichnungs- und Wiedergabezwecke unnötig sind und die sich ohne Beeinträchtigung des für die Aufzeichnung und Wiedergabe verwendeten Strahls erhalten lassen;
und daß die Vorrichtung folgendes aufweist:
eine mit der Berechnungseinrichtung (61a, 61b, 62, 63, 35) gekoppelte Betätigungseinrichtung (36), um in Abhängigkeit von dem von der Berechnungseinrichtung abgegebenen Signal die Haltung der optischen Kopfvorrichtung in bezug auf die Aufzeichnungsfläche der optischen Platte (6) einzustellen, so daß die Neigung der Aufzeichnungsfläche in bezug auf die optische Achse der Sammellinseneinrichtung (5) eingestellt wird.

2. Optische Kopfvorrichtung nach Anspruch 1, wobei die genannten, zu einem seitlichen Punkt der Platte (6) gelenkten Lichtstrahlen von den von der Lichtquelle emittierten Lichtstrahlen durch den genannten Strahlteiler getrennt werden und der Strahlteiler ein halbdurchlässiger Spiegel (4) ist.

3. Optische Kopfvorrichtung nach Anspruch 2, wobei ein Planspiegel (92) zum Reflektieren der gelenkten Strahlen in Richtung auf den seitlichen Punkt der Platte vorgesehen ist und wobei die Vorrichtung außerdem eine konvexe Linseneinrichtung (93) zum Kollimieren des durch den Spiegel (92) reflektierten Teils der Strahlen aufweist.

4. Optische Kopfvorrichtung nach Anspruch 1, wobei die genannten, zu einer seitlichen Stelle der Platte (6) gelenkten Lichtstrahlen von einem Randbereich der genannten, von der Lichtquelle (1) emittierten Lichtstrahlen umgelenkt werden.

5. Optische Kopfvorrichtung nach Anspruch 4, wobei die Einrichtung zum Umlenken von Licht eine Brechungseinrichtung (55a, 55b) ist, die in einem Randbereich der genannten Sammellinse (5) angeordnet ist.

6. Optische Kopfvorrichtung nach Anspruch 5, wobei die Brechungseinrichtung ein Prisma (55a, 55b) aufweist, das an einem Flanschbereich der Sammellinseneinrichtung (5) ausgebildet ist.

7. Optische Kopfvorrichtung nach Anspruch 5, wobei die Brechungseinrichtung eine Einrichtung (55a, 55b) aufweist, um den Randanteil der von der Brechungseinrichtung (55a, 55b) gebrochenen Strahlen konvergent zu machen.

8. Optische Kopfvorrichtung nach Anspruch 4, die folgendes aufweist:
eine erste Beugungsgittereinrichtung (3c) zum Beugen eines zentralen Teils der von der Lichtquelle (1) emittierten Strahlen, um diesen in eine Vielzahl von Strahlbündeln zu zerlegen; und
eine zweite Beugungsgittereinrichtung (3a, 3b), die in integraler Weise mit der ersten Beugungsgittereinrichtung seitlich von dieser ausgebildet ist, um den genannten Randanteil der von der Lichtquelleneinrichtung (1) emittierten Strahlen zu beugen, um diesen Teil umzulenken und ihn über die Sammellinseneinrichtung (5) auf einen seitlichen Punkt auf der Aufzeichnungsfläche der optischen Platte (6) zu lenken, der sich seitlich von den Punkten entlang der Informationsspur befindet, auf welche die Strahlbündel durch die Sammellinseneinrichtung (5) konvergent gemacht werden.

9. Optische Kopfvorrichtung nach Anspruch 8, wobei die zweite Beugungsgittereinrichtung (3a,

3b) folgendes aufweist:
ein Beugungsgitter, dessen Gitterabstand sich allmählich ändert,
sowie eine Einstelleinrichtung (3d) zum Einstellen einer Position des Beugungsgitters in Richtung einer Gitterabstands-Veränderung.

10. Optische Kopfvorrichtung nach Anspruch 8 oder 9,
wobei die erste und die zweite Beugungsgittereinrichtung (3a, 3b) Beugungsgitter mit sägezahnförmigem Querschnitt aufweisen.

11. Optische Kopfvorrichtung nach Anspruch 8, 9 oder 10,
weiterhin mit einer Aperturblendeneinrichtung (16) zum Begrenzen der Apertur der Sammellinseneinrichtung für die Strahlbündel, in die der zentrale Teil der von der Lichtquelleneinrichtung (1) emittierten Strahlen durch die erste Beugungsgittereinrichtung (3c) zerlegt ist.

12. Optische Kopfvorrichtung nach einem der Ansprüche 1 bis 11,
wobei die zweite Photodetektoreinrichtung ein Paar von Photodetektorzellen (53a, 53b) aufweist und das von der Berechnungseinrichtung (61a, 61b, 62, 63, 35) abgegebene Signal einer Differenz zwischen zwei Ausgangssignalen des Paares der Photodetektorzellen (53a, 53b) entspricht.

13. Optische Kopfvorrichtung nach Anspruch 4,
die folgendes aufweist:
eine Reflexionseinrichtung (90) zum Reflektieren des genannten Randteiles der von der Lichtquelle emittierten Lichtstrahlen, um diesen Teil dadurch umzulenken und über die Sammellinseneinrichtung (5) zu dem seitlichen Punkt auf der Aufzeichnungsfläche der optischen Platte (6) zu lenken.

14. Optische Kopfvorrichtung nach Anspruch 13,
wobei die zweite Photodetektoreinrichtung (53a, 53b) ein Paar von Photodetektorzellen (53a, 53b) aufweist und wobei das von der Berechnungseinrichtung (61a, 61b, 62, 63, 35) abgegebene Signal einer Differenz zwischen zwei Ausgangssignalen des Paares der Photodetektorzellen (53a, 53b) entspricht.

15. Optische Kopfvorrichtung nach Anspruch 13 oder 14,
wobei die zweite Photodetektoreinrichtung (53a, 53b) in unmittelbarer Nähe der ersten Photodetektoreinrichtung (10) angeordnet ist, um die Randlichtstrahlen aufzunehmen, die von der Aufzeichnungsfläche der optischen Platte (6) über die Sammellinseneinrichtung (5) und die Strahlteilereinrichtung (4) reflektiert werden.

16. Optische Kopfvorrichtung nach Anspruch 13 oder 14,
wobei die zweite Photodetektoreinrichtung (53a, 53b) an einem Flanschbereich der Sammellinseneinrichtung (5) angeordnet ist, um die an der Aufzeichnungsfläche der optischen Platte (6) reflektierten Randlichtstrahlen direkt von dieser aufzunehmen.

17. Optische Kopfvorrichtung nach Anspruch 13 oder 14,
wobei die zweite Photodetektoreinrichtung (53a, 53b) seitlich von der Sammellinseneinrichtung (5) angeordnet ist, um die Randlichtstrahlen aufzunehmen, die einer Reflexionsbeugung erster Ordnung an der Aufzeichnungsfläche der optischen Platte (6) unterworfen werden.

18. Optische Kopfvorrichtung nach einem der Ansprüche 13 bis 17,
ferner mit einer Aperturblendeneinrichtung (16) zum Begrenzen der Apertur der Sammellinseneinrichtung (5) für den zentralen Teil der von der Lichtquelleneinrichtung (1) emittierten Strahlen.

19. Optische Kopfvorrichtung nach Anspruch 13,
wobei die zweite Photodetektoreinrichtung (53a, 53b) eine Linearpositions-Detektoreinrichtung aufweist, die auf einem Substrat angeordnet ist, an dem die erste Photodetektoreinrichtung (10) angeordnet ist, zum Detektieren einer linearen Position der darauf auftreffenden Randlichtstrahlen nach deren Reflexion auf der Aufzeichnungsfläche der optischen Platte (6), wobei die Linearpositions-Detektoreinrichtung ein Signal abgibt, das der detektierten linearen Position der auftreffenden Strahlen entspricht.

Revendications

1. Dispositif à tête optique pour enregistrer et reproduire une information sur une surface d'enregistrement d'un disque optique (6), comprenant :
un moyen de source de lumière (1) pour émettre des rayons de lumière ;
un moyen de lentille convergente (5) pour converger des rayons émis par ladite source de lumière (1) sur une piste d'information (8) sur la surface d'enregistrement du disque optique (6), où des rayons de lumière convergés sur la surface d'enregistrement du disque optique (6) sont réfléchis par celle-ci pour former des rayons réfléchis de lumière ;
un moyen séparateur de faisceaux (4)

pour séparer desdits rayons émis par la source de lumière (1) lesdits rayons réfléchis de lumière qui ont été réfléchis de la surface d'enregistrement du disque optique (6) et transmis à travers ledit moyen de lentille convergente (5) ;

un premier moyen photodétecteur (10) pour recevoir et détecter lesdits rayons réfléchis de lumière qui sont passés à travers le moyen de lentille convergente (5) et ont été séparés par ledit moyen séparateur de faisceaux (4), reproduisant de la sorte l'information enregistrée sur ladite piste sur le disque optique (6) ;

un moyen (55 ; 3 ; 90) pour diriger une portion desdits rayons de lumière émis par ladite source de lumière (1) à un point latéral sur ladite surface d'enregistrement du disque optique (6) situé sur un côté d'un point sur la piste d'enregistrement d'information (8) sur laquelle la portion centrale des rayons émis par la source de lumière (1) est convergée par le moyen de convergence (5) ;

un second moyen photodétecteur (53a, 53b) pour recevoir et détecter ladite portion des rayons de lumière qui a été dirigée par ledit moyen de direction (53 ; 3 ; 90) et ensuite réfléchie audit point latéral sur la surface d'enregistrement du disque optique (6) ; et

un moyen de calcul (61a, 61b, 62, 63, 35), couplé audit second moyen photodétecteur (53a, 53h), pour calculer d'une sortie dudit second moyen photodétecteur (53a, 53b) une inclinaison de ladite surface d'enregistrement du disque optique (6) par rapport à un axe optique du moyen de lentille convergente (5), ledit moyen de calcul (35) produisant un signal correspondant à l'inclinaison calculée de la surface d'enregistrement du disque optique (6) ;

caractérisé en ce que lesdits rayons de lumière dirigés sur un point latéral du disque (6) sont des rayons de lumière non nécessaires pour des buts d'enregistrement et de reproduction et qui sont obtenus sans affecter le faisceau utilisé pour enregistrer et reproduire; et le dispositif comprend

un moyen actionneur (36), couplé audit moyen de calcul (61a, 61b, 62, 63, 35), pour régler, en réponse audit signal produit par ledit moyen de calcul, une attitude dudit dispositif à tête optique par rapport à la surface d'enregistrement du disque optique (6) de sorte que l'inclinaison de ladite surface d'enregistrement par rapport à l'axe optique du moyen de lentille convergente (5) est réglée.

2. Dispositif à tête optique selon la revendication 1, dans lequel les rayons précités de lumière dirigés à un point latéral du disque (6) sont séparés des rayons de lumière émis par la source de lumière par le séparateur de faisceaux précité et le séparateur de faisceaux est un miroir semi-réfléchissant (4).

3. Dispositif à tête optique selon la revendication 2, dans lequel un miroir plan (92) est prévu pour réfléchir les rayons dirigés vers le point latéral du disque et le dispositif comprend de plus un moyen de lentille convexe (93) pour collimater la portion de rayons réfléchie par le miroir (92).

4. Dispositif à tête optique selon la revendication 1, dans lequel les rayons précités de lumière dirigés à un point latéral du disque (6) sont déviés d'une région périphérique des rayons précités de lumière émis par la source de lumière (1).

5. Dispositif à tête optique selon la revendication 4, dans lequel le moyen pour dévier la lumière est un moyen de réfraction (55a, 55b) disposé dans une région périphérique de la lentille convergente précitée (5).

6. Dispositif à tête optique comme revendiqué en revendication 5, dans lequel le moyen de réfraction précité comprend un prisme (55a, 55b) formé à une portion de bride du moyen de lentille convergente précité (5).

7. Dispositif à tête optique comme revendiqué en revendication 5, dans lequel le moyen de réfraction précité comprend un moyen (55a, 55b) pour converger la portion périphérique précitée des rayons réfractés par le moyen de réfraction précité (55a, 55b).

8. Dispositif à tête optique selon la revendication 4, comprenant :

un premier moyen de réseau de diffraction (3c) pour diffracter une portion centrale des rayons émis par la source de lumière précité (1), afin de la séparer en un certain nombre de pinceaux de rayons ; et

un second moyen de réseau de diffraction (3a, 3b), formé intégralement avec ledit premier moyen de réseau de diffraction à un côté de celui-ci, pour diffracter ladite portion périphérique desdits rayons émis par ladite source de lumière (1) afin de la dévier et la diriger par l'intermédiaire du moyen de lentille convergente (5) sur un point latéral sur la surface d'enregistrement précitée du disque optique (6) qui est situé à un côté des points le long de la piste d'information sur laquelle lesdits pinceaux de rayons sont convergés par ledit moyen de lentille convergente (5).

9. Dispositif à tête optique comme revendiqué en revendication 8, dans lequel le second moyen de

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réseau de diffraction précité (3a, 3b) comprend : un réseau de diffraction dont l'intervalle de réseau est varié graduellement, et un moyen de réglage (3d) pour régler une position du réseau de diffraction dans une direction de variation de l'intervalle du réseau.

10. Dispositif à tête optique comme revendiqué en revendication 8 ou 9, dans lequel les premier et second moyens de réseau de diffraction précités (3a, 3b) comprennent des réseaux de diffraction ayant une section en forme de dents de scie.

11. Dispositif à tête optique comme revendiqué en revendication 9, 9 ou 10, comprenant de plus un moyen limiteur d'ouverture (16) pour limiter une ouverture du moyen de lentille convergente précité pour les pinceaux de rayons dans lesquels la portion centrale précitée des rayons émis par le moyen de source de lumière (1) est séparée par le premier moyen de réseau de diffraction précité (3c).

12. Dispositif à tête optique comme revendiqué dans l'une quelconque des revendications 1 à 11, dans lequel le second moyen photodétecteur précité comprend une paire de cellules de photodétecteur (53a, 53b), et le signal précité produit par le moyen de calcul précité (61a, 61b, 62, 63, 35) correspond à une différence entre deux sorties desdites paires de cellules de photodétetceur (53a, 53b).

13. Dispositif à tête optique selon la revendication 4, comprenant :

un moyen de réflexion (90) pour réfléchir la portion périphérique précitée des rayons précités de lumière émis par la source de lumière précitée, la déviant et la réfléchissant de la sorte par l'intermédiaire du moyen de lentille convergente précité (5) au point latéral sur la surface d'enregistrement précitée du disque optique (6).

14. Dispositif à tête optique comme revendiqué en revendication 13, dans lequel le second moyen photodétecteur précité (53a, 53b) comprend une paire de cellules de photodétecteur (53a, 53b), et le signal précité produit par le moyen de calcul précité (61a, 61b, 62, 63, 35) correspond à une différence entre deux sorties de ladite paire de cellules de photodétecteur (53a, 53b).

15. Dispositif à tête optique comme revendiqué en revendication 13 ou 14, dans lequel le second moyen photodétecteur précité (53a, 53b) est disposé à proximité du premier moyen de photodétecteur précité (10) pour recevoir les rayons périphériques de lumière réfléchis par la surface d'enregistrement du disque optique (6) par l'intermédiaire du moyen de lentille convergente (5) et du moyen séparateur de faisceaux (4).

16. Dispositif à tête optique comme revendiqué en revendication 13 ou 14, dans lequel le second moyen photodétecteur précité (53a, 53b) est disposé sur une portion de bride du moyen de lentille convergente précité (5) pour recevoir les rayons périphériques de lumière réfléchis par la surface d'enregistrement du disque optique (6), directement de celle-ci.

17. Dispositif à tête optique comme revendiqué en revendication 13 ou 14, dans lequel le second moyen photodétecteur précité (53a, 53b) est disposé sur un côté du moyen de lentille convergente précité (5) pour recevoir les rayons périphériques de lumière supportant une diffraction de réflexion du premier ordre à la surface d'enregistrement du disque optique (6).

18. Dispositif à tête optique comme revendiqué dans l'une quelconque des revendications 13 à 17, comprenant de plus un moyen limiteur d'ouverture (16) pour limiter une ouverture du moyen de lentille convergente précité (5) pour la portion centrale des rayons émis par le moyen de source de lumière (1).

19. Dispositif à tête optique comme revendiqué en revendication 13, dans lequel le second moyen photodétecteur (53a, 53b) comprend un moyen détecteur de position linéaire, disposé sur un substrat sur lequel le premier moyen photodétecteur précité (10) est disposé, pour détecter une position linéaire des rayons périphériques de lumière incidents sur celui-ci après avoir été réfléchis à la surface d'enregistrement du disque optique (6), le détecteur de position linéaire produisant un signal correspondant à la position linéaire détectée des rayons incidents.