Description

The present invention relates to an optical head device or an optical pickup device used for optical disk systems to optically perform recording, reproduction and erasure of information such as data, image and music.

An important problem in the optical recording and reproducing art relates to the need for an optical head device which can be manufactured with a simple structure and at as low cost as possible. Generally, for optical recording and reproduction of information, a focus error signal and a tracking error signal are detected on the basis of light spots formed on photodetectors by light beams from an optical recording medium such as an optical disk.

EP-A-0,201,917, on which the pre-characterising portion of appended claim 1 is based, discloses an optical system in which the reflected light beam is split into two beams which are directed to a split photodetector. However, generally the diameters of the spots of beams for the detection of the focus error signal and the detection of the tracking error signal are required to be different from each other, thereby requiring provision of two photodetectors at different positions. The provision of the two photodetectors at the different positions causes complication of the arrangement of the optical system, and this can result in deterioration of the detection accuracy concurrent with increase in the manufacturing cost. Thus, a further improvement in terms of the arrangement of the optical head device would be required from the viewpoint of decrease in the manufacturing cost.

It is therefore an object of the present invention to provide an optical head device or an optical pickup device for use in an optical disk system which has a simple structure to reduce the manufacturing cost.

According to the present invention there is provided an optical head device for optically recording and/or reproducing information on and from an optical recording medium, comprising:

light source means for emitting a light beam;

collimator means for causing said light beam from said light source means to become a parallel light beam;

objective lens means for converging said parallel light beam from said collimator means on said optical recording medium;

first optical means provided between said collimator means and said objective lens means for reflecting the light beam returned from said optical recording medium; and

a reflected light beam path having:

second optical means for separating a light beam to generate two light beams which are optically cross-polarized to each other, said two separated light beams being directed in substantially the same direction and being separated by a predetermined distance from each other;

converging means for converging a light beam; and

photodetector means for respectively receiving two separated light beams; characterised in that

said converging means is arranged to converge the light beam reflected by said first optical means, said photodetector means is arranged to receive the two light beams from said second optical means and said second optical means is arranged to separate the light beam from said converging means and to cause the optical path length to the photodetector means of one of the two separated converging light beams to be longer than that of the other separated converging light beam.

Preferably, the optical head device further comprises third optical means provided between the second optical means and the photodetector means for dividing one of the two separated light beams from the second optical means into two light beams which are separately incident on the photodetector means and for transmitting the other separated light beam which is directly incident thereon. The third optical means can be arranged so that the optical path length of one of the two divided light beams is longer than that of the other divided light beam. Further, the photodetector means can be composed of a substrate and first and second light-receiving portions placed on the substrate, the first light-receiving portion being divided along a line into two portions and the second light-receiving portion comprises two sections each of which is divided along two parallel lines into three portions, the first and light-receiving portions are provided such that the division line of the first light-receiving portion is perpendicular to the two parallel division lines of the second light-receiving portion.

Features of the present invention will become more readily apparent from the following detailed description of the preferred embodiments taken in conjunction with the accompanying drawings in which by way of example:

Fig. 1 is an illustration of a conventional optical head device;

Fig. 2 is an illustration of an arrangement of an optical head according to a first embodiment of the present invention;

Figs. 3A and 3B are partial cross-sectional views of the Fig. 2 optical head device;

Figs. 4A to 4C are illustration of converging states of light beams to be incident on a photodetector assembly;

Fig. 5 is an illustration of an optical head device according to a second embodiment of the present invention;

Figs. 6A to 6C are illustrations of an optical head device according to a third embodiment of this invention;

Figs. 7 and 8 are illustrations for describing the

outputs of a photodetector assembly;
Figs. 9A and 9B are illustrations for describing an optical head device according to a fourth embodiment of this invention; and
Figs. 10A and 10B show a modification of the optical head device illustrated in Figs. 9A and 9B.

DETAILED DESCRIPTION OF THE INVENTION

Prior to describing the embodiments of the present invention, a brief description will be made in terms of a prior art optical head device with reference to Fig. 1 for a better understanding of this invention.

Fig. 1 is an illustration of an arrangement of a conventional optical head device comprising a semiconductor laser 1 coupled to a high-frequency module 2 which is operable only during reproducing operation so as to modulate a laser beam emitted from the semiconductor laser 1 with a frequency of 600 to 800 MHz to improve the S/N ratio of the reproduction signal. This high-frequency module 2 is encased in a metallic case which is in earth connection with a case of the semiconductor laser 1 and a housing of the optical head device by means of the soldering. The laser beam from the semiconductor laser 1 first directs to a collimator lens 3 so as to be substantially collimated, then advancing toward a wedge prism 4 and a polarizing prism 5 whereby the laser beam is enlarged in one direction. Generally, the laser beam is enlarged up to 2.2 to 2.6 times. After passed through the polarizing prism 5, the laser beam is focused on an optical disk 7 by means of an objective lens 6. A beam reflected from the optical disk 7 returns to the objective lens 6 and the polarizing prism 5 where the beam from the optical disk 7 is reflected. Here, in the case of recording and reproduction of a magneto-optical signal, the polarizing prism 5 may be arranged such that the rate of transmission of the P-polarization is 60 to 80% and the rate of transmission of the S-polarization is below 1%, and the rate of reflection of the P-polarization is 20 to 40% and the rate of reflection of the S-polarization is above 98%. Illustrated at numeral 8 is a half-wave plate which is, if required, provided in view of an arrangement of the optical system.

After condensed by a focus detection lens 9, the reflected beam due to the polarizing prism 5 is incident on a plane parallel plate 13 which separates the incident beam into P-polarization and S-polarization. The beam (P-polarization) passing through the plane parallel plate 13 generates astigmatism and reaches a first photodetector 14 where a focus error signal can be obtained in accordance with a well known technique such as an astigmatic method. On the other hand, the beam (S-polarization) reflected at the plane parallel plate 13 is incident on a second photodetector 15 where a tracking error signal can be obtained in accordance with a so-called far-field technique. A magneto-optical signal can be obtained on the basis of the difference between the outputs of the first and second photodetectors 14 and 15.

Such an arrangement of the optical head device requires provision of the two photodetectors 14 and 15 at different positions, because of the difference between the diameters of the beam spots necessary for the detections of the focus error signal and tracking error signal in addition to separation of the P-polarization and S-polarization in different directions. That is, in the case of obtaining the tracking error signal in accordance with the far-field technique, if taking into account the drift and temperature stability, it is preferable that the diameter of a beam spot formed on the photodetector 15 is in an range from about 400 micrometers to 1.5 millimeters, because increase in the area of the photodetector 15 causes deterioration of the frequency characteristic. Similarly, it is preferable that the diameter of a beam spot formed on the photodetector 14 exists in a range from 50 to 250 micrometers, in order for prevention of deterioration of the detection sensitivity and lowering of the S/N ratio. Moreover, in the detection of the focus error signal due to the astigmatic technique, the plane parallel plate 13 causes generation of a spherical aberration and coma aberration concurrent with the generation of the astigmatism. These aberrations causes a complex optical path whereby track-crossing noises produced when a light beam crosses track channels of the optical disk 7 can be extremely introduced into the focus error signal.

Referring now to Fig. 2, there is illustrated an optical head device according to an embodiment of the present invention. In Fig. 2, parts corresponding to those in Fig. 1 are marked with the same reference numerals. Similarly, the optical head device of this embodiment comprises a semiconductor laser 1 coupled to a high-frequency module 2 operated only during reproducing operation so as to modulate a laser beam emitted from the semiconductor laser 1 with a predetermined frequency to improve the S/N ratio of the reproduction signal. The laser beam from the semiconductor laser 1 passes through a collimator lens 3 to then advance into a wedge prism 4 and a first polarizing prism 5. After passed through the first polarizing prism 5, the laser beam is focused on an optical disk 7 through an objective lens 6. A beam reflected from the optical disk 7 returns to the objective lens 6 and reaches the first polarizing prism 5 where the beam from the optical disk 7 is reflected so as to pass through a half-wave plate 8 to be rotated so that the polarizing direction takes 45°. This half-wave plate 8 is provided in order to make simple the configuration of the optical system. If not provided, the optical system (10 to 12, 12') to be located after the first polarizing prism 5 is rotated by 45° about the optical axis.

After passed through the half-wave plate 8 and further a detection lens 9 which condenses the beam from the half-wave plate 8, the beam reaches a sec-

ond polarizing prism 10 for separation to the P-polarization and the S-polarization. The second polarizing prism 10 acts as a polarized beam splitter and hence has a first polarizing film 10a and a second polarizing film (or reflection surface) 10b which are provided so as to make a predetermined angle with respect to the optical axis of the light beam from the detection lens 9, whereby the S-polarization is reflected by the first polarizing film 10a so as to direct along a line A-A' in Fig. 2 and the P-polarization is reflected by the second polarizing film 10b after transmission of the first polarizing film 10a so as to advance along a line B-B' in the same figure. Here, one important feature is that, due to the reflections at the first and second polarizing films 10a and 10b, the optical path length of the P-polarization becomes longer than that of the S-polarization. This can make a difference between the diameters of beam spots formed on a photodetector assembly 20 which will be described hereinafter. The line A-A' corresponds to the optical axis of the S-polarization and the line B-B' corresponds to the optical axis of the P-polarization. The S-polarization and P-polarization reflected at the second polarizing prism 10 respectively reach a third polarizing prism 11 which acts as a partial polarized beam splitter in which the transmission of the P-polarization which is S-polarization in the prism 10 since the prisms 10 and 11 are arranged to be perpendicular to each other is substantially 100% and the transmission of the S-polarization which is P-polarization in the prism 11 because the prisms 10 and 11 are arranged to be perpendicular to each other is about 50% and the reflection of the S-polarization is about 50%. Thereafter, three beams formed by passing through the third polarizing prism 11 respectively reach the photodetector assembly 20. The photodetector assembly 20 comprises two photodetectors 12' and 12 for reception of light beams for detections of the tracking error signal and the focus error signal, the two photodetectors 12' and 12 being located on a common substrate (a wafer). The magneto-optical signal can be obtained by the difference between the outputs of the two photodetectors 12' and 12 due to the beams for the detections of the focus error signal and tracking error signal.

In this embodiment, as the objective lens 6 is used an aspherical lens whose numerical aperture (N.A) is 0.53 and as the detection lens 9 is used a single lens whose focal length is 30 millimeters. In this case, the distance between the optical axes A-A' and B-B' of the S-polarization and P-polarization is preferably determined to be about 3 millimeters, whereby it is possible to cause the beam spot for the far-field tracking to be above 400 micrometers.

Generally, for execution of the far-field tracking, a light beam from an optical recording medium is received by a photodetector means which is divided into two portions. The line for the division of the photodetector means is arranged to be in parallel to a track of the optical recording medium and to be positioned at the center of the far-field light beam. The tracking servo can be effected by operating an objective lens (6) in accordance with the outputs of the two-divided photodetector means as described in USP 4491940, for example. Other than the method of the division of the beam from the optical recording medium, there is a method in which used is a photodetector means having two slits which are arranged to be symmetrically positioned with respect to a line which is placed at the center of the beam and extends in parallel to the track. This method can improve the defocus characteristic of a signal indicative of the track error as described in the Japanese Patent Provisional Publication No. 63-222333, for example. Here, the diameter of the beam for the detection of the tracking error signal is preferable to be in the range from 400 micrometers to 2 millimeters. That is, the position relation between the light beam and the photodetector means can be changed with the passage of time, conditions and others, thereby resulting in variation of the difference between the outputs of the two-divided photodetector means. Thus, in order to stably perform the tracking servo, it is preferable that the diameter of the light beam spot formed on the photodetector means is as great as possible. On the other hand, if taking into account the frequency response characteristic, it is preferable that the area of the photodetector means for reception of the light beam is as small as possible. For obtaining an excellent frequency response characteristic and an adequate signal-to-noise ratio, it is general that the beam receiving area thereof is required to be below about 2 millimeters.

Thus, according to this embodiment, as illustrated in Fig. 3A which is a cross-sectional view taken along the A-A' line in Fig. 2, the beam (S-polarization in the prism 10) for the detection of the far-field tracking error signal from the second polarizing prism 10 penetrates the third polarizing prism 11 as it is and then reaches the photodetector assembly 20, so that the diameter of the beam spot formed on the photodetector 12' is between 400 micrometers and 1 millimeter, for example, about 470 micrometers.

Fig. 3B is a cross-sectional view taken along the line B-B' in Fig. 2 and shows beams for the detection of the focus error signal. Here, as illustrated in Fig. 3B, the beam (P-polarization in the prism 10) from the second polarizing prism 10 is divided into two beams by means of the third polarizing prism 11. That is, the third polarizing prism 11 is arranged so that a portion (first divided beam) of the beam from the second polarizing prism 10 is directly transmitted to direct to the photodetector 12 of the photodetector assembly 20 and the remaining portion (second divided beam) thereof is reflected at a polarizing film 11a and further reflected at a reflection surface 11b so as to advance to the same photodetector 12. Due to the reflections, the optical path length formed by the second divided

beam becomes longer than the optical path length formed by the first divided beam, whereby the beam spots formed on the photodetector 12 by the first and second divided beams are different in diameter from each other.

Figs. 4A to 4C illustrate converging states of the first and second divided beams with respect to the photodetector 12 which converging states depend upon the focusing state of the laser beam with respect to the optical disk 7, Fig. 4A showing the case that the objective lens 6 is relatively close to the optical disk 7, Fig. 4B showing the case that the objective lens 6 is placed at a focusing position with respect to the optical disk 7, and Fig. 4C showing the case that the objective lens 6 is relatively away from the optical disk 7. The photodetector 12 comprises six portions 12-1 to 12-6 which are made by first dividing the photodetector 12 into three portions by two parallel lines and further dividing it with a line normal to the two parallel lines. Here, since, as illustrated in Fig. 3B, one (upper side beam in Figs. 4A to 4C) of the beams divided by the third polarizing prism 11 is obliquely incident on the photodetector 12, the beam spot to be formed thereon has a slightly elliptical configuration. Moreover, this oblique incidence causes generation of astigmatism. In this embodiment, for eliminating the effect of the astigmatism so as to adequately effect the focus error signal detection, the optical system is arranged so that the distance between the two beam spots on the photodetector 12 is about 1 millimeters, and, in the case of the focusing state (the state of Fig. 4B), the upper side beam spot has a long diameter of about 240 micrometers and a short diameter of about 200 micrometers and the lower side beam spot has a diameter of about 200 micrometers. The long axis of the upper side beam spot extends in the longitudinal directions of the photodetector 12. The width of the portions 12-2 or 12-5 is preferable to be in the range from 40 to 100 micrometers, and in this embodiment, it is determined to be 80 micrometers.

In this embodiment, the photodetectors 12 and 12′ for the detections of the focus error signal and the tracking error signal are provided on the same substrate so that the directions of a line dividing the photodetector 12′ into two portions is normal to the directions of the two parallel division lines of the photodetector 12. This provision allows the photodetectors 12 and 12′ to be independently adjustable irrespective of the photodetectors 12 and 12′ being provided on the common substrate. That is, it is possible to accurately obtain the focus error signal and the tracking error signal on the basis of the outputs of the photodetectors 12 and 12′ regardless of the provision of the focus error signal detection photodetector 12 and the tracking error signal detection photodetector 12′ on one substrate.

With the above-described arrangement, the focus error signal can be obtained on the basis of the outputs of the six portions 12-1 to 12-6 of the photodetector 12, i.e., by {(12-1) + (12-3) + (12-5)} - {(12-2) + (12-4) + (12-6)} or (12-2) - (12-5) where (12-1) to (12-6) represent the outputs of the six portions of the photodetector 12, respectively. The detection sensitivity Δ of the focus error signal can be expressed by the following equation.

$$\Delta = \frac{fo^2\, fc^2\, \alpha}{fc^4 - \alpha^2(fo + fc - \ell o)^2} \quad (1)$$

where fo represents the focal length of the objective lens 6, fc designates the focal length of the detection lens 9, ℓo depicts the optical path length from the objective lens 6 to the detection lens 9, and α is a value corresponding to 1/2 of the difference between the optical paths of the upper side beam and the lower side beam illustrated in Fig. 3B.

If $\ell o = fo + fc$ and fc is extremely greater than α, the above-mentioned equation (1) can be rewritten as follows.

$$\Delta = \left(\frac{fo^2}{fc}\right)^2 \alpha \quad (2)$$

This embodiment is arranged so that the focus sensitivity obtained in accordance with this calculation becomes about 22 micrometers.

According to the above-mentioned equation (2), a further improvement of the focus sensitivity can be achieved by increasing fc or decreasing α. However, the increase of fc causes enlargement of the optical system and the decrease of α reduces the beam diameter. In practice, the reduction of the beam diameter is limited up to a predetermined value, for example, 100 micrometers.

This embodiment can reduce the track-crossing noises produced when the laser beam from the objective lens 6 crosses the tracks on the optical disk 7. That is, the direction connecting the portions 12-2 and 12-5 of the photodetector 12 are coincident with the direction of the diffracted light caused by the track of the optical disk 7 due to the focus error signal detection beam. This arrangement causes the track-crossing noise to be reduced.

As a further factor for generation of the track-crossing noise, there is a relation between the track channel and the polarizing direction of the illumination beam. Generally, when the track pitch approaches the wavelength region, the characteristic due to the polarizing direction is started to be varied. In the case that the electrid field vector of the illumination beam detects in a direction parallel to the channel, the diffraction efficiency becomes great to increase the tracking error signal. However, since the diffraction efficiency of the high-order light similarly becomes great, the level of the track-crossing noise to be introduced into the focus error signal becomes high, whereby difficulty is encountered to reduce the modulation of the focus error signal. On the other hand, when the electric field vector of the illumination beam directs in a direction normal to the channel, the dif-

fraction efficiency is lowered. In this embodiment, under the conditions that the track pitch is 1.6 micrometers, the depth of the channel is 1/8 of the wavelength which is 780 nm, and the information recording duty ratio on the track is 30 to 50%, in the case of the vertical electric vector, the level of the tracking error signal becomes about 80%. Although the track-crossing noise level is difficult to be below 1 micrometer in the case of the parallel electric vector, it can be reduced to be below 0.5 micrometers in the case of the vertical electric field vector. Thus, for reducing the track-crossing noise level of the optical head device, the electric field vector perpendicular to the track channel is preferable. On the other hand, for increasing the tracking error signal level, the electric field vector parallel to the track channel is preferable.

It is generally considered that, as a method of making the electric field vertical with respect to the track channel, a second half-wave plate 16 is provided between the first polarizing prism 5 and the objective lens 6 as illustrated in Fig. 2. This arrangement is suitable for thickness reduction of the optical system. It is possible that in construction the second half-wave plate 16 is integrally coupled to the first polarizing prism 5, and further in the separation type optical system allowing only the objective lens 6 to be movable in the directions of the optical axis by means of a transferring base, it is possible to additionally use it as a guarding window for preventing dust from being introduced into the optical system. In the separation type optical system, there is a problem that the sensitivity of the focus error signal is varied. However, according to this embodiment, the sensitivity variation is below about 4% under the condition that the transferring distance of the objective lens 6 is about 22 millimeters.

The optical head device illustrated in Fig. 2 can be used as a light-once type optical head device by changing the characteristic of the polarizing film of the first polarizing prism. In this case, the second half-wave plate 16 is required to be changed to a quarter wavelength plate.

Fig. 5 is an illustration of an optical head device according to another embodiment of the present invention, in which parts corresponding to those in Fig. 2 are marked with the same numerals and the description will be omitted for brevity. In Fig. 5, a light beam reflected from an optical disk 7 passes through a first polarizing prism 5, a half-wave plate 8 and a detection lens 9 and reaches a second polarizing prism 10 to separate the light beam into the S-polarization and the P-polarization. The S-polarization is used for detection of the far-field tracking error signal and the P-polarization is used for detection of the focus error signal in accordance with the astigmatism system. The S-polarization from the second polarizing prism 10 directly directs to a photodetector 12' of a photodetector assembly 20. On the other hand, the P-polarization reaches a photodetector 12 of the photodetector assembly 20 through a plane parallel plate 17 whereby the P-polarization generates astigmatism. Here, the photodetector 12 is of the four-division type whereby the focus error signal ben be obtained in accordance with the astigmatism method. This arrangement is suitable for the case that the track-crossing noise is beside the question. Here, it is appropriate to use a hologram, a loop-type prism or others as the plane parallel plate 17. Further, in the case of no detection of the far-field tracking error signal, the plane parallel plate 17 is not required with the focus error signal being detected by moving the photodetector assembly 20 along the optical axis.

Fig. 6A is an illustration of an optical head device according to a third embodiment of the present invention. In Fig. 6A, a laser beam emitted from a semiconductor 101 passes through a collimator lens 102, a first polarizing prism (polarizing beam splitter) 103 and an objective lens 104 and then reaches an optical disk 105. A beam reflected from the optical disk 105 returns to the objective lens 104 and is reflected at the first polarizing prism 103 so as to pass through a half-wave plate 106 and a signal lens 107 and be incident on a second polarizing prism 108. The half-wave plate 106 is provided in order to rotate the polarized direction by 45°. Of the beam from the half-wave 106, the S-polarization is reflected at a polarizing film 108a of the second polarizing prism 108 and the P-polarization passes through the polarizing film 108a and is then reflected at a reflection surface 108b thereof and further passes through the polarizing film 108a thereof. A reflection beam 109 (S-polarization) and a reflection beam (P-polarization) 110 from the second polarizing prism 108 reach a photoelectric converting device 112 through a third polarizing prism 111. Fig. 6B is a cross-sectional view showing the third polarizing prism 111 and Fig. 6C shows an arrangement of the photo-electric converting device including a first light receiving portion 113 and a second light-receiving portion 114. The photoelectric converting device 112, as illustrated in Fig. 6C, comprises a substrate 112' and the first and second light-receiving portions 113 and 114 placed on the substrate 112'. The first light-receiving portion 113 is divided along a line into two portions and the second light-receiving section 114 comprises two sections 114a and 114b each of which is divided by two parallel lines, extending in parallel to the axis of the section 114a or 114b, into three portions, whereby the second light-receiving portion results in being composed of six portions. The two sections 114a and 114b are successively arranged so that the two parallel division lines of the section 114a are coincident with the two parallel division lines of the section 114b thereof are coincident with each other. The first light-receiving portion 113 is provided adjacent one section 114b of the second light-receiving portion 114, and

the division line of the first light-receiving portion 113 is arranged to be normal to the two parallel division lines of the second light-receiving portion 114. The third polarizing prism 111 is substantially arranged so that the transmission of the P-polarization is 100%, the transmission of the S-polarization is 50% and the reflection of the S-polarization is 50%. Thus, all the reflection beam 109 penetrates the third polarizing prism 111 and is incident on the first light-receiving portion 113 of the photo-electric converting device 112, the reflection beam 110 is divided into two portions as illustrated in Fig. 6B and the two divided beams are incident in parallel on the second light-receiving portion 114 of the photo-electric converting device 112.

The two division beams of the reflection beam 110, as illustrated in Fig. 6C, form two beam spots on the second light-receiving portion 114. The focusing error signal can be obtained on the basis of the outputs of the six portions of the second light-receiving portion 114 in accordance with a well known spot size detection (SSD) technique. That is, with reference to Fig. 7, the focusing error signal can be obtained by the difference between the sum (1) of the outputs of the three portions of the six portions and the sum (2) of the outputs of the remaining three portions thereof. On the other hand, the first light-receiving portion 113 is divided into two portions, and the tracking error signal can be obtained on the basis of the difference between the outputs (3) and (4) of the two divided portions of the first light-receiving portion 113 in accordance with the well known far-field technique. Further, the magneto-optical signal and other information signals can be obtained on the basis of the outputs of the first and second light-receiving portions 113 and 114.

Here, if the tracking control is effected in accordance with the sample servo technique, the photo-electric converting device 112 can be arranged as illustrated in Fig. 8. In this case, the detection of the tracking error signal in accordance with the far-field technique is not required, and therefore it is not necessary to divide the first light-receiving portion 113 into two portions, thereby resulting in a simple structure. The magneto-optical signal can be obtained as (1) + (2) - (5), and the sample servo signal and address information can be obtained on the basis of the result of (1) + (2) + (5).

Fig. 9A shows an optical head device according to a fourth embodiment of this invention. Parts corresponding to those in Fig. 6A are marked with the same numerals. In Fig. 9A, a light beam emitted from a semiconductor laser 101 passes through a collimator lens 102, a polarizing prism (polarizing beam splitter) 103 and an objective lens 104 and then reaches an optical disk 105. A beam reflected at the optical disk 105 returns to the objective lens 104 and reaches the polarizing prism 103 so as to be reflected to advance to a half-wave plate 106 which rotates the polarizing direction by 45°. The beam emerging from the half-wave plate 106 is incident on a Wollaston prism 116 so as to be separated into first and second beams 117 and 118. The first and second beams 117 and 118 are full-reflected by a critical angle prism 119 and then pass through a single lens 120 to reach a photo-electric converting device 121 comprising a first light-receiving portion 122 and a second light-receiving portion 123 as illustrated in Fig. 9B. The first beam 117 is incident on the first light-receiving portion 122 and the second beam 118 is incident on the second light-receiving portion 123. Each of the first and second light-receiving portions 122 and 123 is divided into two portions and the division lines of both the first and second light-receiving portions 122 and 123 are arranged to be normal to each other.

The first beam 117 to be full-reflected by the critical angle prism 119 is arranged to be incident on the critical angle prism 119 with the critical angle with respect to the full-reflection surface of the critical angle prism 119 when the optical head device is in the focus state with respect to the optical disk 105. Further, the second beam 118 is incident thereon with an angle slightly smaller than the critical angle with respect to the full-reflection surface, and therefore, when the optical head device is in the focus state with respect thereto, the second beam 118 is full-reflected thereat. With this arrangement, the focusing error signal can be obtained in accordance with a known critical angle method. That is, with reference to Fig. 9B, the focusing error signal is detected one the basis of the difference between the outputs (6) and (7) of the first light-receiving portion 122. On the other hand, the tracking error signal can be obtained on the basis of the difference between the outputs (8) and (9) of the second light-receiving portion 123. Moreover, the magneto-optical information signal can be obtained as (6) + (7) - (8) - (9) and the address information signal can be obtained as (6) + (7) + (8) + (9). This arrangement can make simple the arrangement of the optical head device as compared with the arrangement of the third embodiment.

Although in the fourth embodiment the half-wave plate 106 is provided between the Wollaston prism 116 and the polarizing prism 103, it is also appropriate to remove the half-wave plate 106 as illustrated in Fig. 10A. In this case, the Wollaston prism 116 is required to be rotated by 45° and hence the first and second light-receiving portions 122 and 123 are positioned as illustrated in Fig. 10B.

It should be understood that the foregoing relates to only preferred embodiments of the invention, and that it is intended to cover all changes and modifications of the embodiments of the invention herein used for the purposes of the disclosure, which do not constitute departures from scope of the claims.

* C L M S *

Claims

1. An optical head device for optically recording and/or reproducing information on and from an optical recording medium (7), comprising:
light source means (1) for emitting a light beam;
collimator means (3) for causing said light beam from said light source means (1) to become a parallel light beam;
objective lens means (6) for converging said parallel light beam from said collimator means (3) on said optical recording medium (7);
first optical means (5) provided between said collimator means (3) and said objective lens means (6) for reflecting the light beam returned from said optical recording medium (7); and
a reflected light beam path having:
second optical means (10) for separating a light beam to generate two light beams which are optically cross-polarized to each other, said two separated light beams being directed in substantially the same direction and being separated by a predetermined distance from each other;
converging means (9) for converging a light beam; and
photodetector means (20) for respectively receiving two separated light beams; characterised in that
said converging means (9) is arranged to converge the light beam reflected by said first optical means (5), said photodetector means (20) is arranged to receive the two light beams from said second optical means (10) and said second optical means (10) is arranged to separate the light beam from said converging means (9) and to cause the optical path length to the photodetector means (20) of one of the two separated converging light beams to be longer than that of the other separated converging light beam.

2. An optical head device as claimed in claim 1 further comprising third optical means (11) provided between said second optical means (10) and said photodetector means (20) for dividing one of the two separated light beams from said second optical means (10) into two light beams which are separately incident on said photodetector means (20) and for transmitting the other separated light beam which is directly incident thereon.

3. An optical head device as claimed in claim 2, wherein said third optical means (11) is arranged so that the optical path length of one of the two divided light beams is longer than that of the other divided light beam.

4. An optical head device as claimed in claim 2 or 3 wherein said photodetector means (20) is composed of a substrate and first (113) and second (114) light-receiving portions placed on said substrate, said first light-receiving portion (113) being divided along a line into two portions and said second light-receiving portion (114) comprises two sections (114a, 114b) each of which is divided along two parallel lines into three portions, said first and second light-receiving portions are provided such that the division line of said first light-receiving portion (113) is perpendicular to the two parallel division lines of said second light-receiving portion (114).

5. An optical head device as claimed in claim 4, wherein said first light-receiving portion (113) receives the other separated light beam emerged from said second optical means (10) and passing through said third optical means (11), and said second light-receiving portion (114) receives the two divided light beams obtained by dividing the one separated light beam from said second optical means (10) by means of said third optical (11) means into two.

6. An optical head device as claimed in any preceding claim, further comprising additional optical means (17) provided between said second optical means (10) and said photodetector means (20) for causing one of the two separated light beams from said second optical means (20) to generate astigmatism.

7. An optical head device as claimed in any preceding claims further comprising a half-wave plate (16) provided between said first optical means (5) and said objective lens means (6).

8. An optical head device as claimed in any preceding claim, further comprising a half-wave plate (8) provided between said first (5) and second (10) optical means.

Patentansprüche

1. Optisches Kopfgerät zur optischen Aufnahme und/oder Wiedergabe von Information auf oder von einem optischen Aufnahmemedium (7), das umfaßt:
Lichtquellenmittel (1), um ein Lichtbündels auszusenden;
Kollimatormittel (3), um zu bewirken, daß das Lichtbündel von dem Lichtquellenmittel (1) ein paralleles Lichtbündel wird;
Objektivlinsenmittel (6), um das parallele Lichtbündel von dem Kollimatormittel (3) auf das optische Aufnahmemedium (7) zu konvergieren;

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erste optische Mittel (5), die zwischen dem Kollimatormittel (3) und dem Objektivlinsenmittel (6) vorgesehen sind, um das von dem optischen Aufnahmemedium (7) zurückkehrende Lichtbündel zu reflektieren; und
einen reflektierten Lichtbündelweg mit:
zweiten optischen Mittel (10) zur Trennung eines Lichtbündels, um zwei Lichtbündel zu erzeugen, die optisch zueinander gekreuzt polarisiert sind, wobei die zwei getrennten Lichtbündel im wesentlichen in die gleiche Richtung gerichtet sind und unter einem vorbestimmten Abstand voneinander getrennt sind;
Konvergenzmittel (9), um ein Lichtbündel zu konvergieren; und
Fotodetektormittel (20), um jeweils zwei getrennte Lichtbündel zu empfangen; dadurch gekennzeichnet, daß
das Konvergenzmittel (9) ausgelegt ist, das von dem ersten optischen Mittel (5) reflektierte Lichtbündel zu konvergieren, das Fotodetektormittel (20) ausgelegt ist, die zwei Lichtbündel von dem zweiten optischen Mittel (10) zu empfangen, und das zweite optische Mittel (10) ausgelegt ist, das Lichtbündel von dem Konvergenzmittel (9) zu trennen und zu bewirken, daß die optische Weglänge zu dem Fotodetektormittel (20) von einem der zwei getrennten konvergenten Lichtbündel länger ist als jene von dem anderen getrennten konvergenten Lichtbündel.

2. Optisches Kopfgerät nach Anspruch 1, das ferner umfaßt dritte optische Mittel (11), die zwischen dem zweiten optischen Mittel (10) und dem Fotodetektormittel (20) vorgesehen sind, um eines der zwei getrennten Lichtbündel von dem zweiten optischen Mittel (10) in zwei Lichtbündel zu teilen, die getrennt auf das Fotodetektormittel (20) einfallen, und um das andere getrennte Lichtbündel zu transmittieren, das direkt darauf einfällt.

3. Optisches Kopfgerät nach Anspruch 2, in dem das dritte optische Mittel (11) so ausgelegt ist, daß die optische Weglänge von einem der zwei geteilten Lichtbündel länger als jene des anderen geteilten Lichtbündels ist.

4. Optisches Kopfgerät nach Anspruch 2 oder 3, in dem das Fotodetektormittel (20) aus einem Substrat und ersten (113) und zweiten (114) auf dem Substrat angeordneten lichtempfangenden Abschnitten zusammengesetzt ist, wobei der erste lichtempfangende Abschnitt (113) entlang einer Linie in zwei Abschnitte geteilt ist, und der zweite lichtempfangende Abschnitt (114) zwei Teile (114a, 114b) umfaßt, von denen jedes entlang zweier paralleler Linien in drei Abschnitte geteilt ist, wobei die ersten und zweiten lichtempfangenden Abschnitte derart vorgesehen sind, daß die Teilungslinie des ersten lichtempfangenden Abschnitts (113) senkrecht zu den zwei parallelen Teilungslinien des zweiten lichtempfangenden Abschnitts (114) ist.

5. Optisches Kopfgerät nach Anspruch 4, in dem der erste lichtempfangende Abschnitt (113) das von dem zweiten optischen Mittel (10) ausgegebene und das dritte optische Mittel (11) durchlaufende andere getrennte Lichtbündel empfängt, und der zweite lichtempfangende Abschnitt (114) die zwei geteilten Lichtbündel empfängt, die erhalten wurden, indem das eine getrennte Lichtbündel von dem zweiten optischen Mittel (10) mittels des dritten optischen Mittels (11) zweigeteilt wurde.

6. Optisches Kopfgerät nach einem der vorhergehenden Ansprüche, das ferner ein zusätzliches optisches Mittel (17) umfaßt, das zwischen dem zweiten optischen Mittel (10) und dem Fotodetektormittel (20) vorgesehen ist, um zu bewirken, daß eines der zwei getrennten Lichtbündel von dem zweiten optischen Mittel (20) einen Astigmatismus erzeugt.

7. Optisches Kopfgerät nach einem der vorhergehenden Ansprüche, das ferner eine Halbwellenplatte (16) umfaßt, die zwischen dem ersten optischen Mittel (5) und dem Objektivlinsenmittel (6) vorgesehen ist.

8. Optisches Kopfgerät nach einem der vorhergehenden Ansprüche, das ferner eine Halbwellenplatte (8) umfaßt, die zwischen dem ersten (5) und zweiten (10) optischen Mittel vorgesehen ist.

Revendications

1. Dispositif de tête optique pour enregistrer et/ou reproduire par voie optique une information sur un milieu (7) d'enregistrement optique, et à partir de celui-ci, qui comprend :
   - un moyen (1) formant source de lumière pour émettre un faisceau lumineux,
   - un moyen (3) formant collimateur pour amener ledit faisceau lumineux provenant dudit moyen (1) formant source de lumière à devenir un faisceau lumineux parallèle,
   - un moyen (6) formant lentille d'objectif pour faire converger sur ledit milieu (7) d'enregistrement optique ledit faisceau lumineux parallèle provenant dudit moyen (3) formant collimateur,

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- un premier moyen optique (5) placé entre ledit moyen formant collimateur (3) et ledit moyen formant lentille d'objectif (6) afin de réfléchir le faisceau lumineux renvoyé par ledit milieu (7) d'enregistrement optique, et
- un trajet de faisceau lumineux réfléchi qui comporte:
  . un second moyen optique (10) pour séparer un faisceau lumineux et produire deux faisceaux lumineux à polarisation optique croisée l'un par rapport à l'autre, lesdits deux faisceaux lumineux séparés étant dirigés sensiblement dans la même direction et étant séparés l'un de l'autre d'une distance prédéterminée,
  . un moyen de convergence (9) pour faire converger un faisceau lumineux, et
  . un moyen photodétecteur (20) pour recevoir respectivement deux faisceaux lumineux séparés,
  caractérisé en ce que ledit moyen de convergence (9) est disposé pour faire converger le faisceau lumineux réfléchi par ledit premier moyen optique (5), ledit moyen photodétecteur (20) est disposé pour recevoir les deux faisceaux lumineux en provenance dudit second moyen optique (10) et ledit second moyen optique (10) est disposé pour séparer le faisceau lumineux en provenance dudit moyen de convergence (9) et faire que la longueur du trajet optique jusqu'au moyen photodétecteur (20) pour l'un des deux faisceaux lumineux convergents séparés soit plus grande que celle de l'autre faisceau lumineux convergent séparé.

2. Dispositif de tête optique selon la revendication 1, comprenant en outre un troisième moyen optique (11) placé entre ledit second moyen optique (10) et ledit moyen photodétecteur (20) pour diviser l'un des deux faisceaux lumineux séparés provenant dudit second moyen optique (10) en deux faisceaux lumineux qui arrivent séparément sur ledit moyen photodétecteur (20) et pour transmettre l'autre faisceau lumineux séparé qui arrive directement sur celui-ci.

3. Dispositif de tête optique selon la revendication 2, dans lequel ledit troisième moyen optique (11) est disposé de telle sorte que la longueur du trajet optique de l'un des deux faisceaux lumineux divisés est plus grande que celle de l'autre faisceau lumineux divisé.

4. Dispositif de tête optique selon la revendication 2 ou 3, dans lequel ledit moyen photodétecteur (20) est composé d'un substrat et de première (113) et seconde (114) parties de réception de la lumière placées sur ledit substrat, ladite première partie (113) de réception de la lumière étant divisée le long d'une ligne en deux parties et ladite seconde partie (114) de réception de la lumière comprenant deux régions (114a, 114b) dont chacune est divisée en trois parties le long de deux lignes parallèles, lesdites première et seconde parties de réception de la lumière étant placées de telle sorte que la ligne de division de ladite première partie (113) de réception de la lumière est perpendiculaire aux deux lignes parallèles de division de ladite seconde partie (114) de réception de la lumière.

5. Dispositif de tête optique selon la revendication 4, dans lequel ladite première partie (113) de réception de la lumière reçoit l'autre faisceau lumineux séparé qui sort dudit second moyen optique (10) et traverse ledit troisième moyen optique (11), et ladite seconde partie (114) de réception de la lumière reçoit les deux faisceaux lumineux divisés obtenus par division en deux à l'aide dudit troisième moyen optique (11) du premier faisceau lumineux séparé provenant dudit second moyen optique (10).

6. Dispositif de tête optique selon l'une quelconque des précédentes revendications, comprenant en outre un moyen optique supplémentaire (17) placé entre ledit second moyen optique (10) et ledit moyen photodétecteur (20) pour amener l'un des deux faisceaux lumineux séparés qui proviennent dudit second moyen optique (20) à produire de l'astigmatisme.

7. Dispositif de tête optique selon l'une quelconque des précédentes revendications, comprenant en outre une lame demi-onde (16) placée entre ledit premier moyen optique (5) et ledit moyen formant lentille d'objectif (6).

8. Dispositif de tête optique selon l'une quelconque des précédentes revendications, comprenant en outre une lame demi-onde (8) placée entre lesdits premier (5) et second (10) moyens optiques.