Description

This invention relates to a drive apparatus suitable for an optical disc player or recorder, such as a video disc digital audio player, for controlling and tracing the read-out light spot on the disc to record or regenerate information without mechanical disc contact.

In general, it is necessary to control and trace the read-out light spot in accordance with the detected amount of three mutually orthogonal deviations, namely focusing deviation of the light spot perpendicular to the disc surface, tracking deviation of the light spot in a direction perpendicular to both the optical axis and the information track on the disc, and time-axis deviation (jitter) in the direction of the information track

Fig. 1 of the accompanying drawings shows a conventional optical video disc player apparatus, including a focus control device 21 comprising an objective lens 30 and a magnetic coil Co for driving the lens, both disposed facing a disc (not shown), and a tracking control device 22 comprising a reflection mirror 20a and a magnetic coil Cra for rotatably driving the mirror about a transverse or diametrical axis. A jitter control device 23 comprising a reflection mirror 20b and a magnetic coil Crb for rotatably driving the mirror 20b is also provided.

In operation, a read-out beam 11 emitted from a light source (not shown) is reflected by the mirrors 20b and 20a, and impinges on the information track 24 of the disc after passing through the lens 30 of the focus control device 21.

Since a video disc is rotated at a high speed, such as 1800 rpm, focus, tracking, and jitter deviations are produced by the swing, eccentricity and rotational non-uniformity of the disc. To compensate for these deviations the objective lens 30 is controlled in the direction of arrow G parallel to the optical axis, the mirror 20a is controlled in the direction of arrow H transverse to the information track, and the mirror 20b is controlled in the direction of arrow I parallel to the information track so that the light spot can precisely read out the information on the track. In effecting these controls the objective lens 30 is moved or driven in the direction of arrow L by the coil Co, mirror 20a is rotated in the direction of arrow K by coil Cra, and mirror 20b is rotated in the direction of arrow J by coil Crb.

Since in this apparatus the focus, tracking and jitter control devices 21, 22 and 23 are mechanically and physically separated from each other, miniaturization is difficult. Additionally, as the light spot, the optical axis of which is oblique, enters the objective lens 30, a sufficient correction for or control of aberration is necessary. Further, since the mutual geometrical and optical relationship between the light beam 11 and the objective lens 30 is adversely influenced by the rotations of the mirrors 20a, 20b, the light beam does not proceed in the appropriate direction towards the objective lens and consequently the optical performance of the latter is diminished.

Another type of conventional optical video disc player apparatus is shown in GB-2 086 646 and EP-A-0 057 070. In these devices, the various tracking and focus control devices have been combined to ease miniaturization, however, tracking errors caused by jitter and other mechanical or electrical effects are overcome only by complex electronic signal processing techniques.

The closest prior art document, EP-A-0 05 70 70, which is reflected in the preamble of claim 1, specifically discloses an optical disc player or other apparatus in which a light beam is directed through an objective lens to be focussed thereby at a record medium surface for optically reading information recorded in a track on the surface, the objective lens having its centray axis offset with respect to the longitudinal laxis of a cylindrical body forming part of a moveable assembly and through which the light beam passes axially. The cylindrical body is both angularly displaceable about is longitudinal axis and axially displaceable relative to a guide bearing forming part of a fixed assembly to correct for tracking errors and for focussing errors, respectively. The fixed assembly further includes a magnetic circuit generating a magnetic field which intersects coils included in the moveable assembly to receive focussing error and tracking error signals, respectively. Adaptions of the cylindrical body to reduce jitter are not described.

The present invention succeeds in combining focus tracking and jitter control into a single compact apparatus. It also eliminates much of the need for electronic jitter and time axis control using novel driving and balancing techniques.

Accordingly, one object of this invention is to provide a mounting arrangement and driving apparatus which allows easy control and tracking of a light beam of an optical disc player or recorder with a high degree of accuracy.

Specifically, the object of the invention is solved by a driving apparatus for controlling and tracking light beams of an optical disc player or recorder, comprising:

(a) a base member;

(b) a first holder member slidably and rotatably disposed on a shaft extending from the base member;

(c) optical means for focussing a light beam irradiated thereon and emitting said light beam as a light spot;

(d) rotation driving means for rotating said holder member and optical means about said shaft to correct

tracking deviations of said light spot transverse to an information track on a storage disc;

(e) thrust driving means for sliding said holder member and optical means on said shaft to correct focus deviations of said light spot with respect to said information track;

characterized by

(f) said optical means being supported on said holder member and positioned on one side of said holder member with respect to said shaft; and

(g) balancing means, positioned on the opposite side of said holder member in relation to said shaft, for balancing said holder member with a high degree of precision.

For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 is a conceptual view of a conventional control/ driving apparatus;

Figure 2 is a plan view of an embodiment of the tridimensional control/driving apparatus of the invention of EP 0121 857 B1;

Figure 3 is a side view of Figure 2:

Figure 4 is a perspective view of a portion of Figure 2:

Figure 5 is a partial cross-sectional view showing the relation between a shaft and a bearing of Figure 2;

Fig. 6 is a cutaway perspective view showing a support means and a driving means for an objective lens of Fig. 2;

Fig. 7 is a side sectional view showing the operation of the objective lens of Fig. 2;

Fig. 8 is a perspective view showing an embodiment of the present invention;

Fig. 9 is a plan view showing another embodiment of the invention of EP 0121 857 B1;

Fig. 10 is a cross-sectional view at line X-X in Fig. 9;

Fig. 11 is a cutaway perspective view of Fig. 9; and

Fig. 12 is a partial perspective view of Fig. 9.

As shown in Figs. 2 and 3, a cylindrical bearing 2 is locate at the center portion of a generally rectangular holder 1 which has two concave recesses 1a, 1b flanking the bearing and circularly curved end surfaces. A shaft 3 is fixed to a base 4 as shown in Fig. 3 and stands upright inside the bearing 2 with a clearance ranging from several microns to several decades of microns to enable free rotation and sliding. The surfaces of the bearing and/or shaft are coated with a resin such as Teflon having a low frictional coefficient. A first coil 5 for focus control is wound around the outside of the rectangularly shaped holder 1. Second coils 6a, 6b, 6c, 6d for tracking control are attached over the coil 5 at each corner of the holder. First permanent magnets 7a, 7b with curved inner surfaces for focus and tracking control are provided at the ends of the base 4 flanking the first and second coils. Second permanent magnets 8a, 8b for jitter control are disposed in the recess 1a.

A holder 9 for the objective lens 30 is located between the jitter control magnets, and third coils 10a, lob for jitter control are wound around the holder on both sides of the objective lens. The holder 9 is mounted, as shown in Figure 5, between the ends of a pair of parallel plate support springs 13a, 13b made of phosphor bronze.

The holder 1 and the base 4 have respective holes 14a, 14b (Fig. 5) through which the light beam 11 passes; it is focused to a light spot 12 by the objective lens. The holder 1 is supported by the shaft 3 fixed to the base 4, and can both rotate in the direction of arrow F and slide in the direction of arrow E.

The holder 1, the bearing 2, the shaft 3, the second coils 6a to 6d and the first permanent magnets 7a, 7b form a rotation driving means, by means of which the lens holder 9 and objective lens 30 may be rotated to correct any track deviation of the read-out spot 12.

The holder 1, the bearing 2, the shaft 3, the first coil 5 and the first permanent magnets 7a, 7b form a thrust driving means for moving the lens 30 in the direction of the optical axis to correct any focus deviation.

The support springs 13a, 13b, the third coils 10a, 10b, and the second permanent magnets 8a, 8b form a parallel driving means for moving the lens 30 in the direction of the information track (arrow A in Fig. 6) to correct any jitter deviation.

In operation, when a tracking deviation of the light spot 12 perpendicular to both the optical axis and the information track is detected, a current of appropriate polarity proportional to the detected deviation is supplied to the coils 6a to 6d to rotate the holder 1 about the shaft 3 in the direction of arrow F in cooperation with the magnets 7a, 7b, thus correcting such tracking deviation.

Similarly, when a focus deviation is detected, a current of appropriate polarity proportional thereto is supplied to the coil 5 to drive the holder 1 and thus the lens 30 in the direction of arrow E in cooperation with the magnets 7a, 7b, thereby correcting such focus deviation.

The objective lens 30 is thus driven and controlled in both the focus controlling direction shown by arrow E in Fig. 3 and in the rotation controlling direction shown by arrow 8 in Fig. 2.

When a time-axis or jitter deviation in the direction of the information track is detected, a current of appro-

priate polarity proportional thereto is supplied to the coils 10a, lob to drive the lens holder 9 and the objective lens 30 in the direction of arrow A in Figs. 6 and 7 in cooperation with the magnets 8a, 8b to thereby correct such jitter.

The means for detecting the three deviations and for generating the appropriate coil correction signals in response thereto are not shown as they are fully conventional and will be apparent to those skilled in the art.

In the foregoing it is assumed that the information track runs parallel to the longitudinal axis of the holder 1, but it could also run transverse thereto in which case arrow A would represent the tracking correction direction and arrow B the jitter direction.

In the tri-axial operation of this embodiment the objective lens 30 is movable in the direction of arrow A by the bending of the parallel support springs 13a, 13b as shown in Fig. 7, whereby the optical axis of the objective lens is maintained substantially parallel to that of the light beam 11 and the latter is always kept substantially perpendicular to the surface of the disc (not shown).

As the distance or spacing between the magnets 7a, 7b and the coils 5, 6a, 6b, 6c, 6d and between the magnets 8a, 8b and the coils 10a, 10b is always substantially constant, the lens holder 9 can be stably shifted to implement deviation corrections by symmetrical and highly-balanced driving forces. To operate the apparatus with a high degree of precision using small driving forces, light weight plastic magnets may be employed as the magnets 8a, 8b fixed to the holder 1. To miniaturize these it is desirable that the objective lens 30 be small and light weight, and a plastics or Fresnel lens would thus be suitable.

An embodiment of the invention is shown in Fig. 8, wherein a counter or balancing weight 40 is provided in the recess lb of the holder 1 and flexible members 50a, 50b comprising metallic or rubber springs are provided between the side of the holder 1 and the base 4 to generate restoring forces in the tracking, jitter and focus directions. Owing to the weight 40 the holder 1 may rotate around the shaft 3 with a higher degree of balancing precision than in Figs. 1 to 7.

Another embodiment of the invention of EP 0121 857 B1 is shown in Figs. 9 to 12 whose structure is essentially similar to that detailed above, the same reference numerals being used to designate the same or equivalent features. In this embodiment a box-like base 4 contains first permanent magnets 7a, 7b fixed thereto and has five walls comprising a bottom wall 4a with a hole 14a, and side walls 4b, 4c, 4d, 4e. The holder 1 has only one recess 1a where the optical means is provided. Of the four side surfaces 1c - 1f, the two end surfaces lc, le are circularly curved to mate with the inner curved surface of the magnets 7a, 7b, similar to the embodiments of Figs. 1 to 8.

The holder 1 is again rotatably and slidably supported by a shaft 3 and a bearing 2, the top ends of which are below the bottom surface of the lens holder 9. Second permanent magnets 8a, 8b are attached to the top central side walls 4b, 4d of the base. The coil 10 is wound around the central portion of the lens holder 9 which has two protruding end portions with symmetrically formed holes 9a and 9b. Elastic restoration springs 50a, 50b (Fig. 12) may be fixed to the bottom wall 4a of the base at their one ends and to the top edges of the holder walls 1d, 1f at their other ends to establish the neutral points of the holder mounting within the base in the rotational and up-down directions.

The operation of this embodiment is similar to that of Figs. 1 to 8, and exhibits improved mechanical balance and lighter weight.

In the foregoing embodiments optical disc players are disclosed, but this invention is equally adaptable to an optical disc recorder.

Claims

1. A driving apparatus for controlling and tracking light beams of an optical disc player or recorder, comprising:
   (a) a base member (4),
   (b) a holder member (1) slidably and rotatably disposed on a shaft (3) extending from the base member;
   (c) optical means (30) for focussing a light beam (11) irradiated thereon and emitting said light beam as a light spot (12);
   (d) rotation driving means (6a-6d; 7a,7b) for rotating said holder member (1) and optical means (30) about said shaft (3) to correct tracking deviations of said light spot (12) transverse to an information track on a storage disc;
   (e) thrust driving means (5, 7a,7b) for sliding said holder member and said optical means on said shaft to correct focus deviations of said light spot with respect to said information track;
   characterized by
   (f) said optical means (30) being supported on said holder member (1) and positioned on one side of said holder member (1) with respect to said shaft (3); and

priate polarity proportional thereto is supplied to the coils 10a, lob to drive the lens holder 9 and the objective lens 30 in the direction of arrow A in Figs. 6 and 7 in cooperation with the magnets 8a, 8b to thereby correct such jitter.

The means for detecting the three deviations and for generating the appropriate coil correction signals in response thereto are not shown as they are fully conventional and will be apparent to those skilled in the art.

In the foregoing it is assumed that the information track runs parallel to the longitudinal axis of the holder 1, but it could also run transverse thereto in which case arrow A would represent the tracking correction direction and arrow B the jitter direction.

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As the distance or spacing between the magnets 7a, 7b and the coils 5, 6a, 6b, 6c, 6d and between the magnets 8a, 8b and the coils 10a, 10b is always substantially constant, the lens holder 9 can be stably shifted to implement deviation corrections by symmetrical and highly-balanced driving forces. To operate the apparatus with a high degree of precision using small driving forces, light weight plastic magnets may be employed as the magnets 8a, 8b fixed to the holder 1. To miniaturize these it is desirable that the objective lens 30 be small and light weight, and a plastics or Fresnel lens would thus be suitable.

An embodiment of the invention is shown in Fig. 8, wherein a counter or balancing weight 40 is provided in the recess lb of the holder 1 and flexible members 50a, 50b comprising metallic or rubber springs are provided between the side of the holder 1 and the base 4 to generate restoring forces in the tracking, jitter and focus directions. Owing to the weight 40 the holder 1 may rotate around the shaft 3 with a higher degree of balancing precision than in Figs. 1 to 7.

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The holder 1 is again rotatably and slidably supported by a shaft 3 and a bearing 2, the top ends of which are below the bottom surface of the lens holder 9. Second permanent magnets 8a, 8b are attached to the top central side walls 4b, 4d of the base. The coil 10 is wound around the central portion of the lens holder 9 which has two protruding end portions with symmetrically formed holes 9a and 9b. Elastic restoration springs 50a, 50b (Fig. 12) may be fixed to the bottom wall 4a of the base at their one ends and to the top edges of the holder walls 1d, 1f at their other ends to establish the neutral points of the holder mounting within the base in the rotational and up-down directions.

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   (a) a base member (4),
   (b) a holder member (1) slidably and rotatably disposed on a shaft (3) extending from the base member;
   (c) optical means (30) for focussing a light beam (11) irradiated thereon and emitting said light beam as a light spot (12);
   (d) rotation driving means (6a-6d; 7a,7b) for rotating said holder member (1) and optical means (30) about said shaft (3) to correct tracking deviations of said light spot (12) transverse to an information track on a storage disc;
   (e) thrust driving means (5, 7a,7b) for sliding said holder member and said optical means on said shaft to correct focus deviations of said light spot with respect to said information track;
   characterized by
   (f) said optical means (30) being supported on said holder member (1) and positioned on one side of said holder member (1) with respect to said shaft (3); and

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(g) balancing means (40), positioned on the opposite side of said holder member (1) in relation to said shaft (3), for balancing said holder member (1) with a high degree of precision.

2. Driving apparatus of claim 1, wherein said holder member (1) has two recesses (1a,1b) symmetrically provided in opposite halves thereof, said balancing means (40) being positioned in one of said recesses and said optical means (30) being positioned in the other of said recesses.

3. Driving apparatus of claim 1 or 2, further comprising restoration means (50a,50b) for generating restoring forces for maintaining said holder member (1) in the tracking and focussing directions, said restoration means being provided between said holder member (1) and said base member (4).

4. Driving apparatus of claim 3, wherein one end of said restoration means (50a,50b) is fixed to the outside portion of said holder member (1) and the other end of said restoration means is fixed to said base member (4).

5. Driving apparatus of claim 4, wherein said fixing member is a portion of said base member (4).

6. Driving apparatus of any of claims 1 to 4, wherein said rotation driving means (6a-6d;7a,7b) and said thrust driving means (5,7a,7b) are attached to said holder member (1).

7. Driving apparatus of any of claims 1 to 6, wherein said holder member (1) is substantially rectangular in shape.

8. Driving apparatus of claim 1, wherein coils (5; 6a-6d) of said thrust driving means and said rotation driving means are arranged in a magnetic field of permanent magnets (7a, 7b).

Patentansprüche

1. Antriebsvorrichtung zur Steuerung und Spurführung eines Lichtstrahls eines Wiedergabe- oder Aufnahmegerätes mit optischer Platte, die aufweist:
(a) ein Basisteil (4);
(b) ein erstes Halteteil (1), das gleitend und drehbar auf einer sich aus dem Basisteil erstreckenden Welle (3) angeordnet ist ;
(c) eine optische Einrichtung (30) zum Fokussieren eines darauf gerichteten Lichtrahls (11) und zum Aussenden des Lichtstrahls als Lichtpunkt (12);
(d) ein Drehantriebseinrichtung (6a bis 6d; 7a,7b)) zum Drehen des Halteteils (1) und der optischen Einrichtung (30) um die Welle (3), um die Spurabweichnungen des Lichtpunkts (12) transversal zu einer Informationsspur auf einer Speicherplatte zu korrigieren;
(e) eine Schiebeantriebseinrichtung (5, 7a, 7b), um das Halteteil und die optische Einrichtung auf der Welle zu verschieben, um Fokusabweichungen des Lichtpunkts bezüglich der Informationsspur zu korrigieren;
gekennzeichnet durch:
(f) die optische Einrichtung (30), die auf dem Halteteil (1) gelagert und bezüglich der Welle (3) auf der einen Seite des Halteteils (1) angeordnet ist.
(g) eine Balanceeinrichtung (40), die auf der gegenüberliegenden Seite des Halteteils (1) bezüglich der Welle (3) angeordnet ist, um das Halteteil (1) mit einem hohen Maß an Präzision auszubalancieren.

2. Antriebvorrichtung nach Anspruch 1, bei der das Halteteil (1) zwei Vertiefungen (1a, 1b) aufweist, die symmetrisch in gegenüberliegenden Hälften davon angeordnet sind, wobei die Balanceeinrichtung (40) in der einen Vertiefung und die optische Einrichtung (30) in der anderen Vertiefung angeordnet ist.

3. Antriebvorrichtung nach Anspruch 1 oder 2, die ferner eine Rückstelleinrichtung (50a, 50b) aufweist, um Rückstellkräfte zu erzeugen und um das Halteteil (1) in den Spur- und Fokusrichtungen zu halten, wobei die Rückstelleinrichtung zwischen dem Halteteil (1) und dem Basisteil (4) angeordnet ist.

4. Antriebvorrichtung nach Anspruch 3, bei der ein Ende der Rückstelleinrichtung (50a, 50b) auf dem äußeren Bereich des Halteteils (1) und das andere Ende der Rückstelleinrichtung auf dem Basisteil (4) befestigt ist.

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5. Antriebvorrichtung nach Anspruch 4, bei der das Befestigungsteil ein Bereich des Basisteils (4) ist.

6. Antriebvorrichtung nach einem der Anspruch 1 bis 4, bei der die Drehantriebseinrichtung (6a bis 6d; 7a, 7b) und die Schiebeantriebseinrichtung (5, 7a, 7b) an dem Halteteil (1) angebracht sind.

7. Antriebvorrichtung nach einem der Anspruch 1 bis 6, bei der das Halteteil (1) im wesentlichen eine rechteckige Form aufweist.

8. Antriebvorrichtung nach Anspruch 1, beim der die Spulen (5; 6a bis 6d) der Schiebeantriebseinrichtung und der Drehantriebseinrichtung in einem magnetischen Feld der Permanentmagnete (7a, 7b) angeordnet sind.

Revendications

1. Dispositif d'entraînement pour la commande et le suivi de faisceaux lumineux d'un tourne-disque ou d'un enregistreur à disques optiques, comprenant :
   (a) un élément formant base (4),
   (b) un élément support (1) placé, de manière à tourner et à coulisser, sur un arbre (3) s'étendant à partir de l'élément formant base ;
   (c) un moyen optique (30) pour focaliser un faisceau lumineux (11) dirigé sur lui et pour émettre ledit faisceau lumineux sous la forme d'un point lumineux (12) ;
   (d) un moyen d'entraînement en rotation (6a à 6d ; 7a, 7b) pour entraîner en rotation ledit élément support (1) et ledit moyen optique (30) autour dudit arbre (3) pour corriger des écarts, par rapport à la piste, dudit point lumineux (12) transversalement à une piste d'informations sur un disque de mémorisation ;
   (e) un moyen d'entraînement en poussée (5, 7a, 7b) pour faire coulisser ledit élément support et ledit moyen optique sur ledit arbre pour corriger des écarts de focalisation dudit point lumineux par rapport à ladite piste d'informations ;
   caractérisé en ce que
   (f) ledit moyen optique (30) est soutenu sur ledit élément support (1) et placé sur un côté dudit élément support (1) par rapport audit arbre (3) ; et
   (g) un moyen d'équilibrage (40), est placé sur le côté opposé dudit élément support (1) par rapport audit arbre (3), pour équilibrer ledit élément support (1) avec un degré de précision élevé.

2. Dispositif d'entraînement selon la revendication 1, dans lequel ledit élément support (1) a deux cavités (1a, 1b) prévues symétriquement dans ses moitiés opposées, ledit moyen d'équilibrage (40) étant placé dans l'une desdites cavités et ledit moyen optique (30) étant placé dans l'autre desdites cavités.

3. Dispositif d'entraînement selon la revendication 1 ou 2, comprenant en outre un moyen de rappel (50a, 50b) pour produire des forces de rappel afin de maintenir ledit élément support (1) dans le sens du suivi de piste et dans celui de la focalisation, ledit moyen de rappel étant situé entre ledit élément support (1) et ledit élément formant base (4).

4. Dispositif d'entraînement selon la revendication 3, dans lequel une extrémité dudit moyen de rappel (50a, 50b) est fixée sur la partie extérieure dudit élément support (1) et l'autre extrémité dudit moyen de rappel est fixée sur ledit élément formant base (4).

5. Dispositif d'entraînement selon la revendication 4, dans lequel ledit élément de fixation est une partie dudit élément formant base (4).

6. Dispositif d'entraînement selon l'une des revendications 1 à 4, dans lequel ledit moyen d'entraînement en rotation (6a à 6d ; 7a, 7b) et ledit moyen d'entraînement en poussée (5, 7a, 7b) sont fixés audit élément support (1).

7. Dispositif d'entraînement selon l'une des revendications 1 à 6, dans lequel ledit élément support (1) est de forme sensiblement rectangulaire.

8. Dispositif d'entraînement selon la revendication 1, dans lequel des bobines (5 ; 6a à 6d) dudit moyen d'entraînement en poussée et dudit moyen d'entraînement en rotation sont placées dans un champ magnétique d'aimants permanents (7a, 7b).

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