TITLE OF THE INVENTION

Objective Lens Inspection Apparatus

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an objective lens inspection apparatus for checking up various characteristics of an objective lens.

2. Description of Related Art

An optical pickup is used in a disc drive for optical discs and magneto-optical discs to write and/or read information into and/or from a disc. Such an optical pickup of this kind has an objective lens which focuses a laser light emitted from a source on a signal recording area of the optical disc.

In the process of manufacturing, the optical pickup is subjected to a quality inspection of an objective lens incorporated therein. In this quality inspection, astigmatism, coma, spherical aberration, etc. of the objective lens are measured.

In the optical disc drive comprising an optical pickup for reading information from an optical disc, the characteristics of the optical pickup are evaluated by measuring a jitter of a read signal from the optical disc.

Therefore, the validity of the characteristics evaluation is low since it is difficult to assure a correlation between the measured optical aberration of an objective lens, not assembled in any optical pickup, and the characteristic of a read signal measured with the objective lens assembled as a part of optical pickup in an

optical disc drive.

Also, since the conventional objective lens inspection apparatus for measurement of an optical aberration is wholly large and considerably affected by environmental conditions such as vibration, temperature, humidity, etc., it should be used in an inspection room where the atmospheric conditions are well controlled for a normal temperature and a predetermined humidity. Thus, with the conventional objective lens inspection apparatus, it is not possible to check up the characteristics of an objective lens in a similar environment to a one in which the optical disc drive is operated in practice.

Therefore, for a statistical evaluation, by the conventional objective lens inspection apparatus, of the characteristics of an objective lens used in a substantially same environment as an actual environment in which the optical pickup is used, an objective lens, not assembled in any optical pickup, is evaluated concerning its optical aberration, then a plurality of objective lenses is sampled and assembled into optical pickups, and the characteristic of a signal read by each optical pickup is evaluated. Thus, the quality inspection using the conventional objective lens inspection apparatus needs much time and cost.

Furthermore, since in an optical pickup having assembled therein an objective lens to be inspected, and adhesive is used to fix the objective lens in the assembling process, the optical pickup cannot easily be removed and repaired when the objective lens is found defective.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to overcome the above-mentioned drawbacks of the prior art by providing an objective lens inspection apparatus adapted to inspect the quality of an objective lens easily and with a high accuracy by evaluating a read signal.

The above object can be achieved by providing an objective lens inspection apparatus, comprising according to the present invention:

a holder with a lens mount on which an objective lens to be inspected is set;

a member to support the holder movably in a first direction parallel to the optical axis of the objective lens and a second direction perpendicular to the optical axis of the objective lens;

means for driving the holder to move in the first and second directions;

a member to retain the objective lens set on the lens mount of the holder; and

a screw to fix the retaining member to the holder.

For inspection of an objective lens by the objective lens inspection apparatus constructed as in the above, the objective lens is set on the lens mount of the holder, and it is retained to the lens mount by the retaining member. The lens retaining member is fixed to the holder with a fixing screw, so that the objective lens is secured to the lens mount. Therefore, since the objective lens inspection apparatus retains the objective lens removably on the lens mount of the holder, an objective lens having been inspected can easily removed and a next objective lens

can easily be set on the lens mount.

These objects and other objects, features and advantages of the present intention will become more apparent from the following detailed description of a preferred embodiment of the objective lens inspection apparatus according to the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of an optical pickup provided with the objective lens inspection apparatus according to the present invention;

FIG. 2 is an exploded perspective view of the objective lens inspection apparatus in FIG. 1;

FIG. 3 is a schematic block diagram of the optical pickup in FIG. 1, showing the signal processing for inspection of the objective lens; and

FIG. 4 is a side elevation of the objective lens inspection mechanism retaining an objective lens.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, there is illustrated in the form of a perspective view an optical pickup provided with the objective lens inspection apparatus of the present invention. The optical pickup is generally indicated with a reference 1. As shown, the optical pickup 1 is provided with an objective lens inspection mechanism 5 on which an objective lens 2 to be inspected is set, and a sliding base 6 to support the objective lens inspection mechanism 5.

As best seen from FIGS. 1 and 2, the objective lens inspection mechanism 5 comprises a lens holder 11 on which the objective lens 2 is removably mounted, a retaining member 12 to retain the objective lens 2 on the lens holder 11, a screw for fixing the retaining member 12 to the lens holder 11, and a base 15 to support the lens holder 11 to be movable axially of, and about, a sliding pivot 14 which will be described later.

As shown in FIGS. 1 and 2, the objective lens inspection mechanism 5 further comprises a biaxial actuator 18 to drive the lens holder 11 in two axial directions including a focusing direction parallel to the optical axis of the objective lens 2 and a tracking direction perpendicular to the optical axis of the objective lens 2.

As shown in FIG. 2, the lens holder 11 has formed nearly at the center of the main surface thereof a hole 20 in which the sliding pivot 14 of which the axial direction is parallel to the optical axis is inserted to be movable axially and pivotable. The lens holder 11 includes a lens mount 21 on which the objective lens 2 to be inspected is set. The lens mount 21 has formed therein a circular opening 23 to provide an optical path to the objective lens 2.

The lens holder 11 has a screw hole 24 formed therein opposite the opening 23 in the lens mount 21with the hole 20 in position between the opening 23 and screw hole 24. The fixing screw 13 is screwed into this hole 21. There is formed on either lateral end of the lens holder 11 a cut-out 26 in which a focusing coil 35

forming the biaxial actuator 18 is installed.

As best shown in FIG. 2, the retaining member 12 is formed from a step-like bent metal plate consisting of a base portion 28 which is to be fixed to the lens holder 11, and a retaining portion 29 to retain the objective lens 2. There is formed in the main surface of the base portion 28 a first elongated hole 31 in which the fixing screw 13 is introduced to be movable radially of the objective lens 2. The retaining portion 29 is stepped from the base portion 28 in the optical- axis direction of the objective lens 2, and elastically deflectable in relation to the base portion 28. The retaining portion 29 has further formed at the opposite end to the base portion 28 a semi-circular cut 33 of which the circumference is to engage on the perimeter of the objective lens 2. Also, the retaining portion 29 has formed in the main surface thereof a second elongated hole 32 in which the sliding pivot 14 is introduced when the objective lens 2 is moved in the optical-axial direction. Note that the retaining member 12 may consist of a rigid plate and an elastic member such as a spring joined to the rigid plate (not shown).

The fixing screw 13 is introduced into the first elongated hole 31 in the retaining member 12 and screwed into the screw hole 24 in the lens holder 11. For positioning the retaining member 12 with respect to the objective lens 2 set on the lens mount 21 of the lens holder 11, the fixing screw 13 screwed in the first elongated hole 31 in the base portion 28 of the retaining member 12 is loosened and the retaining member 12 is moved longitudinally of the hole 31. When the

retaining member 12 is positioned in place radially of the objective lens 2, the fixing screw 13 is retightened to fix the retaining member 12 to the lens holder 11.

The sliding pivot 14 is provided upright nearly at the center of the main surface of the supporting base 15, and the lens holder 11 is movable axially of, and about the sliding pivot 14 in each of the focusing and tracking directions.

As shown in FIG. 2, the biaxial actuator 18 comprises two sets of a cylindrical focusing coil 35 installed in the cut-out 26 of the lens holder 11, toroidal tracking coils 36 disposed outside the focusing coil 35, a U-shaped yoke 37 of which one end is inserted inside the focusing coil 35, and a driving magnet 38 provided on the yoke 37 opposite the focusing and tracking coils 35 and 36. The yoke 37 is projected and formed integrally with the supporting base 15. There is disposed in the middle of the tracking coil 36 a neutralization coil 39 to position the lens holder 11 at a home position for focusing.

As shown in FIG. 1, the sliding base 6 is disposed movably on a main guide shaft 41 and auxiliary guide shaft 42 disposed in parallel to the radius of an optical disc 3. The sliding base 6 includes a mount plate 44 on which the objective lens inspection mechanism 5 is installed, a main guide 46 and an auxiliary guide 47 supported on the main and auxiliary guide shafts 41 and 42, respectively.

The mount plate 44 has formed therein a circular opening 45 to provide an optical path to the objective lens 2. The main guide 46 is formed integrally with the mount plate 44 and has fixed thereon a bearing 48 in which the main guide shaft 41

is supported. Therefore, the main guide 46 is supported to be movable axially of the main guide shaft 41. The auxiliary guide 47 is formed integrally with the mount plate 44 opposite the main guide 46 with the mount plate 44 laid between the main and auxiliary guides 46 and 47. The auxiliary guide 47 has formed integrally thereon a pair of projections 49 and 50 between which the auxiliary guide shaft 42 is introduced, whereby the auxiliary guide is supported to be movable axially of the auxiliary guide shaft 42.

The sliding base 6 has installed thereon an optical block 52 including a laser source to emit a laser light to the objective lens 2, a photodetector to detect a return light from the optical disc, and various lenses having optical paths.

The optical pickup 1 with the aforementioned objective lens inspection mechanism 5 effects a signal processing to read information from the optical disc as will be described below. As schematically shown in FIG. 3, the optical disc drive using the optical pickup 1 comprises a disc spinning mechanism including a disc table 56 on which the optical disc 3 is placed, a spindle motor 55 to drive to spin the disc table 56, and a clamping member 57 to retain the optical disc 3 placed on the disc table 56.

As seen from FIG. 3, the optical disc 3 is set on the disc table 56 of the spindle motor 55 while being retained on the disc table 56 by the clamping member 57. The spindle motor 55 is controlled by the drive controller 58 to run at a predetermined speed.

The optical pickup 1 is connected to a head access controller 59 which moves the optical pickup 1, by seeking operation, to a desired recording track on the optical disc 3. Also, the optical pickup 1 is connected to a servo circuit 60 which provides to the biaxial actuator 18, which moves the objective lens 2 biaxially with respect to the recording track, a servo signal under which the optical pickup 1 having been moved to the desired recording track on the optical disc 3 is moved in the tracking and focusing directions.

The optical pickup 1 focuses a laser light on a signal recording area on the optical axis 3 and detects a return light from the signal recording area, to generate a read signal based on the return light and provide it to a signal demodulator 61. The signal demodulator 61 is connected to a RAM (random access memory) 62 which provisionally stores a signal yet to demodulate, and demodulates the read signal from the RAM 62. The signal demodulator 61 provides a control signal from the spindle motor 55 to the drive controller 58. The read signal demodulated by the signal demodulator 61 has an error corrected by an ECC (error correction code) circuit 63 and is provided to an external computer 65 or the like via an interface 64. The output read signal is measured for characteristic evaluation of the objective lens 2. Note that the characteristics of the objective lens 2 may be evaluated by judging directly an output from the signal demodulator 61, by judging the result of an error correction of read signal by the ECC circuit 63, or by overall judgment of both.

The optical pickup 1 having the objective lens inspection mechanism 5 constructed as in the above functions to read information from the optical disc 3 as will be described below:

As the sliding base 6 is moved axially on and along the main and auxiliary guide shafts 41 and 42, the objective lens 2 in the optical pickup 1 is moved radially of the optical disc 3 to a position corresponding to a desired recording track on the optical disc 3. In the optical pickup 1, as the lens holder 11 is moved axially of, and about, the sliding pivot 14 by means of the biaxial actuator 18, the objective lens 2 is moved in the focusing and tracking directions, respectively, toward the desired recording track on the optical disc 3, and a laser light is focused through the objective lens 2 onto the desired recording track.

Next, how the objective lens 2 is mounted onto the lens holder 11 in the objective lens inspection mechanism 5 having the aforementioned construction, will be described with reference to FIGS. 4 and 5:

In the objective lens inspection mechanism 5, the objective lens 2 is placed on the lens mount 21 of the lend holder 11 and the retaining portion 29 of the retaining member 12 is engaged on the perimeter of the objective lens 2, as shown in FIG. 4. The retaining member 12 is fixed with the fixing screw 13 introduced in the first elongated hole 31. With the fixing screw 13 loosened, the retaining member 12 can be moved longitudinally of the first elongated hole 31 towards or away from the objective lens 2 set on the lens mount 21. That is, the retaining

member 12 can be displaced radially of the objective lens 2 for a difference in outside diameter from an objective lens previously inspected. Thus, by retightening the fixing screw 13, the retaining member 12 can be fixed in place to the lens mount 21 to securely retain the objective lens.

The objective lens inspection mechanism 5 is used in an environment in which the temperature and humidity are controlled to those possible in a practical operating environment, and a read signal from the optical disc 3 is detected through an objective lens 2 mounted on the lens holder 11 to inspect the quality of the objective lens 2.

The aforementioned objective lens inspection mechanism 5 is adapted such the lens holder 11 is supported to be movable axially of, and about, the sliding pivot 14, to attain an improved reliability of the movement of the lens holder 11 in focusing and tracking directions as well as an improved durability of the lens holder 11. This construction may be called a slide-and-pivot type one. For a more compact design, however, the lens holder 11 may of course be supported movably by means of a plurality of wires. This construction may be called a wire-supported type one.

The retaining member 12 and fixing screw 13 provided in the objective lens inspection mechanism 5 enable the objective lens 2 to be retained easily and positively by accommodating a difference in outside diameter from one to another objective lens. Thus the objective lens 2 can be inspected easily and accurately.

Since the objective lens inspection mechanism 5 according to the present invention can be used to judge the acceptability of the objective lens 2 by evaluating a read signal from the optical disc 3, it is possible to surely avoid an incorrect judgement due to an insufficient correlation, as in the conventional objected lens inspection apparatus, between the measured optical aberration of the objective lens 2 not assembled in the optical pickup and the characteristics of read signal.

With the objective lens inspection mechanism 5 according to the present invention, it is possible to inspect an objective lens in a reduced time. Furthermore, since the entire objective lens inspection apparatus according to the present invention can be designed considerably more compact using the objective lens inspection mechanism 5 than the conventional objective lens inspection apparatus, an objective lens can be inspected in various environments in which the temperature and humidity are controlled to those possible in practical environments in which the optical disc drive is normally used.

Since the objective lens inspection mechanism 5 is constructed such that the lens holder 11 is supported to be movable axially of, and about, the sliding pivot 14, and thus the lens holder 11 can be moved with an improved durability as well as with an improved reliability of the movement in the focusing and tracking directions, the objective lens 2 can be inspected with a higher accuracy.

It will be appreciated that although the objective lens inspection mechanism

5 according to the present invention is adapted to inspect the objective lens 2 by acquiring a read signal from an optical disc 3, the objective lens 2 may of course be inspected by writing information into the optical disc 3 and reading the written information from the optical disc 3. For example, a magnetic head may be disposed opposite an objective lens to write and read information with respect to another optical disc such as a magneto-optical disc to inspect the objective lens.

As having been described in the foregoing, in the objective lens inspection apparatus according to the present invention, the objective lens placed on the lens mount of the lens holder can be replaced with another, so that the objective lens can be inspected easily, accurately and rapidly.

WHAT IS CLAIMED IS:

1. An objective lens inspection apparatus, comprising:

a holder with a lens mount on which an objective lens to be inspected is set;

a member to support the holder movably in a first direction parallel to the optical axis of the objective lens and a second direction perpendicular to the optical axis of the objective lens;

means for driving the holder to move in the first and second directions;

a member to retain the objective lens set on the lens mount of the holder; and

a screw to fix the retaining member to the holder.

2. The apparatus as set forth in Claim 1, wherein the retaining member has formed therein an elongated hole through which the fixing screw is introduced to be movable radially of the objective lens.

3. The apparatus as set forth in Claim 2, wherein the retaining member has a plurality of elongated holes formed therein.

4. The apparatus as set forth in Claim 1, wherein the holder is supported to be movable axially of, and about, a sliding pivot of which the axial direction is parallel to the optical axis of the objective lens.

5. The apparatus as set forth in Claim 1, wherein the retaining member is formed from an elastic material.