PICKUP ACTUATOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a pickup actuator employed into an optical device for recording/reproducing an information on/from an optical disc by using an optical means.

2. Description of the Prior Art

A field of optical means for recording/reproducing an information on/from information recording medium such as an optical disc is already in the limelight as a new technique of the coming era. Especially, a pickup actuator is considered as an important component of the optical device, since it determines the speed of recording/reproducing of information. Such pickup actuator schematically comprises a base member, a lens holder, and a lens holder driving means. The leans holder is movably disposed with respect to the base member. An objective lens is mounted on the lens holder. The objective lens projects a light beam to a recordable side of the optical disc to read the optical signal, or record the information on the optical disc. The lens holder driving means drives the lens holder toward directions of focusing and tracking.

An example of such pickup actuator is shown in FIGs. 1 to 3. FIG. 1 is an exploded perspective view showing a conventional pickup actuator, FIG. 2 is a perspective view showing the pickup actuator assembled, and FIG. 3 is a sectional view for showing a main portion of the pickup actuator shown in FIG. 2.

As shown in FIGs. 1 to 3, a base member 10 comprises a body portion 12 and a holder supporting portion 14. The holder supporting portion 14 is attached to an upper side of the body portion 12 by a pair of screws 16a and 16b.

Additionally, an objective lens 22 is mounted on a lens holder 20. The lens holder 20 is suspended at the holder supporting portion 14 of the base member 10 by two pairs of wire springs 24a and 24b. Thus, the lens holder 20 is capable of being moved in directions of focusing and tracking.

A lens holder driving means 30 comprises a pair of magnets 32a and 32b, and a pair of driving coils 34a and 34b. The magnets 32a and 32b are respectively attached to both sides of the lens holder 20, and form a magnetic circuit. The driving coils 34a and 34b are disposed at the body portion 12 of the base member 10, while facing each other and being spaced from the respective magnets 32a and 32b at a predetermined distance. The two driving coils 34a and 34b respectively have a pair of focusing coils and a pair of tracking coils 36a, 36b, and 36c, 36d which are wound in a perpendicular fashion with respect to each other.

In a conventional pickup actuator constructed as above, the focusing and tracking of the objective lens 22 are performed by moving the magnets 32a and 32b, i.e. the lens holder 20 toward the directions of focusing and tracking. Such moving of the lens holder 20 is performed by controlling the direction and intensity of electric currents flowing through the focusing and tracking coils 36a, 36c, 36b, and 36d.

The above conventional pickup actuator, however, has a drawback as follows. Since the lens holder 20 is suspended at the holder supporting portion 14 by a pair of wire springs 24a and 24b, during the focusing and tracking of the objective lens 22, a lot of time is

taken for the objective lens 22 to reach the designated spot and be settled therein.

Above will be described in greater detail with respect to FIG. 4. As shown in FIG. 4, an X-axis ("S") is a distance that the objective lens 22 is supposed to be moved to be settled in the designated spot, and an Y-axis ("t") is a time taken for the objective lens 22 to reach the designated spot and be settled therein.

"Ga" in FIG. 4 is a line for indicating an ideal movement of the objective lens 22. In this case, it takes "0" (zero) second for the objective lens 22 to reach the designated spot "T" and be settled therein. However, it is almost impossible because the objective lens 22 has to have a speed reaching an infinite value in an instant, to be moved to the "T".

"Gb" in FIG. 4 is a line for indicating an actual movement of the objective lens 22. In this case, it takes "t_b" for the objective lens 22 to reach the "T" and be settled therein.

If the objective lens 22 is moved at a greater speed to shorten the time "t_b", the time can be shortened to "t_c", however, there inevitably occurs the vibration of the objective lens 22 until the objective lens 22 is settled in the "T".

As described, the greater speed the moving objective lens 22 has, the greater vibration the objective lens 22 has. Thus, if the vibration is efficiently damped, the objective lens 22 can be settled in the "T" more rapidly.

In the past, it has been suggested that a damper bond 40 in a gel state is injected into the inner portion of the holder supporting portion 14 in order to damp the vibration. Due to the presence of the damper bond 40, the vibration transmitted through the wire springs 24a and 24b are damped more rapidly. (Ref. "Gd" line in FIG. 4)

Despite the damper bond 40, however, there is a limit to increasing the speed of the focusing and tracking operation of the objective lens 22, since the vibration occurring at the

lens holder 20 is damped by the damper bond 40 only after the vibration is transmitted through the wire springs 24a and 24b to the damper bond 40.

Particularly when the optical device is employed into the automobiles which have intensive outside vibrations, or when the physical shock is exerted to the optical device, the vibration occurring at the lens holder 20 is not quickly damped, and there occurs a mis-function of the optical device.

Further, the damper bond 40 has to be injected into an inner space 14a defined within the holder supporting portion 14 from a side thereof. Thus, the injecting of the damper bond 40 itself is a complex process, which deteriorates a productivity of the optical pickup device.

In addition, after injecting the damper bond 40, the damper bond 40 has to be solidified to some degree by ultraviolet rays radiated thereto. Thus, a manufacturing process of the optical pick device becomes more complex, and a manufacturing cost thereof accordingly increases.

SUMMARY OF THE INVENTION

The present invention has been made to overcome above-described problems, and accordingly, it is an object of the present invention to provide a pickup actuator capable of damping a vibration occurring at a lens holder during a focusing and tracking of an objective lens, thus moving the objective lens to a designated spot rapidly.

Another object of the present invention is to provide a pickup actuator capable of rapidly damping a vibration occurring at a lens holder caused by an outside vibration or shock, thus preventing a mis-function of the optical device.

Yet another object of the present invention is to provide a pickup actuator which does not need a damper bond injection process, thus has a simpler manufacturing process, and less manufacturing cost.

Above objects will be accomplished by a pickup actuator of the present invention comprising a base member, a lens holder movably supported with respect to the base member, and damping fluid applied between the base member and the lens holder for damping vibration of the lens holder which is generated when the lens holder is driven.

Here, it is preferable that the damping fluid has a viscosity ranging from 1000cP to 2000cP at 27° C, and is magnetized to 100G ~ 200G in a magnetic field of 3~4k0e.

According to the present invention, when there occurs vibration at the lens holder by any reasons, such vibration is directly damped by the damping fluid applied between the base member and the lens holder. Thus, an objective lens can reach its designated spot more rapidly.

Further, since there is no need for an injection of damping bond into an inner space of the holder supporting portion, the manufacturing process becomes simpler, and the manufacturing costs thereof are accordingly reduced.

According to the first preferred embodiment of the present invention, the pickup actuator comprises a base member, a lens holder disposed at the base member to be moved toward directions of focusing and tracking. An objective lens is mounted on the lens holder. The lens holder is driven by a lens holder driving means which drives the lens holder toward the directions of focusing and tracking. The lens holder driving means comprises a pair of magnets and a pair of driving coils. The magnets are attached to both sides of the lens holder, and the driving coil is disposed at the base member, while spaced

from the magnets at a predetermined distance. The damping fluid is applied between the magnets and the driving coil so as to damp the vibration occurring at the lens holder when the lens holder is driven.

According to another preferred embodiment of the present invention, the pickup actuator comprises a base member, and a lens holder whose one end is suspended by a wire spring. Thus, the lens holder is moved toward directions of focusing and tracking. An objective lens is mounted on the lens holder. A pair of yokes are disposed at the base member, while spaced from each other at a predetermined distance, and a pair of magnets are respectively attached to the yokes. A driving coil is disposed at the lens holder in order to drive the lens holder toward the directions of focusing and tracking, by electromagnetically interacting with the magnets. Additionally, a magnetic fluid is applied between the magnets and the lens holder so as to damp the vibration occurring at the lens holder when the lens holder is driven. Thus, the vibration of the lens holder can be damped more rapidly.

According to yet another preferred embodiment of the present invention, the pickup actuator comprises a base member, and a lens holder whose one end is suspended by a wire spring. Thus, the lens holder is moved toward directions of focusing and tracking. An objective lens is mounted on the lens holder. A pair of yokes are disposed at the base member, while spaced from each other at a predetermined distance. A pair of first magnets and a pair of second magnets are respectively attached to inner and outer surfaces of the yokes. Vertical parts are provided to the lens holder. The vertical parts have openings for accommodating the yokes together with the first and the second magnets attached to the yokes. Additionally, a driving coil is disposed at the lens holder to drive the lens holder

toward the directions of focusing and tracking, by electromagnetically interacting with the magnets disposed at the base member. Further, a magnetic fluid is applied between the first magnets and the lens holder so as to damp the vibration occurring at the lens holder when the lens holder is driven. Here, the magnetic fluid may be applied between the second magnets and the lens holder. Also, the magnetic fluid may be applied between the first magnets and the lens holder, and at the same time between the second magnets and the lens holder. In any case, the remarkable damping effect can be guaranteed.

According to yet another preferred embodiment of the present invention, the pickup actuator comprises a base member, and a lens holder whose one end is suspended by a wire spring. Thus, the lens holder is moved toward directions of focusing and tracking. An objective lens is mounted on the lens holder. The pickup actuator also has a magnetic fluid for damping the vibration occurring at the lens holder when the lens holder is driven. A base member has a shaft protruded upward from a center portion thereof. As the shaft of the base member is inserted into a shaft hole of the lens holder, the lens holder is movably disposed on the base member so as to be moved toward the directions of focusing and tracking. A pair of first yokes and a pair of second yokes are disposed at both sides of the shaft, while having the shaft of the base member in the center and being spaced from each other at a predetermined distance. A pair of first magnets are respectively attached to inner surfaces of the first and the second yokes. A driving coil is disposed at the lens holder, maintaining a predetermined distance from the first and the second magnets. The driving coil comprises a focusing and a tracking coil wound around the lens holder to cross perpendicularly to each other. By an electromagnetic interaction between the magnets and the driving coil, the lens holder is driven toward the directions of focusing and tracking.

Meanwhile, the magnetic fluid is applied between the first magnets and the focusing coil of the lens holder. It would be noted that the magnetic fluid applying is not limited to the above case only. That is, the magnetic fluid may be applied between the second magnets and the tracking coil of the lens holder. Also, the magnetic fluid may be applied between the first magnets and the focusing coils, and at the same time between the second magnets and the tracking coil of the lens holder. In this case, it is preferable that a blocking part is formed at the yokes to prevent the magnetic fluid from gravitating toward the magnets which are disposed adjacently to the yokes. Like mentioned above, the remarkable damping effect can be guaranteed by the subject preferred embodiment of the present invention.

According to yet another preferred embodiment of the present invention, the pickup actuator comprises a base member, and a lens holder whose one end is suspended by a wire spring. Thus, the lens holder is moved toward directions of focusing and tracking. An objective lens is mounted on the lens holder. The pickup actuator also has a magnetic fluid for damping the vibration occurring at the lens holder when the lens holder is driven. A base member has a shaft protruded upward from a center portion thereof. As the shaft of the base member is inserted into a shaft hole of the lens holder, the lens holder is movably disposed on the base member so as to be moved toward the directions of focusing and tracking. A pair of first yokes and a pair of second yokes are disposed at both sides of shaft, while having the shaft of the base member in the center and being spaced from each other at a predetermined distance. The second yokes are substantially in a semi-cylindrica shape. A pair of first magnets and a pair of second magnets are respectively attached to the second yokes, while facing each other. The lens holder has an opening for accommodating the first yokes disposed at the base member. Additionally, a pair of focusing coils are

disposed at the lens holder, while maintaining a predetermined distance from the first magnets. Also, the tracking coils are disposed at the lens holder, while maintaining a predetermined distance from the second magnets. By an electromagnetic interaction between the magnets and the focusing coils and the tracking coils, the lens holder is driven toward the directions of focusing and tracking. Meanwhile, the magnetic fluid is applied between the first magnets and the focusing coils of the lens holder to damp the vibration occurring at the lens holder when the lens holder is driven. The magnetic fluid may be applied between the second magnets and the tracking coils of the lens holder. Also, the magnetic fluid may be applied between the first magnets and the focusing coils, and at the same time between the second magnets and the tracking coils of the lens holder. Also, the magnetic fluid may be applied between the opening of the lens holder and the first yokes accommodated in the opening. And in this case, it is preferable that a blocking part is formed at the yokes to prevent the magnetic fluid from gravitating toward the magnets which are disposed adjacently to the yokes. Like mentioned above, the remarkable damping effect can be guaranteed by the subject preferred embodiment of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The above object and advantages will be more apparent by describing preferred embodiments in greater detail with reference to the drawings accompanied, in which;

FIG. 1 is a perspective view showing a conventional pickup actuator from which a lens holder is detached;

FIG. 2 is a perspective view showing the pickup actuator of FIG. 1 assembled;

FIG. 3 is a sectional view showing a main portion of the pickup actuator of FIG. 2;

FIG. 4 is graph for explaining a damping effect obtained by a conventional damper bond;

FIG. 5A is a perspective view showing a pickup actuator according to a first preferred embodiment of the present invention;

FIG. 5B is a sectional view showing the pickup actuator shown in FIG. 5A;

FIG. 6 is a graph for explaining a damping effect obtained by a damping fluid of the present invention;

FIG. 7A is a perspective view showing a pickup actuator according to a second preferred embodiment of the present invention;

FIG. 7B is a sectional view showing a main portion of the pickup actuator shown in FIG. 7A;

FIG. 8A is a perspective view showing a pickup actuator according to a third preferred embodiment of the present invention;

FIG. 8B is a plan view showing the pickup actuator shown in FIG. 8A;

FIG. 9 is a plan view showing another example of applying the damping fluid to the pickup actuator shown in FIG. 8A;

FIG. 10 is a plan view showing still another example of applying the damping fluid to the pickup actuator shown in FIG. 8A;

FIG. 11 is a plan view showing still another example of applying the damping fluid to the pickup actuator shown in FIG. 8A;

FIG. 12A is a perspective view showing a pickup actuator according to a fourth preferred embodiment of the present invention;

FIG. 12B is a sectional view showing a main portion of the pickup actuator shown

in FIG. 12A;

FIG. 13 is a sectional view showing another example of applying the damping fluid to the pickup actuator shown in FIG. 12A;

FIG. 14 is a sectional view showing still another example of applying the damping fluid to the pickup actuator shown in FIG. 12A;

FIG. 15 is a sectional view showing still another example of applying the damping fluid to the pickup actuator shown in FIG. 12A;

FIG. 16A is a perspective view showing a pickup actuator according to a fifth preferred embodiment of the present invention;

FIG. 16B is a sectional view showing a main portion of the pickup actuator shown in FIG. 16Ap;

FIG. 17A is a sectional view showing another example of applying the damping fluid to the pickup actuator shown in FIG. 16A;

FIG. 17B is a sectional view showing a main portion of FIG. 17A;

FIG. 18 is a perspective view showing another example of applying the damping fluid to the pickup actuator shown in FIG. 16A;

FIG. 19A is a perspective view showing still another example of applying the damping fluid to the pickup actuator shown in FIG. 16A; and,

FIG. 19B is a sectional view showing a main portion of FIG. 19A.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGs. 5A to 6 show a pickup actuator according to the first preferred embodiment of the present invention. It would be understood that the like elements would be given the

same reference numerals as above. Accordingly, a reference numeral 10 in the figures is a base member, 20 is a lens holder, 30 is a lens holder driving means, and 50 is a damping fluid.

As shown in FIGs. 5A to 6, the base member 10 comprises a body portion 12 and a holder supporting portion 14. The holder supporting portion 14 is attached to an upper side of the body portion 12 by a pair of screws 16a and 16b.

An objective lens 22 is mounted on the lens holder 20, while the lens holder 20 is suspended at the holder supporting portion 14 of the base member 10 by two pairs of wire springs 24a and 24b, while being capable of being moved toward focusing and tracking direction.

The lens holder driving means 30 comprises a pair of magnets 32a and 23b, and a pair of driving coils 34a and 34b. The magnets 32a and 32b are respectively attached to both sides of the lens holder 20, and form a magnet circuit. The driving coils 34a and 34b are disposed at the body portion 12 of the base member 10, while facing each other and being spaced from the respective magnets 32a and 32b at a predetermined distance. The two driving coils 34a and 34b respectively have a pair of focusing coils and a pair of tracking coils 36a, 36b, and 36c, 36d which are wound in a perpendicular fashion with respect to each other.

A damping fluid 50 is applied to surfaces of the magnets 32a and 32b so as to contact with the driving coils 34a and 34b sufficiently. The damping fluid 50 functions to damp the vibration occurring at the lens holder 20 while the lens holder 20 is driven.

The damping fluid 50 is in a colloid state, having ferromagnetic super particulates dispersed therein. Thus, the magnetic particles are not separated from the damping fluid 50

even when the centrifugal force of high intensity, or the magnetic field is exerted to the fluid. Here, Fe_3O_4 can be utilized as the magnetic particles.

It is preferable that the damping fluid 50 has a viscosity ranging from 1000cP to 2000cP, at an atmospheric temperature twenty seven centigrade (27°C). Additionally, it is preferable that the damping fluid 50 is magnetized to a degree from 100G to 200G in the magnetic field of 3~4k0e.

Accordingly, due to the viscosity thereof, the damping fluid 50 damps the vibration of the lens holder 20, and at the same time, the damping fluid 50 does not gravitate downward. Thus, the appropriate amount of damping fluid 50 stays between the magnets 32a and 32b and the driving coils 34a and 34b.

U.S. corporation, the Ferrofluidics disclosed a preferred example of such damping fluid 50, i.e., a magnetic fluid. According to the related data, the disclosed magnetic fluid are composed of 4~6% of magnetite, 16~20% of oil soluble dispersant, 73~80% of carrier liquid, and 0~1% of aromatic amine.

The pickup actuator of the present invention constructed as above performs the focusing and tracking of the objective lens 22 by moving the magnets 32a and 32b, i.e. lens holder 20 toward the directions of focusing and tracking. The lens holder 20 is moved by controlling directions and intensity of electric currents flowing through the focusing and tracking coils 36a, 36c and 36b, 36d.

In such situation, as described in the Prior Art, the vibration occurs. Such vibration, however, is directly damped by the damping fluid 50 disposed between the magnets 32a and 32b and the driving coils 34a and 34b, before the vibration is transmitted to the wire springs 24a and 24b.

Accordingly, as indicated by a line "Ge" in FIG. 6, the time "Te" taken for the objective lens 22 to reach the designated spot "T" and be settled therein is remarkably shortened, in comparison with the time spent with the conventional damper bond (see line "Gd" of FIG. 6).

More specifically, when the vibration occurs during the focusing and tracking of the objective lens 22, the objective lens 22 can be rapidly settled in the designated spot "T", because the vibration is directly damped by the damping fluid 50 disposed between the magnets 32a and 32b and the driving coils 34a and 34b before the vibration is transmitted to the wire springs 24a and 24b.

Especially, according to the pickup actuator of the present invention constructed as above, even when the vibration occurs at the lens holder 20 due to the outside vibration or the shock, the vibration of the lens holder 20 is efficiently damped. Thus, the pickup actuator of the present invention has a high adaptability so that it can be employed into the optical devices having vibrations of high intensity such as the optical device in automobiles, etc.

Further, since a heat generated from the driving coils 34a and 34b during the focusing and tracking of the pickup actuator is efficiently cooled through the damping fluid 50, the functional deterioration of the pickup actuator, or damage to the optical pickup due to the heat can be prevented.

Still further, according to the pickup actuator of the present invention, since there is no need to inject the damper bond into the inner space of the holder supporting portion of the base member, the manufacturing process of the optical pick device becomes simpler, and the manufacturing costs are accordingly reduced.

Meanwhile, the damping fluid of the present invention can be used together with the conventional damper bond, and still has the same superb damping and coil cooling effect as described above. Thus, it would be understood that the term "comprise" in the Claims does not exclude such case.

Even though the preferred embodiment of the present invention suggests the magnetic fluid as the damping fluid, it is not limited to the suggested magnetic fluid only, but can be any substances if they perform the same function as the suggested magnetic fluid.

FIGs. 7A and 7B show a pickup actuator according to the second preferred embodiment of the present invention. According to the second preferred embodiment, a damping means utilizing the damping fluid is provided to the pickup actuator. A reference numeral 110 is a base member, 120 is a lens holder, 130 is a lens holder driving means, and 150 is a damping fluid.

As shown, the base member 110 comprises a body portion 112 and a holder supporting portion 114. A pair of yokes 115a and 115b are disposed at an upper surface of the body portion 112, while being spaced from each other at a predetermined distance. The holder supporting portion 114 is fixedly attached to an outer surface of one yoke 115a by a plurality of screws.

An objective lens 122 is mounted on the lens holder 120, and the lens holder 120 is suspended at the holder supporting portion 114 of the base member 110 by two pairs of wire springs 124a and 124b so that the lens holder 120 can be moved to the direction of the focusing and the tracking.

The lens holder driving means 130 comprises a pair of magnets 132a and 132b, and

a driving coil 134. The magnets 132a and 132b are respectively attached to an inner surface of the two yokes 115a and 115b, and form a magnetic circuit. Here, the yokes 115a and 115b are disposed at the base member 110, having a predetermined distance from each other. The yokes 115a and 115b function to maximize and concentrate the magnetic flux density toward a desired direction. The driving coil 134 comprises a focusing coil 134a and a tracking coil 134b which are wound to perpendicularly cross each other. The driving coil 134 is disposed at the lens holder 120, maintaining a predetermined distance from each of the magnets 132a and 132b.

The damping fluid 150 is applied to the surfaces of the magnets 132a and 132b so as to contacts with the driving coil 134 disposed at the lens holder 120 sufficiently. The damping fluid 150 is the same one employed in the first preferred embodiment of the present invention. Thus, the description of the damping fluid 150 along with its effect will be omitted since it has been described as above in the description of the first preferred embodiment of the present invention.

FIGs. 8A to 11 show a pickup actuator according to the third preferred embodiment of the present invention. According to the third preferred embodiment, the damping means utilizing a damping fluid is provided to the pickup actuator having two pairs of magnets. A reference numeral 210 is a base member, 220 is a lens holder, 230 is a lens holder driving means, and 250 is a damping fluid.

As shown, the base member 210 comprises a body portion 212 and a holder supporting portion 214. The holder supporting portion 214 is fixedly attached to an upper side of the body portion 212 by a plurality of screws 216a and 216b. A pair of yokes 215a and 215b are disposed at the upper surface of the body portion 212, having a predetermined

distance from each other.

A pair of first magnets 232a and 232b are respectively attached to the inner surfaces of the yokes 215a and 215b, while another pair of second magnets 232c and 232d are respectively attached to the outer surfaces of the yokes 215a and 215b.

An objective lens 222 is mounted on the lens holder 220, and the lens holder 220 is suspended at the holder supporting portion 214 of the base member 210 by two pairs of wire springs 224a and 224b so as to be moved toward the directions of focusing and tracking. Further, the lens holder 220 comprises a pair of yokes 215a and 215b, and a pair of vertical parts 228a and 228b. The yokes 215a and 215b are disposed at the base member 210, and the vertical parts 228a and 228b have openings 226 to accommodate the first and the second magnets 232a, 232b, 232c, and 232d.

The lens holder driving means 230 comprises a pair of first magnets 232a and 232b, a pair of second magnets 232c and 232d, and a driving coil 234. The first and the second magnets 232a, 232b, 232c, and 232d are respectively attached to inner and outer surfaces of two yokes 215a and 215b which are mounted on the base member. The driving coil 234 comprises a pair of focusing coils 234a wound around the vertical parts 228a and 228b formed at both sides of the lens holder 220, and a tracking coil 234b wound around the linking portion of the both vertical parts 228a and 228b. The tracking coil 234b is wound to cross perpendicularly to the focusing coils 234a.

The damping fluid 250 is applied between the inner walls of the openings 226 and the first magnets 232a and 232b, to damp the vibration occurring while the lens holder 220 is driven. Here, the openings 226 are defined at the vertical parts 228a and 228b of the lens holder 220.

Alternatively, as shown in FIG. 9, the damping fluid 250 may be applied between the outer walls of the openings 226 defined at the vertical parts 228a and 228b of the lens holder 220, and the second magnets 232c and 232d. Also, as shown in FIG. 10, the damping fluid 250 may be applied between the inner and outer walls of the openings 226 and the first and the second magnets 232a, 232b, 232c, and 232d. Still also, as shown in FIG. 11, the damping fluid 250 may be applied among the whole inner wall surfaces of the openings 226, side surfaces of the yokes 215a and 215b accommodated therein, and the whole outer wall surfaces of the first and the second magnets 232a, 232b, 232c, and 232d. Here, the damping fluid 250 is the one utilized by the first and the second preferred embodiment of the present invention. Thus, the further description of the damping fluid along with its effects are omitted, since it has been described as above in the description of the first preferred embodiment of the present invention.

FIGs. 12A to 15 show the pickup actuator according to the fourth preferred embodiment of the present invention. According to the fourth preferred embodiment of the present invention, a damping means utilizing the damping fluid is applied to a shaft-type pickup actuator.

As shown, the pickup actuator according to the fourth preferred embodiment of the present invention comprises a base member 310, a lens holder 320, a lens holder driving means 330, and a damping fluid 350. The lens holder 320 is disposed at the base member 31, capable of being moved toward the directions of focusing and tracking, and the lens holder driving means 330 drives the lens holder 320 toward the direction of focusing and the tracking. The damping fluid 350 damps the vibration occurring at the lens holder 320, when the lens holder 320 is driven.

A shaft 311 is disposed at a center portion of the base member 310. A pair of first yokes 315a and 315b are disposed at both sides of the shaft 311, while having the shaft 311 in the center and being spaced from each other at a predetermined distance. Another pair of second yokes 317a and 317b are disposed at the outer side of the first yokes 315a and 315b, having a predetermined distance from each other. A pair of first magnets 332a and 332b are attached to the inner surfaces of the first yokes 315a and 315b, while facing each other. Another pair of second magnets 332c and 332d are respectively attached to the inner surfaces of the second yokes 317a and 317b, also facing each other.

A shaft hole 321 is defined at the center portion of the lens holder 320 so as to accommodate a shaft 311 of the base member 310. As the shaft 311 of the base member 310 is inserted into the shaft hole 321, the lens holder 320 is mounted on the base member 310. An objective lens 322 is mounted on the lens holder 320. The lens holder 320 comprises a pair of openings 323a and 323b for accommodating the first yokes 315a and 315b. Accordingly, the lens holder 320 is mounted on the base member 310 so as to be moved toward the directions of focusing and tracking.

The lens holder driving means 330 comprises a first and a second magnets 332a, 332b, 332c, and 332d, and a driving coiil 334. Here, the first and the second magnets 332a, 332b, 332c, and 332d are respectively attached to the first yokes 315a and 315b and the second yokes 317a and 317b. The driving coil 334 comprises a focusing coil 334a and a pair of tracking coils 334b. The focusing coil 334a is wound around a circumference of the shaft hole 321 of the lens holder 320, maintaining a predetermined distance from the first magnets 332a and 332b. While, the tracking coils 334b are wound around both sides of the lens holder 320, maintaining the a predetermine distance from the second magnets 332c and

332d. The focusing coil 334a and the tracking coils 334b are wound to cross perpendicularly to each other. Therefore, the lens holder 320 can be moved from the base member 310 toward the directions of focusing and tracking by an electromagnetic interaction of the first and the second magnets 332a, 332b, 332c, and 332d, the focusing coil 334a, and a pair of tracking coils 334b.

The damping fluid 350 is applied to the surfaces of the first magnets 332a and 332b such that the damping fluid 350 can be in contact with the focusing coil 334a of the lens holder 320 sufficiently, whereby the vibration occurring at the lens holder 320 during a driving of the lens holder 320 is rapidly damped.

As shown in FIG. 12B, the damping fluid 350 is applied between the focusing coil 334a of the lens holder 320 and the first magnets 332a and 332b. However, it is not limited thereto, but the damping fluid 350 can be applied to the other places. That is, as shown in FIG. 13, the damping fluid 350 may be applied to the surfaces of the second magnets 332c and 332d, to be in contact with the tracking coils 334b disposed at both sides of the lens holder 320 sufficiently. Alternatively, as shown in FIG. 14, the damping fluid 350 may be applied between the focusing coil 334a of the lens holder 320 and the first magnets 332a and 332b, and at the same time between the tracking coils 334b of the lens holder 320 and the second magnets 332c and 332d.

Also, as shown in FIG. 15, the damping fluid 350 may be applied between the openings 323a and 323b of the lens holder 320 and a pair of first yokes 315a and 315b which are accommodated in the openings 323a and 323b. In this case, it is preferable that a blocking part 319 is provided at edges of the yokes 315a and 315b to block the damping fluid 350, since the damping fluid 350 applied to the yokes 315a and 315b may gravitate

toward the first magnets 332a and 332b which are disposed adjacently to the yokes 315a and 315b due to the magnetic property thereof. The damping fluid 350 here is the same one utilized in the first, second, and the third preferred embodiments of the present invention. Thus, further description of the damping fluid and its effects will be omitted, since it has been already described as above in the description of the first preferred embodiment of the present invention.

FIGs. 16A to 19B show the pickup actuator according to the fifth preferred embodiment of the present invention.

As shown, the pickup actuator according to the fifth preferred embodiment of the present invention, schematically comprises a base member 410, a lens holder 420, a lens holder driving means 430, and a damping fluid 450. The lens holder 420 has a cylindrical shape, and is disposed at the base member so as to be moved toward the directions of focusing and tracking. The lens holder driving means 430 drives the lens holder 420 toward the directions of focusing and tracking, and the damping fluid 450 damps the vibration occurring at the lens holder 420 when the lens holder 420 is driven.

A shaft 411 is disposed at the center portion of the base member 410. A pair of first yokes 415a and 415b are disposed at both sides of the shaft 411, while having the shaft 411 in the center and being spaced from each other at a predetermined distance. Another pair of second yokes 417a and 417b are disposed at the outer sides of the first yokes 415a and 415b, while facing each other and being spaced from each other at a predetermined distance. Here, the second yokes 417a and 417b are substantially in semi-cylindrical shape. A pair of first magnets 432a and 432b are attached to one sides of the semi-cylindrical second yokes 417a and 417b, while the other pair of second magnets 432c and 432d are

attached to the other sides of the second yokes 417a and 417b. Here, each of the first magnets 432a and 432b faces each other, and so is each of the second magnets 432c and 432d.

A shaft hole 421 is defined at the center portion of the lens holder 420, to accommodate the shaft 411 of the base member 410. As the shaft 411 is inserted into the shaft hole 421, the lens holder 420 is mounted on the base member 410. An objective lens 422 is mounted on the lens holder 420. The lens holder 420 is provided with at least one pair of openings 423a and 423b for accommodating a pair of first yokes 415a and 415b disposed at the base member 410, whereby the lens holder 420 is mounted on the base member 41 so as to be moved toward the directions of focusing and tracking.

The lens holder driving means 430 comprises a first and a second magnets 432a, 432b, 432c, and 432d respectively attached to the second yokes 417a and 417b, and a driving coil 434. The driving coil 434 comprises a pair of focusing coils 434a, and a pair of tracking coils 434b. The focusing coils 434a are wound around the both sides of the lens holder 320, maintaining a predetermined distance from the first magnets 432a and 432b. While, the tracking coils 434b are wound around the both sides of the lens holder 420, maintaining a predetermined distance from the second magnets 432c and 432d. The focusing coils 434a and the tracking coils 434b are wound to cross perpendicularly to each other. Thus, the lens holder 420 is moved toward the directions of focusing and tracking, by the electromagnetic interaction of the first and the second magnets 432a, 432b, 432c, and 432d, the focusing coil 434a, and the tracking coils 434b.

The damping fluid 450 is applied to the surfaces of the first magnets 432a and 432b so as to be in contact with the focusing coils 434a at both sides of the lens holder 420

sufficiently. Accordingly, the vibration occurring at the lens holder 420 is rapidly damped when the lens holder 420 is driven.

As shown in FIGs. 17A and 17B, the damping fluid 450 may be applied to the surfaces of the pair of second magnets 432c and 432d, to be in contact with the tracking coils 434b at both sides of the lens holder 420 sufficiently. Alternatively, as shown in FIG. 18, the damping fluid 450 may be applied between the focusing coil 434a of the lens holder 420 and the first magnets 432a and 432b, and at the same time between the tracking coils 434b of the lens holder 420 and the second magnets 432c and 432d.

Also, as shown in FIG. 19A and 19B, the damping fluid 450 may be applied between the openings 423a and 423b of the lens holder 420 and the pair of first yokes 415a and 415b accommodated within the openings 423a and 423b. In this case, it is preferable that a blocking part 419 is formed at edges of the first yokes 415a and 415b to block the damping fluid 450, since the damping fluid 450 applied to the first yokes 415a and 415b may gravitate toward the first magnets 432a and 432b which are disposed adjacently to the first yokes 415a and 415b due to the magnetic property thereof. Here, the damping fluid 450 is the one utilized in the first, second, third, and the fourth preferred embodiment of the present invention. Thus, further description of the damping fluid 450 along with its effects is omitted, since it has been described as above in the description of the first preferred embodiment of the present invention.

While the present invention has been particularly shown and described with reference to the preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be effected therein without departing from the spirit and scope of the invention as defined by the appended claims.

CLAIMS

1. A pickup actuator of an optical device comprising:

a base member (10, 110, 210, 310, 410);

a lens holder (20, 120, 220, 320,420) which is disposed at the base member so as to be moved in directions of focusing and tracking, and on which an objective lens (22,122, 222, 322, 422) is mounted;

a lens holder driving means (30, 130, 230, 330, 430) for driving the lens holder toward the directions of focusing and tracking; characterised in that there is

a damping fluid (50, 150, 250, 350, 450) applied directly between the base member or parts fast with the base member and the lens holder or parts fast with the lens holder for damping a vibration occurring at the lens holder when the lens holder is driven by the lens holder driving means in both the focusing and tracking direction, the damping fluid having a viscosity ranging from 1000cP to 2000cP at 27°C, in which magnetic particulates are stably dispersed.

2. The pickup actuator as claimed in claim 1, wherein the base member comprises a body portion (12, 112, 212) and a holder supporting portion (14, 114, 214) attached to one side of the upper surface of the body portion, and the lens holder is suspended by two pairs of wire springs (24a, 24b, 124a, 124b, 224a, 224b).

3. The pickup actuator as claimed in claim 1, wherein the base member is provided with a shaft (311, 411) on the center portion thereof, and the lens holder has a shaft hole (321, 421) for accommodating the shaft, and the lens holder is supported with respect to the base member in the manner of being inserted to the shaft through the shaft hole.

4. The pickup actuator as claimed in claim 2, wherein the lens holder driving means comprises:

a pair of magnets (32a, 32b) respectively attached to both sides of the lens holder; and

a driving coil (34a, 34b) which is disposed on an upper surface of the base member so as to maintain a predetermined distance from the pair of magnets, and which generate an electromagnetic force for driving the lens holder along with the magnets.

5. The pickup actuator as claimed in claim 4, wherein the driving coil comprises a pair of focusing coils (36a, 36b) and a pair of tracking coils (36c, 36d), which are wound to cross perpendicularly to each other.

6. The pickup actuator as claimed in claim 4 or 5, wherein the damping fluid (50) is applied to the surfaces of the magnets to be in contact with the driving coil sufficiently.

7. The pickup actuator as claimed in claim 2, 3, 4, 5, or 6, wherein the lens holder driving means comprises:

a pair of magnets (132a, 132b, 232a, 232b, 332a, 332b, 432a, 432b) disposed on an upper surface of the base member, spaced from each other at a predetermined distance;

a pair of yokes which support the pair of magnets (115a, 115b, 232a, 323b, 332a, 332b, 432a, 432b) with respect to the base member, and which maximize and concentrate a magnetic flux density of the magnets toward a desired direction; and

a driving coil (134a, 134b, 234a, 234b, 334a, 334b, 434a, 434b) which is disposed on an upper surface of the lens holder so as to maintain a predetermined distance from the magnets, and which generate an electromagnetic force for driving the lens holder along with the magnets.

8. The pickup actuator as claimed in claim 7, wherein the driving coil comprises focusing coils (134a, 234a, 334a, 434a) which are wound around the center of the lens holder

in an horizontal fashion with respect to the lens holder, and tracking coils (134b, 234b, 334b, 434b) which are wound around both sides of the lens holder to cross perpendicularly to the focusing coils.

9. The pickup actuator as claimed in claim 7 or 8, wherein the damping fluid (150, 250, 350, 450) is applied to surfaces of the magnets to be in contact with the driving coil at both sides of the lens holder sufficiently.

10. The pickup actuator as claimed in claim 2, wherein the lens holder driving means comprises:

a pair of first magnets (232a, 232b) disposed on an upper surface of the base member while facing each other and being spaced from each other at a predetermined distance;

a pair of second magnets (232c, 232d) respectively disposed at outer sides of the first magnets;

a pair of yokes (215a, 215b) which support the first and the second magnets with respect to the base member, and which maximize and concentrate a magnetic flux density toward a desired direction; and

a driving coil (234) which is mounted on the lens holder, and which generate an electromagnetic force for driving the lens holder along with the first and second magnets, the lens holder having a pair of vertical parts which have openings (226) for accommodating the yokes and the first and the second magnets attached to the yokes.

11. The pickup actuator as claimed in claim 10, wherein the two pairs of first (232a, 232b) and second (232c, 232d) magnets are respectively attached to inner and outer side surfaces of the yokes (215a, 215b), while having the yokes therebetween.

12. The pickup actuator as claimed in claim 10, wherein the driving coil has a pair of focusing coils (234a)

respectively wound to be in horizontal fashion with respect to the lens holder, and a tracking coil (234b) wound around a middle portion of the lens holder to cross perpendicularly to the focusing coils.

13. The pickup actuator as claimed in claim 10, wherein the damping fluid (250) is applied between the openings of the lens holder and the first magnets.

14. The pickup actuator as claimed in claim 10 or 13, wherein the damping fluid (250) is applied between the openings of the lens holder and the second magnets.

15. The pickup actuator as claimed in claim 3, wherein the lens holder driving means comprises:

a pair of first magnets (332a, 332b) respectively disposed at both sides of the shaft, while having the shaft of the base member in the center and respectively having a predetermined distance from each other;

a pair of second magnets (332c, 332d) respectively disposed at outer sides of the first magnets, while being spaced from the first magnets at a predetermined distance;

a pair of first yokes (315a, 315b) and a pair of second yokes (317a, 317b) which support the first and the second magnets with respect to the base member, and which concentrate and maximize a magnetic flux density of the first and second magnets toward a desired direction; and

a driving coil (334) which is disposed at the lens holder, and generates an electromagnetic force together with the magnets to drive the lens holder, wherein

the lens holder has a pair of openings (323a, 323b) for accommodating the pair of first yokes together with the first magnets attached to the first yokes.

16. The pickup actuator as claimed in claim 15, wherein the driving coil comprises:

a focusing coil (334a) disposed around a circumference of the shaft hole of the lens holder, while maintaining a predetermined distance from the first magnets; and

a pair of tracking coils (334b) disposed around both sides of the lens holder, while maintaining a predetermined distance from the second magnets;

wherein the focusing coil and the tracking coils are wound to cross perpendicularly to each other.

17. The pickup actuator as claimed in claim 15 or 16, wherein the damping fluid (350) is applied to surfaces of the first magnets so as to be in contact with the focusing coil of the lens holder sufficiently.

18. The pickup actuator as claimed in claim 15, 16 or 17, wherein the damping fluid (350) is applied to surfaces of the second magnets so as to be in contact with the tracking coils of the lens holder sufficiently.

19. The pickup actuator as claimed in claim 15, wherein the damping fluid (350) is applied between the openings of the lens holder and the first yokes.

20. The pickup actuator as claimed in claim 19, wherein the first yokes has a blocking part (319) to prevent the damping fluid from gravitating toward the first magnets.

21. The pickup actuator as claimed in claim 3, wherein the lens holder driving means comprises:

a pair of first yokes (415a, 415b) disposed at the both sides of the shaft, while having the shaft of the base member in the center and being spaced from each other at a predetermined distance;

a pair of second yokes (417a, 417b) which are disposed at outer sides of the first yokes, and each of which is substantially in a semi-cylindrical shape;

a pair of first magnets (432a, 432b) attached to one sides of the second yokes, while facing each other;

a pair of second magnets (432c, 432d) respectively attached to the other sides of the second yokes, while facing each other; and

a driving coil (434) which is disposed at the lens holder, and which generate an electromagnetic force together with the first and the second magnets to drive the lens holder, wherein the lens holder has at least a pair of openings (423a, 423b) for accommodating the first yokes.

22. The pickup actuator as claimed in claim 21, wherein the driving coil comprises:

a pair of focusing coil (434a) disposed at both sides of the lens holder, while maintaining a predetermined distance from the first magnets; and

a pair of tracking coils (434b) disposed at both sides of the lens holder, while maintaining a predetermined distance from the second magnets, wherein the focusing coils and the tracking coils are wound to cross perpendicularly to each other.

23. The pickup actuator as claimed in claim 21 or 22, wherein the damping fluid (450) is applied to surfaces of the first magnets so as to be in contact with the focusing coils of the lens holder sufficiently.

24. The pickup actuator as claimed in claim 21, 22 or 23, wherein the damping fluid (450) is applied to surfaces of the second magnets so as to be in contact with the tracking coils of the lens holder sufficiently.

25. The pickup actuator as claimed in claim 21, wherein the damping fluid (450) is applied between the openings of the lens holder and the first yokes accommodated in the openings.

26. The pickup actuator as claimed in claim 25, wherein the first yokes has a blocking part (419) to prevent the damping fluid from gravitating toward the first magnets.

5