TITLE OF THE INVENTION

HEAD SUSPENSION ASSEMBLY HAVING HEAD IC CHIP, MAGNETIC DISK DRIVE HAVING HEAD SUSPENSION ASSEMBLY, AND HEAD IC CHIP

BACKGROUND OF THE INVENTION

The present invention relates to a head IC chip suitable for use in the suspension of a head suspension assembly, a head suspension assembly mounted with the head IC chip, and a magnetic disk drive having the head suspension assembly.

In general, a magnetic disk drive has a head suspension assembly where a suspension supports a head, for example, a magnetic head, serving as an electromagnetic transducer mounted on a slider. In the magnetic disk drive, an integrated circuit device including a read amplifier circuit that amplifies the signal read from a magnetic recording medium by the magnetic head and a write driver circuit that writes data onto the magnetic recording medium by means of the magnetic head by switching the direction of current supplied to the head is generally referred to as head IC. The head IC has been typically mounted on a flexible printed circuit board (FPC), which is a representative cable material for wiring.

In recent years, Japanese Patent Disclosure KOKAI No. 11-213365, for example, has proposed an improved configuration in which the head IC (signal processing

IC, and integrated circuit device) is placed near the magnetic head on the suspension of the head suspension assembly in order to reduce the inductance and capacitance of the wiring pattern by shortening the length of the wiring pattern that ranges from the magnetic head to the head IC.

The above KOKAI Publication describes a wiring configuration where the wiring pattern on the suspension is formed symmetric with respect to the center axis on the main surface of the suspension in order to prevent a misplacement of the magnetic head caused by a suspension twist due to a difference in the thermal expansion coefficient between the resin film covering the wiring pattern and the suspension material when temperature changes. It is also described in the KOKAI Publication that the suspension has symmetric wiring patterns on both sides of the suspension in order to prevent warpage caused by changes in temperature.

The above KOKAI Publication, however, does not refer to a possible problem that the balance between the two areas separated by the longitudinal center axis on the suspension may be degraded by mounting the head IC chip on the suspension. This problem will be further described.

First, in order to mount the head IC chip on the suspension, the head IC chip has a plurality of bumps

serving as signal input and output terminals for electrical contacts. A force is imposed on each of the bumps of the IC chip when the head IC chip is mounted on the suspension. As a result, when the bump array is not formed symmetric with respect to the longitudinal center axis on the suspension, the read-write performance of the magnetic head may be affected by an imbalance between the two areas separated by the center axis, even if the head IC chip itself is mounted on the suspension symmetrically with respect to the longitudinal center axis.

Moreover, although the head IC chip allows the DC test at probing tests conducted on the wafer, all the performance tests including the AC test cannot be done with this configuration employing this type head IC chip instead of common package type devices.

On the other hand, a capacitor may be inserted between the power source line and the ground line (or minus power source line) for smoothing the supply voltage. However, since conventional capacitors have electrodes on both the top and bottom surfaces, solder runs into between the bottom surface of the capacitor and the circuit substrate, and the profile after mounting becomes higher by the thickness of the electrode itself and formed solder layer. If the thickness of the capacitor is reduced, its capacitance and mechanical strength will be lowered.

BRIEF SUMMARY OF THE INVENTION

The present invention has been contrived in consideration of the above circumstances and its object is to provide a head IC chip that can maintain a good balance between the two areas separated by the center axis on the suspension when it is mounted on the suspension of a head suspension assembly, a head suspension assembly having such a head IC chip, and a magnetic disk drive having such a head suspension assembly.

Another object of the invention is to provide a magnetic disk drive having a head suspension assembly that allows connection and function checks for the head IC chip while mounting the head IC chip on the suspension and maintains a good balance between the two areas separated by the center axis on the suspension, and a magnetic disk assembly that has such a head suspension assembly.

Still another object of the present invention is to provide a head suspension assembly which can maintain a good balance between the two areas separated by the center axis on the suspension while smoothing voltage by a capacitor, and which can keep a low profile of the capacitor, and to provide a magnetic disk assembly that has such a head suspension assembly.

In order to achieve such objects, a head IC chip according to the present invention, namely, the head IC

chip that will be mounted on the suspension of a head suspension assembly, comprises a chip body having a center axis extending in a direction substantially perpendicular to the predetermined direction and a shape symmetric with respect to the center axis; and a plurality of bumps provided on the chip body and serving as input and output electrodes for electrical contact, the bumps being arranged symmetrically with respect to the center axis of the chip body.

It becomes thereby possible to mount the head IC chip along with its bumps on the suspension symmetrically with respect to the longitudinal center axis of the suspension by forming and arranging the bumps symmetrically with respect to the center axis. Then it also becomes possible to distribute the loads applied on the suspension through the bumps, particularly mechanical stress due to temperature change, equally to both areas separated by the longitudinal center axis on the suspension when the head IC chip is mounted on the suspension.

A head suspension assembly according to the present invention comprises a suspension, and a head IC chip that has the above-mentioned structure and is mounted on the suspension symmetrically with respect to its longitudinal center axis.

With the suspension assembly having the above-mentioned mounting structure, the loads acting on

the bumps of the head IC chip can be distributed equally to both sides of the suspension separated by the longitudinal center axis and a good balance can be maintained between the two sides. Then good reading and writing performance of the magnetic head will be maintained. This invention works most effectively in the hybrid type magnetic head comprising an MR (magneto-resistive) element for data reading and a thin-film head for data writing.

The head suspension assembly according to the present invention comprises an interconnection flexible printed circuit board mounted on the suspension and having a wiring pattern including a plurality of conductive wires electrically connected to a plurality of bumps of the head IC chip, the wiring pattern being arranged symmetrically with respect to the longitudinal center axis of the suspension; and a plurality of test pads provided on the respective conductive wires and arranged symmetrically with respect to the longitudinal center axis of the suspension.

Since the test pads used for the function and connection tests of the head IC chip are provided on the conductive wires of the interconnection flexible printed circuit board on which the head IC chip is mounted, it becomes possible to conduct those tests while holding the head IC chip on the suspension. In addition, since the wiring pattern and the test pads

are formed and located symmetrically with respect to the longitudinal center axis of the suspension, there is no concern that the balance between the two sides separated by the longitudinal center axis on the suspension is degraded by the interconnection flexible printed circuit board and test pads.

The head suspension assembly according to the present invention has a capacitor for smoothing source power having a pair of electrodes electrically connected to the head IC chip and mounted on the suspension symmetrically with respect to the longitudinal center axis of the suspension.

Since the capacitor is connected between the power source electrode (of power source line) of the head IC chip and the ground (or minus line of the power source line) to smooth the source voltage and mounted symmetrically with respect to the longitudinal center axis of the suspension, the balance between the two areas separated by the longitudinal center axis on the suspension is well maintained.

Further, the capacitor has a pair of side-walls standing on the suspension and the pair of electrodes are provided only on the side-walls. Then it is possible to keep the profile of the capacitor itself low, and its height after mounting also becomes small because there is no bottom solder layer formed.

The magnetic disk drive according to the present

invention comprises a magnetic recording medium having opposed first and second recording surfaces; a driver supporting and rotating the magnetic recording medium; a first magnetic head for reading data from and writing data on the first recording surface; a second magnetic head for reading data from and writing data on the second recording surface; a first head suspension assembly supporting the first magnetic head to be movable in a predetermined direction with respect to the first recording medium; and a second head suspension assembly supporting the second magnetic head to be movable in a predetermined direction with respect to the second recording medium and opposing the first head suspension assembly with the magnetic recording medium being interposed therebetween; the first and second head suspension assemblies each including a slider on which the magnetic head is mounted, a suspension supporting the slider, and a head IC chip mounted on the suspension and electrically connected to the magnetic head. Each of head IC chips has a center axis, and a plurality of bumps serving as input and output electrodes for electrical contact and arranged symmetrically with respect to the center axis, the bumps of the head IC chips of the first and second head suspension assemblies being arranged in a plane symmetrical with respect to each other.

As described above, since the bumps for electrical

contact are located symmetrically in the first and second head suspension assemblies with respect to the suspension surface, the wiring patterns on the suspension become symmetric as well and they can be formed and located also symmetrically with respect to the longitudinal center axis on the suspension. As a result, the first and second head suspension assemblies become equal in read-write characteristics and at the same time a good balance between the sides separated by the longitudinal center axis on the suspension can be maintained.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invented may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the inevitable, and together with the general description given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

FIG. 1 is a plan view showing a head IC chip

according to a first embodiment of the present invention and a head suspension assembly mounted with the head IC chip;

FIG. 2 is an enlarged plan view of the head IC chip;

FIG. 3 is a plan view showing a head suspension assembly according to a second embodiment of the present invention;

FIGS. 4A and 4B are schematic diagrams showing the connection states of a capacitor mounted on the head suspension assembly according to a second embodiment of the present invention;

FIG. 5 is a cross sectional view showing the mounting structure of the capacitor;

FIG. 6 is a perspective view illustrating a magnetic disk drive according to a third embodiment of the present invention:

FIG. 7 is a perspective view illustrating the structure of a board unit of the magnetic disk drive;

FIG. 8A is a plan view showing the head suspension assembly for the UP head in the magnetic disk drive; and

FIG. 8B is a plan view showing the head suspension assembly for the DOWN head in the magnetic disk drive.

DETAILED DESCRIPTION OF THE INVENTION

Now embodiments of the present invention will be described in detail with reference to the drawings.

Referring to FIG. 1, a head suspension assembly 30 (hereafter, referred as HSA) having a head IC chip according to the first embodiment of the present invention includes an arm 21 and a suspension 22 which extrudes from the arm 21, and its base end is spot-welded or adhered to the distal end of the arm 21. The arm 21 is made of stainless steel such as SUS304 into a thin plate with about 250 μm thick and has a through hole 23 in its base end portion. The suspension 22 is made of an elongated plate spring with 60 to 70 μm thick. The suspension 22 may be integrated with the arm 21, using the same material.

HSA 30 is mounted on a bearing assembly of the magnetic disk drive (described later) by inserting the hub of the bearing assembly into the through hole 23 and rotated around the bearing assembly by a voice coil motor (not shown) serving as a driving mechanism. When the HAS 30 is rotated, the distal end portion of the suspension 22 moves substantially in the radial direction D of a magnetic disk. The arm 21 and suspension 22 have a longitudinal center axis 26 extending to pass through the center of the through hole 23, namely the rotational center of HSA 30, and the arm and the suspension are fabricated symmetric with respect to this center axis 26.

Further, HSA 30 includes a magnetic head 24 as an electro-magnetic transducer mounted on the distal end

of the suspension 22, and a head IC chip 10. As the magnetic head 24, a hybrid-type magnetic head is employed which comprises an MR (magneto-resistive) device for data reading and a thin film head for data writing.

The magnetic head 24 is fixed on a rectangular slider 25, and the slider is mounted on a gimbal (not shown) at the distal end portion of the suspension 22. The slider 25 is urged toward the magnetic disk by the spring repulsion of the suspension 22 and serves to fly the magnetic head 24 at a predetermined height over the magnetic disk surface, utilizing the aerodynamic forces set up by rotation of the magnetic disk. The magnetic head 24 and slider 25 are formed and arranged symmetrically with respect to the center axis 26 of HSA 30.

As shown in FIGS. 1 and 2, the head IC chip 10 is a bear chip and has a flat rectangular shape with a center axis 13. On one surface of the head IC chip 10 are provided a plurality of, for example, ten bumps 11 serving as input and output electrodes for electrical contact. These bumps 11 are arranged symmetrically with respect to the center axis 13.

This head IC chip 10 is mounted on the suspension 22 at a position between the slider 25 and the arm 21. The head IC chip 10 is mounted on the suspension 22, with its center axis 13 being matched with the

longitudinal center axis 26 of the suspension 22, and the center axis 13 extends in a direction substantially perpendicular to the direction D in which the magnetic head 24 moves. As a result, the head IC chip 10 is positioned on the suspension symmetrically with respect to the longitudinal center axis 26 of the suspension 22. Since ten bumps 11 are formed and arranged symmetrically with respect to the center axis 13, they are also located symmetrically with respect to the center axis 26 of the suspension 22 as well.

As described above, since the head IC chip itself and the bumps 11 are arranged symmetrically with respect to the longitudinal center axis 26 of the suspension 22, the balance of the suspension between the areas separated by the center axis 26 is not disturbed even after the head IC chip 10 is mounted. Consequently, mechanical stress on the suspension 22 can be spread evenly to both areas separated by the longitudinal center axis 26 and then the balance between the areas separated by the center axis 26 on the suspension is well maintained even when there is a change in ambient temperature. Misplacement of the magnetic head 24 due to a loss of balance of the suspension is thereby prevented. Also deterioration in the performance of the magnetic head 24 caused by temperature changes, for example, read/write errors in

the magnetic head 24 due to its inclination, can be prevented.

HSA 30, as shown in FIG. 1, has a trace 31 which is a wiring structure for electrically connecting the magnetic head 24 and the head IC chip 10 to the control unit of the magnetic disk drive. This trace 31 has a stainless steel plate and an interconnection flexible printed circuit board (hereafter, interconnection FPC) that is formed on this stainless steel plate and made into an elongated band. The trace 31 is fixed on the suspension 22 and arm 21, extending from the distal end portion of the suspension to an intermediate portion of the arm. A solder pad section 33 fabricated on the base end portion of the trace 31 extends outside from the arm 21. The slider 25 and the head IC chip 10 are mounted on the trace 31.

The interconnection FPC of the trace 31 has a wiring pattern including four conductive wires 32 that connect, for example, four electrodes of the magnetic head 24 to four bumps among ten bumps 11 of the head IC chip 10, and another wiring pattern having six conductive wires 34 that connect the rest six bumps 11 of the head IC chip 10 to the solder pad section 33. On the suspension 22, the wiring patterns of conductive wires 32, 34 are formed and located symmetrically with respect to the longitudinal center axis 26 of the suspension.

The solder pad section 33 constitutes a connecting end portion of the trace 31 and has six electrode pads 35 as many as conductive wires 34. This solder pad section 33 is connected to the main FPC in the magnetic disk drive which will be described later.

On the conductive wires 32 and 34 near the head IC chip 10 are provided test pads 36. Those test pads 36 are located symmetrically with respect to the longitudinal center axis 26 on the suspension 22.

Since the test pads 36 are provided on the conductive wires 32 and 34 which are connected to the head IC chip 10, connection and function checks can be made on the head IC chip 10 using those pads 36 after the chip 10 has been mounted on the suspension 22. Further, the test pads 36 and the wiring patterns consisting of conductive wires 32, 34 are all located symmetrically with respect to the longitudinal center axis 26 on the suspension 22. Therefore, when the test pads 36 and the wiring patterns of wires 32 and 34 are formed on the suspension 22, the balance of the suspension 22 between the sides separated by the center axis 26 can be well maintained.

Next, an HSA according to a second embodiment of the present invention will be described.

As shown in FIG. 3, the HSA 30 according to the second embodiment has a capacitor 41 (capacitor chip) for voltage smoothing, in addition to the components

of the HSA described in the first embodiment. This capacitor 41 is connected between the head IC chip 10 and the arm 21 on the suspension 22, and mounted on the interconnection FPC of the trace 31. As shown in FIG. 4A, the capacitor 41 is connected between the power source line Vcc and the ground line GND or, as shown in FIG. 4B, between the power source line Vcc and the minus power source line Vee, to remove noise in the power line.

The capacitor 41 has a substantially rectangular shape and mounted on the suspension 22 symmetrically with respect to the longitudinal center axis 26.

Even when the capacitor 41 is mounted on the suspension 22 to suppress noise in the power line Vcc, the above configuration prevents a loss of balance of the suspension 22 between the sides separated by the longitudinal center axis 26.

As shown in FIG. 5, the capacitor 41 has a pair of electrodes 42 which are formed on both sides of the capacitor so as not to reach the top or bottom surface of the capacitor. As a result, the profile of the capacitor 41 after mounting can be kept low, when the capacitor 41 is soldered on the trace 31, because a solder layer is not formed on the top or bottom surface.

The structure of the other parts is all the same as that described in the first embodiment. In the

figures, the same reference numerals represent the same numbers as in the first embodiment and their detailed description will be omitted.

The following is an explanation of a magnetic disk drive according to a third embodiment of the present invention.

Referring now to FIG. 6, the magnetic disk drive has a rectangular metallic case 100 having an opening on the top and a metallic top cover (not shown) that fits the opening, being fastened to the case 100 with screws.

In the case 100 are arranged magnetic disks 120, for example three disks, as magnetic recording media, a spindle motor 130 that supports and rotates those disks, a plurality of magnetic heads for reading data from and writing data on the disks 120, a carriage assembly 140 that supports those magnetic heads to be movable with respect to the magnetic disks 120, a voice coil motor (hereafter, referred as VCM) 160 that rotates and positions the carriage assembly 140, and a board unit 170.

On the outside of the case 100, a printed circuit board (not shown) facing the case bottom is fastened with screws that controls the spindle motor 130, VCM 160 and magnetic heads through the substrate unit 170.

Each magnetic disk 120 has a diameter, for example 65 mm (2.5 inches), and has recording layers on its

upper and lower surfaces. The three disks 120 are coaxially fitted on the hub (not shown) of the spindle motor 130 so that they are stacked with predetermined intervals in the direction of the axis of the hub. The magnetic disks 120 are rotated by the spindle motor 130 at a predetermined speed.

The carriage assembly 140 has a bearing assembly 180 fixed to the bottom of the case 100. The bearing assembly 180 has a shaft 200 and a cylindrical hub that is supported on the shaft by a pair of bearing units.

Further, the carriage assembly 140 has three HSAs 30a for UP heads that are attached to the hub of the bearing assembly 180 and face the lower surfaces of the three magnetic disks 120, and three HSAs 30b for DOWN heads that are attached to the hub of the bearing assembly 180 and face the upper surfaces of the three magnetic disks 120. Namely, a pair of HSA 30a for the UP head and HSA 30b for the DOWN head are provided for each magnetic disk 120, and are opposed to each other with interposing the magnetic disk therebetween.

As shown in FIGS. 8A and 8B, the HSA 30a for the UP head and HSA 30b for the DOWN head has substantially the same structure as in the first embodiment of the invention. Namely, each of the HSA 30a and HSA 30b has an arm 21 and a suspension 22 extruding from the arm 21, and a through hole 23 is formed in the base portion of the arm 21. The HSAs 30a and 30b have

magnetic heads 24a and 24b and head IC chips 10a and 10b mounted on the distal end portions of the suspensions 22, respectively. The HSAs 30a and 30b are fastened on the bearing assembly, with the hub of the bearing assembly 180 being inserted in the through holes 23, and they are aligned substantially in parallel to each other.

Each of the magnetic heads 24a and 24b has four electrodes (leads) numbered 1, 2, 3 and 4. Four electrodes 1, 2, 3 of the magnetic heads 24a and Four electrodes 1, 2, 3 of the magnetic heads 24a are arranged in a plan symmetrical manner with respect to one another. In other words, when the HSA 30a and HSA 30b are opposed to each other with sandwiching the magnetic disk 120, the four electrodes 1, 2, 3 and 4 of the magnetic head 24a and another four electrodes 1, 2, 3 and 4 of the magnetic head 24b are also opposed to one another.

According to this configuration, the MR devices for data reading and the thin-film heads for data writing of the magnetic heads 24a and 24b are always located on the same position over the same cylinder of each magnetic disk 120.

In the present embodiment, since the electrodes 1, 2, 3 and 4 of the magnetic head 24a of the HSA 30a and the electrodes 1, 2, 3 and 4 of the magnetic head 24b of the HSA 30b are arranged in a plane symmetrical

manner with respect to one another, ten electrodes (bumps) A, B ,C ,D ,E ,F ,G ,H ,I and J of the head IC chip 10a and another ten electrodes (bumps) A, B, C, D, E, F, G, H, I and J of the head IC chip 10b are also located in a plane symmetrical with respect to one another. Namely, when the head IC chips 10a and 10b are mounted on the suspensions 22 to face each other, each pair of the electrodes of the same numbering, for example, two "A" electrodes, face each other symmetrically.

The arrangements of the bumps of the head IC chips 10a and 10b are the same as those of the bumps of the head IC chip 10 in the first embodiment. They are located symmetrically with respect to the center axis 13 of each chip. Each chip is mounted on the suspension 22 so that its center axis 13 is aligned with the longitudinal center axis 26 of the suspension 22.

The trace 31a on the HSA 30a for the UP head and the trace 31b on the HSA 30b for the DOWN head are also formed and located in a plane symmetrical with respect to one another.

Specifically, the wiring pattern of conductive wires 32a providing electrical connection between the magnetic head 24a and the head IC chip 10a and another wiring pattern of conductive wires 32b providing electrical connection between the magnetic head 24b and

the head IC chip 10b are formed in a plane symmetrical with respect to one another. At the same time, the wiring pattern of conductive wires 34a running between the head IC chip 10a and the solder pad section 33a and another wiring pattern of conductive wires 34b running between the head IC chip 10b and the solder pad section 33b are also formed in a plane symmetrical with respect to one another. On the suspension 22 of the traces 31a and 31b, the conductive wires 32a, 32b, conductive wires 34a, 34b, and test pads 36a, 36b are located symmetrically with respect to the longitudinal center axis of the suspension 22.

The configuration of the other parts of the HSA is the same as that described in the first embodiment. The same reference numerals denotes the same parts and their detailed description will be omitted.

As described above, since the HSA 30a for the UP head and the HSA 30b for the DOWN head along with the magnetic heads, head IC chips and traces are all arranged in a plane symmetrical with respect to one another, the mechanical properties of the suspensions 22 for the UP head and DOWN head become substantially equal to each other.

Since the traces 31a and 31b are arranged in a plane symmetrical manner with respect to each other, it becomes possible to arrange the solder pad sections 33a and 33b formed in the base portions of traces 31a and

31b both in the same side on the base portions of the arms 21. Then it becomes easy to connect the solder pad section of each HSA to the connection pad array 600 of a main FPC 560 which is described below.

As shown in FIGS. 6 and 7, the board unit 170 of the magnetic disk drive has a rectangular base board 520 that is fixed onto the bottom of the case 100. This base board 520 is mounted with a plurality of electronic parts, a connector 540, and the like. The board unit 170 has a main flexible printed circuit board (hereafter, referred as a main FPC) that extends from the base board 520. This main FPC electrically connects the head IC chips 10a on HSA 30a and the head IC chip 10b on HSA 30b to the base board 520 via the traces 31a and 31b, respectively.

The main FPC 560 has a wiring pattern comprising a group of conductive wires 580 running in parallel to its longitudinal axis for electrical connection. In the distal end portion 560a of the main FPC 560 are provided six connection pad sections 600 corresponding to the number of the magnetic heads 24a and 24b. Every pad section 600 has six connection pads 620 and those pads provide an electrical conduct with the base board 520 through the conductive wires 58. Six connection pads 620 are arranged in a predetermined form, for example, in a straight line, with predetermined intervals along the axis of the main

FPC 560. Six connection pad sections 600 are located in parallel to one another with predetermined intervals.

The end portion 560a of the main FPC 560 has a pair of through holes 640 for screws so that it is fastened to the bearing assembly 180 of the carriage assembly 140 with screws (not shown).

Six-electrode pads 35a, 35b formed on the solder pad sections 33a, 33b of the traces 31a, 31b on the HSAs 30a, 30b, respectively, are soldered to the respective six pads 620 of the corresponding pad section 600 on the main FPC 560. Then solder pad sections 33a and 33b are electrically and mechanically connected to the distal end portion 560a of the main FPC 560, and the magnetic heads 24a, 24b and head IC chips 10a, 10b are electrically connected to the base board 520 through the traces 31a, 31b and the main FPC 560.

In the magnetic disk drive with such a configuration described above, since the contact bumps of the head IC chips are arranged in a plane symmetrical with respect to the one another, the wiring patterns for the UP and DOWN heads on the suspensions also become a plane symmetrical with respect to one another, and those patterns become symmetric as well with respect to the longitudinal center axis of each suspension. As a result, the characteristics of the

HSAs become substantially equal to each other and the balance between the sides separated by the longitudinal center axis of the suspension can be well maintained. Eventually, the read-write performance of the magnetic heads are thereby held at a high level.

Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.



WHAT IS CLAIMED IS:

1. A head suspension assembly comprising:

a magnetic head for reading from and writing data on a magnetic recording medium;

a slider on which the magnetic head is mounted;

a suspension supporting the slider and having a longitudinal center axis; and

a head IC chip formed symmetrically with respect to its center axis;

the head IC chip having a plurality of bumps serving as input and output electrodes for electrical contact and arranged symmetrically with respect to the center axis, and being mounted on the suspension via the bumps to be symmetrical with respect to the longitudinal center axis of the suspension.

2. A head suspension assembly according to claim 1, wherein the head IC chip is mounted on the suspension so that the center axis of the head IC chip is aligned with the longitudinal center axis of the suspension.

3. A head suspension assembly according to claim 1, which further comprises an interconnection flexible printed circuit board mounted on the suspension and having a wiring pattern including a plurality of conductive wires electrically connected to a plurality of bumps of the head IC chip, the wiring pattern being arranged symmetrically with respect to



the longitudinal center axis of the suspension; and

a plurality of test pads provided on the respective conductive wires and arranged symmetrically with respect to the longitudinal center axis of the suspension.

4. A head suspension assembly according to claim 1, which further comprises a capacitor for smoothing source power, having a pair of electrodes electrically connected to the head IC chip and mounted on the suspension symmetrically with respect to the longitudinal center axis of the suspension.

5. A head suspension assembly according to claim 4, wherein the capacitor has a pair of side-walls standing on the suspension and the pair of electrodes are provided only on the side-walls.

6. A head suspension assembly according to claim 3, which further comprises a capacitor for smoothing source power, having a pair of electrodes electrically connected to the head IC chip and mounted on the suspension symmetrically with respect to the longitudinal center axis of the suspension.

7. A head suspension assembly according to claim 6, wherein the capacitor has a pair of side-walls standing on the suspension and the pair of electrodes are provided only on the side-walls.

8. A magnetic disk drive comprising:

a magnetic recording medium having opposed first



and second recording surfaces;

a driver supporting and rotating the magnetic recording medium;

a first magnetic head for reading data from and writing data on the first recording surface;

a second magnetic head for reading data from and writing data on the second recording surface;

a first head suspension assembly supporting the first magnetic head to be movable in a predetermined direction with respect to the first recording medium; and

a second head suspension assembly supporting the second magnetic head to be movable in a predetermined direction with respect to the second recording medium and opposing the first head suspension assembly with the magnetic recording medium being interposed therebetween;

the first and second head suspension assemblies each including a slider on which the magnetic head is mounted, a suspension supporting the slider, and a head IC chip mounted on the suspension and electrically connected to the magnetic head,

each of head IC chips having a center axis, and a plurality of bumps serving as input and output electrodes for electrical contact and arranged symmetrically with respect to the center axis,

the bumps of the head IC chips of the first and



second head suspension assemblies being arranged in a plane symmetrical with respect to each other.

9. A magnetic disk drive according to claim 8, wherein each of the suspensions has a longitudinal center axis, and each of the head IC chips is mounted on the suspension through the plurality of bumps and arranged symmetrically with respect to the longitudinal center axis of the suspension.

10. A magnetic disk drive according to claim 9, wherein each of the first and second head suspension assemblies has an interconnection flexible printed circuit board mounted on the suspension and having a wiring pattern including a plurality of conductive wires connected to the plurality of bumps of the head IC chip, the wiring pattern being arranged symmetrically with respect to the longitudinal center axis of the suspension;

the interconnection flexible printed circuit boards of the first and second head suspension assemblies being arranged in a plane symmetrical with respect to each other.

11. A magnetic disk drive according to claim 10, wherein each of the first and second head suspension assemblies has a plurality of test pads which are provided on the plurality of conductive wires and arranged symmetrically with respect to the longitudinal center axis of the suspension.



12. A magnetic disk drive comprising:

a magnetic recording medium having a recording surface;

a driver supporting and rotating the magnetic recording medium; and

a head suspension assembly according to claim 1.

13. A magnetic disk drive comprising:

a magnetic recording medium having a recording surface;

a driver supporting and rotating the magnetic recording medium; and

a head suspension assembly according to claim 3.

14. A magnetic disk drive comprising:

a magnetic recording medium having a recording surface;

a driver supporting and rotating the magnetic recording medium; and

a head suspension assembly according to claim 4.

15. A head IC chip to be mounted on a suspension of a head suspension assembly, the head suspension assembly including a magnetic head for reading from and writing data on a magnetic recording medium, a slider supporting the magnetic head, and the suspension supporting the slider, for supporting the magnetic head to be movable in a predetermined direction with respect to the magnetic recording medium, the head IC chip comprising:



a chip body having a center axis extending in a direction substantially perpendicular to the predetermined direction and a shape symmetrical with respect to the center axis; and

a plurality of bumps provided on the chip body and serving as input and output electrodes for electrical contact, the bumps being arranged symmetrically with respect to the center axis of the chip body.