

MAGNETIC RECORDER

BACKGROUND OF THE INVENTION

The present invention relates to a magnetic recorder in which a head is held on an information recording medium such as magnetic disk or magneto-optical disk for recording information to the information recording medium or for reading out information from the information recording medium and more particularly to the support mechanism of the head.

Known as conventional magnetic recorders is an air-bearing flying type magnetic disk unit for carrying out recording and reproduction of information while flying a magnetic head element (hereinafter, referred to as magnetic head) on a magnetic disk (hereinafter, referred to as disk) serving as a magnetic recording medium with a predetermined gap. Generally, in the air-bearing flying type magnetic disk unit, the magnetic head is provided on a member called slider and the slider is operated by a scheme called CSS (Contact-Start-Stop). With this scheme, the slider is in contact with the surface of a disk when the disk stops and slides on the surface of the disk from the time when the disk begins to rotate till the time when the slider flies up by receiving fluid force accompanied by the rotation. Also when the rotation of a disk stops, the slider begins to slide on the surface of the disk as soon as the rotation of the disk slows down and no sufficient fluid force acts

on the slider.

Also as conventional magnetic recorders, there is a contact-recording type magnetic disk unit for carrying out recording and reproduction of information while making
5 a magnetic head or slider be in a sliding contact with the disk. With this magnetic disk unit, the magnetic head or slider is always in contact with the disk.

With the magnetic head and the head support mechanism for supporting this magnetic head in conventional
10 magnetic disk units, as disclosed in Japanese Patent Unexamined Publication No. 55-22296, a gimbal section comprising a pivot serving as a load point and a rotation spring for rotatably supporting a slider around the pivot in the pitching and rolling directions thereof is connected
15 to a support arm for giving an urging load for the disk to the slider and a top face of the slider is attached to the gimbal section.

The term "head support mechanism" refers to a support arm and a slider inclusive in some cases and refers
20 to a support arm for supporting the slider (hereinafter, referred to as head support arm) in other cases. In the subsequent description, it shall refer to the head support arm unless otherwise stated. In addition, in the subsequent description, an opposed face of the slider to
25 the disk and the other face are called as the bottom face and the top face, respectively and the upstream and downstream in the rotating direction of a disk are called as the front and rear, respectively.

With the above-mentioned head support mechanism, because the center of rotation in the pitching direction of the slider is situated over the sliding surface of the slider, the contact force of the slider with the disk becomes very large at the front of the disk when the slider receives a frictional force due to its sliding action to the disk as described above. That is, the slider comes to fall forward toward the front of the disk. At that time, there is a possibility that, due to unstable oscillation of the slider and a very large contact force locally generated as mentioned above, the surface of the disk and that of the slider are damaged.

In contrast to this, the head support mechanism disclosed in Japanese Patent Unexamined Publication No. 2-192082 is so arranged that the slider is unlikely to fall forward even if a frictional force from the disk acts to the slider. On the front end of an arm attached to a carriage, a parallel, flat plate structure comprising an upper plate and a lower plate parallel thereto is provided, which forms a structure for giving the load. A gimbal section comprises upper and lower main plates, and front and rear plates for linking these main plates. With this support mechanism, when a frictional force acts in the rear direction of the slider, the front plate and the rear plate of the gimbal are deformed so as to become parallel and perpendicular to the surface of the disk, respectively. At that time, since the center of rotation in the pitching direction of the slider is under the sliding surface, the

slider becomes in a posture in which the forward of the slider rises and the above-mentioned falling forward does not occur.

With the head support mechanism mentioned above,
5 however, the front of the slider is not raised but instead the rear deviates in such a direction as to be pressed onto the surface of a disk, so that the slider has a distribution (load distribution) of a load generated on its sliding surface to increase from front toward rear. At that time,
10 since the urging load imposed on the slider itself does not change, an increase in the contact force on the rear portion of the slider would lead to a possibility of the slider and disk to be damaged.

In addition, with the head support mechanism
15 disclosed in Japanese Patent Unexamined Publication No. 2-192082, the structure of the gimbal section is complicated, and it is left out of consideration to downsize the disk unit, particularly narrow the disk interval in a disk unit of disk stack type and to lower the price.

20 SUMMARY OF THE INVENTION

It is one object of the present invention to provide a magnetic recorder provided with a head support mechanism appropriate for the prevention or reduction of an increase in local contact force on the sliding surface when
25 a member supporting a magnetic head on the surface of a disk slides over the disk.

In order to attain the above object, a magnetic

recorder according to the present invention comprises a first deformable portion, a first rigid portion, a second deformable portion and a second rigid portion in order from the upstream in the moving direction of a recording medium to constitute a head support mechanism and support a magnetic head in the shape of a cantilever from the upstream in the moving direction of the recording medium. For this purpose, a first deformable portion side is attached to an actuator for moving the magnetic head, while the magnetic head is provided on a second rigid portion side.

The magnetic head may be provided on the second rigid portion via the slider having a sliding surface to the recording medium or may be provided directly on the second rigid portion in such a structure that the second rigid portion serves also as slider. However, the slider is so constructed as not to rotate around the axis transverse to the moving direction of the recording medium relative to the second rigid portion. And in either case, the head support mechanism generates a load of urging the slider or the sliding surface of the second rigid portion onto the recording medium.

Furthermore, it is arranged that, in the state of the magnetic head set up on the rest recording medium, the upstream end of the slider or the sliding surface of the sliding part of the second rigid portion in the moving direction of the recording medium lies on the downstream side in the moving direction of the recording medium from

the intersection of the extension of a virtual line joining the above first and second deformable portions linearly and the above recording medium.

Appropriate aspects of magnetic recorders to the present invention are shown as follows.

(1) A magnetic recorder comprises a block comprising a magnetic head and a sliding part supported in the shape of a cantilever from the upstream in the moving direction of a recording medium via a rigid support having
10 respective soft supports at both ends, while in the rest state of the recording medium, an upstream end of the above sliding part in the moving direction of the recording medium is provided downstream of an intersection of an extension of a line section connecting the above two soft
15 supports and the above recording medium in the moving direction of the recording medium.

(2) A magnetic recorder comprises a magnetic head, a slider for holding the magnetic head on a recording medium and a head support arm for supporting the slider to
20 generate a load to urge it onto the recording medium, the head support arm comprising a first deformable portion, a first rigid portion, a second deformable portion and a second rigid portion in order from the upstream in the moving direction of the recording medium, supports the
25 above slider attached to the second rigid portion in the shape of a cantilever from an upstream in the moving direction of the recording medium, while in the rest state of the recording medium, an upstream end of a sliding part

of the above slider over the recording medium in the moving direction of the recording medium is provided downstream of an intersection of an extension of a line connecting the above first and second deformable portions and the above recording medium in the moving direction of the recording medium.

(3) In (2), the above second rigid portion comprises a frame body, a slider attachment portion and a support portion for rotatably supporting the slider attachment portion around a rotational axis parallel to the moving direction of the recording medium and present on the above frame body.

(4) A magnetic recorder comprises a head support arm comprising a first deformable portion, a first rigid portion, a second deformable portion and a second rigid portion in order from the upstream in the moving direction of the recording medium, and a sliding part sliding over the recording medium on an opposite side of the second rigid portion to the recording medium. The head support arm supports the above sliding part in the shape of a cantilever from an upstream in the moving direction of the recording medium and moreover supports magnetic head on the recording medium to generate a load to urge it onto the recording medium, while in the rest state of the recording medium, an upstream end of the above sliding part in the moving direction of the recording medium is provided downstream of an intersection of an extension of a line connecting the above first and second deformable portions

and the above recording medium in the moving direction of the recording medium.

(5) In (4), the above second rigid portion comprises a frame body and a support portion for rotatably supporting the above sliding part around a rotational axis parallel to the moving direction of the recording medium and present on the above frame body.

(6) In any of (2) to (5), the above first and second deformable portions are formed by bending treatment of a thin plate.

(7) In any of (2) to (5), the above first and second deformable portions are formed by cut treatment of a thin plate.

(8) In any of (2) to (7), the above first and second rigid portions, and the above first and second deformable portions are molded into one piece by using a resin material.

(9) In (4), the above head support arm, the above sliding part, the above magnetic head and wiring to this magnetic head are formed as an integrated one-piece structure.

(10) In any of (2) to (9), the rigidity of the above second deformable portion is made smaller than that of the above first deformable portion. This aspect permits a structure that is likely to absorb errors in the attachment of a head support arm to guide arm, in a direction perpendicular to the surface of a recording medium at an attached position of the head support arm.

(11) In any of (2) to (10), the above magnetic head comprises at least a magnetoresistance effect reproduction element for carrying out a reproduction of information from a recording medium.

5 (12) In any of (2) to (11), the above sliding part comprises a plurality of sliding surfaces.

 (13) A magnetic recorder comprises a magnetic head and a head support arm for supporting the magnetic head so as to generate a load to urge it onto the recording
10 medium. The head support arm comprises a second rigid portion, a second deformable portion connected to an upstream portion of the second rigid portion in the moving direction of a recording medium, a first rigid portion connected to an opposite side of the second deformable
15 portion to the second rigid portion and a first deformable portion connected to an opposite side of the first rigid portion to the second deformable portion. The above second rigid portion comprises a sliding part equipped with the above magnetic head and sliding on the recording medium and
20 a support portion rotatably supporting the sliding part around an axis parallel to the moving direction of the recording medium. The above first and second deformable portions and a part of the above support portion are composed of wiring to the above magnetic head to be
25 provided on the above head support arm and the above head support arm, the above magnetic head and the above wiring are formed in the laminate process of a thin film. In the rest state of the recording medium, the upstream end of the

above sliding part in the moving direction of the recording medium is provided downstream of an intersection of an extension of a line connecting the above first and second deformable portions and the above recording medium in the moving direction of the recording medium.

(14) In (1), the natural frequency of a head support mechanism comprising the block and a rigid support for supporting the block in the moving direction of a recording medium is set at not higher than 200Hz.

(15) In any of (2) to (13), the natural frequency of the above head support arm in the moving direction of a recording medium is set at not higher than 200Hz.

Hereinafter, the operation of the present invention will be described. Those having a slider is used to describe the operation in the following but even those having a second rigid portion provided with the sliding part is similar if attention is paid to the sliding surface.

In the above arrangement, since the first and second rigid portions or rigid supports hardly deform and the first and second deformable portions take charge of deformation, the second deformable portion is movable on a circle around the first deformable portion and on a circle around a sliding point of the slider. The sliding point may be considered to be an upstream end of the slider or the sliding surface in the moving direction of the recording medium when the head support mechanism is viewed from the direction parallel to the recording medium surface and

transverse to the moving direction of the recording medium
(from sideways).

When the upstream end of the sliding surface in
the moving direction of the recording medium is provided
5 downstream in the moving direction of the recording medium
from the intersection of the above recording medium and the
extension of the line connecting the first and second
deformable portions in the rest state of the recording
medium, the following relation as to the position of the
10 second deformable portion is established. Namely, when the
recording medium is at rest, the second deformable portion
is situated at one intersection of the above two circles
and can move only to another intersection when the sliding
point is subjected to a frictional force from the recording
15 medium. In the present invention, this displaceable
position is in the departing direction from the recording
medium relative to the position of the second deformable
portion when the recording medium is at rest. A rotational
center of the slider in the pitching direction becomes an
20 intersection between the extension of the virtual line
connecting the first and second deformable portions and a
vertical line to the sliding surface on which the
frictional force acts and lies on the recording medium side
relative to the sliding surface.

25 Then, when a frictional force acts, the first and
second deformable portions are deformed and the second
deformable portion is displaced in the departing direction
from the recording medium, so that the load imposed on the

slider decreases and moreover the slider also is displaced in the lifting direction of the upstream side of the slider in the moving direction of the recording medium (hereinafter, referred to as front). The recording medium and the slider are kept in contact with each other while elastically being deformed and the surface pressure distribution of the slider sliding surface becomes in a state of decreasing in the front and increasing in the rear owing to the displacement of the slider in the lifting direction.

10 When an acting force is large and a displacement is large, there may be a lifting state of the slider in the front. Here, theoretically, because the load has been reduced, the surface pressure on the outflow side never becomes greater than the initial average surface pressure. Thus, falling

15 forward can be avoided and the accompanying instable vibration can be also avoided.

And, when a frictional force acts, the load is reduced due to the above action, and therefore the frictional force is decreased, a fluctuation in frictional force is moderated and action of equalizing the frictional

20 force is also expectable.

And, when setting the slider on a recording medium under a predetermined load, the support portion for supporting a slider attachment portion deforms in such a manner that the slider sliding surface becomes in parallel

25 to the information recording medium due to torsional deformation. Thus, even if the slider is slant in the rolling direction owing to errors in attachment portion,

errors in treatment or other errors, these errors can be absorbed.

And, when a resin material is used, vibrations of the magnetic head and the head support mechanism can be suppressed because the material has a high dumping effect. In addition to a reduction of instable vibrations due to falling forward of the slider as mentioned above, if a further attenuation of vibrations is achieved by using a resin material, a stable support of the magnetic head is enabled from the start till the stationary rotation of the recording medium. This is effective for the speed-up of record/reproduction operation and considered to be effective especially in the contact recording system.

And, if the natural frequency of movement of the sliding surface toward the moving direction of the information medium, accompanied with deformations of the first and second deformable portions, is set at not higher than 200Hz, since the slider does not respond to a higher frequency than the natural frequency, no vibration is generated by a component of the frictional force having a higher frequency than 200Hz when the frictional force during sliding is inputted.

According to the present invention, when the slider is subjected to a frictional force due to contact sliding with the disk, the slider is displaced at the front in the departing direction from the disk surface without causing an increase in local urging load against the disk. Thus, instable vibrations and an increase in local contact

force due to falling forward can be prevented or reduced and accordingly damages to the slider and recording medium are reduced to the utmost, thereby enabling a highly reliable head support mechanism and magnetic recorder to be
5 provided.

And if the present invention is applied to the contact recording system, there is an advantage also in providing a highly reliable magnetic recorder since instable vibrations and an increase in local contact force
10 can be prevented or reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a head support arm, a magnetic head and a slider showing one embodiment of the present invention;

15 FIG. 2 is an illustration showing an advantage of the present invention;

FIG. 3 is an illustration showing another advantage of the present invention;

FIG. 4 is an illustration showing the operation
20 of a head support arm different from that of the present invention;

FIG. 5A is a perspective view of a head support arm and a slider showing another embodiment of the present invention, FIGS. 5B and 5C are a sectional view taken along
25 line B-B and a sectional view taken along line C-C in FIG. 5A, FIG. 5D is a side view of the head support arm of FIG. 5A set up on the disk (state of load setting) and FIG. 5E

is a side view of the slider with the sliding surface subjected to a frictional force due to the rotation of the disk (state of sliding);

FIG. 6 is a perspective view of a head support arm, a magnetic head and a slider showing a third embodiment of the present invention;

FIGs. 7A and 7B are a perspective view from the opposite side to the disk and a side view at the load setting of a head support arm, a magnetic head and a slider showing a fourth embodiment of the present invention;

FIGs. 8A and 8B are perspective views of a head support arm, a magnetic head and a slider showing a fifth embodiment and a sixth embodiment of the present invention;

FIG. 9A is a sectional view of a head support arm and a magnetic head showing a seventh embodiment of the present invention, FIG. 9B is an enlarged view of the head element 21 of FIG. 9A and FIGs. 9C and 9D are enlarged views of other respective embodiments of head element 21;

FIGs. 10A-10C are sectional views of head support arms and magnetic heads showing eighth, ninth and tenth embodiments of the present invention, respectively;

FIG. 11 is a sectional view showing the setup state of a head support arm having a slider formed in an integrated one-piece type structure shown in FIGs. 9 and 10;

FIG. 12 is a perspective view of a head support arm showing an eleventh embodiment of the present invention;

FIG. 13 is a plan view of a magnetic disk unit according to the present invention; and

FIG. 14 is a side view of a magnetic disk unit according to the present invention.

5 DESCRIPTION OF THE EMBODIMENTS

Hereinafter, embodiments of the present invention will be described referring to the drawings.

FIG. 1 is a perspective view showing one embodiment of a head, a slider and a head support mechanism
10 according to the present invention. In FIG. 1, the reference number 30 denotes a guide arm 30 attached to an actuator not shown and a head support mechanism comprising a head support arm 10 and a slider 20 is attached to the guide arm 30. On a rear end face (downstream end face in
15 the moving direction of a recording medium) of the slider 20, a magnetic head (head element) 21 is provided.

The head support arm 10 comprises a sheet of thin plate and deformable portions 12 and 14 are formed by grooving towards thickness direction by laser or etching
20 treatment. The portions 13 and 15 in FIG. 1 are sufficiently higher in rigidity than the deformable portions 12 and 14 and can be regarded as rigid portions. Numerals 16 and 17 denote wiring and a through hole, respectively and an example of wiring 16 led from a slider attached surface
25 to a back surface is shown. Here, the wiring comprises a one-piece wiring on the head support arm 10.

The head support mechanism may be referred to as

with the slider inclusive or may designate a support arm for supporting the slider (hereinafter, referred to as head support arm). In the following description, it shall designate a head support arm unless otherwise indicated.

5 Here, referring to FIG. 2A to 2C, the operation of the head support arm of this embodiment will be described.

FIG. 2A shows a state that the slider 20 is attached to the head support arm 10. At this stage, the
10 thin plate is not deformed but assumes the shape of a plane. Next, FIG. 2B shows a state that the slider 20 and the head support arm 10 are installed on a disk 40 serving as recording medium and an urging load W is imposed on the slider 20. In this state, a sliding surface 201 of the
15 slider 20 is parallel to a surface of the disk 40 and an attachment portion 11 of the head support arm 10 is made slant. In a state of setting the load, an intersection P of an extension 202 of a virtual line connecting the deformable portions 12 and 14 with the disk 40 lies
20 upstream of sliding parts 20a, 20b of the slider in the sliding direction (recording medium moving direction). If a center of the sliding parts 20a, 20b is regarded as a sliding point, a rotating center Q of the slider becomes an intersection of a vertical line of the sliding point with
25 respect to the sliding surface with the extension 202 of the virtual line connecting the deformable portions 12 and 14 and is situated on an inner side of the disk from the sliding surface 201 as shown in FIG. 2B.

In this state, when the unit is actuated, the disk rotates in the direction of the arrow 203 and a frictional force acts, the state of FIG. 2C is implemented. In FIG. 2C, the state indicated with the dotted line 204 represents that of FIG. 2B. While the head support arm 10 is stretched as a whole in the direction of sliding, the deformable portion 14 is displaced in the departing direction from the disk surface, so that the head support arm as a whole also is displaced in the departing direction from the disk surface. The urging load W' at this time becomes smaller than the initially set load W . The sliding surface 201 of the slider 20 is displaced in the lifting direction of the inflow side (in front of the slider) 20a around the rotating center Q .

FIGs. 3A and 3B show an example that this operation was ensured by calculation. Setting the load during the stop to 100mgf, the displacement angle θ and the load W' of the inflow end 20a during the exertion of any frictional force F are shown in FIG. 3A and FIG. 3B, respectively. Here, $F = 0\text{mgf}$ represents the time when the rotating speed v of the disk is equal to 0rpm in both drawings. It is found that exertion of a frictional force F leads to a decrease in load W' and a displacement of the inflow side in the lifting direction. Actually, as there is elastic deformation in material of the disk and the slider 20, it may be considered that distribution of the surface pressure increasing from the inflow side to the outflow side is resulted without perfect detachment of the

inflow side of the sliding surface 201. This surface pressure distribution can be arbitrarily designed by the length of the rigid portions 13, 15 and the rigidity of the deformable portions 12, 14 in the head support arm 10.

5 In accordance with the above operation, an input of a large frictional force during the sliding would lead to a large decrease in load, thereby lowering the frictional force. When there is a fluctuation in frictional force on the circumference of the disk, use of a head
10 support mechanism comprising the slider 20 and the head support arm 10 according to this embodiment leads to a great decrease of frictional force for a large frictional force and a small decrease of frictional force for a small frictional force, so that a uniform frictional force is
15 achieved. This effect becomes effective for the attainment of a stable contact especially in a contact recording in which the slider always slides.

Referring to FIGs. 4A, 4B and 4C, the difference in operation from examples not belonging to the present
20 invention will be described.

FIGs. 4A and 4B show an example formed on grooving of a thin plate in the same way as the first embodiment, whereas FIG. 4C shows an example formed on bending of a thin plate. In FIGs. 4B and 4C, the dotted
25 lines 401 and 402 show stable states of the head support mechanisms set up on the disk 40, whereas the solid lines show acting states of frictional force due to the rotation of the disk 40, respectively.

An intersection P of a disk surface with a virtual line 202 connecting a deformable portion 12 and a deformable portion 14 is situated downstream of a sliding surface 201 of a slider in the sliding direction. At this time, a rotating center Q of the slider 20 is present on a slider side from the sliding surface. When a frictional force acts, the slider rotates around the rotating center Q and a front of the sliding part is displaced in the pressed direction onto the disk 40, so that the slider 20 comes to fall forward (a state of falling over toward the upstream in the rotating direction of the disk). In addition, at this time, since the second deformable portion also is displaced in the pressed direction onto the disk, the urging load also increases.

FIGs. 5A to 5E show one embodiment of a head support arm using a resin material with wiring molded in one piece. FIG. 5A is a perspective view of the head support arm, FIG. 5B is a sectional view taken along line B-B in FIG. 5A, FIG. 5C is a sectional view taken along line C-C in FIG. 5A. FIG. 5D is a side view of the head support arm of FIG. 5A set on the disk (state of load setting) and FIG. 5E is a side view of the head support arm, in which the sliding surface of the slider receives a frictional force due to the rotation of the disk (state of sliding).

First, a substrate of resin material is prepared with wiring formed thereon. The outline of preparation method of the substrate is shown in the following. An

about 18 μm thickness copper foil 504 is adhered onto a 25 μm thickness polyimide base 502 via an adhesive layer 503 and is further covered with an about 10 μm thickness resin cover material 505. Then, an about 200 μm thickness polyimide 501 is adhered to the rear side of the polyimide base 502 as backing material. Furthermore, portions to be connected to electrodes (not shown) of the head element 21 and portions needed for connecting to a circuit are formed with electrodes by plating on the copper foil 504. Next, the shape is processed with an excimer laser or the like. The deformable portions 12 and 14 in FIG. 5 are cut out with the wiring portion left and worked over to reduce the rigidity. The portions 13 and 15 in FIG. 5 are remained substrate and are sufficiently higher in rigidity than the portions 12 and 14 and can be regarded as rigid portions.

With this embodiment, the rotational rigidity of the first deformable portion 12 is 4.8gf/rad and that of the second deformable portion 14 is 2.8gf/rad. And this embodiment is an embodiment in which an attaching surface 11 of the head support arm 10 is made parallel to the disk surface and the first deformable portion 12 is subjected to bending treatment after grooved so that a predetermined load can be given to the sliding surface 201 of the slider with it kept parallel to the disk surface. As shown in FIG. 5D and 5E, similarly to the first embodiment, when a frictional force acts, the load is decreased and the head support arm 10 is deformed in the lowering direction of the surface pressure of the inflow side of the sliding part, so

that the slider 20 is displaced. With this embodiment, no gradient is required to be provided on the portion of the guide arm 30 serving as the attachment portion of the head support arm 10, thus enabling work to be simplified.

5 FIG. 6 shows an embodiment wherein a head support arm 10 is constructed by bending treatment of a thin plate. A first deformable portion 12 is bent beforehand in such a manner that a predetermined load can be settled on it, while rigid portions 13 and 15 have both ends in width
10 flanges 601 to raise the rigidity.

 FIGs. 7A and 7B show an embodiment having a slider on which a magnetoresistance effect reproduction element is mounted, FIG. 7A is a perspective view viewed from an opposed face side to the disk and FIG. 7B is a side
15 view at the setting of a load. Also in FIG. 7B, the operation during a frictional force acting is indicated with the solid line in contrast to the dotted line 701 indicating a state of no frictional force. Numerals 21 and 22 in FIG. 7 denote a record/reproduction element containing a magneto-
20 resistance effect reproduction element and an electrode, respectively and the electrode 22 is connected to the wiring 16b wired in one piece on the head support arm 10. In the magnetoresistance effect reproduction element, a thermal asperity may occur, which is an output loss due to
25 heat resulted from the sliding or the like movements, and the reproduction may be obstructed. Thus, the head element 21 is placed on the inflow side of the sliding surface 201 so that the surface pressure on the inflow side is lowered

when the frictional force acts. Accordingly, the influence of heat resulted from sliding to the head element 21 can be reduced and occurrence of thermal asperity can be also reduced.

5 Next, FIGs. 8A and 8B show another embodiment of a head support arm. FIG. 8A refers to an embodiment wherein a deformable portion is provided by using a cut portion in the same way as one shown in FIG. 1, whereas FIG. 8B refers to an embodiment wherein rigid portions are
10 provided by forming flanges in the same way as one shown in FIG. 6.

 In this embodiment, a second rigid portion 15 comprises a frame body 15b linked to the second deformable portion 14, a slider attachment portion 19 and a support
15 portion 18 for supporting the slider attachment portion 19 relative to the frame body 15b in such a manner that the slider attachment portion 19 can rotate around a rotational axis parallel to the moving direction of a recording medium and present on the frame body 15b.

20 When incorporated in the unit, the sliding surface 201 of a slider 20 may be installed slantingly to the disk surface due to working errors, assembling errors or the like. Slant errors in the pitching direction of the slider 20 can be absorbed by deformation of the first and
25 second deformable portions. This embodiment is to correct slant errors in the rolling direction of the slider 20.

 The frame body 15b is connected to the second deformable portion 14. The slider attachment portion 19 is

connected to the frame body 15b through the support portion 18 of which width is narrow and the slider 20 can be rotated in the rolling direction by torsional deformations of the support portion 18. When the slider 20 is slantly mounted, the slider 20 is subjected to a rotational moment in the departing direction from the disk surface at the contact portion and rotates in such a manner that the contact portion is pushed up and the non-contact portion is pushed down, so that the sliding surface 201 of the slider is set up in parallel to the disk surface. For this surface matching effect, it is more effective to combine a 3-pad slider 28 having sliding surfaces 201a and 201b placed symmetrically to the rotational axis as shown in FIGs. 8A and 8B with the head support arm of this embodiment.

FIGs. 9-10 show embodiments of a head support arm according to the present invention made into an integrated one-piece type structure containing a head element and wiring. Here, the integrated one-piece type structure is related to a method for producing a head support arm, a head element and a slider. Here defined is a structure obtained either by manufacturing a head support arm according to the present invention by the thin film forming treatment technique and embedding a head element therein in this manufacturing process or by directly forming an element portion at the front end of the second rigid portion after forming a head support arm. By making an integrated one-piece type structure like this, in contrast

to the case of adhering a slider with a head element formed thereon to a head support arm, there is also an advantage that the shift in head attachment position can be prevented and moreover the connection of the element to wiring and
5 the process of accompanying positioning can be omitted and the cost is reduced. In contrast to the case of adhering a slider, there is also an advantage that the whole structure can be low-profiled so as to downsize the unit.

FIG. 9A shows an example of forming a head
10 support arm in an integrated one-piece type structure, FIG. 9B is an enlarged view of a head element 21 of FIG. 9A and FIGS. 9C and 9D show other embodiments of the head element 21. A base material 61 of the attachment portion 11 for attaching the head support arm 10 to the guide arm and the
15 rigid portions 13, 15 is formed by spattering of Al_2O_3 . Because the deformable portions 12 and 14 serve also for wiring, portions 63 are formed by a thin film of copper or gold thin film or the sandwich structure of a thin film of copper or gold sandwiched between insulating films made of
20 a single substance, Al_2O_3 or other compounds. A portion 62 is formed with copper, gold or the like for electrical connection between the first deformable portion 12 and the second deformable portion 14. After formation of a head support arm 10, the head element 21 is formed at the end of
25 the second rigid portion 15 and a pad comprising the sliding surface is formed by the etching treatment technique after formation of a medium-opposed surface protective film 26 on the sliding surface 201 of the head element 21.

Next, referring to FIG. 9B, the details of the head element will be described. A recording element 23 comprises a coil 23a made of copper or aluminum alloy and a magnetic pole 23b formed of a permalloy soft magnetic film of iron nickel alloy. A reproduction element 25 comprises a magnetoresistance effect element 25a of permalloy having a large magnetoresistance effect and a magnetic pole 25b formed of a permalloy soft magnetic film of iron nickel alloy. An electrode 22 is formed by copper or gold. A portion enclosing these element parts is formed by Al_2O_3 serving as an insulating and protective film. These head element parts are all formed in succession by a thin-film forming treatment technique such as sputtering, vacuum deposition, etching and plating. For the reproduction element 25, a laminate film of permalloy and Co alloy or a laminate film of permalloy and Co alloy with an antiferromagnetic film of NiO or the like may be available, while a soft magnetic material such as Co-Fe alloy or Fe-Al-Si alloy may be available for the magnetic pole 25b in addition to Fe-Ni alloy.

In contrast to the embodiment of FIG. 9B, that of FIG. 9C has a structure wherein the reproduction element 25 and the recording element 23 are exchanged in position and is characterized in that formation of the electrode 22 and wiring 16 is simplified. The embodiment of FIG. 9D is one in which the recording element is used also for reproduction without formation of a magnetoresistance reproduction element. In the case of contact recording

keeping the slider in sliding on the disk at all times, because a thermal asperity due to sliding heat generation is likely to occur in a magnetoresistance reproduction element, there is a tendency of a signal to become
5 instable. Thus, an arrangement having a recording element used also for reproduction like this embodiment without use of a magnetoresistance effect element for reproduction element is advantageous in ensuring a stable output.

Referring to FIGs. 10A-10C, other examples of the
10 head support arm will be described.

FIG. 10A shows an embodiment having a coil 23a formed in the longitudinal plane of a head support arm 10 with a structure that a head element 21 is embedded in the head support arm 10. In this case, the magnetic pole 23b
15 related to a coil comprises a single body and is suitable for the vertical magnetic recording system.

FIG. 10B shows an embodiment having two coils 23a formed in the longitudinal plane of a head support arm 10 in which both recording and reproducing are carried out in
20 this element and which has a suitable structure for the in-plane magnetic recording system.

FIG. 10C shows an embodiment having a coil 23a formed in the longitudinal plane of a head support arm 10 in which a magnetoresistance effect element 25a is formed
25 as reproduction element. In this embodiment, this element forms a return yoke as a part of the magnetic pole 25b and has a suitable structure for the attainment of a high recording density in the in-plane magnetic recording

system.

FIG. 11 shows the setup state of the head support arm having a slider formed in an integrated one-piece type structure as shown in FIG. 9 to FIG. 10. Portions 12 and 14 in FIG. 11 are formed solely by a copper or gold thin film or a sandwich structure comprising a copper or gold thin film sandwiched between insulating films of Al_2O_3 or the like and become deformable portions, while portions 13 and 15 formed of the base material Al_2O_3 can be defined as rigid portions. The operation under the action of a frictional force is the same as with the first embodiment of the present invention.

FIG. 12 shows an embodiment of the head support arm of the present invention in an integrated one-piece type structure wherein a second rigid portion comprises a frame body connected to a second deformable portion, a slider attachment portion and a support portion for rotatably supporting the slider attachment portion relative to the frame body around a rotational axis parallel to the moving direction of a recording medium and present on the frame body.

A method for forming the integrated one-piece type structure is similar to that of the above-mentioned embodiment. The portion 69 in FIG. 12 is the head attachment portion comprising Al_2O_3 base material on which a head element is formed. This head attachment portion 69 is connected to the second rigid portion 15 comprising a frame body through wiring members 68 formed solely by a copper or

gold thin film or a sandwich structure comprising a copper or gold thin film sandwiched between insulating films of Al_2O_3 or the like. By distortional deformation of the wiring members 68, the head attachment portion 69 can be
5 rotated in the rolling direction. In addition, the head attachment portion 69 is equipped with a sliding surface and serves also as slider. When the head attachment portions 69 is slantly mounted, it is subjected to a rotational moment in the departing direction from the disk
10 surface at the contact portion and rotates in such a manner that the contact portion is pushed up and the non-contact portion is pushed down and consequently the sliding surface of the slider is set up in parallel to the disk surface. For this surface matching effect, it is more effective to
15 combine a 3-pad slider having sliding surfaces placed symmetrically to the rotational axis as mentioned above with the head support arm of this embodiment.

FIGs. 13 and 14 show one embodiment of a magnetic disk unit according to the present invention. FIG. 13 is a
20 plan view of the whole magnetic disk unit and FIG. 14 is a side view of a head support arm 10 set up relative to magnetic disks.

A head support arm 10 equipped with a slider 20 formed in one piece with a tip of a second rigid portion 15
25 is attached to a guide arm 30. The guide arm 30 is attached to a voice coil motor 80, so that the slider 20 and a head element provided thereon are movable in the radial direction of a magnetic disk 40, information

recording medium. The magnetic disk 40 is attached to a spindle motor 81 and rotates at 5400rpm - 10000rpm. If the spindle motor or another performance permits, it can rotate at a higher number of rotation and further may be used at the side of a lower number of rotation. Numbers of disks are mounted and FIG. 14 shows a construction composed of two disks among them. As seen in this embodiment, use of a head support arm composed as the integrated one-piece type structure mentioned above facilitates the narrowing of disk gaps and is suitable for a thinner disk unit. And needless to say, the head support arm according to the present invention which has been described in each of the above embodiments can be employed.

In the above, embodiments according to the present invention are described referring to the drawings. Even if any embodiment is used, a slider never falls forward and slides stably in spite of action of a frictional force, so that the contact system of keeping the magnetic head slider in contact with a magnetic recording medium at all times can be implemented, thereby enabling a high record density of about 2Gbit/inch² to be achieved.

Incidentally, a magnetic disk unit is mainly taken as an example to describe the embodiments but the present invention is not limited to a magnetic disk unit and is applicable to other ordinary magnetic recorders so long as they are units allowing a magnetic head or a member for supporting the magnetic head to slide over a recording medium.

In addition, in each of the above embodiments, a record/reproduction element containing a magnetoresistance effect element may be used as magnetic head and an inductive head alone or other magnetic head, further one
5 using an optical element is also usable.

In the description of each of the above embodiments, the pitching signifies a rotating movement having a rotational axis perpendicular to the moving direction of a recording medium and the rolling signifies a rotating
10 movement having a rotational axis in the moving direction of a recording medium.

Incidentally, the drawings used for the above description are not always correct in slenderness ratio or dimensional ratios of individual portions to purposes of
15 description.

According to each of the embodiments of the present invention, when a magnetic head slider slides on a magnetic recording medium and a frictional force acts to the slider, a load applied to the slider is decreased and
20 the slider is displaced in the lifting direction of the front thereof and accordingly there is an advantage that occurrence of an instable vibration and a local stress due to falling forward can be avoided and also another advantage that frictional forces are made uniform.

25 Furthermore, there is an advantage that use of the present invention enables a high density and large capacity magnetic recorder of the contact recording system to be provided.



CLAIMS:

1. A magnetic recorder comprising a block comprising a magnetic head and a sliding part supported in the shape of a cantilever from the upstream in the moving direction of a recording medium via a rigid support having respective soft supports at both ends, wherein in the rest state of the recording medium, an upstream end of said sliding part in the moving direction of the recording medium is provided downstream of an intersection of an extension of a line section connecting said two soft supports and said recording medium in the moving direction of the recording medium.

2. A magnetic recorder comprising a magnetic head, a slider for holding the magnetic head on a recording medium and a head support arm for supporting the slider to generate an urging load onto the recording medium, wherein the head support arm, comprising a first deformable portion, a first rigid portion, a second deformable portion and a second rigid portion in order from the upstream in the moving direction of the recording medium, supports said slider attached to the second rigid portion in the shape of a cantilever from an upstream in the moving direction of the recording medium, and in the rest state of the recording medium, an upstream end of a sliding part of the slider over the recording medium in the moving direction of the recording medium is provided downstream of an intersection of an extension of a line connecting said first and second deformable portions and said recording medium in the moving

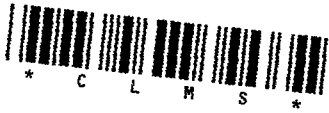


direction of the recording medium.

3. The magnetic recorder as set forth in Claim 2, wherein said second rigid portion comprises a frame body, a slider attachment portion and a support portion for rotatably supporting the slider attachment portion around a rotational axis parallel to the moving direction of the recording medium and present on said frame body.

4. A magnetic recorder comprising a head support arm comprising a first deformable portion, a first rigid portion, a second deformable portion and a second rigid portion in order from the upstream in the moving direction of the recording medium, and a sliding part sliding over the recording medium on an opposite side of the second rigid portion to the recording medium, supports said sliding part in the shape of a cantilever from an upstream in the moving direction of the recording medium and moreover supports magnetic head on the recording medium to generate an urging load onto the recording medium, and in the rest state of the recording medium, an upstream end of said sliding part in the moving direction of the recording medium is provided downstream of an intersection of an extension of a line connecting said first and second deformable portions and said recording medium in the moving direction of the recording medium.

5. The magnetic recorder as set forth in Claim 4, wherein said second rigid portion comprises a frame body and a support portion for rotatably supporting said sliding part around a rotational axis parallel to the moving



direction of the recording medium and present on said frame body.

6. The magnetic recorder as set forth in any of Claims 2 to 5, wherein said first and second deformable portions are formed by bending treatment of a thin plate.

7. The magnetic recorder as set forth in any of Claims 2 to 5, wherein said first and second deformable portions are formed by cut treatment of a thin plate.

8. The magnetic recorder as set forth in any of Claims 2 to 7, wherein said first and second rigid portions, and said first and second deformable portions are molded into one piece by using a resin material.

9. The magnetic recorder as set forth in Claim 4, wherein said head support arm, said sliding part, said magnetic head and the wiring to this magnetic head are formed as an integrated one piece type structure.

10. The magnetic recorder as set forth in any of Claims 2 to 9, wherein the rigidity of said second deformable portion is smaller than that of said first deformable portion.

11. The magnetic recorder as set forth in any of Claims 2 to 10, wherein said magnetic head comprises at least a magnetoresistance effect reproduction element for carrying out a reproduction of information from a recording medium.

12. The magnetic recorder as set forth in any of Claims 2 to 11, wherein said sliding part comprises a plurality of sliding surfaces.



13. A magnetic recorder comprising a magnetic head and a head support arm for supporting the magnetic head so as to generate an urging load onto the recording medium, wherein the head support arm comprises a second rigid portion, a second deformable portion connected to an upstream portion of the second rigid portion in the moving direction of a recording medium, a first rigid portion connected to an opposite side of the second deformable portion to the second rigid portion and a first deformable portion connected to an opposite side of the first rigid portion to the second deformable portion,

said second rigid portion comprises a sliding part equipped with said magnetic head and sliding on the recording medium and a support portion rotatably supporting the sliding part around an axis parallel to the moving direction of the recording medium,

said first and second deformable portions and a part of said support portion are composed of wiring to said magnetic head to be provided on said head support arm,

said head support arm, said magnetic head and said wiring are formed in the laminate process of a thin film,

and in the rest state of the recording medium, the upstream end of said sliding part in the moving direction of the recording medium is provided downstream of an intersection of an extension of the line connecting said first and second deformable portions and said recording medium in the moving direction of the recording medium.



14. The magnetic recorder as set forth in Claim 1, wherein the natural frequency of a head support mechanism comprising the block and a rigid support for supporting the block in the moving direction of a recording medium is set at not higher than 200Hz.

15. The magnetic recorder as set forth in any of Claims 2 to 13, wherein the natural frequency of said support head arm in the moving direction of a recording medium is set at not higher than 200Hz.