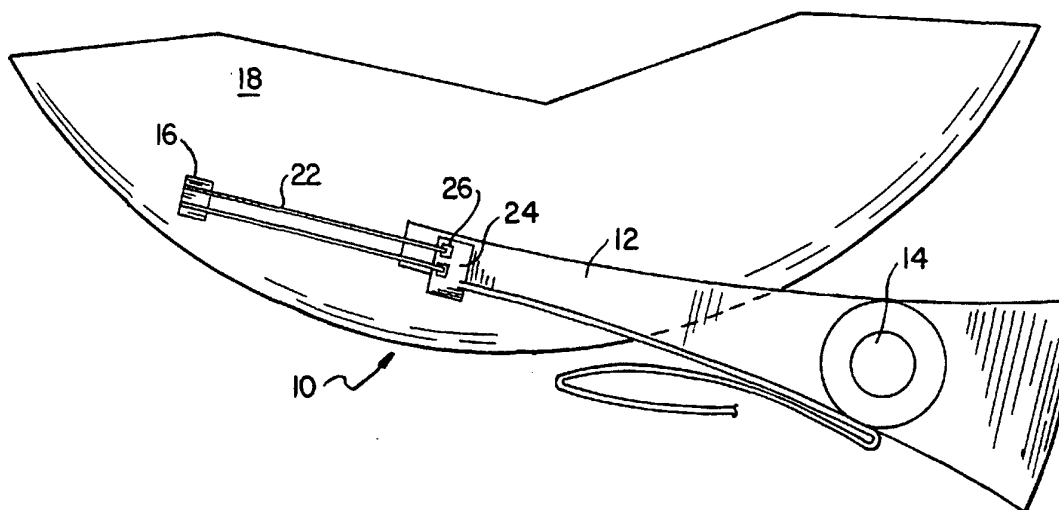




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(21) International Application Number: PCT/US94/14126 (22) International Filing Date: 8 December 1994 (08.12.94) (30) Priority Data: 164,356 8 December 1993 (08.12.93) US (71) Applicant: MAXTOR CORPORATION [US/US]; 211 River Oaks Parkway, San Jose, CA 95134 (US). (72) Inventor: KIMMAL, Jay, M.; 1480 Barlow Court, Fremont, CA 94536 (US). (74) Agents: BLAKELY, Todd, P. et al.; Sheridan Ross & McIntosh, Suite 3500, 1700 Lincoln Street, Denver, CO 80203 (US).		(81) Designated States: AU, CA, CN, JP, KR, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i>

(54) Title: WIRE LEAD-FRAME HEAD SUSPENSION



(57) Abstract

An actuator arm assembly for a hard disk drive which does not have a flexbeam substrate. The actuator arm assembly includes an actuator arm (12) and a magnetic head (16) that is electrically coupled to the electronics of the drive by a plurality of wires (22). The wires are also constructed to structurally support the head in a position cantilevered from the actuator arm. To provide structural integrity, the wires can be either twisted, constructed from beryllium copper, attached to a polyimide sheet or have any combination of the above. The wires may also have a sheet of viscoelastomeric material to dampen the structure.

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WIRE LEAD-FRAME HEAD SUSPENSION**BACKGROUND OF THE INVENTION****5 FIELD OF THE INVENTION**

The present invention relates to an actuator arm assembly for a hard disk drive.

DESCRIPTION OF RELATED ART

10 Hard disk drives contain a magnetic disk(s) which rotates relative to a magnetic head(s). The head is mounted to an actuator arm assembly which has a voice coil motor that moves the head relative to the disk. The head contains a slider surface which creates an air bearing
15 between the head and the disk surface when the disk is rotating. The air bearing prevents contact and corresponding wear between the head and the disk.

The head is typically mounted to a flexbeam which is cantilevered from the actuator arm. The flexbeam must be
20 flexible enough to allow the formation of the air bearing, yet rigid enough to withstand shock loads applied to the system. The flexbeam must also be constructed to operate without any frequency resonance. Flexbeams are conventionally constructed from a sheet of metal that is
25 attached to the end of the actuator arm. The head is then pivotally connected to the end of the metal sheet. A typical flexbeam may be a 0.003 inch thick sheet of 300 series stainless steel.

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To electrically couple the head to the remaining electronics of the drive, a plurality of wires are routed from the head to a flexible circuit mounted to the actuator arm. The wires are typically bonded to the flexbeam and
5 soldered to both the head and the flexible circuit. Having to bond and solder individual wires increases the assembly time of the drive unit.

Hard disk drives are installed into portable computers which must be light and compact. A significant portion of
10 the weight of a portable computer is the hard disk drive. Consequently, it is desirable to construct a disk drive which is as light and compact as possible. To reduce the height, weight and reduce the assembly cost of a disk drive, it would be desirable to provide an actuator arm
15 assembly which did not have a conventional flexbeam substrate.

SUMMARY OF THE INVENTION

The present invention is an actuator arm assembly for
20 a hard disk drive which does not have a flexbeam substrate. The actuator arm assembly includes an actuator arm and a magnetic head that is electrically coupled to the electronics of the drive by a plurality of wires. The wires are also constructed to structurally support the head in a
25 position cantilevered from the actuator arm. To provide structural integrity, the wires can be either twisted, constructed from beryllium copper, attached to a polyimide sheet or have any combination of the above. The wires may

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also have a sheet of viscoelastomeric material to dampen the structure.

It is therefore an object of the present invention to provide an actuator arm assembly which does not require a flexbeam substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and advantages of the present invention will become more readily apparent to those ordinarily skilled in the art after reviewing the following detailed description and accompanying drawings, wherein:

Figure 1 is a top view of an actuator arm assembly of the present invention;

Figure 2 is a top view of an alternate embodiment of an actuator arm assembly of the present invention;

Figure 3 is another alternate embodiment of the actuator assembly;

Figure 4 is a side view of an alternate embodiment of a flexbeam of the actuator arm assembly.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings more particularly by reference numbers, Figure 1 shows a actuator arm assembly of the present invention. The assembly 10 includes an actuator arm 12 that can rotate about a pivot bearing 14. The assembly 10 also has a magnetic head 16 which can magnetize and sense the magnetic field of a disk 18. The disk 18 is rotated relative to the head 16 by a spin motor

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(not shown). At the end of the actuator arm 12 is a voice coil motor 20 which can move the head 16 relative to the disk 18. The magnetic head 16 is constructed to create an air bearing that lifts the head 16 above the surface of the disk. The head 16 can be constructed for contact, near contact or no contact recording. Additionally, the head can be constructed to provide either horizontal or vertical recording.

The head 16 is electrically coupled to the electronics (not shown) of the hard disk drive through wires 22 that are connected to a flexible circuit board 24. The flexible circuit board 24 is typically bonded to the actuator arm 12. The electrical wires 22 are constructed to be rigid enough to also structurally support the head 16. In one embodiment, the wires 22 are constructed from a beryllium copper of a sufficient thickness that is flexible enough to allow the head 16 to be deflected when the air bearing is formed, but rigid enough to not yield when subjected to external shock or vibration loads. By way of example, if the head weighs .0003 grams, and the wires are approximately .5 inches long, the wires 22 should have a combined thickness of approximately .004 inches. The wires 22 are preferably insulated to prevent arcing and other negative events.

The wires 22 are attached to the head 16 at one end and soldered to surface contact pads 26 of the flexible circuit board 24 at the opposite end. Figure 2 shows an alternate embodiment, wherein the wires are twisted about

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each other. Twisting the wires increases the stiffness of the structural coupling between the head 16 and the actuator arm 12. The increase in stiffness will allow thinner beryllium copper wire or pure copper wire to be
5 used in the assembly 10.

Figure 3 shows an alternate embodiment, wherein the head 16 is coupled to the actuator arm 12 by a flexible circuit board 28. The flexible circuit board 28 contains a plurality of copper conductive traces 30 that are
10 encapsulated by sheets of dielectric material 32. The dielectric material is typically a polyimide material marketed by E.I. du Pont de Nemours & Co. under the trademark KAPTON. The copper traces 30 are etched into the patterns shown by methods well known in the art. The
15 combination of KAPTON and copper traces should be flexible enough to allow the formation of the air bearing, yet strong enough to withstand external loads.

The flexible circuit board 28 has a number of first conductive surface pads 34 that may be soldered to the
20 surface pads 26 of the flexible circuit 24. The circuit board 28 also has a plurality of second conductive surface pads 36 that are coupled to the head 16 either directly or through bonded wires 38. The head 16 can be mounted to the end of the flexible circuit board 28. The lateral
25 flexibility of the circuit board 28 allows the head 16 to pivot about the board 28 as indicated by the arrows.

As shown in Figure 4, a viscoelastomeric material 40 may be attached to the flexible circuit board 28. The

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viscoelastomeric material 40 will dampen vibrational loads that are applied to the actuator arm assembly. The viscoelastomeric material 40 may be attached to a thin metal sheet 42, which adds additional stiffness to the flexible circuit board 28. The metal backing 42 and elastomeric material is preferably a product sold by Minnesota Manufacturing and Mining Co. ("3M") under the trademark SCOTCHDAMP. The elastomeric material of the 3M product also has adhesive properties that allow the elastomer 40 and sheet 42 to be readily mounted to the flexible circuit board 28.

The present invention thus provides an actuator arm assembly which does not have a conventional flexbeam substrate. To assemble the arm assembly 10, the magnetic head 16 can be constructed with either the wires or flexible circuit wrapped around the head 16. The head 16 can be assembled to the actuator arm 12 by merely unwinding the wires/circuit and soldering the same to the flexible circuit board 24 of the actuator arm. The present invention thus reduces the assembly time required to produce the arm relative to conventional actuator arms which require assembly of the flexbeam substrate.

While certain exemplary embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention, and that this invention not be limited to the specific constructions and arrangements shown and described, since various other

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modifications may occur to those ordinarily skilled in the art.

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What is claimed is:

1. An actuator arm assembly for a hard disk drive,
comprising:
an actuator arm;
5 movement means for moving said actuator arm;
a magnetic head; and,
a pair of wires attached to said actuator arm and said
magnetic head, said wires extend from said actuator arm and
structurally support said magnetic head.
- 10 2. The assembly as recited in claim 1, wherein said
wires are twisted about each other.
3. The assembly as recited in claim 1, wherein said
wires are constructed from beryllium copper.
4. The assembly as recited in claim 1, further
15 comprising a sheet of dielectric material attached to said
wires, wherein said wires and said dielectric sheet define
a flexible circuit.
5. The assembly as recited in claim 4, wherein said
dielectric material is a polyimide.
- 20 6. The assembly as recited in claim 4, further
comprising a viscoelastomeric material attached to said
dielectric sheet.
7. The assembly as recited in claim 6, further
comprising a sheet of metal attached to said dielectric
25 material.
8. The assembly as recited in claim 4, wherein said
flexible circuit has a pair of conductive surface pads on
an end adjacent to said actuator arm.

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9. The assembly as recited in claim 8, wherein said flexible circuit has a pair of conductive surface pads on an end adjacent to said magnetic head.

10. The assembly as recited in claim 4, wherein said
5 magnetic head is pivotally connected to said flexible circuit.

11. The assembly as recited in claim 9, wherein said magnetic head is attached to said conductive surface pads and pivotally connected to said flexible circuit.

10 12. A hard disk drive, comprising:
a media;
a spin motor that rotates said media;
an actuator arm;
a voice coil motor assembly that can move said
15 actuator arm relative to said media;
a magnetic head; and,
a pair of wires attached to said actuator arm and said magnetic head, said wires extend from said actuator arm and structurally supporting said magnetic head.

20 13. The hard disk drive as recited in claim 12, wherein said wires are twisted about each other.

14. The hard disk drive as recited in claim 12, wherein said wires are constructed from beryllium copper.

15. The hard disk drive as recited in claim 12,
25 further comprising a sheet of dielectric material attached to said wires, wherein said wires and said dielectric sheet define a flexible circuit.

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16. The hard disk drive as recited in claim 15, wherein said dielectric material is a polyimide.

17. The hard disk drive as recited in claim 15, further comprising a viscoelastomeric material attached to
5 said dielectric material.

18. The hard disk drive as recited in claim 17, further comprising a sheet of metal attached to said viscoelastomeric material.

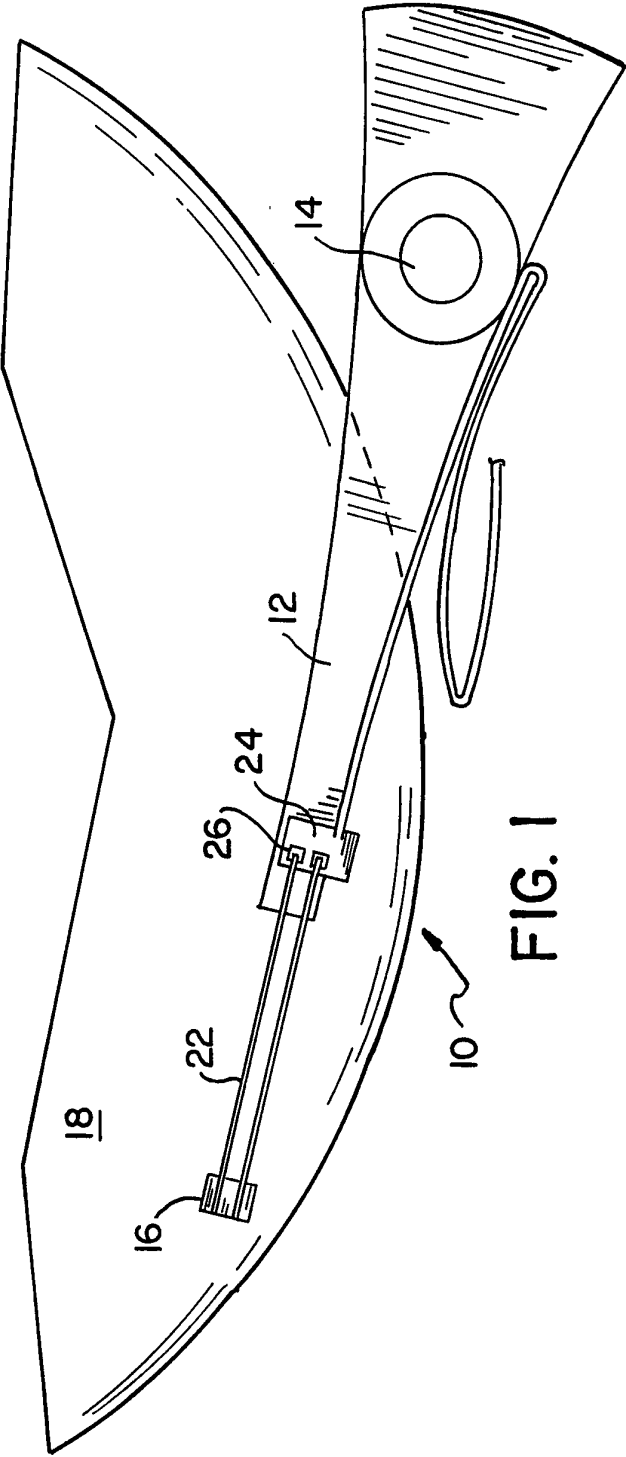
19. The hard disk drive as recited in claim 15,
10 wherein said flexible circuit has a pair of conductive surface pads on an end adjacent to said actuator arm.

20. The hard disk drive as recited in claim 19, wherein said flexible circuit has a pair of conductive surface pads on an end adjacent to said magnetic head.

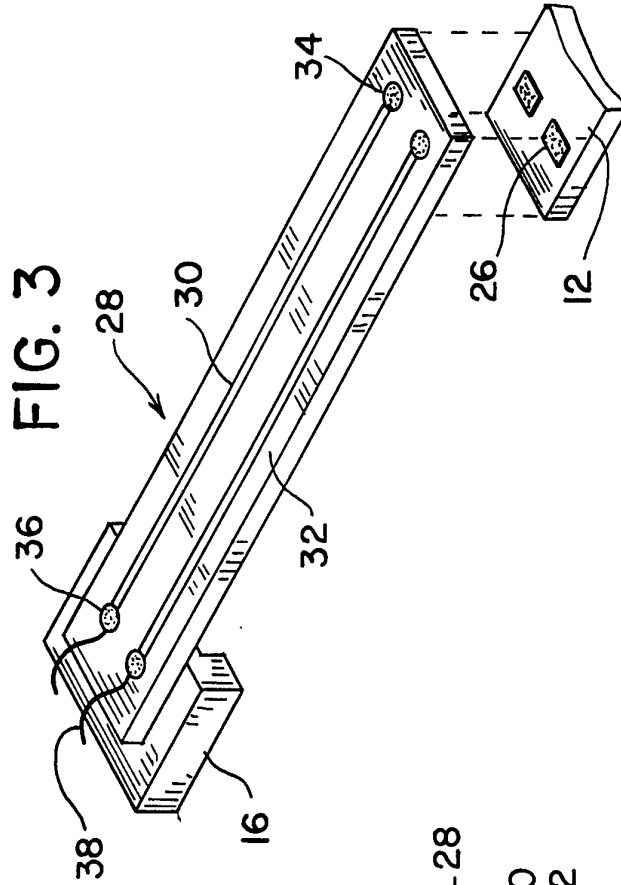
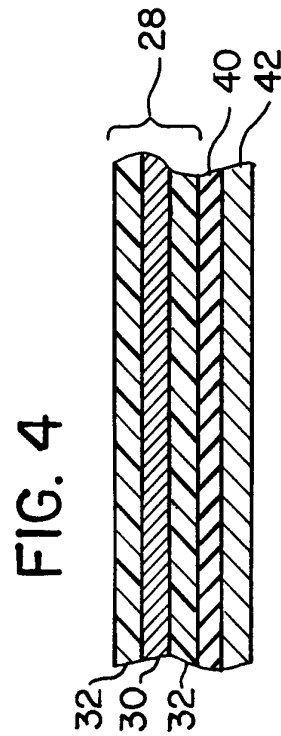
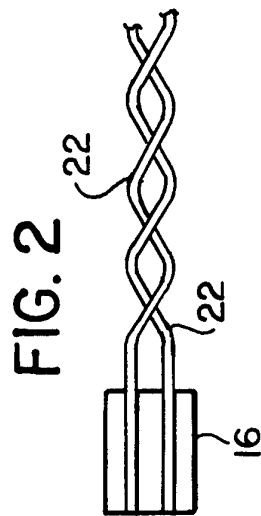
15 21. The hard disk drive as recited in claim 15, wherein said magnetic head is pivotally connected to said flexible circuit.

22. The hard disk drive as recited in claim 20, wherein said magnetic head is attached to said conductive
20 surface pads and pivotally connected to said flexible circuit.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/14126

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : G 11 B 5/60, 21/12

US CL : 360/106, 104

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 360/106, 105, 104

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, JAPANESE ABSTRACTS

search terms: magnetic head, actuator arm, wires, support, beryllium copper, flexure, spring

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,965,684 (STEFANSKY) 23 October 1990, Figures 2 and 4.	1-22
Y	IBM Technical Disclosure Bulletin, Volume 22, No. 4, issued September 1979, J.R. Reidenbach, "Combination Suspension-Lead Cable For A Multi-Gap Read/Write Head", pages 1602-1603.	1, 3, 12 & 14
Y	US, A, 4,740,854 (SHIBUYA ET AL) 26 April 1988, col. 5, lines 17-24.	3 & 14
Y	US, A, 3,939,495 (NAGAI ET AL) 17 February 1976, Figure 2.	1, 2, 12 & 13
Y	US, A, 4,996,623 (ERPELDING ET AL) 26 February 1991, col. 3, line 63 et seq.	1, 4-12 & 15-22

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 5,187,625 (BLAESER ET AL) 16 February 1993, col. 2, lines 35-45.	6, 7, 17 & 18
Y,P	US, A, 5,296,983 (BLANC ET AL) 22 March 1994, col. 5, line 8 et seq.	8, 9, 11, 19, 20 & 22