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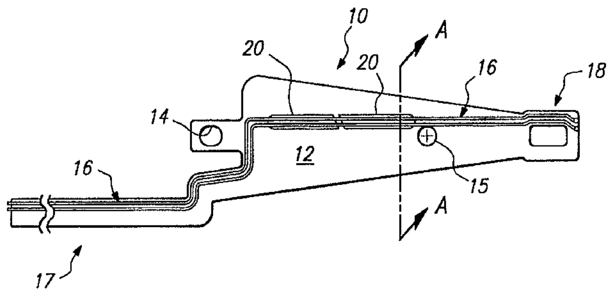
(30) 1996/03/25 (08/621,431) US

(54) SUSPENSION AVEC CONDUCTEUR INTEGRE A CAPACITE REGLABLE

(54) SUSPENSION WITH INTEGRATED CONDUCTOR HAVING CONTROLLED CAPACITANCE



(57) Suspension (10) comportant des conducteurs intégrés (16) qui supportent une tête de lecture/écriture (36) et la relient électriquement à un circuit électronique d'un lecteur de disque. La capacité des conducteurs (16) par rapport à la masse est commandée par le positionnement sélectif de vides façonnés (20) dans la suspension (10), dans des zones adjacentes aux trajets des conducteurs. Des parties de la suspension (10) peuvent être de manière générale complémentaires de la forme de la structure conductrice (16).

(57) A suspension (10) having integrated conductors (16) for supporting and electrically interconnecting a read/write head (36) to electronic circuitry in a disk drive. The capacitance to ground of the conductors (16) is controlled by the selective placement of shaped voids (20) in the suspension (10) at regions adjacent to the conductor paths. Portions of the suspension (10) may be generally the complement of the conductor structure (16) shape.

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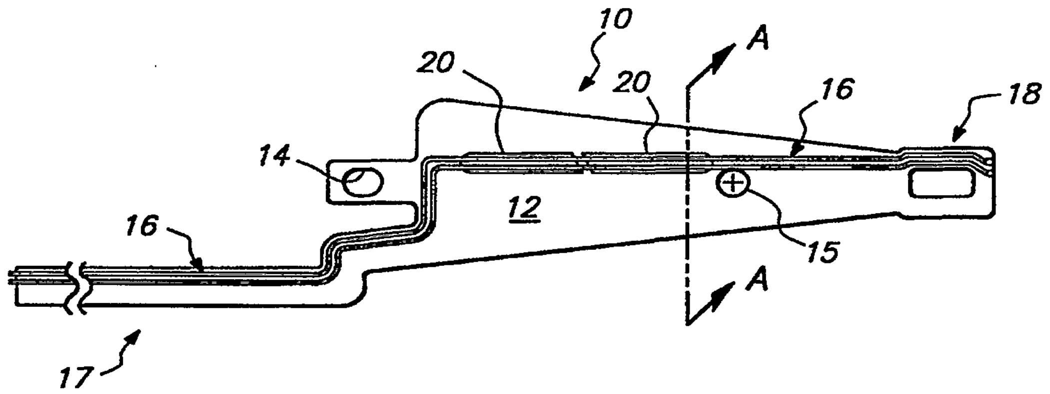


(57) Abstract

A suspension (10) having integrated conductors (16) for supporting and electrically interconnecting a read/write head (36) to electronic circuitry in a disk drive. The capacitance to ground of the conductors (16) is controlled by the selective placement of shaped voids (20) in the suspension (10) at regions adjacent to the conductor paths. Portions of the suspension (10) may be generally the complement of the conductor structure (16) shape.

SUSPENSION WITH INTEGRATED CONDUCTOR HAVING CONTROLLED CAPACITANCE

Field of the Invention

This invention relates generally to structure and method of controlling capacitance and impedance arising from integral conductors in a suspension for supporting a read/write head adjacent to a relatively moving recording medium in a disk drive. More particularly, it relates to an integrated suspension and conductor stucture wherein the suspension includes voids such that portions of the suspension are generally the complement of the conductor structure and a method for fabricating the same.

Background

Contemporary disk drives typically include a rotating rigid storage disk and a head positioner for positioning a data transducer at different radial locations relative to the axis of rotation of the disk, thereby defining numerous concentric data storage tracks on each recording surface of the disk. The head positioner is typically referred to as an actuator. Although numerous actuator structures are known in the art, in-line rotary voice coil actuators are now most frequently employed due to their simplicity, high performance, and their ability to be mass balanced about their axis of rotation, the latter being important for making the actuator less sensitive to perturbations. A closed-loop servo system is employed to operate the actuator and thereby position the heads with respect to the disk surface.

The read/write transducer, which may be of a single or dual element design, is typically deposited upon a ceramic slider structure having an air bearing surface for supporting the transducer at a small distance away from the surface of the moving medium. Single element designs typically require two wire connections while dual element designs require four. Magnetoresistive (MR) heads, in particular, generally require four wires. The combination of an air bearing slider and a read/write transducer is also known as a read/write head or a recording head.

Sliders are generally mounted to a gimbaled flexure structure attached to the distal end of a suspension's load beam structure. A spring biases the load beam, and therethrough the head, towards the disk, while the air pressure beneath the head pushes the head away from the disk. The equilibrium distance then determines the "flying height" of the head. By utilizing such an "air bearing" to support the head away from the disk surface, the head operates in a hydrodynamically lubricated regime at the head/disk interface rather than in a boundary lubricated regime. The air bearing maintains spacing between the transducer and the medium which reduces transducer efficiency, however, the avoidance of direct contact vastly improves the reliability and useful life of the head and disk components. Demand for increased areal densities may nonetheless require that heads be operated in pseudo contact or even boundary lubricated contact regimes, however.

The disk drive industry has been progressively decreasing the size and mass of the slider structures in order to reduce the moving mass of the actuator assembly and to permit closer operation of the transducer to the disk surface, the former giving rise to improved seek performance and the latter giving rise to improved transducer efficiency that can then be traded for higher areal density. The size (and therefore mass) of a slider is usually characterized with reference to a so-called standard 100% slider (minislider). The terms 70%, 50%, and 30% slider (microslider, nanoslider, and picoslider, respectively) therefore refer to more recent low mass sliders that have linear dimensions that are scaled by the applicable percentage relative to the linear dimensions of a standard minislider. Smaller slider structures generally require more compliant gimbals, hence the intrinsic stiffness of the conductor wires attached to the slider can give rise to a significant bias effect.

To reduce the effects of this intrinsic wire stiffness or bias, integrated flexure/conductor structures have been proposed which effectively integrate the wires with an insulating flexible polymeric resinous flexure such that the conductors are exposed at bonding pads positioned at the distal end of the flexure in the proximity of the head. U.S. Patent No. 5,006,946 to Matsuzaki discloses an example of such a configuration. While such wiring configurations do enjoy certain performance and assembly advantages, the introduction of the disclosed flexible polymeric resinous material in the flexure and gimbal structure raises a number of challenging design issues. For example, the thermal expansion properties of the resinous material is not the same as the prior art stainless steel structures and the long-term durability of such resinous structures, including any requisite adhesive layers, is unknown. Therefore, hybrid stainless steel flexure and conductor structures have been proposed which incorporate most of the benefits of the integrated conductor flex-circuit flexure structures while remaining largely compatible with prior art fabrication and loadbeam attachment methods. Such hybrid designs typically employ stainless steel flexures having deposited insulating and conductive layers for electrical interconnection of the head to the associated drive electronics, e.g., a preamp chip and read channel circuitry.

These hybrid flexure designs employ relatively lengthy runs of conductors which extend from bonding pads at the distal, head-mounting end of the flexure to the proximal end of the flexure to provide a conductive path from the read/write head along the length of the associated suspension structure to the preamp or read-channel chip(s). Because the conductors are positioned extremely close to but electrically isolated from the conductive stainless steel flexure structure which is in turn grounded to the load beam, the magnitude of the conductor capacitance to ground is increased relative to a conventional insulated discrete wire twisted pair conductor structure. This increased capacitance tends to deleteriously affect the performance of the read/write head, conductor, and preamp system, hence there is a need for a manufacturable and reliable integrated flexure and conductor structure which exhibits reduced capacitance to ground.

The invention to be described provides, inter alia, a flexure for a suspension in a disk drive which includes integrated conductor structure configured to limit the parasitic capacitance between the conductor structure and other parts of the suspension structure and a method for fabricating the same.

Summary of the Invention

A suspension assembly in accordance with a preferred embodiment of the invention includes a flexure having one or more shaped voids and having integrated conductors which extend along the flexure generally adjacent to the voids. The integral conductors replace prior art discrete twisted-pair, insulated conductor wires which would normally extend along the length of the associated suspension. The size and shape of the flexure voids as well as the conductor geometry are controlled to reduce undesirable effects of conductor capacitance to ground. Additionally, the conductor traces may be configured to reduce the mutual capacitance of the traces. The invention provides improved electrical performance without materially affecting the suspension's mechanical performance.

A general object of the present invention is to provide a low-profile, robust, reliable, suspension having integral conductors for electrically interconnecting a read/write head to associated read/write circuitry which overcomes limitations and drawbacks of the prior art.

A more specific object of the present invention is to provide a method to control the capacitance or impedance of an integrated flexure/conductor structure for use with a read/write head in a disk drive.

Still another object of the invention is to provide an integrated flexure and conductor structure and fabrication method that facilitates the separate optimization of the capacitances and impedances of the conductors of both the read and the write elements of a dual-element read/write head.

Another object of the invention is to provide an improved suspension for supporting read/write heads in the drive.

The invention provides an economical and reliable method for electrically interconnecting a transducer mounted on a slider to an integrated flexure/conductor structure which implements a gimbal and includes exposed conductive electrical bonding pads positioned near the slider mounting region at the distal end of a conductive flexure. The bonding pads and associated conductors are electrically isolated from the flexure by a dielectric layer affixed to the flexure with the conductors extending generally coplanarly along a flexure surface. The flexure includes one or more voids and the conductors are configured to extend adjacent to the voids. The conductor aspect ratio and the interconductor spacing may be tailored to reduce the mutual capacitance between conductors while concurrently maintaining low capacitance to ground. The boundaries of the voids may be configured to prevent discontinuous impedance changes along the conductor path.

These and other objects, advantages, aspects, and features of the present invention will be more fully appreciated and understood upon consideration of the following detailed descriptions of a preferred embodiment presented in conjunction with the accompanying drawings.

Brief Description of the Drawings

In the Drawings:

Fig. 1 is an enlarged diagrammatic plan view of an integrated flexure/conductor structure in accordance with the invention.

Fig. 2 shows a cross section of the integrated flexure/conductor structure of Fig. 1 taken along section line A-A.

Fig. 2A illustrates an alternative cross sectional detail of an integrated flexure/conductor structure of the type illustrated in Fig. 1.

Fig. 3 is an enlarged diagrammatic plan view of a head gimbal assembly (HGA) in accordance with the invention which includes a loadbeam, an integrated flexure/conductor structure, and a read/write head.

Fig. 4 illustrates a graph showing conductor capacitance to ground versus adjacent void width.

Fig. 5A - 5D illustrate a variety of exemplary void outlines which may be defined in an integrated flexure/conductor structure in accordance with the invention.

Fig. 6 illustrates an equivalent circuit diagram of a typical read circuit, conductor, and read/write head system which employs an integrated-conductor type conductive flexure member.

Fig. 7 is a graph modeling the transfer function of the circuit of Fig. 6 assuming a typical capacitance-to-ground value for a flexure having no voids adjacent the conductors.

Fig. 8 is a graph modeling the transfer function of the circuit of Fig. 6 assuming a typical capacitance-to-ground value achievable by employing voids adjacent the conductors.

Fig. 9 illustrates a plan view of a disk drive in accordance with the invention.

Detailed Description of a Preferred Embodiment

Referring to the drawings, where like characters designate like or corresponding parts throughout the views, Fig. 1 is a plan view of an integrated flexure/conductor structure 10 in accordance with a preferred embodiment of the invention. Flexure/conductor structure 10 includes a generally planar stainless steel flexure member 12 which is approximately 20-microns thick and which includes tooling holes 14 and 15 which are used during manufacturing and assembly for precision component alignment. A pair of conductive traces of approximately 10-microns thick copper form part of a conductor structure 16 which extends from the proximal end 17 of flexure member 12 to the head supporting distal end 18 of flexure member 12. Conductor structure 16 includes a thin (e.g., 10-microns) insulating base film 25 (omitted for clarity but shown in Fig. 2) interposed between the conductive traces of the conductor structure and stainless steel flexure member 12 to prevent shorting of the conductive traces of conductor structure 16. Flexure member 12 includes one or more voids 20 which are positioned adjacent to the path along which conductor structure 16 is routed to reduce the capacitance between the conductor structure and the stainless steel flexure member 12. Accordingly, the invention provides a method for controlling the capacitance arising from the integration of the conductor structure 16 with the stainless steel flexure member 12. As is well known in the art, excessive conductor or lead wire capacitance has a deleterious impact on signals traveling between the associated read/write head and preamp circuit.

Additionally, because at sufficiently high frequencies conductor structure 16 behaves as a transmission line for signals passing between the read/write head and read channel electronics, the geometry of the voids is an important factor for controlling and avoiding abrupt impedance changes along the signal path of conductor structure 16. Discontinuous impedance changes tend to give rise to undesireable reflection effects in the transmission line. Fig. 2 illustrates a cross section of the flexure/conductor structure 10 of Fig. 1 taken along section line A-A. Conductor structure 16 includes, in this embodiment, a pair of conductive traces 22 and an insulating polyimide (a flexible polymeric resinous material) layer 24 which spans the void 20 to provide support for the conductive traces. In this embodiment, the pair of traces are configured as close together as the fabrication process reliably permits to reduce the magnitude of the mutual capacitance between the conductors. Although not strictly required, an additional insulation layer of about 4-microns thickness may be used as a protective overcoat for the traces 22. Preferrably, the voids should be shaped so as to cause a smooth or relatively continuous change in the cross sectional area of the void 20 along the length of flexure/conductor structure 10 so as to avoid abrupt transitions in the impedance along the signal path defined by conductor structure

16. In the areas where the boundaries of the void(s) 20 cross the traces 22, it is desirable to either curve the boundary or angle the boundary so that the boundary does not cross the traces at a right angle so that the impedance changes along the transmission line defined by conductive structure 16 are made more gradual. Additionally, the flexure member interior boundary that defines void(s) 20 may be undercut (as shown in Fig. 2 or 2A) to further smooth impedance changes along the signal path.

Numerous methods for laminating and patterning stainless steel sheet stock, dielectric films, and conductors are known in the art. Additionally, methods for depositing and patterning dielectrics and conductors onto stainless steel are also known in the art. In accordance with a preferred embodiment of the invention, the conductive traces 22 are plated and photolithographically defined, rather than laminated and etched, so that the insulation and conductive trace layers may be made suitably thin so as not to materially affect the mechanical properties of the stainless steel flexure member. After the insulator and conductor structures are formed, the outlines of the flexure and the voids may be selectively etched to complete the formation of an intergrated flexure/conductor structure.

Fig. 3 shows a fully assembled head gimbal assembly (HGA) 30 in accordance with the invention which includes a baseplate 32 for mounting the HGA to an actuator arm in a disk drive and a loadbeam 34 for applying a load force onto read/write head 36. Head 36 is affixed to the distal end 18 of flexure/conductor structure 10 and the transducer element(s) (not shown) of read/write head 36 are electrically interconnected to the conductive traces 22. Flexure/conductor structure 10 may be conventionally spot welded to loadbeam

34. Loadbeam 34 typically includes a protuberance or load button (not shown) which approximates point contact between loadbeam 34 and read/write head 36 so that head 36 is capable of limited relative pitch and roll with respect to loadbeam 35. It should be noted that although loadbeam 34 is a conductive stainless steel structure (like flexure member 12) in the preferred embodiment of the invention, the conductive traces 22 are positioned sufficiently far from the loadbeam structure so as not to give rise to significant capacitance to ground concerns with respect to the loadbeam. If however, a loadbeam structure having an integrated gimbal is employed so that the intermediate flexure body member described in connection with Fig. 2 is not required, in accordance with the principles of the invention, the loadbeam itself may be etched so as to include voids along the signal path to reduce capacitance to ground.

Fig. 4 illustrates a graph 40 plotting capacitance to ground as a function of the width of the void 22 when the flexure is affixed to a grounded loadbeam. Graph 42 shows only minor capacitance reductions in the case where the grounded loadbeam is not present. Thus, it is not necessary to fabricate or etch voids into the loadbeam itself, unless, for example, the conductors are integrated with a loadbeam having an integral gimbal that is not implemented with a separate flexure member. Returning to graph 40, if the void width is made too small, the capacitance remains relatively high, however, if the void width is made too large, a point of diminishing returns is reached and structural rigidity may be unecessarily compromised. The appropriate void width is ultimately dependent upon the specific conductor configuration under examination but can be readily determined either via modeling or empirically. It should be noted that the capacitance to ground can also be reduced by increasing the thickness of the insulating layer, however, this solution is not desirable because it tends to increase the thickness of the resultant suspension and because the added material and associated mass may give rise to adverse mechanical effects. Also, narrower conductive traces may be employed to reduce capacitance to ground, however the narrower conductive traces exhibit undesirable increases in conductor resistance. Thus, the use of precision shaped voids facilitates the fabrication of potentially thinner suspension structures having integrated conductors that offer improved electrical performance.

Figs. 5A - 5D illustrate several alternative void shapes that may be employed adjacent to either the read or write signal path to control the capacitance of that signal path. Fig. 5A illustrates a substantially rectangular interior boundary defining a void in a flexure member. Although the illustrated void helps to reduce the magnitude of the capacitance to ground, the perpendicular crossing of the conductor and the void boundary can give rise to a sharp or step-function transition in the impedance along the conductor path.

For a single conductor, the capacitance per unit length is approximated by:

$$\frac{C_g}{l} = 8.84\varepsilon_r K_C\left(\frac{b}{t}\right)\text{pf/m}$$

where:

C_g = *capacitance to ground*

l = *length of conductor*

ε_r = *dielectric constant*

K_C = *capacitive fringing factor*

b = *conductor width*

t = *thickness of insulator*

The capacitance to ground of the conductor regions near the boundary but adjacent the conductive flexure member is therefore substantially different from the capacitance to ground of the conductor regions near the boundary but adjacent the void. This abrupt capacitance change gives rise to an approximately step-function impedance change in the conductor as it crosses the boundary.

In high frequency applications, step function changes in impedance along the conductor path cause traveling wave reflections that distort the transmitted waveform. Therefore, curved or angled void boundaries such as those disclosed in Figs. 5B-5D appear to provide better high frequency performance than the void boundary illustrated in 5A. Of course, the thickness of the flexure member, which acts as a ground plane, may also be varied (Fig. 2A) to cause a more gradual impedance change for any of the void geometries illustrated in Figs. 5A-5D. It should be noted that the void boundary may be either an interior or exterior boundary of the flexure member, since voids may be formed along a lateral edge of the flexure member, for example.

Fig. 6 shows an equivalent circuit diagram representing a characteristic transmission line model 49 of a typical read circuit, conductor, and magnetoresistive (MR) read head system which employs an integrated conductor type stainless steel flexure. MR head equivalent circuit 50 is a conventional model of a 150-kfci (kilo flux changes per inch) read element. Conductive trace equivalent circuit 52 represents the conductive traces adjacent a grounded, conductive flexure structure. Forward and rearward looking capacitances to ground arising from the conductor traces are represented by capacitors 53 and 54. A driving source 56 is swept from about 10-mhz to 5-Ghz to analyze the frequency driven transfer function of the overall circuit. Figs. 7 and 8 show modeling results of the transfer functions of the circuit for the cases where there are no voids in the flexure adjacent the traces and where there are voids in flexure, respectively. In the former case, the forward looking and rearward looking capacitance to ground is assumed to be on the order of about 14-picofarads, whereas, with the voids, the forward looking and rearward looking conductor capacitance to ground may readily be reduced to about 4-picofarads. Without the voids, the modeled circuit has a reduced bandwidth and earlier rolloff than the same structure employing voids in accordance with the invention. Thus, an integrated-conductor flexure in accordance with the invention provides better bandwith and a higher cutoff frequency in the head circuit. Moreover, the overall circuit behaves as a bandpass filter and exhibits a higher Q with the voids.

Those skilled in the art will recognize that, in accordance with the principles of the invention, advanced dual element transducer designs (such as an MR head design) may have the capacitances and/or impedances of the signal paths of the read and write elements separately optimized by employing different conductor geometries and/or the void configurations for the read and write conductive traces, respectively.

Fig. 9 illustrates an integrated-conductor flexure employed in the context of a disk drive. Disk drive 70 includes a rigid base 75 and a rotating storage disk 80 which is rotatably mounted with respect to base 75 via conventional spindle motor means (not shown). Drive 70 also includes a rotary actuator assembly 82 which includes a voice-coil 84 that, when selectively energized, is used to move and position HGA 30 (discussed in greater detail in connection with Fig. 3), and therethrough head 36, relative to a radius of disk 80. Flex circuit 82 is electrically connected to the conductors on flexure 10 to facilitate communication between head 36 and remotely located signal processing circuitry (not shown).

Although the present invention has been described in terms of the presently preferred embodiment, i.e., a deposited conductor flexure structure which implements a gimbal, it should be clear to those skilled in the art that the present invention may also be utilized in conjunction with, for example, an integrated gimbal loadbeam structure, or other conductive suspension members having proximately mounted, deposited, or embedded conductors with or without insulating overcoatings. Thus, it should be understood that the instant disclosure is not to be interpreted as limiting. Various alterations and modifications will no doubt become apparent to those skilled in the art after having read the above disclosure. Accordingly, it is intended that the appended claims be interpreted as covering all alterations and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An integrated flexure/conductor structure for supporting a read/write head adjacent to a storage medium and for electrically interconnecting the head to read/write circuitry, the flexure/conductor structure comprising:

a generally planar conductive flexure member including at least one void;

an electrical insulation layer disposed on the flexure member and at least partially overlaying the void; and

electrically conductive traces disposed on the electrical insulation layer and at least partially overlaying the void.

2. The integrated flexure/conductor structure of claim 1 wherein impedance changes along the conductive traces near a boundary of the void are substantially continuous.

3. The integrated flexure/conductor structure of claim 2 wherein a cross sectional area of the void defined by upper and lower surfaces of the flexure member and a boundary of the void changes substantially continuous along the length of the flexure member.

4. An integrated flexure/conductor structure for supporting a read/write head adjacent to a storage medium and for electrically interconnecting the head to read/write circuitry, the flexure/conductor structure comprising:

a generally planar conductive flexure member having a boundary defining a void;

electrically conductive traces disposed adjacent to the flexure member and at least partially overlaying the void; and

an electrical insulation layer interposed between the flexure member and the traces for electrically isolating the flexure member from the traces.

5. The integrated flexure/conductor structure of claim 4 wherein the conductive traces comprise distinct read and write traces for conducting signals to and from the head.

6. The integrated flexure/conductor structure of claim 4 wherein the boundary is an interior boundary.

7. The integrated flexure/conductor structure of claim 4 wherein the boundary is an exterior boundary.

8. The integrated flexure/conductor structure of claim 6 or 7 wherein impedance changes along the conductive traces near the boundary are substantially continuous.

9. The integrated flexure/conductor structure of claim 4 wherein a cross sectional area of the void defined by upper and lower surfaces of the flexure member and the boundary changes substantially continuously along the length of the flexure member.

10. The integrated flexure/conductor structure of claim 4 wherein the flexure member has a thickness which tapers towards the boundary.

11. The integrated flexure/conductor structure of claim 4 wherein the interior boundary is undercut.

12. The integrated flexure/conductor structure of claim 4 wherein an orthogonal projection of the electrically conductive traces onto the planar conductive flexure member intersects the void.

13. The flexure/conductor structure of claim 12 wherein the flexure member is stainless steel.

14. The flexure/conductor structure of claim 13 wherein the electrically conductive traces comprise a material selected from the group consisting of aluminum, copper, and gold.

15. The flexure/conductor structure of claim 14 wherein the insulation layer is a flexible polymeric resinous material.

16. A laminated conductor and suspension structure for supporting a read/write head adjacent to a storage medium, the structure comprising:

a generally planar conductive loadbeam having a proximal actuator mounting end and a gimbaled head mounting region at a distal end for attaching the head, the loadbeam including a boundary defining a void;

electrically conductive traces disposed adjacent to the loadbeam and partially overlying the void, wherein impedance changes along the conductive traces near the boundary are substantially continuous; and an electrical insulation layer interposed between the loadbeam and the traces for electrically isolating the loadbeam from the traces.

17. An integrated-conductor suspension for supporting a read/write head adjacent to a storage medium and for electrically interconnecting the head to read/write circuitry, the suspension comprising:

a baseplate at a proximal actuator mounting end of the suspension;

a loadbeam connected to the baseplate;

a generally planar conductive flexure member attached to the loadbeam and having a boundary defining a void;

electrically conductive traces disposed adjacent to the flexure member and at least partially overlaying the void, wherein impedance changes along the conductive traces near the boundary are substantially continuous; and

an electrical insulation layer interposed between the flexure member and the traces for electrically isolating the flexure member from the traces.

18. An integrated-conductor head gimbal assembly for reading information from and writing information to a storage medium in a disk drive, the head gimbal assembly comprising:

a baseplate at a proximal mounting end of the head gimbal assembly;

a loadbeam connected to the baseplate;

a generally planar conductive flexure member attached to the loadbeam and having a boundary defining a void;

electrically conductive traces disposed adjacent to the flexure member and at least partially overlaying the void, wherein impedance changes along the conductive traces near the boundary are substantially continuous;

an electrical insulation layer interposed between the flexure member and the traces for electrically isolating the flexure member from the traces; and

a read/write head affixed to the flexure member at a distal end of the head gimbal assembly and electrically connected to the conductive traces.

19. A disk drive for storing and reproducing information, the disk drive comprising:

a disk drive base;

a storage disk rotatably mounted to the base;

motor means for rotating the disk;

a read/write head for reading information from and writing information to the storage disk;

signal processing means for communicating with head;

a movable actuator mounted to the base for selectively positioning the head relative to a radius of the storage disk; and

an integrated-conductor suspension attached to the actuator for supporting the head adjacent to the storage disk and for electrically interconnecting the head to the signal processing means, the suspension comprising:

a baseplate at a proximal actuator mounting end of the suspension;

a loadbeam connected to the baseplate;

a generally planar conductive flexure member attached to the loadbeam and having a boundary defining a void;

electrically conductive traces disposed adjacent to the flexure member and at least partially overlaying the void, wherein impedance changes along the conductive traces near the boundary are substantially continuous;

an electrical insulation layer interposed between the flexure member and the traces for electrically isolating the flexure member from the traces; and

wherein the head is mechanically affixed to the conductive flexure member at a distal end of the suspension and is electrically connected to the conductive traces and therethrough the signal processing means.

20. The disk drive of claim 19 wherein the head includes separate read and write elements and the conductive traces comprise distinct read and write traces for conducting signals to and from the read and write elements, respectively.

21. The disk drive of claim 20 wherein the boundary is optimized with respect to the read traces.

22. The disk drive of claim 20 wherein the boundary is optimized with respect to the write traces.

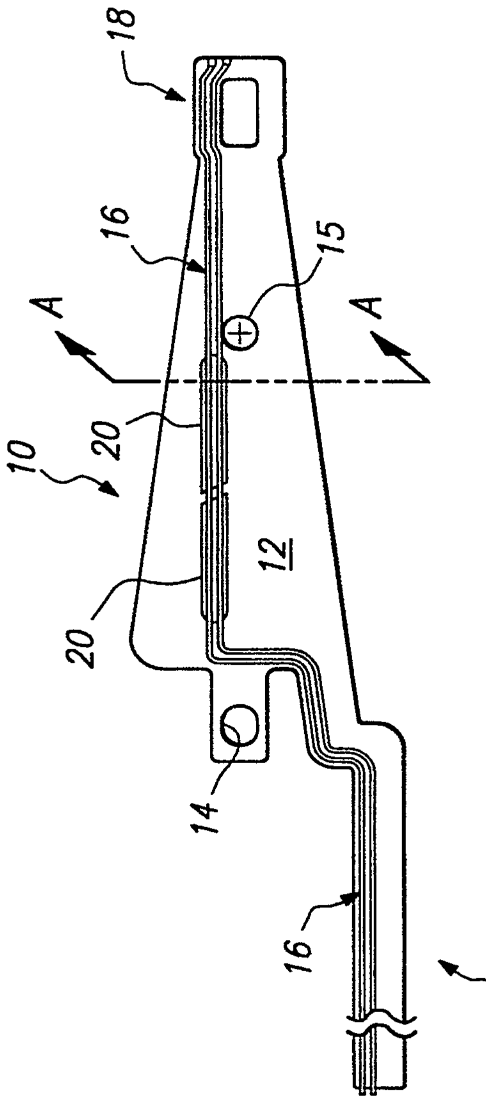


FIG. 1

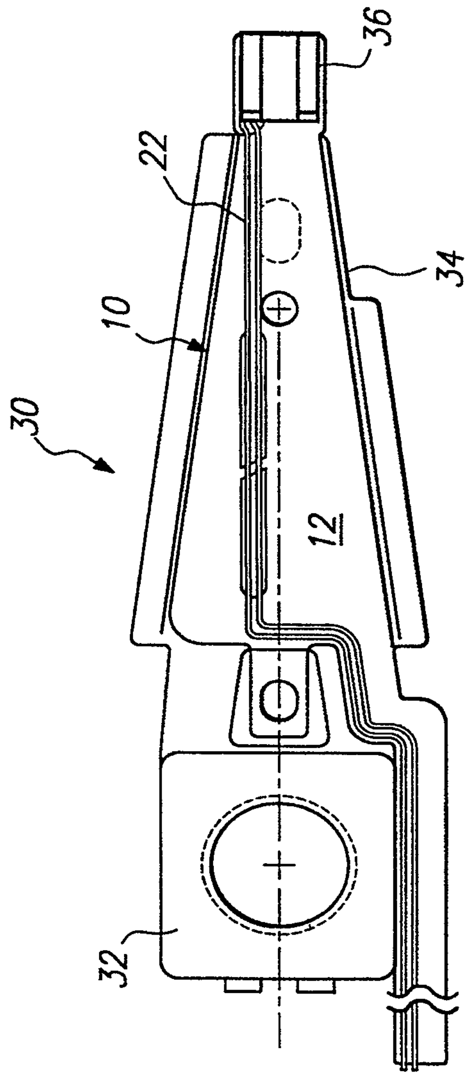


FIG. 3

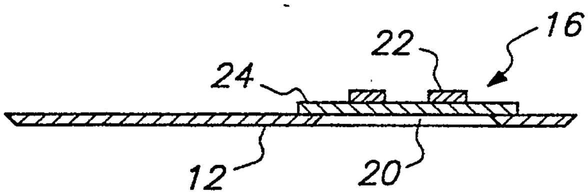


FIG. 2

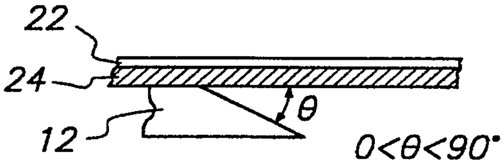


FIG. 2a

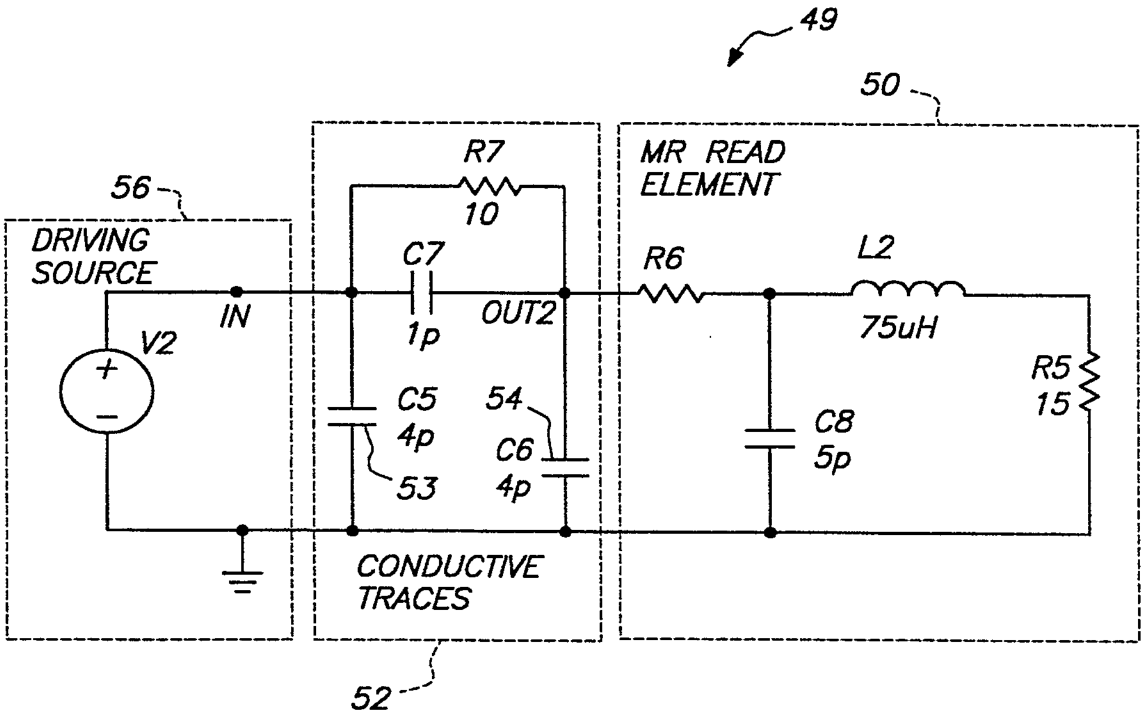


FIG. 6

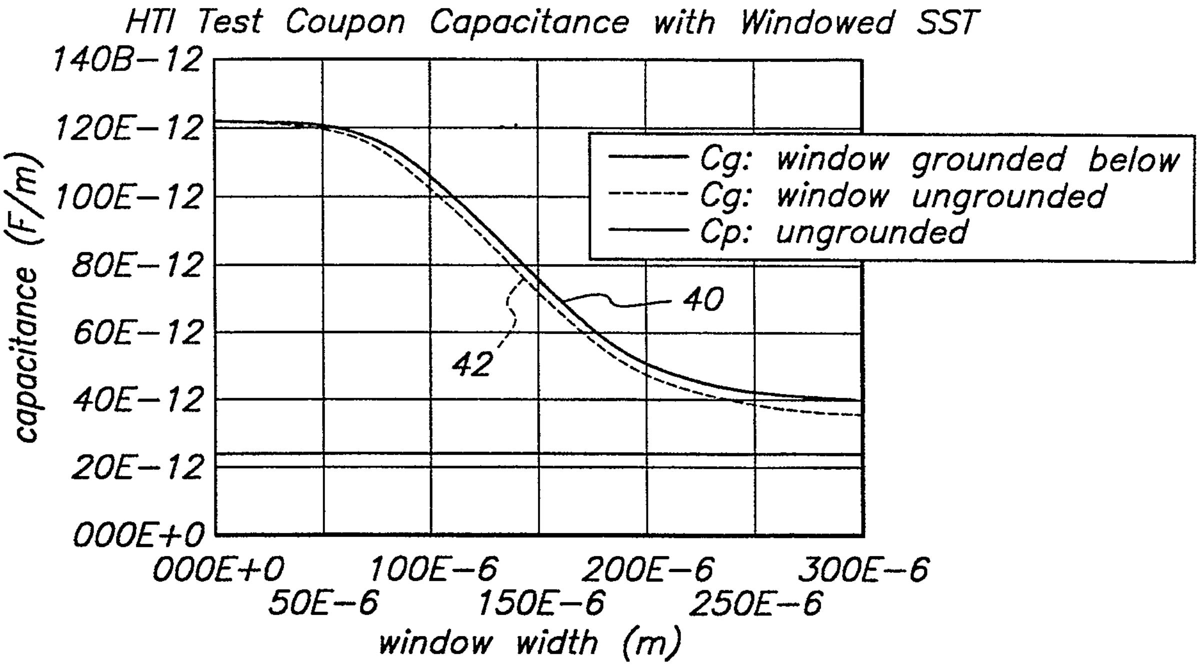


FIG. 4

FIG. 5a

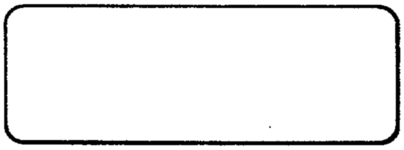
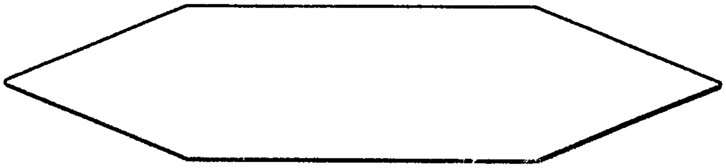


FIG. 5b

FIG. 5c

FIG. 5d



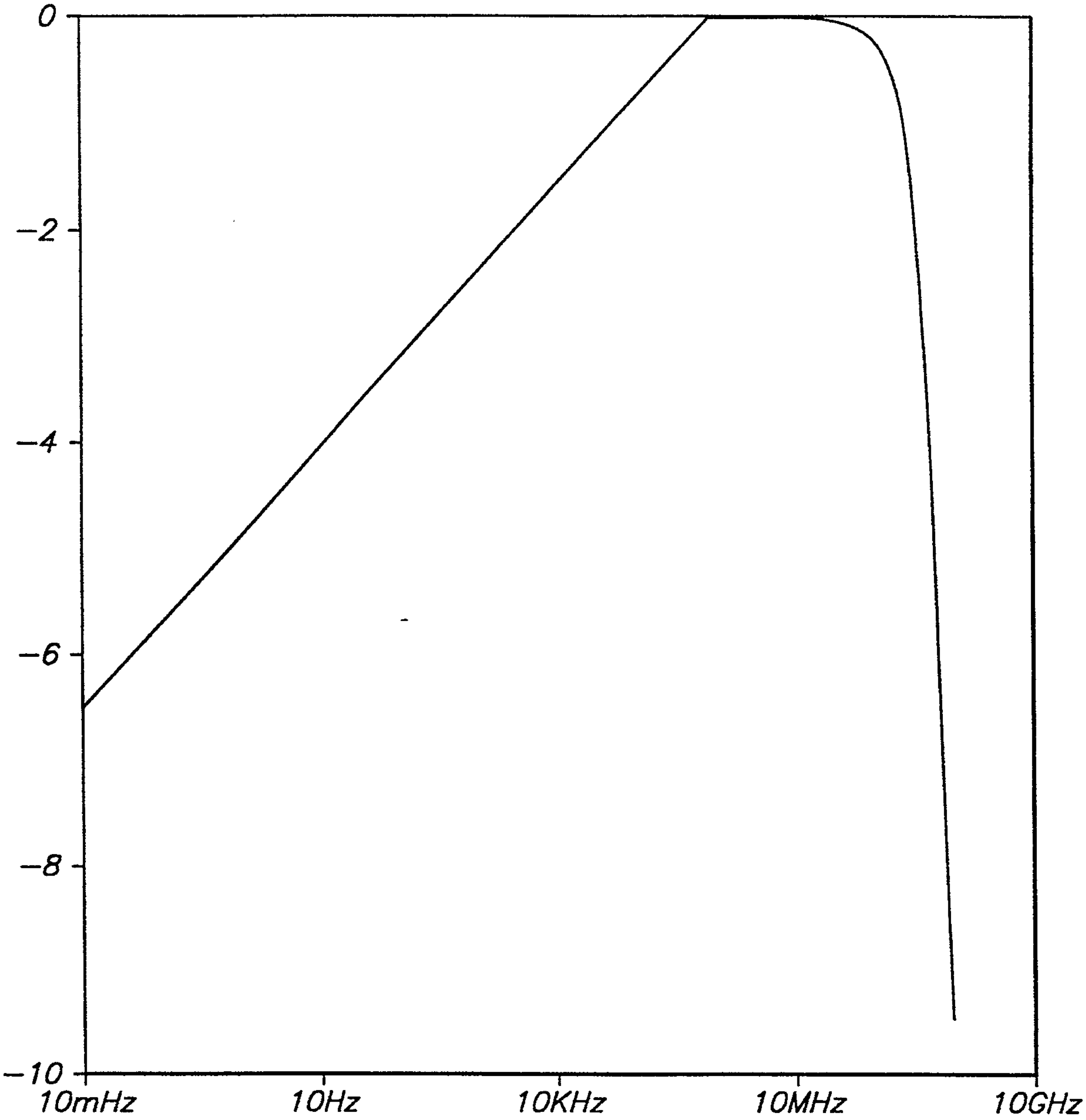


FIG. 7

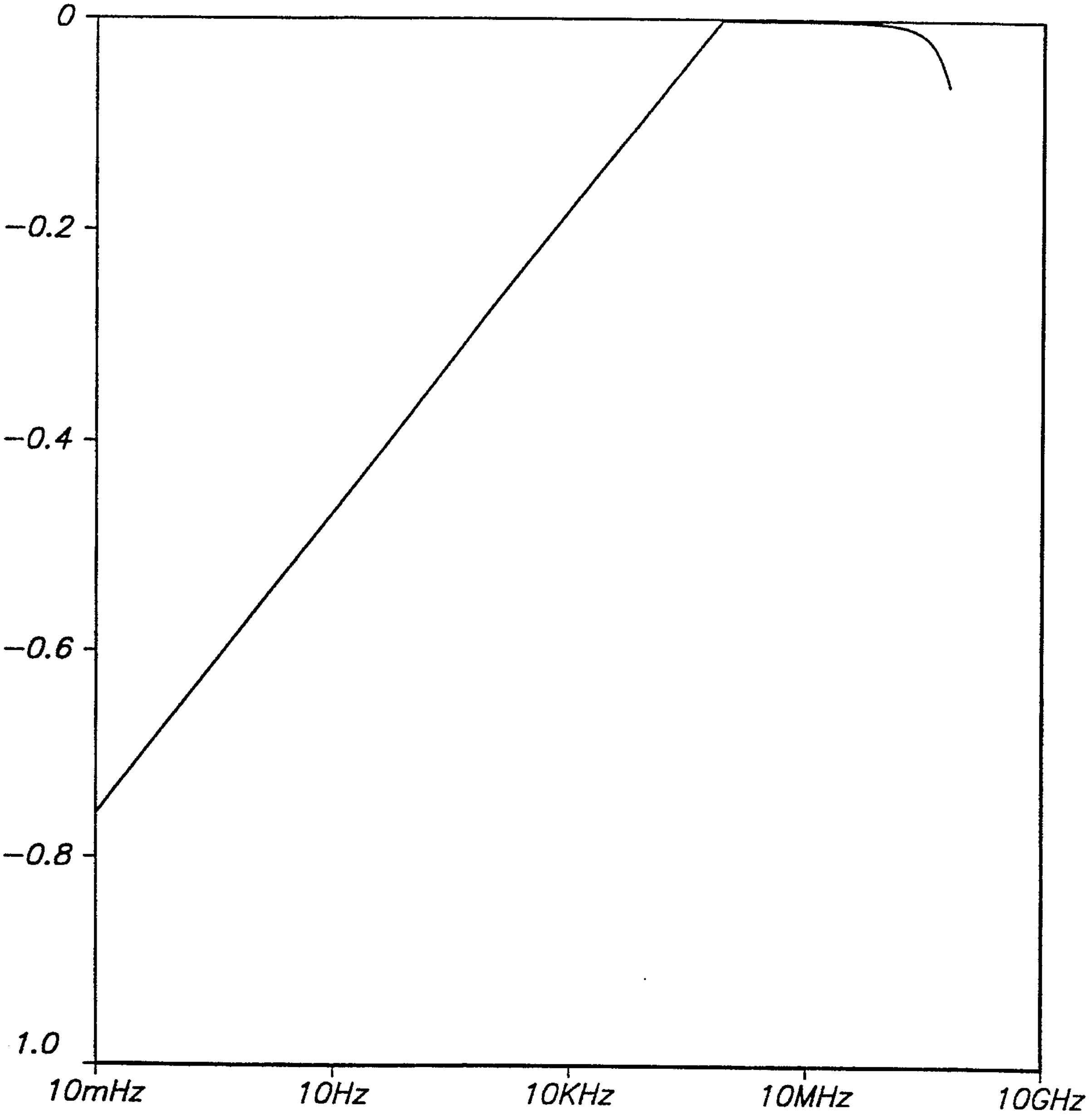


FIG. 8

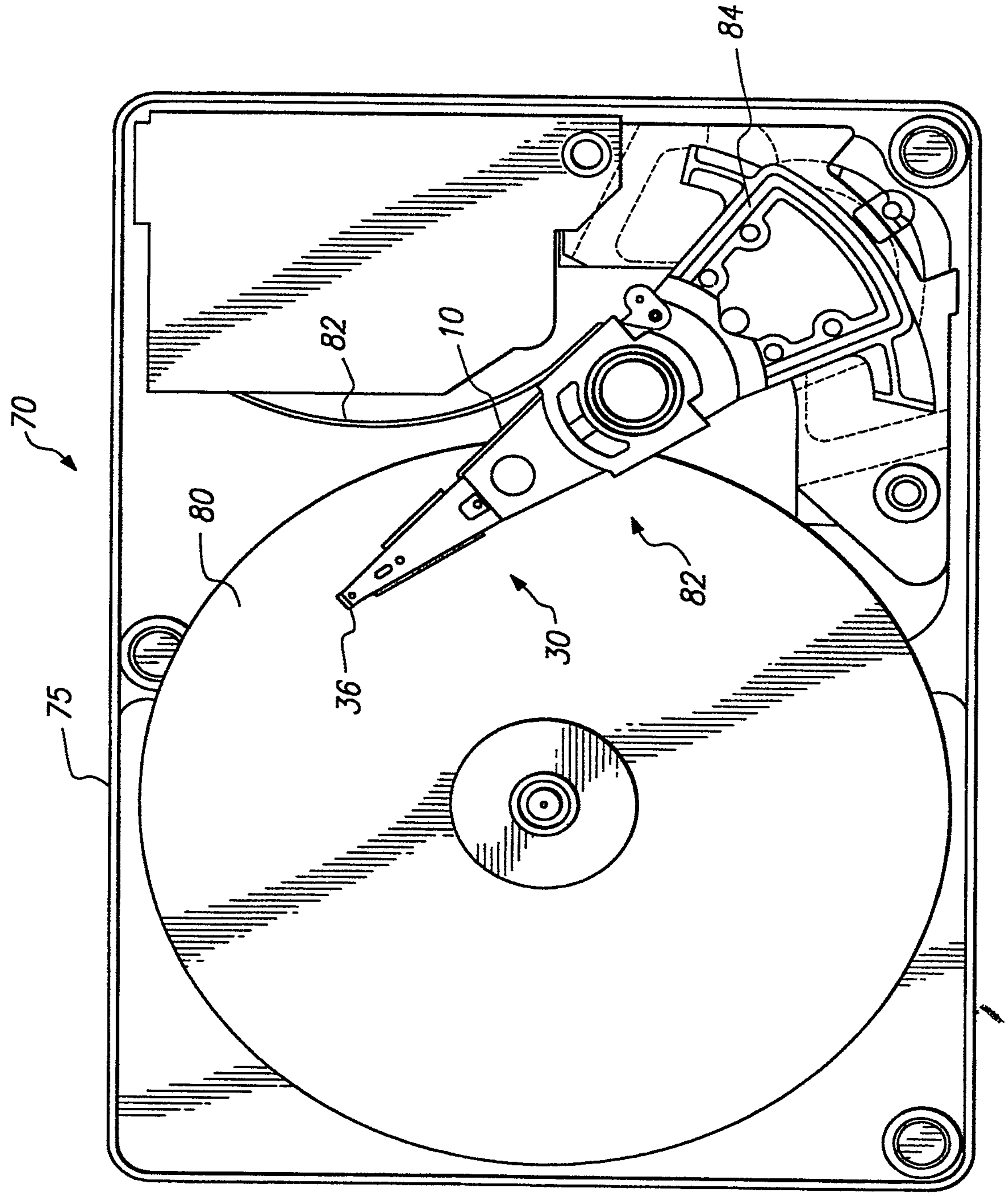
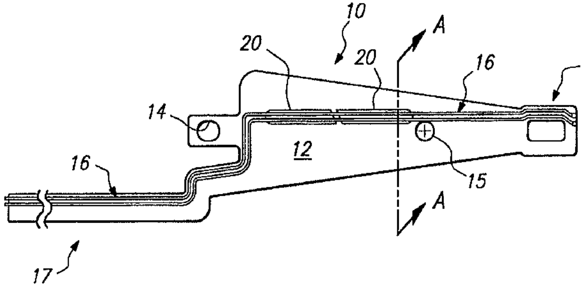


FIG. 9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