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DATA TRANSFER HEAD

DESCRIPTION

This invention relates to data transfer heads for disk drive systems, and to a method of making such heads using thin film deposition, etching and wafer-processing techniques.

Disk drives are information storage devices which utilize at least one rotatable disk with concentric data tracks containing data information, a transducer for reading the data from or writing the data to the various tracks, a slider for holding the transducer adjacent to the track in close proximity to the media, a suspension for resiliently holding the slider and the transducer over the tracks, and a positioning actuator connected to the combination for moving the transducer over the disk surface to the desired track and maintaining the transducer over the track center line during a read or a write operation. The transducer is formed on a surface of or otherwise attached to the slider which is supported in a flying mode by a cushion of air generated by the rotating disk. The suspension provides a high spring stiffness and dimensional stability between the slider and the actuator arm. The suspension is required to maintain the transducer and the slider adjacent to the data surface of the disk with as low a loading force as possible. The actuator positions the transducer over the correct track according to the data desired on a read operation or to the correct track for recording of the data during a write operation. The actuator is controlled to position the transducer over the correct track by shifting the combination generally transverse to the motion of the track.

In conventional disk drives, the transducer and the slider are formed separately from the suspension and then attached to the suspension through an operator-controlled precision attachment procedure. The parts are small and the positioning of each relative to the other must be highly accurate. The transducer must be precisely positioned relative to the track which in turn means that the suspension must be precisely positioned onto the slider. Additionally, the suspension must provide flexibility and pitch and roll motion for the slider relative to the direction of motion of the rotating disk and yet provide resistance to the yaw motion. Any error in the placement of the suspension relative to the slider results in the destruction of both pieces. Even if the suspension and the slider are

correctly positioned, the conductor leads to the transducer must then be connected to the transducer and directed along the suspension or connection to an amplifier placed adjacent to the suspension on the actuator. The conductor leads must not add to the spring stiffness of the slider while providing good electrical interconnection. The conductor leads are generally bonded by ultrasonic energy or by soldering, for example, to both the transducer output and the amplifier by an operator. Again, errors can cause destruction of the entire combination.

U.S. Patent No. 4,670,804 to Kant, et al., assigned to the assignee of the present invention, describes a slider-suspension assembly that includes flexible sheets of material for the suspension to which the conductors for the transducer are deposited and which support the slider and the transducer combination. The stainless steel suspension of the prior art is replaced by the flexible sheet onto which the conductors are deposited. In this patent, the polyimide flexible sheets are formed separately from the slider-transducer combination and then attached to each other by gluing, for instance, followed by a further connection step between the suspension and the slider.

It is known that the suspension arm can be formed from a polyimide material with the conductors to the transducer deposited directly on the polyimide suspension. U.S. Patent No. 4,789,914 to Ainslie, et al., assigned to the assignee of the present invention, discloses that contact soldering can be used to connect the suspension containing the conductors directly to a slider having the transducer deposited thereon, with the slider having conductor pads and interconnecting leads deposited onto the slider between the conductor pads and the transducer. Again the slider and transducer are separately produced from the suspension arm and then interconnected later through contact soldering as disclosed in this patent.

U.S. Patent No. 4,761,699 to Ainslie, et al., assigned to the assignee of the present invention, discloses a method for mechanically attaching a slider to a suspension by the use of reflowed solder balls. A pattern of solder contact pads is formed on the back side of the slider and a similar pattern of solder-wetable regions is formed on the suspension. The slider with the transducers deposited thereon are placed adjacent to the suspension assembly. The solder is reflowed thereby causing the solder balls on the transducer to come in contact with and flow together with the solder balls formed on the regions of the suspension. The mechanical

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attachment of the slider to the suspension is made simultaneously with the electrical connections of the transducer leads to the further electronics of the amplifier. As with the remainder of the known prior art, the slider and transducer portion of the combination are produced separately from the suspension assembly which includes interconnecting conductors.

Accordingly, the invention provides a data transfer head for a disk drive assembly comprising:

a slider having an air bearing surface;

at least one transducer on the slider and having conductor leads;

suspension means comprising layers of deposited material, the suspension means having a predetermined length, with a first end of the suspension means attached to the slider, and a second end of the suspension means for attachment to means for positioning the data transfer head; and

electrical connecting members formed in at least one of the layers of deposited material of the suspension means and extending from the second end of said suspension means to said conductor leads of the transducer.

Such a data transfer head offers an enhanced, integrated, combination transducer-slider-suspension assembly.

In a preferred embodiment, the suspension means comprises an insulation layer, a conductive circuitry layer, a dielectric layer, and a structural suspension layer. Alternatively, the suspension means may comprise a membrane suspension, including at least a conductive circuitry layer and an insulation layer.

Preferably the data transfer head further comprises an amplifier connected by said electrical connecting members to the transducer, and the slider includes two transducers formed on a side thereof adjacent said air bearing surface. It is also preferred that the suspension means has a uniform thickness profile throughout.

In one preferred embodiment there is a plurality of sliders, each supporting at least one transducer. The suspension means is typically slotted inbetween each slider, although it is possible to support all of these on a continuous structure.

The invention further provides a method for fabricating a data transfer head for a disk drive assembly, said data transfer head comprising a slider, at least one transducer on the slider, suspension means, and

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electrical connecting members, comprising the steps of:

depositing a plurality of transducers onto a wafer substrate having a thickness equal to the desired suspension length;

separating the wafer substrate into a plurality of rows, each row including one of said deposited transducers;

depositing lead conductors from each of the transducers;

etching an air bearing surface adjacent to each of the transducers; and wherein the suspension means is formed by the steps of:

depositing a layer of an electrically insulating material (40) over the deposited lead conductors;

patterning said deposited layer of insulating material to expose said deposited conductor leads;

forming electrically conductive lines extending from the conductor leads to an opposing end of suspension means;

depositing a support layer for the suspension means; and wherein the slider portion of the device is formed by the steps of:

depositing a layer of an etch protective material on the side containing the etched air bearing surface;

patterning the etch protective material to leave the etch protective material covering the desired slider size portion; and

etching the wafer substrate material not protected by the etch protective material.

Preferably the method further comprises the step of separating the suspension means support layer adjacent to each slider portion to form individual devices, each having one slider and its transducer and having layers forming the suspension means.

It is also preferred that the method further comprises the step of depositing a layer of dielectric material over the electrically conductive lines and said deposited layer of insulating material, and wherein said support layer for the suspension means is deposited over the layer of dielectric material. A preferred material for the dielectric is a polyimide.

Preferably said layer of electrically insulating material comprises a thin film layer, and said dielectric layer comprises a membrane layer.

Thus the improved integrated structure comprising a combination transducer-suspension arm-slider can be produced by providing a substrate

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material having an air bearing or contact configuration provided on one surface for flying over or contact with a media and positioning the transducer-slider combination over specific tracks on the media. An air bearing or air bearing surface refers to the surface of the slider parallel and adjacent to the disk or media surface. It includes both surfaces designed to fly above the disk, and those designed for contact recording wherein the slider contacts the disk surface during read/write operations.

A read/write transducer is deposited on the air bearing surface of the substrate and adjacent to the air bearing surface to place the transducer in position to read or write magnetic transitions onto the media. The transducer includes electrical leads which are formed into the substrate material away from the air bearing surface. An insulating layer is deposited on a second side of the substrate and is patterned to leave an area adjacent to the electrical leads with no insulation. Connection studs are deposited in the areas with no insulation for electrical connection to the electrical leads of the transducer. Then conductors are deposited onto the insulation layer and electrically connected to the connection studs and to external control circuitry. A stiffening material is then deposited onto the conductors and the insulation layer. The stiffening material is electrically insulated with respect to at least one of the conductors. The substrate material is then removed from beneath the deposited stiffening material except for the section over the slider wherein the stiffening material forms the suspension of the combination.

Preferably a combination transducer-slider-suspension is made by the process of first depositing thin film transducers or heads onto one surface of a substrate. An air bearing surface is then etched onto the one surface of the wafer adjacent to the transducer to provide a surface which places the transducer in a relationship with the magnetic media to provide the reading and/or writing of magnetic transitions onto the media. The next step is to deposit patterned insulation to permit the electrical connection to the transducer. Conductors are then deposited onto the pattern insulation to interconnect the transducer leads for external connection. The conductors are then coated with a polyimide layer. A relatively stiff, resilient layer is then deposited over the polyimide layer. The substrate is then pattern etched to remove a section of the substrate adjacent to the transducers and air bearing surface along the length of the conductor leads to form a suspension region in the substrate. Each individual slider and suspension assembly including the transducer and the interconnecting

conductors are separated from the wafer substrate by a dicing operation. The simultaneous formation of a plurality of the combination assemblies produces a unified product.

In other words, the data transfer head can be made by batch processing to produce both the transducer and the suspension by depositing the required layers onto a substrate that forms the assemblies after etching. The processes, including the formation of a media contact area or an air bearing surface, are performed prior to dicing for separation into the individual assemblies. Conductors to the transducer can be deposited onto the suspension during the batch processing. Optionally individual integrated circuit amplifiers may be deposited onto the suspension layer for each transducer before the separation process.

The method for making the combined suspension-slider-transducer assembly includes the step of preparing the substrate for deposition of different layers onto the substrate. In a typical process, at least one thin film transducer is then deposited onto a first surface of the prepared substrate. Rails or pads are then etched into the substrate to define an air bearing slider or contact-recording pads on the first surface of the substrate in a position for producing a flying or contact relationship with the magnetic media to position each transducer in its transducing relationship to the media. Conductive circuitry is then patterned onto a second surface of the prepared substrate for each transducer. The patterned circuitry is then overlaid on the second surface of the substrate with a resilient, yet stiffening material. The first surface of the substrate is then etched adjacent to the etched air bearing surface or contact recording pad of each transducer to remove a section of the substrate. The section removed is adjacent to the air bearing surface and transducer to the patterned conductive circuitry and the overlaid resilient stiffening material. The etched section produces the suspension section of the combination. The substrate is then partitioned into separate assemblies, each including at least one transducer, one associated air bearing surface, one conductive circuitry, and one suspension section.

Such a process permits the batch processing of a plurality of the combination assemblies from a single wafer substrate. Multitrack assemblies having multiple transducers can be formed using the combination transducer-slider-suspension process by cutting the wafer such that a row of transducers with their sliders are suspended from a single suspension

assembly. The single membrane suspension can include the leads conducting the signals to and from each of the transducers. The suspension positions the row of transducers in correct relationship to a plurality of the tracks on a disk media surface.

This batch fabrication provides a multitrack assembly wherein a plurality of transducer-slider assemblies are suspended from a single membrane suspension. In a single membrane suspension system, the row of transducers can be separated into individual transducer-slider configurations such that each transducer and its associated slider individually flies over the media in the transducing relationship while still being suspended over a plurality of tracks by the single membrane suspension. Thus the individual transducer-slider portions can be separated while leaving the suspension as a single piece of membrane to position a plurality of the transducer-slider configurations for multitrack recording and reading. This provides a multitransducer assembly for use in disk drives by the process of forming individual transducer-slider portions suspended by a single membrane suspension, all formed by batch processing on a wafer substrate.

Preferred embodiments of the invention will now be described in more detail by way of example, with reference to the following drawings:

FIGS 1A and 1B are perspective views of a data transfer head attached to an actuator for positioning over a disk surface;

FIG 2 is an enlarged perspective view of a data transfer head of the type shown in FIG 1A;

FIG 3 is a enlarged perspective view of a data transfer head of the type shown in FIG 1B having a plurality of transducer-sliders suspended by a single membrane suspension;

FIG 4 is a perspective view of a possible relationship between the transducer-slider assembly and the single membrane suspension of FIG 3;

FIG 5 is a perspective view of an alternative possible relationship between the transducer-slider assembly and the single membrane system of FIG 3;

FIGS 6A-6J illustrate a fabrication process for a data transfer head as shown in FIGS 2 or 3.

The present invention relates generally to large multiple disk drives but will also find application with respect to the single disk drives used generally for personal computers. In Fig. 1A is illustrated a linear

actuator 10 and a segment of an associated disk 12 of a data recording disk file. The linear actuator 10 includes a voice coil motor, which is a coil 14 movable within the magnetic field of a fixed permanent magnet assembly (not shown) having a core within coil 14 and an outer structure supported by housing 16. An actuator arm 20 is attached to the movable coil 14. Attached to the other end of the actuator arm 20 generally is a plurality of arms 21, one shown, each of which support a combination transducer-slider-suspension assembly 22 produced according to the procedure set forth herein. The assembly 22 includes a transducer-slider section 24 and a suspension section 26. The suspension section 26 supports the transducer-slider 24 above the surface of the disk 12 on a bearing or cushion of air generated by the rotation of the disk 12 or can support the transducer-slider 24 in sliding contact with the disk media. The air bearing or air bearing surface refers to the surface of the slider parallel and adjacent to the disk or media surface. It includes both configurations where the slider is designed to fly above the disk, and where the slider is designed to be in sliding contact with the recording media, the disk 12, during operation.

The actuator arm 20 includes the plurality of the arms 21 with each arm 21 supporting the combination assembly 22, each combination assembly 22 associated with each surface of the disk 12. Therefore, disk 12 also has a combination assembly 22 mounted to an arm 21 of the actuator arm 20 on the underside of the disk 12. Further, other combination assemblies are associated with the top and bottom sides of other disks, the transducer access of which is controlled by the actuator 10.

The suspension section 26 of the combination transducer-slider-suspension assembly 22 provides a load to the transducer-slider assembly 24 which is generally perpendicular to the surface of the disk 12. This perpendicular load maintains the transducer-slider assembly 24 in contact with the data surface of the disk 12 when the disk 12 is not rotating. During rotation of the disk 12, for sliders designed to fly above the media during operation, the air bearing generated between the transducer-slider assembly 24 and the disk 12 opposes the perpendicular load applied to the transducer-slider assembly 24 by the suspension section 26.

During operation, the transducer-slider assembly 24 is moved to the desired track of the concentric data tracks on the data surface of the disk 12 by means of the coil 14, which moves within the magnetic field of the

magnet assembly. Because it is desired to provide rapid access of the transducer-slider assembly 24 from one track to another track for read or write operations, it is necessary that the transducer of the assembly 24 be properly positioned over the desired track and reach that track in a minimum amount of time. It should be noted that while the actuator 10 illustrated in FIG 1A is a linear actuator which moves the combination assembly 22 in a precisely radial direction transverse to the tracks, other types of conventional disk files utilize a rotary actuator such as is shown in U.S. Patent No. 3,849,800, assigned to the assignee of the present invention. The rotary actuator moves the combination assembly of the present invention in an arcuate path which is only generally in the radial direction and which may be a substitute for the linear actuator 10.

The combination assembly 22 must provide radial stiffness, and have substantial flexibility in the pitch and roll directions as it rides on the air bearing above the data surface of the disk 12. If desired, an integrated circuit assembly 28, such as electronic signal processing circuitry, for example, may also be produced on the suspension section 26 of the combination assembly 22. The integrated circuit amplifier is shown symbolically as reference numeral 28 and will be described later. Fig. 1B shows a further embodiment for use in a multitrack configuration. Similar reference numerals are given to identify corresponding parts in the different drawings.

Referring now to Fig. 1B, in lieu of the combination transducer-slider-suspension assembly 26 of Fig. 1A, a multitrack combination assembly 30 is shown attached to the actuator arm 20 and positioned to access a plurality of concentric tracks on the disk 12. In Fig. 1B, the arm 21 of the actuator arm 20 extends further across the radial direction of disk 12. The multitrack combination assembly 30 includes a multitrack suspension section 32 and a multitrack transducer-slider assembly shown generally at reference numeral 34. The multitrack assembly 34 includes a plurality of transducer-slider assemblies 24 for this particular embodiment. As will be described herein below with reference to Fig. 5, the multitrack transducer-slider assembly 34 may comprise a single row of sliders with a plurality of transducers. An integrated circuit assembly 35 may be placed or formed onto the multitrack combination assembly 32 to provide read and write capability for all of the transducers of the assemblies 24.

During the operation of the disk file of Fig. 1B, the combination

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assembly 30 need not move as far radially across the disk, since the plurality of transducer-slider assemblies 24 cover a significant portion of the total number of tracks on the disk surface of the disk 12 at a given position over the disk 12. The number of transducer-slider assemblies could be any number from two to the total number of tracks on the disk 12. The actuator 10 thereby may only be required to move half of the distance of a single transducer-slider assembly, for example, as shown in Fig. 1A up to merely actuating the combination assembly 30 from off-track to on-track positioning. Further discussion of the multitrack combination assembly 30 of Fig. 1B is provided below with reference to Figs. 3, 4 and 5. An enlarged configuration of the transducer-slider assembly 24 of Figs. 1A and 1B is shown in Fig. 2.

Referring now to Fig. 2, the one side of the combination assembly 22 is shown positioned over the disk 12. The rotation of the disk 12 is shown by the arrow 18 to be in the direction where the transducers 25 are located either on the trailing edge of the transducer-slider assembly 24, a so called vertical head, or are located on the air bearing surface which would constitute a horizontal head. The suspension section 26 is deposited over an entire section of a wafer as will be described below. A portion of the wafer becomes the slider 23 of the transducer-slider assembly 24. Two transducers 25 are shown on the slider 23, but it is possible that only one is used for operation with the track of the disk 12. Two or more transducers 25 are deposited during fabrication in order to increase the yield since only one transducer 25 need be in operation to produce a workable combination assembly 22.

The suspension section 26 includes an insulation layer 40, a conductive circuitry layer 42, a dielectric layer 44, and a structural suspension layer 46 which could be a plated nickel-iron alloy, or a sputtered beryllium copper layer or a sputtered stainless steel layer. Conductor leads 43 interconnect the transducer 25 to the conductor circuitry layer 42. Electrical connection pads 48 are provided to interconnect with the amplifier located adjacent thereto or could be the position in which an integrated circuit amplifier, such as integrated circuit amplifier 28, is deposited together with the remaining layers as will be discussed below with reference to Fig. 6. The insulation layer 40 provides electrical insulation between the conductor layer 42 and the possibly conductive substrate of the slider 23. The dielectric layer 44, such as a polyimide material, for example, provides insulation for the

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conductive circuit layer 42 from the metal structural suspension layer 46. The dielectric layer 44 together with the structural suspension layer 46 provides the suspension support which holds the transducer-slider assembly 24 in position over the desired track of disk 12. As stated previously, the suspension section 26 must provide a spring action to hold the transducer-slider section 24 in place over the disk 12 while allowing the pitch and roll motion to enable the transducer-slider section 24 to follow the surface of the disk 12 yet preventing or minimizing the yaw motion which would possibly place the transducer 25 out of the required transverse position with respect to the tracks.

A further embodiment is shown in Fig. 3. In Fig. 3 a combination transducer-slider-suspension 50 is shown attached to the arm 21 of the actuator arm 20 (see Fig. 1A). The combination assembly 50 includes a membrane suspension section 52 supporting a plurality of transducer-slider sections 54 positioned adjacent to the surface of the disk 12. The rotation of the disk 12 is in the direction shown by the arrow 18. Thus the transducer-slider section 54 is placed at the trailing edge of the suspension section 52. An integrated circuit 56 is shown as part of the combination assembly 50 and can be deposited together with the other layers as will be discussed further for Figs. 6A-6J. Alternatively, the integrated circuit 56 can be mounted onto the membrane combination assembly in the well known manner. Electrical conductor pads 58 interconnect the conductive circuitry (not shown) of the combination assembly to the rest of the disk drive. The conductive circuitry interconnects the transducer-slider section 54 with the integrated circuit 56 and integrated circuit 56 in turn directs its output to the electrical conductive pads 58. The conductor circuitry for the transducer-slider section are placed internal to the combination assembly 50 in a manner similar to that shown for the single combination assembly 22 of Fig. 2. The internal lines of the circuitry are not shown. Further details of the transducer-slider section 54 is shown in Fig. 4.

Referring to Fig. 4, the transducer-slider section 54 includes a slider 60 and one or more transducers 62. Conductors 64 interconnect the transducers 62 to a conductor circuitry 66 which extends along the suspension section 52 of the combination assembly 50. The transducer-slider section 54 comprise a plurality of individual sliders 60 and transducers 62. The membrane combination assembly 50 may be produced in a similar manner to the combination assembly 22 of Fig. 2 and essentially can

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comprise the same layers for the suspension section. Thus, the suspension section 52 of the membrane combination assembly 50 of Fig. 4 can comprise the same layers as that set forth for the suspension section 26 of the combination assembly 22. A further embodiment of the membrane combination assembly 50 of Fig. 3 is shown in Fig. 5.

In Fig. 5, the membrane combination assembly 50 is similar in construction as that shown for Figs. 3 and 4 except that a transducer-slider section 70 comprises a plurality of transducers 72 deposited onto a row section from a wafer substrate. The individual slider sections are not separated but are interconnecting thus dispensing with the dicing operation that separates the individual sliders. An air bearing surface can be formed into the row in the same manner as for the individual sliders. A more complete description of the operation and manufacture will be described later. The construction of the membrane combination assembly 50 of Fig. 5 is in the same manner as that discussed for the membrane combination assembly 50 of Fig. 3 and Fig. 4 and can comprise the same layers. The membrane combination assembly 50 suspends the transducer-slider row 70 over the surface of the disk 12 at the trailing edge of the suspension section 52. The disk 12 rotates in the direction of the arrow 18 in the same manner as discussed previously for Figs. 3 and 4.

A step by step method of making the combination assemblies shown in Figs. 1-5 is described in Figs. 6A-6J for the instance where the transducer is a horizontal head. In Fig. 6A, a wafer substrate 100 is shown having a plurality of the combination assemblies 22, for instance, deposited thereon in a plurality of rows 102 and a plurality of columns 104. According to the principles of the present invention, the thickness of the wafer 100 is chosen to be approximately equal to the desired length of the finished suspension slider combination. The wafer 100 is shown with a plurality of the combination assemblies, it being known that more or less than the number of rows 102 and columns 104 as shown can be produced. The number is dependent on the size of the wafer and on the size of the individual combination assemblies. Fig. 6A shows the wafer layout of the combination assemblies.

Fig. 6B shows a cross-section of one row 102 with two columns 104. Thus in Fig. 6B can be shown two combination assemblies 106 and 108 taken from Fig. 6A. A step in the process shown in Fig. 6B, a plurality of transducers 110 are produced on one side 112 of the wafer 100. Through

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conductors 114 are formed through the wafer 100 to a second surface 116 of the wafer 100. The through conductors can be formed by a reactive ion etch process as disclosed in U.S. Patent No. 4,601,782, assigned to the assignee of the present invention and then plated with copper. The horizontal head transducers 110 can be produced on the first surface 112 of the wafer 100 in the manner as shown in U.S. Patent No. 4,698,708 which shows the deposition of what is referred to as an integrated circuit transducer. Further, the transducer 110 can be a standard one-turn construction which again would comprise the deposition of layers onto the first surface 112 of the wafer 100. The next step, as shown in Fig. 6C, is the etching of the air bearing surface pocket 120 into each of the columns 106 and 108 and adjacent to the transducer 110. The air bearing surface pockets 120 can be formed by reactive ion or laser induced etching, or by mechanical tools to carve out the section. In the embodiment shown in the figures, a two-rail slider is assumed. The air bearing surface pocket 120 could be a negative pressure or self loading slider such as is disclosed in U.S. Patent No. 3,855,625, assigned to the same assignee as this application. Reactive ion etching to form air bearing surface pockets is well known in the art as described in U.S. Patent No. 4,375,390, assigned to the assignee of the present invention.

Referring now to Fig. 6D, the next step in the process is to deposit and pattern an insulation layer onto the second surface 116 of the wafer. The insulation layer 122 includes openings 124 to leave the through conductors 114 exposed at the second surface 116 of the wafer 100. The insulation layer 122 is patterned over the entire section of the combination assembly to permit interconnection of all of the transducers 110 to the conductive circuitry shown deposited in Fig. 6E.

In Fig. 6E, a layer of copper 126 is deposited to form the conductive patterns along the length of the suspension section. Copper studs 128 are also deposited to interconnect the leads 114 of the transducer 110 to the copper conductors 126. The material forming the conductor circuitry 126 can be formed by plating copper, for instance, or by sputtering gold or other well known electrically conductive materials to form the interconnections between the transducer leads 114 and the output at the end of the suspension section.

In Fig. 6F, a dielectric layer of a polyimide material 130, for instance, is then placed over the insulation layer 122 and the conductor

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circuitry 126. The polyimide layer 130 insulates the conductor circuitry 126 from the remaining suspension layers. The polyimide layer 130 can provide stiffness to the suspension section as discussed in the aforementioned U.S. Patent 4,670,804 or merely an insulation factor for the conductive circuitry 126. Thus the polyimide dielectric layer 130 could be formed by spin coating the material across the surface of the wafer or the polyimide layer 130 could be preformed and adhered over the other layers to add stiffness to the suspension section, if desired. Other types of insulating dielectrics could be used instead of the polyimide layer. The polyimide material is preferred because of its dielectric and inert properties and because of the stiffness which can be obtained from the material.

Fig. 6G shows the next step in the process wherein a structural suspension layer 132 is deposited over the polyimide layer 130. The structural suspension layer 132 can be produced by placing a conductive seed layer (not shown) by sputtering over the polyimide layer 130 and then plating a nickel-iron alloy, for instance, onto the seed layer. Alternatively, the structural suspension layer 132 could be formed by sputtering a beryllium copper or stainless steel layer, for example, over the entire surface of the wafer. The structural suspension layer 132 provides additional suspension support to the polyimide layer 130 or can provide the entire structural suspension support for suspending the slider-transducer assembly as shown in Fig. 1A.

The next step in the batch process for forming the combination assembly is shown in Fig. 6H wherein the wafer area 134 beneath a suspension section 136 is etched away to produce the individual slider assemblies 138 and the suspension section 136 having a desired thickness profile to provide the desired suspension characteristics. A protective coating 140 is shown placed over the transducer-slider section 138 to protect that section from the etching process, for instance when reactive ion etching is used to etch away the wafer section 134. The protective coating 140 could be a photoresist as is well known in the prior art. The etching away of the wafer substrate at the section 134 is well known in the art as shown in U.S. Patent 4,624,048, assigned to the assignee of the present invention. In the step shown in Fig. 6H, the individual combination assemblies are defined to produce the combination assemblies 106 and 108. Each combination assembly includes the suspension section 136, the slider 138, and a transducer 110. The protective coating 140 is

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removed after the etching process utilizing a well known process. The individual combination assemblies 106 and 108 are separated as shown in Fig. 6I by dicing wheels 142, for instance, to separate the rows and columns as shown in the wafer 100 of Fig. 6A. The individual combination assemblies 22 of Fig. 2, for instance, can be produced exactly as shown in the steps of Figs. 6A-6I. Likewise, the membrane combination assembly 50 of Figs. 3 and 4 can be produced in the same fashion. The only difference is that the suspension section 52 (see Fig. 3) will cover an entire column 104 and will thereby include a plurality of the slider-suspension assemblies 138. The wafer will be diced apart to create individual columns while the wafer will not be split into individual rows and columns to produce the individual items as previously discussed. The conductive patterns will be likewise individually produced in order, again, to interconnect the transducers to the external connection or the integrated circuit 56 as shown in Fig. 3. One entire row 102 as shown in Fig. 6A can produce the embodiment as shown in Fig. 5 in that the transducers 72 and the slider row 70 can be produced in the same manner as discussed in Figs. 6A-6I with the production only of one row on a wafer, rather than a plurality of rows and columns.

In Fig. 6J, an integrated circuit driver 144 can be deposited onto each suspension section 136, either before or after the etching process of Fig. 6H. The layers and procedures required are well known in the prior art to produce the electronics to drive the transducer 110. If desired, the integrated circuit 144 could be separately formed and then adhered by soldering, for instance, to each suspension section 136. The integrated circuit 144 of Fig. 6J is essentially the integrated circuit assembly 28 as shown in Fig. 1A. Conductor 146 can interconnect the driver circuit 144 to the conductors 126. The location and interconnection of the integrated circuit 144 as described herein is only illustrative, for specific slider designs and materials, other locations and interconnection methods may be utilized. For example, if the slider 138, i.e., the wafer 100, is of silicon or other semiconductor material, the integrated circuit may be fabricated directly on the back or opposite side of the air bearing surface prior to deposition of the insulation layer 122 as shown in Fig. 6D.

Variations on the above described data transfer head and method for fabrication thereof will be recognised by the skilled person. For instance, a transducer may be produced onto the wafer such as is described in U.S. Patent No. 4,190,872, assigned to the assignee of the present invention.

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The wafer may be made of material such as is the subject matter of U.S. Patent No. 4,251,841, entitled "Magnetic Head Slider Assembly" and assigned to the assignee of the present invention. Other relevant teachings include US 4,190,872, issued on February 26, 1980 concerning a thin film inductive transducer, US 3,975,772 issued on August 17, 1976 concerning a thin film magnetoresistive head, US 4,624,048, issued on November 25, 1986 concerning a process for making magnetic head sliders, and US 4,251,841, issued on February 17, 1981 concerning a wafer-substrate material, all of which are useful in conjunction with the present invention. The suspension section described above could be a dual layer of a polyimide material and a metal layer deposited thereon to provide sufficient resiliency and stiffness as required by a suspension assembly. It should be noted that the suspension assembly could be produced in a single layer if the correct thickness and stiffness were obtained in the single layer. It is also well understood that many electrically conductive materials are available to form the conductive circuitry and the transducer leads. Copper or gold are the preferred materials but many others are available as is well known in the art. Whilst the discussion has focussed on air bearing surface sliders, the present invention is also applicable to contact recording sliders in which the air bearing surface of the slider is any suitable surface or pad that can be maintained in sliding contact with the media during operation over the expected lifetime of the head-disk assembly. Further, while horizontal heads are shown in the preferred embodiments, the present invention is also applicable to vertical heads in which the slider-suspension combination is produced by the disclosed process without the transducer and the vertical style transducer is separately produced and bonded to the slider-suspension combination. It is also evident that the linear actuator shown in the examples could easily be a rotary type actuator instead.

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CLAIMS

1. A data transfer head (22) for a disk drive assembly comprising:

a slider (24) having an air bearing surface;

at least one transducer (25) on the slider and having conductor leads (43);

suspension means (26) comprising layers of deposited material, the suspension means having a predetermined length, with a first end of the suspension means attached to the slider, and a second end of the suspension means for attachment to means (10) for positioning the data transfer head; and

electrical connecting members (42) formed in at least one of the layers of deposited material of the suspension means and extending from the second end of said suspension means to said conductor leads of the transducer.

2. A data transfer head as in Claim 1 wherein the suspension means comprises an insulation layer (40), a conductive circuitry layer (42), a dielectric layer (44), and a structural suspension layer (46).

3. A data transfer head as in Claim 1, wherein the suspension means is a membrane suspension and includes a conductive circuitry layer and an insulation layer.

4. A data transfer head as in any preceding claim, further comprising an amplifier (28) connected by said electrical connecting members to the transducer.

5. A data transfer head as in any preceding claim, wherein the slider includes two transducers (25, 25) formed on a side thereof adjacent said air bearing surface.

6. A data transfer head as in any preceding claim, wherein the suspension means has a uniform thickness profile throughout.

7. A data transfer head as in any preceding claim, comprising a plurality of sliders (24), each supporting at least one transducer.

8. A data transfer head as in Claim 7, wherein the suspension means is slotted inbetween each slider.

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9. A disk drive assembly including rotatable data storage means (12), a data transfer head (22) according to any preceding claim, and means (10) for positioning the data transfer head with respect to the data storage means.

10. A method for fabricating a data transfer head (22) for a disk drive assembly, said data transfer head comprising a slider (24), at least one transducer (25) on the slider, suspension means (26), and electrical connecting members (42), comprising the steps of:

depositing a plurality of transducers onto a wafer substrate (100) having a thickness equal to the desired suspension length;

separating the wafer substrate into a plurality of rows, each row including one of said deposited transducers;

depositing lead conductors (43) from each of the transducers;

etching an air bearing surface adjacent to each of the transducers; and wherein the suspension means is formed by the steps of:

depositing a layer of an electrically insulating material (40) over the deposited lead conductors;

patterning said deposited layer of insulating material to expose said deposited conductor leads;

forming electrically conductive lines (42) extending from the conductor leads to an opposing end of suspension means;

depositing a support layer (26) for the suspension means; and wherein the slider portion of the device is formed by the steps of:

depositing a layer of an etch protective material on the side containing the etched air bearing surface;

patterning the etch protective material to leave the etch protective material covering the desired slider size portion; and

etching the wafer substrate material not protected by the etch protective material.

11. A method as defined in Claim 10 further comprising the step of separating the suspension means support layer adjacent to each slider portion to form individual devices, each having one slider and its transducer and having layers forming the suspension means.

12. A method as claimed in claim 10 or 11, further comprising the step of depositing a layer of dielectric material over the electrically conductive lines and said deposited layer of insulating material, and wherein said support layer for the suspension means is deposited over the layer of

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dielectric material.

13. A method as defined in Claim 12 wherein said dielectric material comprises a polyimide material.

14. A method as claimed in any of claims 11 to 13, wherein said layer of electrically insulating material comprises a thin film layer, and said dielectric layer comprises a membrane layer.

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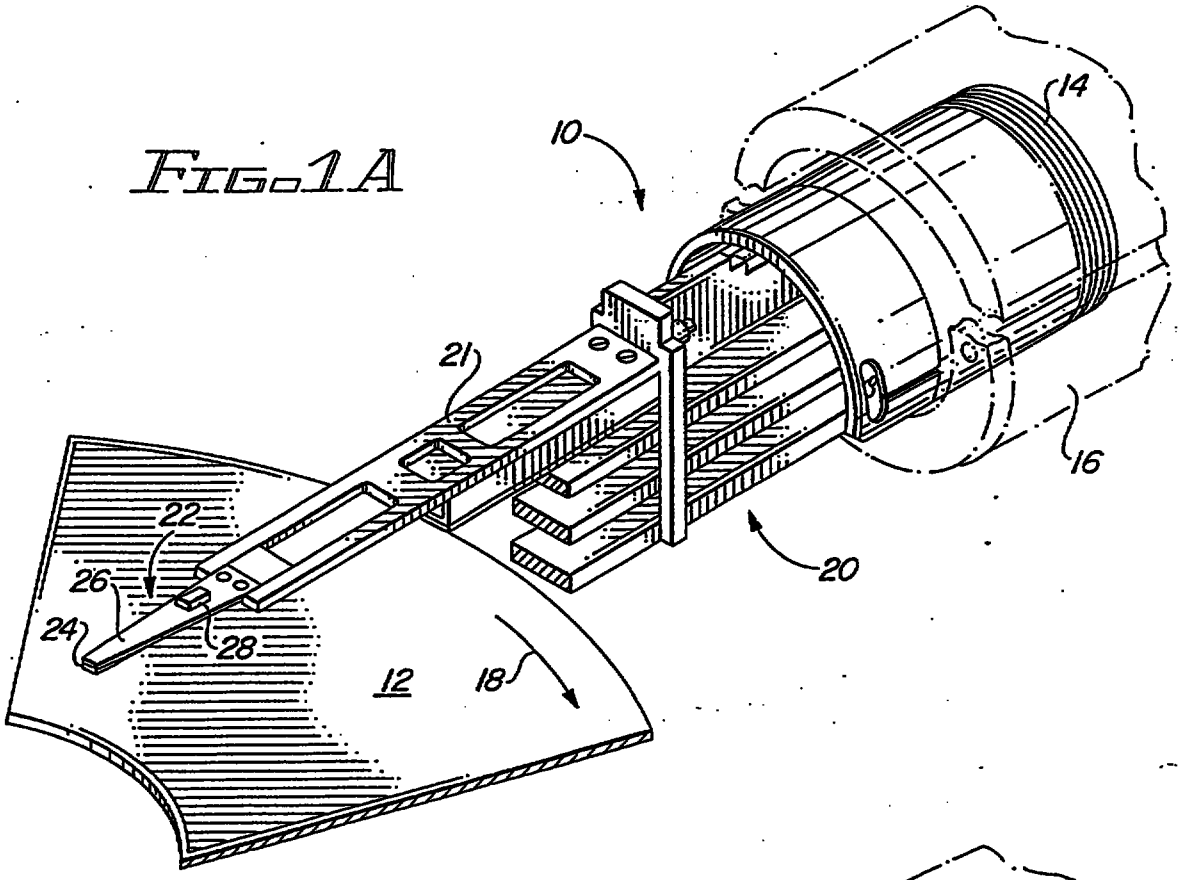
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DATA TRANSFER HEAD

ABSTRACT

A data transfer head 22 comprises a combination assembly formed from an integrated suspension 26, slider 24 and transducer 25. The combination transducer-slider-suspension assembly is batch produced by forming a plurality of the combination assemblies onto a single wafer 100. The wafer is then diced to separate the assemblies into individual sections 106, 108. The transducers are deposited onto the wafer and the air bearing surface formed. Conductors 42 to interconnect each transducer with the external circuits are insulated from the wafer and deposited along a path which will form the suspension. A spring-like resilient layer is then deposited over and electrically insulated from the conductors. The wafer is then pattern etched to remove a portion of the wafer backside to form the suspension. Integrated circuit amplifiers 56 can be deposited at the free end of the conductors prior to separation of individual assemblies.

FIG. 1A



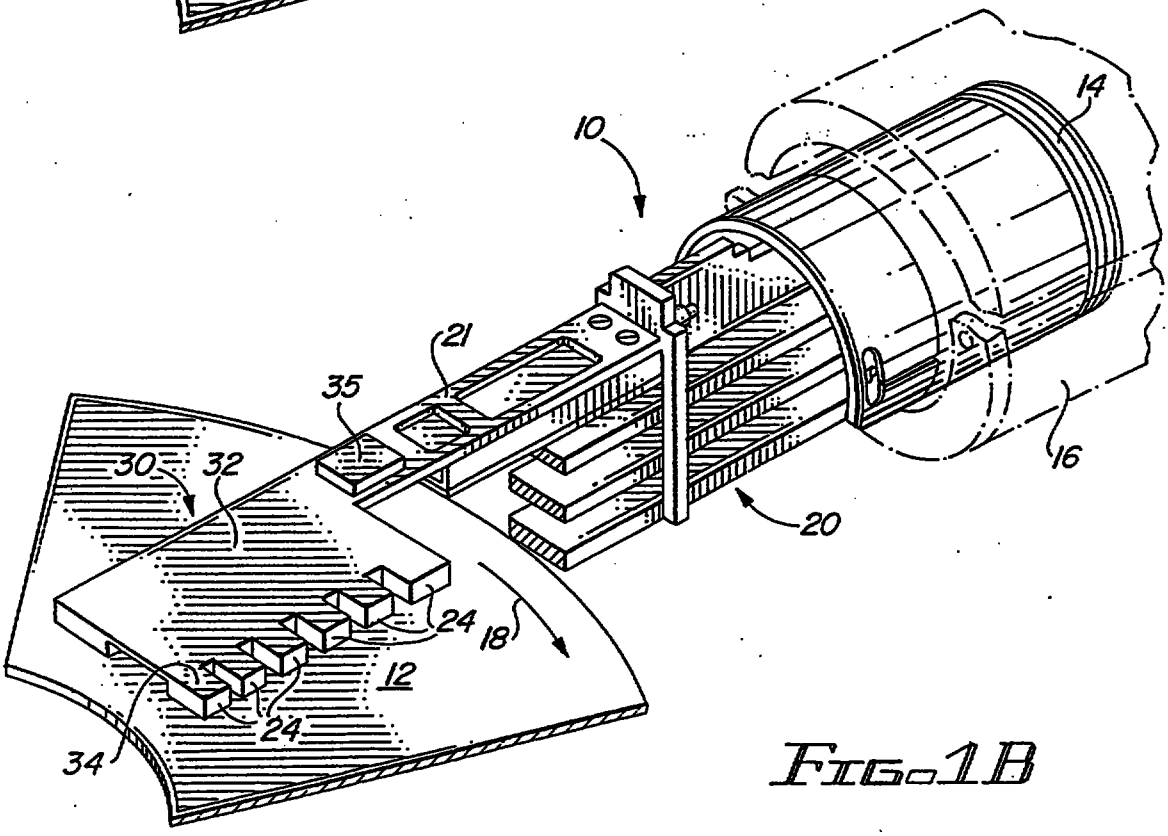
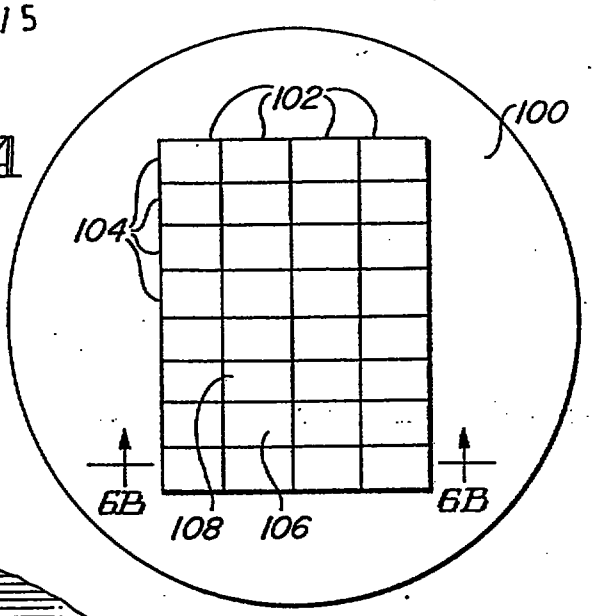


FIG. 1B

FIG-6A



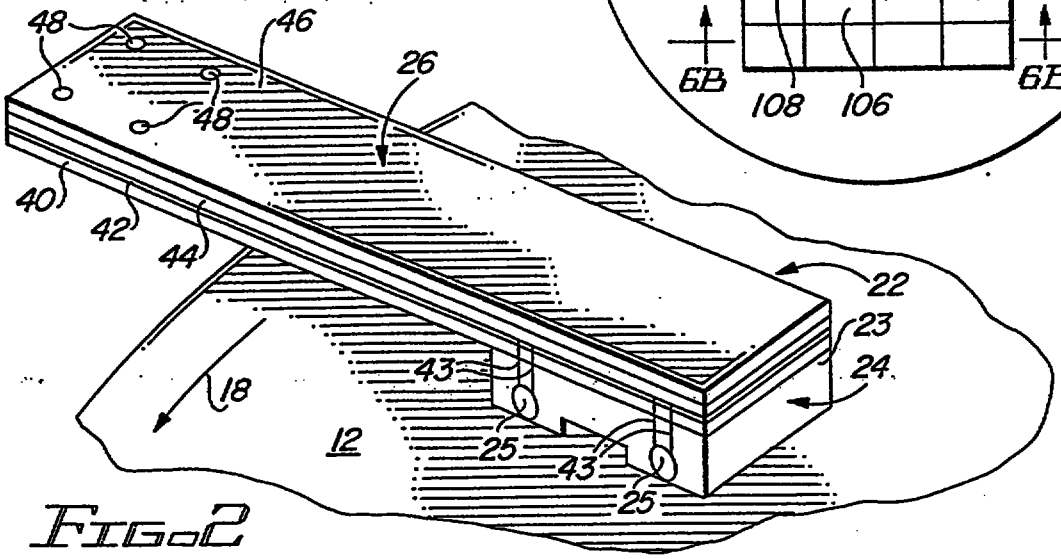


FIG-2

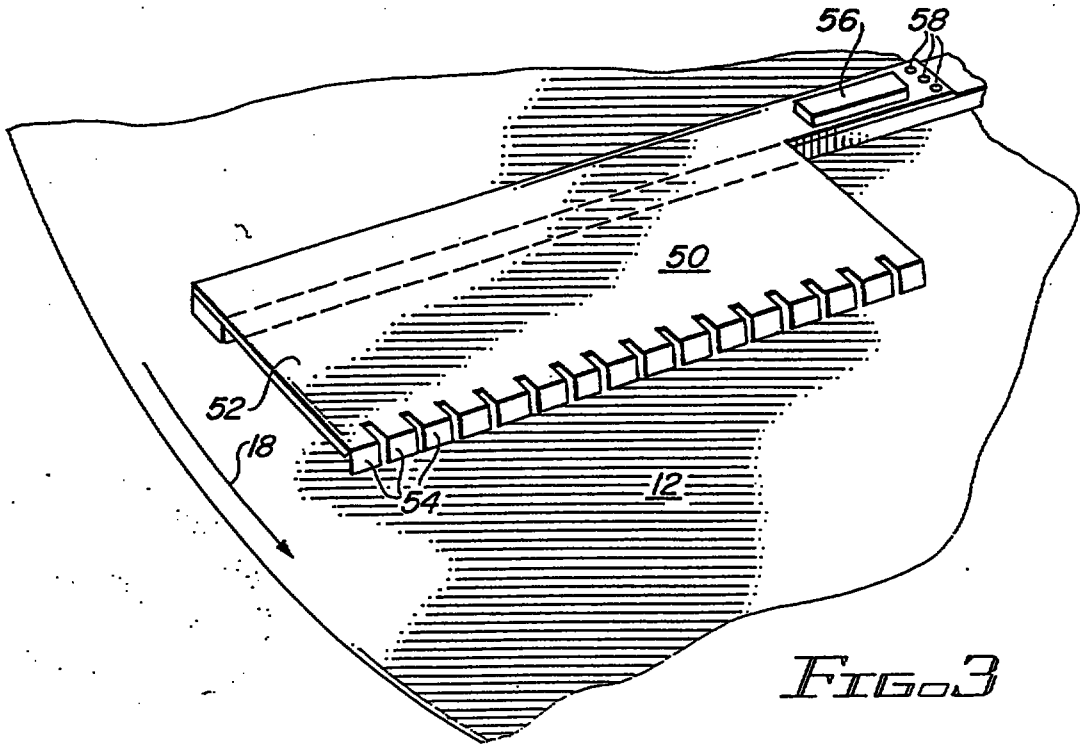


FIG-3

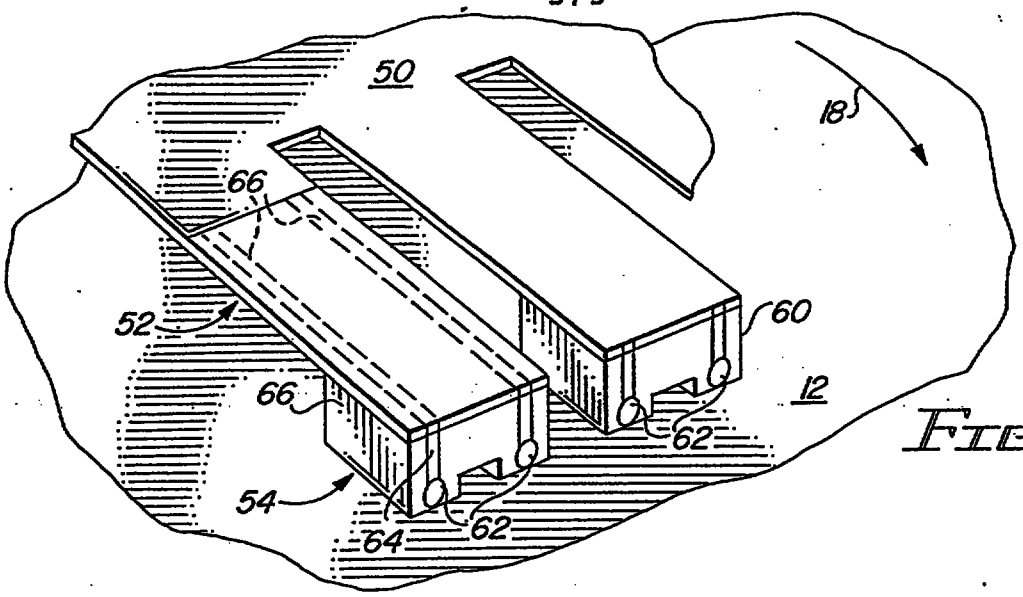


FIG-4

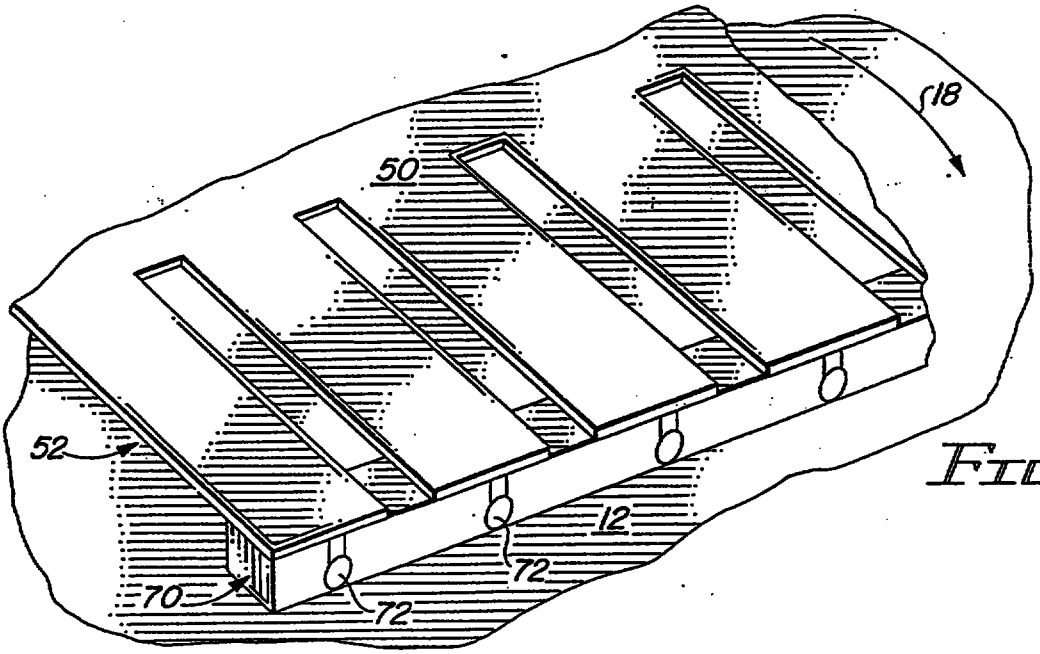


FIG-5

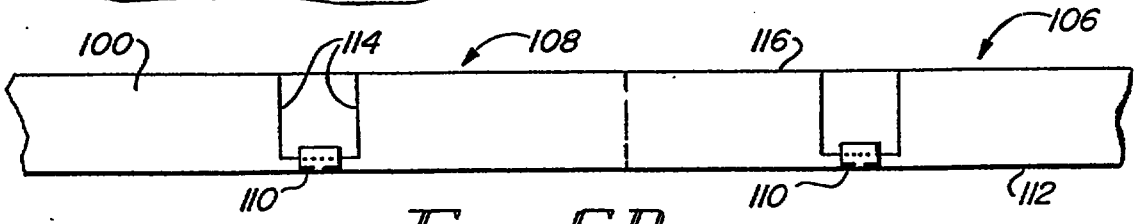


FIG-6B

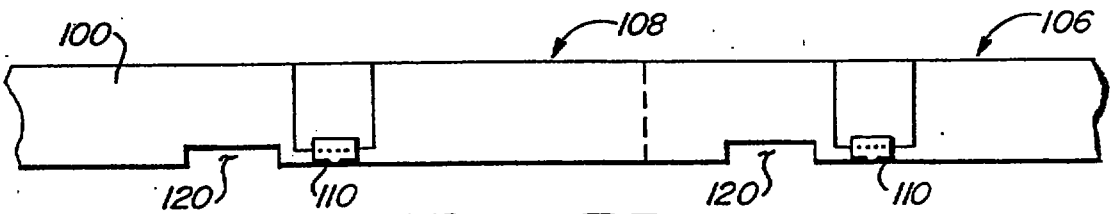


FIG-6C

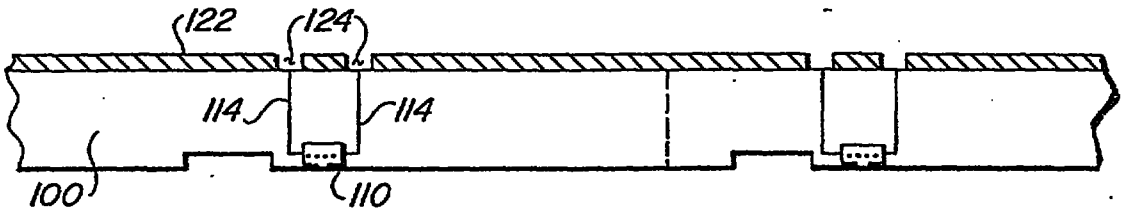


FIG-6D

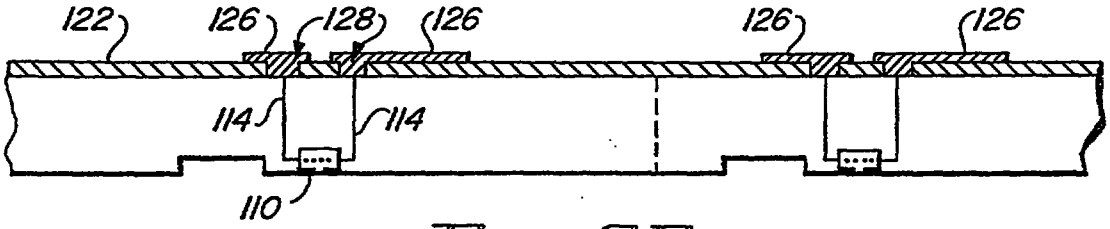


FIG-6E

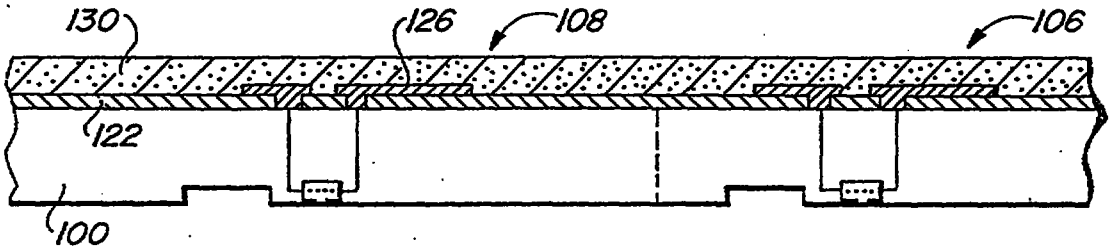


FIG-6F

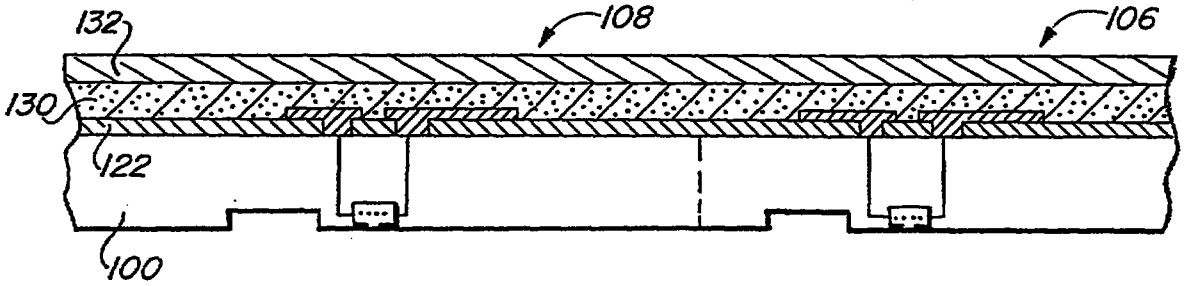


FIG-6G

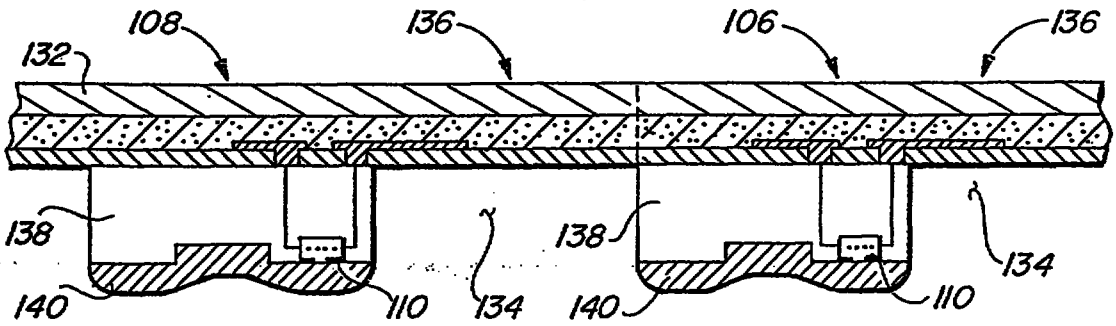


FIG. 6H

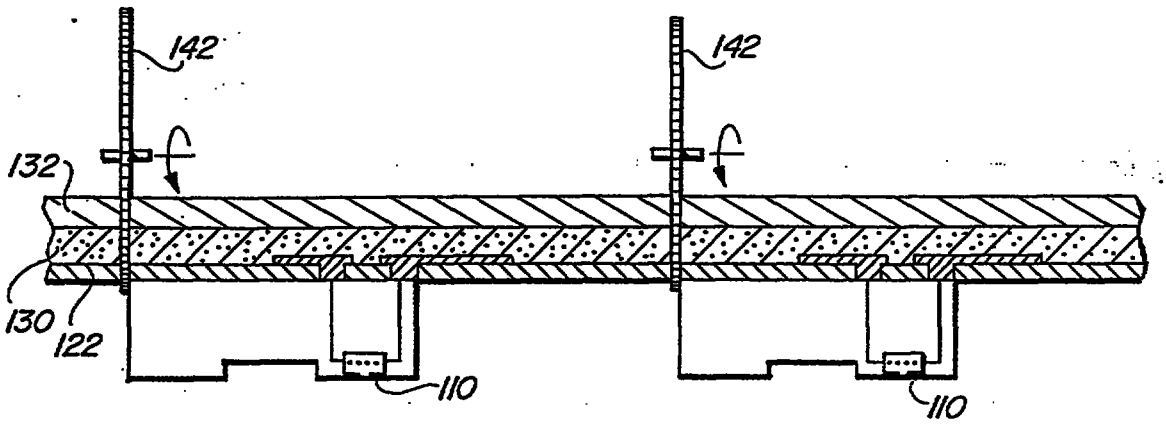


FIG. 6I

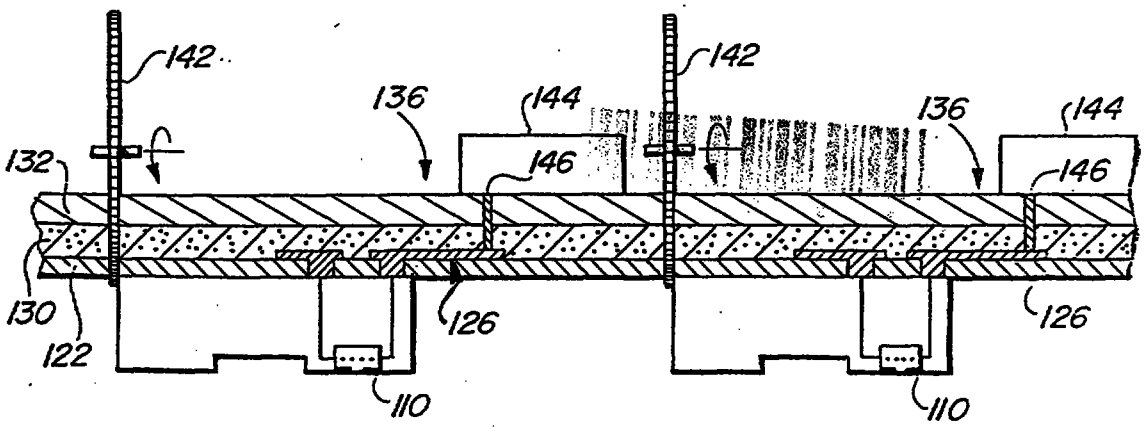


FIG. 6J

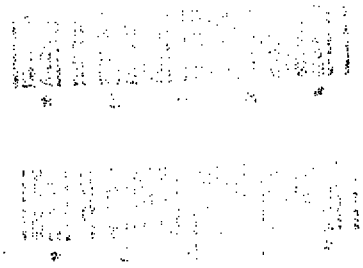
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DATA TRANSFER HEAD

ABSTRACT

A data transfer head (22) comprises a combination assembly formed from an integrated suspension (26), slider (24) and transducer (25). The combination transducer-slider-suspension assembly is batch produced by forming a plurality of the combination assemblies onto a single wafer (100). The wafer is then diced to separate the assemblies into individual sections (106, 108). The transducers are deposited onto the wafer and the air bearing surface formed. Conductors (42) to interconnect each transducer with the external circuits are insulated from the wafer and deposited along a path which will form the suspension. A spring-like resilient layer is then deposited over and electrically insulated from the conductors. The wafer is then pattern etched to remove a portion of the wafer backside to form the suspension. Integrated circuit amplifiers 56 can be deposited at the free end of the conductors prior to separation of individual assemblies.

FIG. 2



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attachment of the slider to the suspension is made simultaneously with the electrical connections of the transducer leads to the further electronics of the amplifier. As with the remainder of the known prior art, the slider and transducer portion of the combination are produced separately from the suspension assembly which includes interconnecting conductors.

EP-A-430407 discloses an integrated magnetic read/write head/flexure/conductor device, comprising an elongate, dielectric body, with an embedded magnetic read/write pole structure.

Accordingly, the invention provides a data transfer head for a disk drive assembly comprising:

a slider having an air bearing surface;

at least one transducer on the slider and having conductor leads;

suspension means comprising layers of deposited material, the suspension means having a predetermined length, with a first end of the suspension means attached to the slider, and a second end of the suspension means for attachment to means for positioning the data transfer head; and

electrical connecting members formed in at least one of the layers of deposited material of the suspension means and extending from the second end of said suspension means to said conductor leads of the transducer;

and characterised in that the suspension means comprises an insulation layer, a conductive circuitry layer, a polyimide dielectric layer, and a metal structural suspension layer.

Such a data transfer head offers an enhanced, integrated, combination transducer-slider-suspension assembly.

Preferably the data transfer head further comprises an amplifier connected by said electrical connecting members to the transducer, and the slider includes two transducers formed on a side thereof adjacent said air bearing surface. It is also preferred that the suspension means has a uniform thickness profile throughout.

In one preferred embodiment there is a plurality of sliders, each supporting at least one transducer. The suspension means is typically slotted in between each slider, although it is possible to support all of these on a continuous structure.

The invention further provides a method for fabricating a data transfer head for a disk drive assembly, said data transfer head comprising a slider, at least one transducer on the slider, suspension means, and electrical connecting members, comprising the steps of:

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depositing a plurality of transducers onto a first surface of a wafer substrate in a row and column patter, the distance separating one transducer from an adjacent transducer in a row defining the length of the suspension means;

forming conductors leads from each of the transducers extending through to a second surface of said wafer substrate;

etching an air bearing surface in the first surface of the wafer substrate adjacent to each of the transducers;

and forming the suspension means by the steps of:

depositing a layer of an electrically insulating material on said second surface of said wafer substrate;

patterning said deposited layer of insulating material to expose said deposited conductor leads;

depositing a layer of an electrically conducting material over said layer of insulating material, said layer of conducting material being patterned to form electrically conductive lines extending from the conductor leads along the length of said suspension means;

depositing a polyimide dielectric layer over said electrically conductive lines and said layer of insulating material;

and depositing a metal structural suspension layer over said dielectric layer;

and forming the slider portion of the head by the steps of:

depositing a layer of an etch protective material over said first surface of said wafer substrate;

patterning the etch protective material to leave the etch protective material covering the desired slider portion, including said air bearing surface; and

etching the wafer substrate material not protected by the etch protective material, the etched material underlying the suspension means.

Preferably said layer of electrically insulating material comprises a thin film layer, and said dielectrically layer comprises a membrane layer.

Thus the improved integrated structure comprising a combination transducer-suspension arm-slider can be produced by providing a substrate

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assembly 30 need not move as far radially across the disk, since the plurality of transducer-slider assemblies 24 cover the significant portion of the total number of tracks on the disk surface of the disk 12 at a given position over the disk 12. The number of transducer-slider assemblies could be any number from two to the total number of tracks on the disk 12. The actuator 10 thereby may only be required to move half of the distance of a single transducer-slider assembly, for example, as shown in Fig 1A up to merely actuating the combination assembly 30 from off-track to on-track positioning. Further discussion of the multi track combination assembly 30 of Fig. 1B is provided below with reference to Figs. 3, 4 and 5. An enlarged configuration of the transducer-slider assembly 24 of Figs 1A and 1B is shown in Fig. 2.

Referring now to Fig. 2, the one side of the combination assembly 22 is shown positioned over the disk 12. The rotation of the disk 12 is shown by the arrow 18 to be in the direction where the transducers 25 are located either on the trailing edge of the transducer-slider assembly 24, a so called vertical head, or are located on the air bearing surface which would constitute a horizontal head. The suspension section 26 is deposited over an entire section of a wafer as will be described below. A portion of the wafer becomes the slider 23 of the transducer-slider assembly. Two transducers 25 are shown on the slider 23, but it is possible that only one is used for operation with the track of the disk 12. Two or more transducers 25 are deposited during fabrication in order to increase the yield since only one transducer 25 need be in operation to produce a workable combination assembly 22.

The suspension section 26 includes an insulation layer 40, a conductive circuitry layer 42, a dielectric layer 44, and a structural suspension layer 46 which could be a plated nickel-iron alloy, or a sputtered beryllium copper layer or a sputtered stainless steel layer. Conductor leads 43 interconnect the transducer 25 to the conductor circuitry layer 42. Electrical connection pads 48 are provided to interconnect with the amplifier located adjacent thereto or could be the position in which an integrated circuit amplifier, such as integrated circuit amplifier 28, is deposited together with the remaining layers as will be discussed below with reference to Fig. 6. The insulation layer 40 provides electrical insulation between the conductor layer 42 and the possibly conductive substrate of the slider 23. The dielectric layer 44, which is a polyimide material, provides insulation for the

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comprise the same layers for the suspension section. Thus, the suspension section 52 of the membrane combination assembly 50 of Fig. 4 can comprise the same layers as that set forth for the suspension section 26 of the combination assembly 22. A further embodiment of the membrane combination assembly 50 of Fig. 3 is shown in Fig. 5.

In Fig. 5, the membrane combination assembly 50 is similar in construction as that shown for Figs. 3 and 4 except that a transducer-slider section 70 comprises a plurality of transducers 72 deposited onto a row section from a wafer substrate. The individual slider sections are not separated but are interconnecting thus dispensing with the dicing operation that separates the individual sliders. An air bearing surface can be formed into the row in the same manner as for the individual sliders. A more complete description of the operation and manufacture will be described later. The construction of the membrane combination assembly 50 of Fig. 5 is in the same manner as that discussed for the membrane combination assembly 50 of Fig. 3 and Fig. 4 and can comprise the same layers. The membrane combination assembly 50 suspends the transducer-slider row 70 over the surface of the disk 12 at the trailing edge of the suspension section 52. The disk 12 rotates in the direction of the arrow 18 in the same manner as discussed previously for Figs. 3 and 4.

A step by step method of making the combination assemblies shown in Figs. 1-5 is described in Figs. 6A-6J for the instance where the transducer is a horizontal head. In Fig. 6A, a wafer substrate 100 is shown having a plurality of the combination assemblies 22, for instance, deposited thereon in a plurality of rows 102 and a plurality of columns 104. The wafer 100 is shown with a plurality of the combination assemblies, it being known that more or less than the number of rows 102 and columns 104 as shown can be produced. The number is dependent on the size of the wafer and on the size of the individual combination assemblies. Fig. 6A shows the wafer layout of the combination assemblies.

Fig. 6B shows a cross-section of one row 102 with two columns 104. Thus in Fig. 6B can be shown two combination assemblies 106 and 108 taken from Fig. 6A. A step in the process shown in Fig. 6B, a plurality of transducers 110 are produced on one side 112 of the wafer 100. Through conductors 114 are formed through the wafer 100 to a second surface 116 of the wafer 100. The through conductors can be formed by a reactive ion etch process as disclosed in U.S. Patent No. 4,601,782, assigned to the assignee of the present invention and then plated with copper. The horizontal head transducers 110 can be produced on the first surface 112 of the wafer 100 in the manner as shown in U.S. Patent No. 4,698,708 which shows the deposition of what is referred to as an integrated circuit transducer. Further, the transducer 110 can be a standard one-turn construction which again would comprise the deposition of layers onto the first

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surface 112 of the wafer 100. The next step, as shown in Fig. 6C, is the etching of the air bearing surface pocket 120 into each of the columns 106 and 108 and adjacent to the transducer 1010. The air bearing surface pockets 120 can be formed by reactive ion or laser induced etching, or by mechanical tools to carve out the section. In the embodiment shown in the figures, a two-rail slider is assumed. The air bearing surface pocket 120 could be a negative pressure or self loading slider such as is disclosed in U.S. Patent No. 3,855,625, assigned to the same assignee as this application. Reactive ion etching to form air bearing surface pockets is well known in the art as described in U.S. Patent No. 4,375,390, assigned to the assignee of the present invention.

Referring now to Fig. 6D, the next step in the process is to deposit and pattern an insulation layer onto the second surface 116 of the wafer. The insulation layer 122 includes openings 124 to leave the through conductors 114 exposed at the second surface 116 of the wafer 100. The insulation layer 122 is patterned over the entire section of the combination assembly to permit interconnection of all of the transducers 110 to the conductive circuitry shown deposited in Fig. 6E.

In Fig. 6E, a layer of copper 126 is deposited to form the conductive patterns along the length of the suspension section. Copper studs 128 are also deposited to interconnect the leads 114 of the transducer 110 to the copper conductors 126. The material forming the conductor circuitry 126 can be formed by plating copper, for instance, or by sputtering gold or other well known electrically conductive materials to form the interconnections between the transducer leads 114 and the output at the end of the suspension section.

In Fig. 6F, a dielectric layer of a polyimide material 130 is then placed over the insulation layer 122 and the conductor circuitry 126. The polyimide layer 130 insulates the conductor circuitry 126 from the remaining suspension layers. The polyimide layer 130 can provide stiffness to the suspension section as discussed in the aforementioned U.S. Patent 4,670,804 or merely an insulation factor for the conductive circuitry 126. Thus the polyimide dielectric layer 130 could be formed by spin coating the material across the surface of the wafer or the polyimide layer 130 could be preformed and adhered over the other layers to add stiffness to the suspension section, if desired. The polyimide material has been selected because of its dielectric and inert properties and because of the stiffness which can be obtained from the material.

Fig. 6G shows the next step in the process wherein a structural suspension layer 132 is deposited over the polyimide layer 130. The structural suspension layer 132 can be produced by placing a conductive seed layer (not shown) by sputtering over the polyimide layer 130 and then plating a nickel-iron alloy, for instance, onto the seed layer. Alternatively, the structural suspension layer 132 could be formed by sputtering a

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beryllium copper or stainless steel layer, for example, over the entire surface of the wafer. The structural suspension layer 132 provides additional suspension support to the polyimide layer 130 or can provide the entire structural suspension support for suspending the slider-transducer assembly as shown in Fig. 1A.

The next step in the batch process for forming the combination assembly is shown in Fig. 6H wherein the wafer area 134 beneath a suspension section 136 is etched away to produce the individual slider assemblies 138 and the suspension section 136 having a desired thickness profile to provide the desired suspension characteristics. A protective coating 140 is shown placed over the transducer-slider section 138 to protect that section from the etching process, for instance when reactive ion etching is used to etch away the wafer section 134. The protective coating 140 could be a photoresist as is well known in the prior art. The etching away of the wafer substrate at the section 134 is well known in the art as shown in U.S. Patent 4,624,048, assigned to the assignee of the present invention. In the step shown in Fig. 6H, the individual combination assemblies are defined to produce the combination assemblies 106 and 108. Each combination assembly includes the suspension section 136, the slider 138, and a transducer 110. The protective coating 140 is

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The wafer may be made of material such as is the subject matter ~~of U.S. Patent No.~~ 4,251,841, entitled "Magnetic Head Slider Assembly" and assigned to the assignee of the present invention. Other relevant teachings include US 4,190,872, issued on February 26, 1980 concerning a thin film inductive transducer, US 3,975,772 issued on August 17, 1976 concerning a thin film magnetoresistive head, US 4,624,048, issued on November 25, 1986 concerning a process for making magnetic head sliders, and US 4,251,841, issued on February 17, 1981 concerning a wafer-substrate material, all of which are useful in conjunction with the present invention. The suspension section described above could be a dual layer of a polyimide material and a metal layer deposited thereon to provide sufficient resiliency and stiffness as required by a suspension assembly. It is also well understood that many electrically conductive materials are available to from the conductive circuitry and the transducer leads. Copper or gold are the preferred materials but many others are available as is well known in the art. Whilst the discussion has focussed on air bearing surface sliders, the present invention is also applicable to contact recording sliders in which the air bearing surface of the slider is any suitable surface or pad that can be maintained in sliding contact with the media during operation over the expected lifetime of the head-disk assembly. Further, while horizontal heads are shown in the preferred embodiments, the present invention is also applicable to vertical heads in which the slider-transducer combination is produced by the disclosed process without the transducer and the vertical style transducer is separately produced and bonded to the slider-suspension combination. It is also evident that the linear actuator shown in the examples could easily be a rotary type actuator instead.

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CLAIMS

1. A data transfer head for a disk drive assembly comprising:

a slider having an air bearing surface;

at least one transducer on the slider and having conductor leads;

suspension means comprising layers of deposited material, the suspension means having a predetermined length, with a first end of the suspension means attached to the slider, and a second end of the suspension means for attachment to means for positioning the data transfer head; and electrical connecting members formed in at least one of the layers of deposited material of the suspension means and extending from the second end of said suspension means to said conductor leads of the transducer;

and characterised in that the suspension means comprises an insulation layer, a conductive circuitry layer, a polyimide dielectric layer, and a metal structural suspension layer.

2. A data transfer head as in Claim 1, wherein the suspension means is a membrane suspension and includes a conductive circuitry layer and an insulation layer.

3. A data transfer head as in any preceding claim, further comprising an amplifier connected by said electrical connecting members to the transducer.

4. A data transfer head as in any preceding claim, wherein the slider includes two transducers formed on a side thereof adjacent said air bearing surface.

5. A data transfer head as in any preceding claim, wherein the suspension means has a uniform thickness profile throughout.

6. A data transfer head as in any preceding claim, comprising a plurality of sliders, each supporting at least one transducer.

7. A data transfer head as in claim 6, wherein the suspension means is slotted in between each slider.

8. A disk drive assembly including rotatable data storage means, a data transfer head according to any preceding claim, and means for positioning the data transfer head with respect to the data storage means.

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9. A method for fabricating a data transfer head for a disk drive assembly, said data transfer head comprising a slider, at least one transducer on the slider, suspension means, and electrical connecting members, comprising the steps of:

depositing a plurality of transducers onto a first surface of a wafer substrate in a row and column pattern, the distance separating one transducer from an adjacent transducer in a row defining the length of the suspension means;

forming conductors leads from each of the transducers extending through to a second surface of said wafer substrate;

etching an air bearing surface in the first surface of the wafer substrate adjacent to each of the transducers;

and forming the suspension means by the steps of:

depositing a layer of an electrically insulating material on said second surface of said wafer substrate;

patterning said deposited layer of insulating material to expose said deposited conductor leads;

depositing a layer of an electrically conducting material over said layer of insulating material, said layer of conducting material being patterned to form electrically conductive lines extending from the conductor leads along the length of said suspension means;

depositing a polyimide dielectric layer over said electrically conductive lines and said layer of insulating material;

and depositing a metal structural suspension layer over said dielectric layer;

and forming the slider portion of the head by the steps of:

depositing a layer of an etch protective material over said first surface of said wafer substrate;

patterning the etch protective material to leave the etch protective material covering the desired slider portion, including said air bearing surface; and

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etching the wafer substrate material not protected by the etch protective material, the etched material underlying the suspension means.

10. The method of Claim 9, further comprising the step of cutting the wafer substrate by rows and columns to separate the wafer into individual data transfer heads.

11. A method as defined in claim 9 or 10 wherein said dielectrically material comprises a polyimide material.

12. A method as claimed in any of claims 9 to 11, wherein said layer of electrically insulating material comprises a thin film layer, and said dielectric layer comprises a membrane layer.