Description

The present invention relates to an assembly of a transducer and a support for the transducer, and has a particular application in an assembly including a suspension unit which both supports the transducer from the actuator arm of the transducer positioning actuator of a data recording disk file and moves the transducer to and away from the surface of the disk of the file during start and stop operations, respectively.

Disk files are information storage devices which utilise at least one rotatable disk with concentric data tracks containing the information, a head (or "transducer") for reading data from or writing data in the various tracks, and a head positioning actuator connected to the head for moving it to the desired track and maintaining it over the track centreline during read and write operations. The transducer may be attached to an air-bearing slider which is supported adjacent the data surface of the disk by a cushion of air generated by the rotating disk. The slider is connected to a support arm of the head positioning actuator by means of a suspension unit.

The suspension unit provides high spring stiffness and dimensional stability between the slider and the actuator arm, some flexibility in pitch and roll motion of the slider in respect of its direction of motion relative to the rotating disk, and resistance to yaw motion. In certain disk files the suspension unit provides a load or force against the slider which is compensated by the force of the air bearing between the slider and the disk, thus maintaining the slider in extremely close proximity to, but out of contact with, the data surface of the disk. Other types of disk files utilise a "negative pressure" or "self-loading" slider, such as is disclosed in United States Patent 3,855,625. It is desirable to maintain the self-loading slider adjacent the data surface of the disk with as low a "loading" force as possible since the slider creates a vacuum between it and the disk which holds the slider adjacent the data surface.

Conventional assemblies of transducers and suspension units have several inherent disadvantages. First, because some load is typically applied to the slider by the suspension unit in a direction generally perpendicular to the data surface of the disk, the slider comes to rest on the data surface of the disk when disk rotation stops and the air bearing disappears. The starting and stopping of the disk with the slider in contact with the data surface can cause damage to the data surface of the disk and to the slider or attached transducer. If it is desired to maintain the slider away from the disk when the disk is not rotating, it is necessary to use some type of "load/unload" device which mechanically moves the suspension unit and slider away from the disk when disk rotation stops and back to the disk when the disk has reached its operating speed and the air bearing is present to maintain the slider out of contact with the data surface. Second, because conventional suspension units are designed to flex in a direction generally perpendicular to the data surface of the disk and are thus not generally rigid in that direction, the data surface of the disk and the slider can be damaged if the slider suddenly impacts the disk, such as may occur during shipping of the disk file.

DD-B-214,707 discloses an assembly of a transducer and a support therefor including a transducer mounted on an inflatable envelope which is secured to an actuator arm. The envelope is made of a rubber-like elastic material and is provided with two flat surface portions, one of which is attached to the actuator arm and to the other of which is attached the transducer. The envelope can be inflated to move the transducer into an operating position and can be deflated subsequently to return the transducer to a rest position. The parts of the envelope between the two flat surface portions include flexible reinforcing fibres. The reinforcing fibres ensure that the two flat surface portions are substantially parallel when the envelope is inflated.

The present invention seeks to provide an improved assembly of a transducer and a support therefor and has a particular application in a record disk file.

The present invention relates to an assembly of a transducer, an actuator arm, an inflatable envelope including two flat surface portions, one of which surface portions is secured to the actuator arm and on the other of which surface portions is mounted the transducer, means for inflating the envelope so as to move the transducer into an operating position in relation to a record disk and for deflating the envelope so as to return the transducer to a rest position, and reinforcements, associated with the parts of the envelope between the flat surface portions, for maintaining the flat surface portions substantially parallel to each other when the envelope is inflated.

According to the invention the assembly is characterised in that the envelope is formed from a flexible non-elastic material, and in that the reinforcements constantly maintain the parts of the envelope between the flat surface portions substantially parallel to each other also when the transducer is moved to the record disk by inflating the envelope.

In a preferred embodiment of the invention, the envelope comprises two flat sheets of flexible polyimide bonded together about their perimeters and having stainless steel stiffening members forming the reinforcements, bonded to their outer surfaces. There are gaps between the end of one of the stiffening members and the portion of the envelope which is secured to the actuator arm as well as between the end of the other stiffening member and the slider on which the transducer is mounted. These gaps are formed by strips of polyimide, the strips being generally parallel to one another. These strips of polyimide, which are portions of the sheets, function as hinges when the envelope is inflated and deflated, thus causing the envelope to deform in the manner of a four-bar linkage. With this manner of inflation and deflation, the slider is moved towards and away from the disk with its air-bearing surface maintained generally parallel to the data surface of the disk.

The envelope stiffening members provide stiffness of the envelope between the slider and the actuator arm, which typically extends in the same direction as the direction of track accessing, i.e. generally in the radial direction relative to the disk. Because the slider is isolated from the stiffening members by the hinges, the suspension unit provides excellent flexibility in both pitch and roll motion. Because the portion of the sheet on which the slider is attached is not generally flexible in the plane of the sheet in the hinge region, the suspension unit also provides resistance of the slider to yaw motion and contributes to the high stiffness between the slider and the actuator arm.

Thus the suspension unit functions both as a conventional suspension unit in that it provides stiffness in the radial direction, flexibility in pitch and roll motion, and resistance to yaw motion; and as a "load/unload" device in that it automatically moves the slider and attached transducer into read/write engagement with the data surface of the disk when disk rotation is started and away from the disk when disk rotation is stopped. Moreover, in its rest or unexpanded position the envelope has substantially zero volume. Thus it is resistant to external flexure due to sudden impact, such as may occur during shipping, because such flexure would tend to create a vacuum within the envelope interior and because the opening into the envelope interior is a relatively small restricted orifice. Accordingly, the suspension unit alone functions to prevent damage to the slider or disk during shipping or sudden impact to the disk file.

How the invention can be carried out will now be described by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is a diagram of a conventional transducer and support assembly mounted on the arm of a voice coil motor (VCM) actuator in a conventional disk file;

Fig. 2 is a perspective view, to a scale larger than that of Fig. 1, of a transducer and support assembly embodying the invention and illustrating an envelope, forming part of the transducer support, in its relaxed position with the transducer attached at one end and a mounting block for attachment to the actuator arm at the other end;

Fig. 3 is an exploded view of the assembly illustrated in Fig. 2 showing the various components making up the transducer and support assembly;

Fig. 4 is an edge view of a portion of a recording disk and the transducer and support assembly of Fig. 2 with the envelope in its relaxed or unexpanded position;

Fig. 5 is an edge view of a portion of a recording disk and the transducer and support assembly of Fig. 2 with the envelope in its pressurised or expanded position and the transducer in read/write engagement with the data surface of the disk; and

Fig. 6 is an expanded view of a portion of Fig. 5 illustrating the strip of flexible material of the envelope between the actuator arm mount and a stiffening member associated with the envelope.

Referring first to Fig. 1, there is illustrated a conventional actuator 10 and a segment of an associated disk 12 of a data recording disk file. The actuator 10 includes a voice coil motor, which comprises 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, and an actuator arm 20 one end of which is attached to the movable coil 14. Attached to the other end of actuator arm 20 are slider and suspension unit assemblies, such as slider and suspension unit assembly 22 comprising slider 24 and suspension unit 26. The slider 24 of slider and suspension unit assembly 22 supports a read/write transducer (not shown) and has a surface generally parallel to the surface of disk 12 for supporting the transducer above the surface of disk 12 on a bearing or cushion of air generated by the rotation of disk 12. The segment of disk 12 is shown in dashed line in Fig. 1 in order to present the view of an additional slider-suspension assembly 28 associated with the opposite data recording surface of disk 12.

The suspension unit 26 of slider and suspension unit assembly 22 provides a load to the slider which is generally perpendicular to the surface of disk 12. This perpendicular load maintains slider 24 in contact with the data surface of disk 12 when disk 12 is not rotating. During rotation of disk 12 the air bearing generated between the slider 24 and disk 12 opposes the perpendicular load applied to the slider 24 by suspension unit 26.

During operation, the slider 24 is moved to the desired track of the concentric data tracks on the data surface of 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 on slider 24 from one track to another track for read or write operations, it is necessary that the transducer on slider 24 be properly positioned over the desired track and reach that track in a minimum amount of time. This requires that the suspension unit 26 provide sufficient stiffness and dimensional stability between slider 24 and actuator arm 20. If the resonant frequency of the slider and suspension unit assembly is too low in the direction of track access, i.e. the direction generally radially relative to the disk and perpendicular to the data tracks, it will not be possible for the head positioning servo control system to allow the actuator to move the transducer to the desired track and maintain the transducer over the centreline of the desired track during read or write operations. It should be noted that while the actuator 10 illustrated in Fig. 1 is a linear actuator which moves the slider in a precisely radial direction perpendicular to the tracks, other types of conventional disk files utilise a rotary actuator which moves the slider in an arcuate path which is only approximately in the radial direction.

In addition to providing radial stiffness, the suspension unit 26 must be attached to the slider 24 in such a manner that the slider 24 has substantial flexibility in pitch and roll directions as it rides on the air bearing above the data surface of disk 12. One type of suspension unit which provides both a rela-

tively low perpendicular load to the slider and a flexible attachment to the slider is a suspension unit commonly referred to as the Watrous suspension unit, which is described in United States patent 4,167,765.

In a conventional disk file there are additional slider and suspension unit assemblies which are attached to the actuator arm 20. These slider and suspension unit assemblies are associated with the data surfaces of additional disks in a stack of disks which make up the disk file. That portion of arm 20 which would otherwise support those additional assemblies has been sectioned off in Fig. 1 to permit the simplified view of the actuator 10, the segment of disk 12 and the slider and suspension unit assembly 22.

Referring now to Fig. 2, in lieu of the slider and suspension unit assembly 22 of Fig. 1, a transducer and support assembly embodying the invention and including a slider and suspension assembly comprises an expandable envelope 30 which has a self-loading slider 32 supporting a transducer attached at one end and which is secured to an actuator arm 34 at the other end by a suspension mounting means, the mounting means including block 36 and plate 38. The envelope 30 includes reinforcements or stiffening means, such as stiffeners 40, 42, which generally provide stiffness between the slider 32 and actuator arm 34, and an opening for the entry of pressurised gas into its interior.

The construction of the slider and suspension unit assembly can be better understood by reference to the exploded view of Fig. 3. The envelope 30 includes generally flat flexible sheets 50, 52 and stiffeners 40, 42 and 56. The sheets 50, 52 are secured together about their perimeters, the secured-together perimeters of the sheets 50, 52 being designated as line 54. The slider 32 has the read/write transducer 33 attached to its rear portion and a generally flat back surface which is secured, as by bonding with epoxy, to the end of sheet 50. The stiffeners 40, 42 are secured to the outer surface of sheet 50, and the stiffener 56 is secured to the outer surface of sheet 52. While two separate stiffeners 40, 42 are used in the preferred embodiment, it is possible to use a single stiffener on the outer surface of sheet 50. Plate 38 is also attached to the outer surface of sheet 52.

The clamping or mounting of the slider and suspension unit assembly to the actuator arm 34 is accomplished by mounting block 36, by plate 38 which is secured to sheet 52, and by bolts 47, 49 (Fig. 2). In the preferred embodiment the sheets 50, 52 are bonded together about their entire perimeter 54 as well as over their inner surfaces in the region covered by block 36. As shown in Fig. 3, an opening 70 in plate 38 and an opening 72 in sheet 52 permit access to the interior of the envelope for the entry of pressurised gas from outside the slider and suspension unit assembly.

The sheets 50, 52 may be made of any type of plastic film which has a good flex life. If the sheets are to be in close proximity to soldering of electrical leads to the transducer 33 on the slider 32, the plastic film should also have a high tolerance to heat. In the preferred embodiment the sheets 50, 52 are made of polyimide, such as the Kapton brand of polyimide manufactured by DuPont. The sheets 50, 52 can be bonded about their perimeter 54 by a commercial sheet adhesive, such as adhesive model WA available from DuPont, or a liquid polyimide-based adhesive. The sheet adhesive is placed between the two polyimide sheets 50, 52 in the region of the perimeter 54. The sheets 50, 52 are then pressed together about their perimeter 54 and heated. If a liquid adhesive is used it can be applied in any conventional manner, such as by spraying onto the sheets 50, 52 in the region of perimeter 54.

The stiffeners 40, 42 are bonded to the outer surface of sheet 50 and stiffener 56 is bonded to the outer surface of sheet 52. The mounting plate 38 is also bonded to the outer surface of sheet 52. The stiffeners 40, 42, 56 and the mounting plate 38 are preferably thin members of stainless steel which are bonded to the polyimide sheets 50, 52 in the same manner as previously described for the bonding of the sheets 50, 52 together.

The slider 32, which is typically made of a ceramic material, has its generally flat rectangular back surface bonded to the outer surface of sheet 50 by conventional bonding means, such as epoxy. The end 35 of slider 32 is generally parallel to and slightly spaced from the straight edges 41, 43 of stiffeners 40, 42 respectively. The slight spacing or gap between end 35 of slider 32 and edges 41, 43 of stiffeners 40, 42 defines a strip of the flexible polyimide material, indicated by dashed line 60, which serves as a hinge or flex line when the envelope 30 expands. Similarly, when the mounting block 36 supports the envelope 30 on the actuator arm, the edges 45, 47 of stiffeners 40, 42, respectively, are located generally parallel to and slightly spaced from the end 39 of mounting block 36 so as to define a second strip of flexible material, indicated by dashed line 62, which serves as a hinge.

The stiffener 56 bonded to sheet 52 has opposite generally parallel edges 55, 57, the edge 55 being generally parallel to and spaced from the end 59 of mounting plate 38. Edge 57 of stiffener 56 terminates beyond the end 37 of slider 32 opposite slider end 35 so as to generally coincide with that portion of bonded perimeter 54 near slider end 37. The spacing between edge 55 of stiffener 56 and end 59 of plate 38 defines a strip of flexible material, indicated by dashed line 63, which functions as a hinge. Similarly, that portion of bonded perimeter 54 near slider end 37 and edge 57 of stiffener 56 defines a strip of flexible material, indicated by dashed line 64, which also functions as a hinge. Stiffener 56 which is bonded to the outer surface of sheet 52 is generally the same length as stiffeners 40, 42, but is offset from stiffeners 40, 42 when the envelope 30 is in its flat or unexpanded position. This amount of offset generally equals the width of slider 32 plus the spacing between slider end 37 and perimeter 54, which equals the amount the width of mounting plate 38 exceeds that of mounting block 36. The portion of sheet 50 defined by the spacing between slider end 37 and perimeter 54 provides for the necessary roll flexibility of slider 32 when the envelope is expand-

d and the slider 32 is supported adjacent the data surface by the air bearing.

Since polyimide is used in the preferred embodiment of the suspension unit, it is possible to deposit, using conventional vapour deposition processes, electrical conductors 80 directly on the polyimide sheet 50 to provide electrical connection between the read/write transducer 33 on slider 32 and the read/write circuitry of the disk file. While not shown in Fig. 3, an additional layer of polyimide may be bonded over the portion of the conductors 80 between the slider 32 and the conductors 80 before the slider is bonded to sheet 50. An opening is provided in the additional polyimide layer in the region of the transducer leads to permit soldering of the transducer leads to the conductors 80. Alternatively, if only one stiffener is used on the outer surface of sheet 50, then the conductors 80 may extend between the stiffener and perimeter 54 into contact with the leads of the transducer 33 on slider 32.

The suspension unit as thus described is shown in its relaxed or unexpanded configuration in the edge view of Fig. 4 with the slider 32 away from the data surface 74 of disk 76. A conduit 78 passes into actuator arm 34 and into communication with openings 70, 72 (Fig. 3) in plate 38 and sheet 52 respectively. In the preferred embodiment the source of pressurised gas through conduit 78 into the interior of the envelope 30 is the pressurised air flow generated by the rotating disk. In this embodiment, the other end (not shown) of conduit 78, i.e. the end not in communication with the envelope interior, is a pitot tube which is aligned with the direction of air flow adjacent the surface of one of the rotating disks in the disk file. Each suspension can have its own associated pitot tube, or one or more pitot tubes on each actuator arm can supply pressurised air to the suspensions supported on the associated arm. Alternatively, the conduit can be connected to an external supply of pressurised gas.

The above described slider and suspension unit assembly can be better understood by considering the function of the various component parts during operation of the disk file. Before start-up of the disk file the disk 76 is not rotating and the suspension unit is generally in the configuration shown in Fig. 4 with the slider 32 out of engagement with the data surface 74. When the disk file is first turned on and disk rotation begins, the air flow generated by the rotating disk passes through the pitot tube (not shown) and into conduit 78 and the interior of envelope 30, thus increasing the gas pressure within the interior of the envelope 30. As the disk rotation increases, the interior pressure increases and the envelope expands. In the unexpanded position (Fig. 4), the sheets 50, 52 are generally in contact throughout their entire interior surfaces, and envelope 30 has substantially no internal volume.

When a pressurised gas enters through conduit 78 and openings 70, 72 into the interior of envelope 30, the envelope expands to the position depicted in Fig. 5. Because the strips 60, 62, 63, and 64 (which are portions of the sheets 50, 52) function as hinges, the envelope expands generally in the form of a four-bar linkage, as illustrated in Fig. 5, with the portion of the surface of the envelope on which the slider is mounted and the portion of the surface of the envelope which is attached to the mounting block 36 remaining substantially parallel to each other, and with the stiffeners 40, 42 remaining substantially parallel to stiffener 56. Fig. 6 depicts an expanded view of the strip 63 between plate 38 and stiffener 56. The four-bar linkage form of expansion, i.e. from the relaxed position of Fig. 4 to the expanded position of Fig. 5, moves the slider generally perpendicularly relative to the data surface 74 with the air bearing surface of slider 32 being maintained generally parallel to the data surface 74 during the movement. Because the air bearing surface of slider 32 is moved into read/write engagement with the disk 76 in this manner, there is less likelihood of any damage to the slider 32 or data surface 74 in the event of inadvertent contact between the rotating disk 76 and the slider 32.

The direction of disk rotation is generally as indicated by arrow 90 in Fig. 3. The leading edge of the bonded sheets 50, 52 is formed so as to be swept or angled relative to this direction so as to provide a swept planform to the air flow. This swept planform of bonded sheets 50, 52 improves the air flow past the envelope and minimises flutter of the envelope. In addition to or instead of the swept planform, an air dam 77 (Fig. 2) may be attached to mount block 36 to deflect the air flow past the leading edge of the envelope 30.

Because the slider 32 is attached to the flexible sheet 50 near its end, the slider 32 has sufficient pitch and roll flexibility to allow it to ride the air bearing adjacent the disk. The portion of sheet 50 between end 37 of slider 32 and end 57 of stiffener 56 is substantially wider than strips 60, 62 or 63 and provides for the necessary roll flexibility of slider 32 when the envelope 30 is expanded. As shown in Fig. 3 the disk rotates past slider 32 in the direction indicated by arrow 90; pitch of the slider being indicated by arrow 92 and roll by arrow 94. However, it should be apparent from Fig. 3 that, because of the close spacing of slider 32 to the ends 41, 43 of stiffeners 40, 42 and because of the general inflexibility of sheet 50 within its own plane in the region where the slider is attached, the slider 32 possesses the desired resistance to yaw motion, i.e. motion in the direction indicated by arrow 96.

The strips of flexible material 60, 62, which are essentially portions of the flexible material defined by the gaps between the mounting block 36, the stiffeners 40, 42 and the slider 32, are of sufficiently minimal thickness that the slider and suspension unit assembly possesses excellent stiffness in the radial direction. The slider and suspension unit assembly thus has a relatively high resonant frequency well outside the bandwidth of the head positioning servo control system. This allows the actuator to position the slider so as to access different tracks accurately and remain on the centreline of the desired track.

When the disk file is turned off, disk rotation slows, the gas pressure within the envelope reduces and the envelope ultimately returns to its unexpanded position (Fig. 4). Thus the slider 32 is disen-

gaged from the data surface 74 without having been in contact with the data surface, thereby eliminating the problem associated with contact of the slider and the disk. When the air pressure is reduced within the interior of the envelope, the elastic strain energy in the polyimide hinges (strips 60, 62, 63, 64) and the portions of the sheets 50, 52 generally between the stiffeners and the perimeter, which have been flexed by the expansion of the envelope, causes the envelope to return to the unexpanded configuration shown in Fig. 4.

The amount of "load" force applied perpendicularly to the slider by the expanded envelope is a function of, among other things, the interior gas pressure and the thickness of the polyimide sheets. When the suspension unit is used with a self-loading slider, the air flow from one of the rotating disks in the disk file generates sufficient pressure to move the slider with minimal force close enough to the disk so that the self-loading action can take place. This pressure is generally in the range of 1 to 3 inches of water above atmospheric and causes the slider to be "loaded" with a force of approximately 1 gram. Once the self-loading slider has been "loaded", the force holding the slider adjacent the data surface is approximately 20 times that of the "loading" force generated by the envelope 30.

In the preferred utilisation of the suspension unit in the disk file, the disks are rotated about an axis in the horizontal plane. In such an orientation, gravity has minimal effect upon the expansion of the envelope. However, if the disk file is oriented so that the disks rotate about a vertical axis, the suspension units located on the bottom surfaces of the disks must overcome the gravitational force when the sliders are "loaded". In such a situation a greater internal pressure may have to be applied to those suspension units. In addition, an external return spring may be required between the mounting means and those suspension units associated with the top surfaces of the disks to facilitate the "unloading" of those sliders.

It should be apparent, by reference to Fig. 4, that, when the disks are not rotating, the sheets 50, 52 are in close contact and there is substantially no internal volume to the envelope 30. In this position, the envelope is resistant to any sudden external movement, since such movement would tend to create a vacuum within the envelope interior and since the opening into the envelope interior is a relatively small restricted orifice. Thus, the suspension unit alone is sufficient to prevent accidental impact of the slider with the disk, such as may occur during shipping. Though the invention has been described with respect to a magnetic recording disk file, it is capable of implementation in optical recording disk files, the primary difference being that the envelope in the suspension unit would support an optical sensing head instead of the slider-transducer assembly described herein. While the preferred embodiment of the suspension unit has been described and illustrated with a self-loading slider, the basic concept of the suspension unit is capable of utilisation with a slider requiring a loading force.

Claims

1. An assembly of a transducer (33), an actuator arm (34), an inflatable envelope (30) including two flat surface portions, one of which surface portions is secured to the actuator arm and on the other of which surface portions is mounted the transducer, means (72) for inflating the envelope so as to move the transducer into an operating position in relation to a record disk and for deflating the envelope so as to return the transducer to a rest position, and reinforcements (40,42,56), associated with the parts of the envelope between the flat surface portions, for maintaining the flat surface portions substantially parallel to each other when the envelope is inflated, the assembly being characterised in that the envelope (30) is formed from a flexible non-elastic material, and in that the reinforcements (40,42,56) also constantly maintain the parts of the envelope between the flat surface portions substantially parallel to each other when the transducer is moved to the record disk by inflating the envelope.

2. An assembly as claimed in claim 1, in which the envelope is formed from a first and a second sheet (50,52) of flexible non-elastic material, the two sheets being perimetrically bonded to one another,
an inner portion of the first sheet is secured to the actuator arm and the transducer is mounted on an outer portion of the second sheet,
at least one reinforcing member (40,42) extends from the inner end of the second sheet to the inner edge of said outer portion thereof and serves to keep flat the portion of that sheet over which it extends, and at least one other reinforcement (56) extends from the outer edge of the inner portion of the first sheet to the outer edge of that sheet and serves to keep flat the portion of that sheet over which it extends,
said inner portion of the first sheet being provided with an opening (72) to enable the envelope to be inflated,
and strip portions (60,62,63,64) of the sheets adjacent the ends of the reinforcements serving as hinges so that the envelope can expand and relax in a manner analogous to that of a four-bar linkage.

3. An assembly as claimed in claim 2, including ducting means (78), operable when the assembly is mounted in co-operative relation to a rotating record disk, to direct a pressurised air flow produced by the rotating disk into the opening in the inner portion of the one sheet in order to inflate the envelope.

4. An assembly as claimed in any preceding claim, in which the flexible non-elastic material is a polyimide material.

5. An assembly as claimed in any preceding claim, in which each reinforcement comprises at least one flat piece of metal.

6. An assembly as claimed in claim 5, in which each reinforcement comprises at least one flat piece of stainless steel.

7. An assembly as claimed in any preceding claim, including electrical conductors (80) deposited on

gaged from the data surface 74 without having been in contact with the data surface, thereby eliminating the problem associated with contact of the slider and the disk. When the air pressure is reduced within the interior of the envelope, the elastic strain energy in the polyimide hinges (strips 60, 62, 63, 64) and the portions of the sheets 50, 52 generally between the stiffeners and the perimeter, which have been flexed by the expansion of the envelope, causes the envelope to return to the unexpanded configuration shown in Fig. 4.

The amount of "load" force applied perpendicularly to the slider by the expanded envelope is a function of, among other things, the interior gas pressure and the thickness of the polyimide sheets. When the suspension unit is used with a self-loading slider, the air flow from one of the rotating disks in the disk file generates sufficient pressure to move the slider with minimal force close enough to the disk so that the self-loading action can take place. This pressure is generally in the range of 1 to 3 inches of water above atmospheric and causes the slider to be "loaded" with a force of approximately 1 gram. Once the self-loading slider has been "loaded", the force holding the slider adjacent the data surface is approximately 20 times that of the "loading" force generated by the envelope 30.

In the preferred utilisation of the suspension unit in the disk file, the disks are rotated about an axis in the horizontal plane. In such an orientation, gravity has minimal effect upon the expansion of the envelope. However, if the disk file is oriented so that the disks rotate about a vertical axis, the suspension units located on the bottom surfaces of the disks must overcome the gravitational force when the sliders are "loaded". In such a situation a greater internal pressure may have to be applied to those suspension units. In addition, an external return spring may be required between the mounting means and those suspension units associated with the top surfaces of the disks to facilitate the "unloading" of those sliders.

It should be apparent, by reference to Fig. 4, that, when the disks are not rotating, the sheets 50, 52 are in close contact and there is substantially no internal volume to the envelope 30. In this position, the envelope is resistant to any sudden external movement, since such movement would tend to create a vacuum within the envelope interior and since the opening into the envelope interior is a relatively small restricted orifice. Thus, the suspension unit alone is sufficient to prevent accidental impact of the slider with the disk, such as may occur during shipping. Though the invention has been described with respect to a magnetic recording disk file, it is capable of implementation in optical recording disk files, the primary difference being that the envelope in the suspension unit would support an optical sensing head instead of the slider-transducer assembly described herein. While the preferred embodiment of the suspension unit has been described and illustrated with a self-loading slider, the basic concept of the suspension unit is capable of utilisation with a slider requiring a loading force.

Claims

1. An assembly of a transducer (33), an actuator arm (34), an inflatable envelope (30) including two flat surface portions, one of which surface portions is secured to the actuator arm and on the other of which surface portions is mounted the transducer, means (72) for inflating the envelope so as to move the transducer into an operating position in relation to a record disk and for deflating the envelope so as to return the transducer to a rest position, and reinforcements (40,42,56), associated with the parts of the envelope between the flat surface portions, for maintaining the flat surface portions substantially parallel to each other when the envelope is inflated, the assembly being characterised in that the envelope (30) is formed from a flexible non-elastic material, and in that the reinforcements (40,42,56) also constantly maintain the parts of the envelope between the flat surface portions substantially parallel to each other when the transducer is moved to the record disk by inflating the envelope.

2. An assembly as claimed in claim 1, in which the envelope is formed from a first and a second sheet (50,52) of flexible non-elastic material, the two sheets being perimetrically bonded to one another,
an inner portion of the first sheet is secured to the actuator arm and the transducer is mounted on an outer portion of the second sheet,
at least one reinforcing member (40,42) extends from the inner end of the second sheet to the inner edge of said outer portion thereof and serves to keep flat the portion of that sheet over which it extends, and at least one other reinforcement (56) extends from the outer edge of the inner portion of the first sheet to the outer edge of that sheet and serves to keep flat the portion of that sheet over which it extends,
said inner portion of the first sheet being provided with an opening (72) to enable the envelope to be inflated,
and strip portions (60,62,63,64) of the sheets adjacent the ends of the reinforcements serving as hinges so that the envelope can expand and relax in a manner analogous to that of a four-bar linkage.

3. An assembly as claimed in claim 2, including ducting means (78), operable when the assembly is mounted in co-operative relation to a rotating record disk, to direct a pressurised air flow produced by the rotating disk into the opening in the inner portion of the one sheet in order to inflate the envelope.

4. An assembly as claimed in any preceding claim, in which the flexible non-elastic material is a polyimide material.

5. An assembly as claimed in any preceding claim, in which each reinforcement comprises at least one flat piece of metal.

6. An assembly as claimed in claim 5, in which each reinforcement comprises at least one flat piece of stainless steel.

7. An assembly as claimed in any preceding claim, including electrical conductors (80) deposited on

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e surface of the envelope and connected to the transducer.

8. An assembly as claimed in claim 7, in which the electrical conductors are deposited on a central, longitudinal portion of the envelope and the envelope is provided with a reinforcement (40,42) on each side of the electrical conductors.

Patentansprüche

1. Baugruppe bestehend aus einem Transducer (33), einem Zugriffsarm (34), einer aus zwei flachen Oberflächenteilstücken bestehenden aufblasbaren Umhüllung (30), wobei das eine Oberflächenteilstück an dem Zugriffsarm befestigt und auf dem anderen Oberflächenteilstück der Transducer angebracht ist, Mitteln (72) zum Aufblasen der Umhüllung, so daß der Transducer in Betriebsstellung in bezug auf die Aufzeichnungsplatte gebracht wird und zum Ablassen aus der Umhüllung, so daß der Transducer in Ruhestellung zurückgeführt wird und Verstärkungen (40, 42, 56), die mit den Teilen der Umhüllung zwischen den flachen Oberflächenteilstücken verbunden sind, damit die flachen Oberflächenteilstücke in aufgeblasenem Zustand der Umhüllung weitgehend parallel gehalten werden, wobei die Baugruppe dadurch gekennzeichnet ist, daß die Umhüllung (30) aus flexiblem, nichtelastischen Material besteht, und daß die Verstärkungen (40, 42, 56) die Teile der Umhüllungen zwischen den flachen Oberflächenteilstücken weitgehend in parallelem Zustand zueinander halten, auch wenn der Transducer durch Aufblasen der Umhüllung auf die Aufzeichnungsplatte versetzt wird.

2. Baugruppe nach Anspruch 1, dadurch gekennzeichnet, daß die Umhüllung aus einer ersten und einer zweiten Schicht (50, 52) flexiblen, nicht-elastischen Materials besteht, wobei die beiden Schichten entlang ihrer Ränder miteinander verbunden sind,

wobei ein innerer Teil der ersten Schicht an dem Zugriffsarm befestigt und auf einem äußeren Teil der zweiten Schicht der Transducer angebracht ist,

wobei mindestens ein Verstärkungsglied (40, 42) vom inneren Ende der zweiten Schicht zum Innenrand des davon äußeren Teils führt und dazu dient, den Teil der Schicht, über den es entlangführt, flach zu halten und mindestens eine weitere Verstärkung (56) vom äußeren Rand des Innenteils der ersten Schicht zum äußeren Rand dieser Schicht führt und dazu dient, den Teil der Schicht, über den die Verstärkung führt, flach zu halten, wobei der Innenteil der ersten Schicht mit einer Öffnung (72) zum Aufblasen der Umhüllung versehen ist,

wobei an die Enden der Verstärkungen angrenzende Streifenteilstücke (60, 62, 63, 64) der Schichten als Angelpunkte dienen, so daß die Umhüllung dem Prinzip nach ähnlich wie ein Viergelenkgetriebe gespannt und gelockert werden kann.

3. Baugruppe nach Anspruch 2, dadurch gekennzeichnet, daß Leitungsstränge (78) enthalten sind, die einsatzfähig sind, wenn die Baugruppe in gegenseitiger Relation zu einer rotierenden Aufzeichnungsplatte montiert ist, um einen von der rotierenden Platte erzeugten, unter inneren Überdruck gesetzten Luftstrom in die am Innenteil der ersten Schicht befindliche Öffnung zwecks Aufblasen der Umhüllung zu lenken.

4. Baugruppe nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß es sich bei dem flexiblen, nicht-elastischen Material um Polyimid handelt.

5. Baugruppe nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß jede Verstärkung mindestens ein flaches Metallstück enthält.

6. Baugruppe nach Anspruch 5, dadurch gekennzeichnet, daß jede Verstärkung mindestens ein aus rostfreiem Stahl bestehendes Flachstück enthält.

7. Baugruppe nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß elektrische Leiter (80) enthalten sind, die auf der Oberfläche der Umhüllung angebracht und an den Transducer angeschlossen sind.

8. Baugruppe nach Anspruch 7, dadurch gekennzeichnet, daß die elektrischen Leiter am zentralen Längsteil der Umhüllung angebracht sind und die Umhüllung auf jeder Seite der elektrischen Leiter mit einer Verstärkung (40, 42) versehen ist.

Revendications

1. Ensemble d'un transducteur (33), d'un bras actionneur (34) d'une enveloppe dilatable (30) comprenant deux parties de surface plate, l'une desquelles partie de surface est fixée au bras actionneur et sur l'autre desquelles partie de surface est monté le transducteur, un moyen (72) servant à gonfler l'enveloppe de façon à déplacer le transducteur jusqu'à une position fonctionnelle en relation avec un disque d'enregistrement et servant à dégonfler l'enveloppe de façon à retourner le transducteur jusqu'à une position de repos, et des renforcements (40, 42, 56) associés aux parties de l'enveloppe entre les parties de surface plane, servant à maintenir les parties de surface plane sensiblement parallèles l'une avec l'autre lorsque l'enveloppe est gonflée, l'ensemble étant caractérisé en ce que l'enveloppe (30) est formée à partir d'un matériau non élastique flexible, et en ce que les renforcements (40, 42, 56) maintiennent également constamment les parties de l'enveloppe entre les parties de surface plane sensiblement parallèle l'une avec l'autre, lorsque le transducteur est déplacé vers le disque d'enregistrement par le gonflage de l'enveloppe.

2. Ensemble selon la revendication 1, dans lequel l'enveloppe est formée à partir d'une première et d'une seconde feuilles (50, 52) de matériau non élastique flexible, les deux feuilles se trouvant collées l'une à l'autre sur leur pourtour,
une partie interne de la première feuille est fixée au bras actionneur et le transducteur est monté sur une partie extérieure de la seconde feuille,
au moins un élément de renforcement (40, 42) s'étend depuis l'extrémité interne de la seconde feuilles jusqu'au bord interne de ladite partie extérieure de celle-ci et sert à maintenir plate la partie de cette feuille sur laquelle il s'étend, et au moins un autre renforcement (56) s'étend depuis le bord ex-

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terne de la partie interne de la première feuille jusqu'au bord externe de cette feuille et sert à maintenir plate la partie de cette feuille sur laquelle il s'étend,
ladite partie interne de la première feuille étant prévue avec une ouverture (72) pour permettre à l'enveloppe d'être gonflée,
et des parties de bandes (60, 62, 63, 64) des feuilles adjacentes aux extrémités des renforcements servant comme charnières de façon que l'enveloppe puisse se dilater et se relâcher d'une manière analogue à celle d'une liaison à quatre barres.

3. Ensemble selon la revendication 2, comprenant un moyen de conduit (78), pouvant fonctionner lorsque l'ensemble est monté en relation de coopération avec un disque d'enregistrement tournant, pour diriger une circulation d'air sous pression produite par le disque en rotation dans l'ouverture de la partie interne de la feuille afin de gonfler l'enveloppe.

4. Ensemble selon l'une quelconque des revendications précédentes, dans lequel le matériau non élastique flexible est un matériau de polyimide.

5. Ensemble selon l'une quelconque des revendications précédentes dans lequel chaque renforcement comprend au moins une pièce métallique plate.

6. Ensemble selon la revendication 5, dans lequel chaque renforcement comprend au moins une pièce plate d'acier inoxydable.

7. Ensemble selon l'une quelconque des revendications précédentes, comprenant des conducteurs électriques (80) déposés sur la surface de l'enveloppe et connectés au transducteur.

8. Ensemble selon la revendication 7, dans lequel les conducteurs électriques sont déposés sur une partie centrale, longitudinale de l'enveloppe et dans lequel l'enveloppe est pourvue d'un renforcement (40, 42) sur chaque côté des conducteurs électriques.

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