Description

The subject invention relates generally to a head positioning assembly for disc drive apparatus and more particularly to an improved band drive for use in either a linear or rotary positioning assembly.

Disc drive machines record and reproduce information stored on concentric circular tracks on magnetic discs. Tracks are written and read by magnetic heads which cooperate with the surface of the disc. Various methods have been used to position the head; The two common types of data accessing mechanisms are linear and rotary head carriages. In both types, the objective is to position a magnetic head over a concentric track on the surface of a magnetic disc for reading or writing of information.

Various methods have been used to move the carriage and position the head including lead screws, cams and band drives. Band drives are shown and described in U.S. Patent 3,881,139 and 4,161,004, and 4,170,146 among others. These drives convert rotary motion of a stepper motor shaft to motion of the carriage to move the heads mounted on the carriage across the disc to record and read adjacent concentric circular tracks. A typical drive band is wrapped around the motor shaft or a pulley attached to the shaft, and has its ends attached to the carriage so that rotation of the shaft wraps one portion of the band on the pulley while unwrapping the other, causing the carriage to move. A new track is recorded at each step of the stepper motor as it moves the head across the disc.

While band drives have proved to be the most popular form of drive, a long term problem with such drives has been that the total rotation of the motor shaft available to drive the head from the innermost track to the outermost track has been typically limited to less than one complete rotation of the shaft. This is because in the present split band technology, the band tied to the motor drive shaft and to one end of the carriage passes between the two portions of the band which are fastened to the drive shaft and to the other end of the carriage as the carriage is driven back and forth.

Such an arrangement is disclosed in GB-A-2139403A in which there is disclosed a device for positioning at least scanning head in a drive unit for disc records in which the scanning head is mounted on a carriage and a flexible drive band has substantially the shape of a two-pronged fork and is wound around a cylindrical member that could be rotated by a drive motor fastened at either end to the carriage. The narrow end portion runs between the two prong like end portions so that when the cylindrical member is rotated, the end portions are wound onto and off said member thereby causing the carriage bearing the scanning head to move in the longitudinal direction. In one arrangement disclosed the band is attached to the peripheral surface of the cylindrical member at two points but this limits the utilisable angle of rotation of the shaft too about 340°. If the band is not fastened to the peripheral surface, a greater angle of rotation of the shaft is permissable. In either case the bands require a shaft of significant length in wrapping and unwrapping from the shaft.

This invention provides a positioning apparatus for positioning a magnetic head relative to a recording medium including a movable member adapted to mount said magnetic head to move said head relative to said recording medium, drive means including a drive motor having a rotatable shaft, and flexible band means connected to said carriage and comprising first and second band parts each having an end connected to said shaft at spaced locations and helically wound on and unwound from said shaft for moving said member, wherein the first and second band parts comprise separate bands aligned in parallel at a common acute angle to said shaft and wrap on the same angular cross section of the surface area of the motor shaft between said spaced locations with one band wrapping on to the surface adjacent to the portion left by the unwrapping of the other bands, thereby permitting said shaft to rotate for at least 360°.

Thus the length of the shaft is minimised even though no band portion ever physically lies on top of another portion of the band. Therefore the carriage can be moved a greater distance, allowing for an increased number of tracks to be defined. This is a highly significant advantage in a technology wherein increased data storage is of critical importance.

Preferably each of said first and second bands are at least as long as the full length of travel of said carriage.

In one specific construction according to the invention the drive motor may be positioned with said drive shaft perpendicular to said recording medium and the direction of travel of said carriage and may be adapted to rotate 360° or more to extend the length of the path of travel of the carriage.

In any of the above arrangements said first and second bands may be fastened to opposite ends of the rotatable drive shaft, one of said bands being helically wrapped on said shaft surface area towards the centre of said shaft depending on the direction of rotation of said shaft simultaneously with the unwrapping of the other band from said shaft, the centre lines of each of said bands lying substantially in parallel when they are unwrapped from the shaft.

Said bands may be connected to said carriage so that said band portions unwrap from said drive shaft rest on and are supported by said carriage.

In the latter arrangement means may be provided for fastening one end of each of said bands to said drive shaft, said carriage including notches located on the edges of the carriage aligned with the path of movement of the fastening means to allow the fastening means to clear the carriage as the drive shaft rotates a complete 360°.

In any of the above arrangements the movable member may comprise a linearly movable carriage adapted to mount the magnetic head.

In a further construction the movable member may comprise a head carrying mechanism mounted for rotary movement over said recording medium, and a drive arm may be connected to the head carrying mechanism and may be rotatable about a pivot point, the distal end of said arm from said pivot point mounting a curved end portion, and drive means may be provided for rotating said drive arm comprising a drive motor having a drive shaft perdendicular to said recording medium and the direction of travel of the band carrying mechanism, said drive shaft being mounted just outside the arc of the circle along which said curved end portion travels and being connected to said end portion for causing movement thereof by said flexible band means, each having one end connecting to said shaft and the other end connected to said end portion of said arm.

The following is a description of some specific embodiments of the invention reference being made to the accompanying drawings in which:

Figure 1 is a side elevational view of a typical linear drive carriage;

Figure 2 is a plan view of a drive carriage and stepper motor shaft incorporating the helically wound band of the present invention;

Figure 3 is a plan view of a rotary disc drive actuator which incorporates the present invention;

Figure 4A, 4B and 4C are graphic diagrams depicting the stress levels on split and helical bands.

The helically wound band of the present invention was designed to translate the rotary motion of a stepper motor drive shaft to a carriage or other driven object while providing two significant advantages:

1. increasing the number of steps through which the stepper motor can rotate; and

2. reducing the instantaneous changes in stress on the band.

These advantages can be more easily understood by considering the use of the band in one important environment i.e. to drive a head actuator in a disc drive.

In a U.S. Patent No. 4,323,939 issued April 16, 1982 and entitled "HARD FIXED DISC DRIVE ASSEMBLY AND READ/WRITE HEAD ACTUATOR" assigned to the assignee of this invention there is described a disc apparatus in which the present invention is useful. The disclosure of that patent is incorporated herein by reference.

Figure 1 shows the basic elements of a linear disc drive head actuator including a stepper motor 6 having a drive shaft 12, a pulley 13 carried at the end of the drive shaft and adapted to receive a drive band 14 and a carriage 17. The band includes a first portion 14A and a second portion 14B each secured by a screw 18A, 18B to a distant end of the carriage 17 and by a screw or other fastener 20A, 20B to the drive shaft. Rotation of the drive shaft 12 and pulley 13 clockwise or counter-clockwise winds and unwinds the first and second band portions 14A, 14B on the pulley to move the cartridge. The carriage includes cut-out portions 17a, 17b to allow the drive shaft securing screws or fasteners 20a and 20b to rotate past the plane of the carriage.

The carriage itself mounts an E-shaped or other suitable mount 32 for a plurality of heads 33 which are adapted to cooperate with one or more associated discs. By controlling the stepper motor, the carriage, which in this embodiment is a linear carriage, moves linearly along a track to move the heads in and out on the surface of the associated disc to read and write information on the disc surface.

More particularly as clearly appears in Figure 2, the band portions 14A, 14B helically wind on portions of the pulley 13, thus each band can wind around more than one complete revolution of the pulley, the stepper motor is capable of more than one complete revolution. Further, as can be seen from Figure 2, as the pulley turns from one end of its allowed rotation to the other, the band portion being wound on the pulley is wound on substantially the same pulley surface area as the other pulley has just been unwound from. Thus the length of the pulley is minimized, even though no band ever physically lies on top of another portion of the band. Therefore, the carriage can be moved a greater distance, allowing for an increased number of tracks to be defined. This is a highly significant advantage in a technology where increased data storage is of critical importance.

The reason for the control of stress in the band being particularly advantageous, is that this is one of the key points of breakdown in disc drives. Breaks do occur due to the instantaneous changes in stress on the band. It is also known that almost all breaks in the band material occur parallel with the cross section. Therefore, with the band wound helically around the pulley, the present invention produces a larger effective radius and less stress is imposed on the cross section of the band. For example, figure 4A depicts the average stress level imposed on a normally wound split band as is now in common use, and particularly the instantaneous change in stress on the band at the point 100 where the band comes in contact with the pulley. In contrast, looking at figure 4B, it can be seen that as to any cross section of the band (see the line 106 in figure 4C identifying such a cross section) only one point on the cross sectional line reaches the pulley 13 at a time. Therefore, as can be seen from the line 102 of figure 4B, the change in stress imposed on any cross sectional area of the band is much more gradual, and therefore easier for the band to absorb and significantly less likely to result in undue aging or breaking of the band. Therefore, a combination of a stepper motor driven pulley and helical band can be expected to have a much longer life than the normally wound bands in present use.

Turning next to Figure 3, shown therein are the pertinent portions of a rotary actuator embodying the present invention. Figure 3 demonstrates the means for converting the rotary motion of a stepper motor to rotary motion of a mechanical arm, which can then be used to position a head carrying mechanism. Omitted from Figure 3 is the actual head carrying mechanism, which can be embodied in various ways known to anyone familiar with the art.

More specifically, Figure 3 shows a stepper motor 50 having a rotatable shaft 51 on which is mounted a pulley 52. A rotating arm (shown partially at 56) extends along line 57 to pivot point 58. At the distal end of arm 56 is mounted a curved end portion 59 whose radius is the distance from pivot point 58 to a point closely adjacent to the pulley 52. Connecting the pulley 52 to the curved end portion 59 of arm 56 are two helically wound band segments 53A and 53B. One end of each of the band segments 53A, 53B is secured to the ends of the curved end portion 59 of arm 56 by screws or other appropriate fasteners 54A, 54B. The other ends of the band segments 53A, 53B are secured to the pulley 52 by screws or other appropriate fasteners 55A, 55B. As the stepper motor 50 rotates the shaft 51 and attached pulley 52 clockwise or counterclockwise, the band segments 53A, 53B are wound on and unwound from pulley 52 rotating the arm 56 along path "A". The curved end portion 59 of the arm 56 is notched, as shown previously in Figure 2, to allow clearance for fasteners 55A, 55B, and supports the unwound portions of the band segments 53A, 53B.

The distance that the arm 56 moves along path "A" with each step of the motor 50 is determined by several factors: a) the amount of rotation the motor makes with each step, b) the diameter of the pulley 52, and the length of the arm 56.

The total portion of the circular path "A" through which the arm 56 can rotate is dependent only on the length of the band segments 53A, 53B and the length of the curved end portion 59 of the arm 56, since the helically wound band segments allow the pulley to rotate through more than 360°.

As shown herein, a positioning assembly has been provided which is especially useful in a disc drive or the like. Use of this invention provides for an increased number of tracks being recorded on the disc, and for highly accurate positioning of the head in movement across the disc. Further, the life of any machine incorporating this helical band drive is lengthened due to reduced exposure of the band to instantaneous changes in stress.

Claims

1. Positioning apparatus for positioning a magnetic head relative to a recording medium including a movable member (17) adapted to mount said magnetic head (32) to move said head relative to said recording medium, drive means including a drive motor (6) having a rotatable shaft (12), and flexible band means (14) connected to said carriage and comprising first and second band parts (14A, 14B) each having an end connected to said shaft at spaced locations (20A, 20B) and helically wound on and unwound from said shaft for moving said member, characterised in that the first and second band parts comprise separate bands aligned in parallel at a common acute angle to said shaft and wrap on the same angular cross section of the surface area of the motor shaft between said spaced locations with one band wrapping on to the surface adjacent to the portion left vacant by the unwrapping of the other band, thereby permitting said shaft to rotate for at least 360°.

2. Positioning apparatus as claimed in Claim 1, characterised in that each of said first and second bands (14A, 14B) are at least as long as the full length of travel of said carriage (17).

3. Positioning apparatus as claimed in Claim 1 or Claim 2, characterised in that said drive motor (6) is positioned with said drive shaft (12) perpendicular to said recording medium and the direction of travel of said carriage (17) and is adapted to rotate 360° or more to extend the length of the path of travel of the carriage.

4. Positioning apparatus as claimed in any of Claims 1 to 3, characterised in that said first and second bands (14A, 14B) are fastened (20A, 20B) to opposite ends of the rotatable drive shaft (13), one of said bands being helically wrapped on said shaft surface area towards the centre of said shaft depending on the direction of rotation of said shaft simultaneously with the unwrapping of the other band from said shaft, the centre lines of each of said bands lying substantially in parallel when unwrapped from the shaft.

5. Positioning apparatus as claimed in any of Claims 1 to 4, characterised in that said bands (14A, 14B) are connected to said carriage (17) so that said band portions unwrap from said drive shaft (12) rest on and are supported by said carriage.

6. Positioning apparatus as claimed in Claim 5 including means (20A, 20B) for fastening one end of each of said bands (14A, 14B) to said drive shaft (13), said carriage (17) including notches (17a) located on the edges of the carriage aligned with the path of movement of the fastening means to allow the fastening means to clear the carriage as the drive shaft rotates a complete 360°.

7. Positioning apparatus as claimed in any of proceeding claims wherein the movable member comprises a linearly movable carriage (17) adapted to mount the magnetic head (32).

8. Positioning apparatus as claimed in any of Claims 1 to 6, characterised in that the movable member comprises a head carrying mechanism mounted for rotary movement over said recording medium, and a drive arm (56) is connected to the head carrying mechanism and is rotatable about a pivot point (58), the distal end of said arm from said pivot point mounting a curved end portion (59), and drive means are provided for rotating said drive arm comprising a drive motor (50) having a drive shaft (10) perdendicular

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5. Positioning apparatus as claimed in any of Claims 1 to 4, characterised in that said bands (14A, 14B) are connected to said carriage (17) so that said band portions unwrap from said drive shaft (12) rest on and are supported by said carriage.

6. Positioning apparatus as claimed in Claim 5 including means (20A, 20B) for fastening one end of each of said bands (14A, 14B) to said drive shaft (13), said carriage (17) including notches (17a) located on the edges of the carriage aligned with the path of movement of the fastening means to allow the fastening means to clear the carriage as the drive shaft rotates a complete 360°.

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to said recording medium and the direction of travel of the band carrying mechanism, said drive shaft (51) being mounted just outside the arc of the circle along which said curved end portion (59) travels and being connected to said end portion for causing movement thereof by said flexible band means (53A, 53B), each having one end connecting to said shaft (51) and the other end connected to said end portion (59) of said arm.

Patentansprüche

1. Positioniervorrichtung zum In-Lage-Bringen eines Magnetkopfs bezüglich eines Aufzeichnungsmediums mit einem beweglichen Element (17), das zum Tragen des Magnetkopfs (32) ausgelegt ist, um ihn bezüglich des Aufzeichnungsmediums zu bewegen, mit einer Antriebseinrichtung, welche einen Antriebsmotor (6) mit einer drehbaren Welle (12) aufweist, und mit einer flexiblen Bandeinrichtung (14), die mit dem Schlitten verbunden ist und einen ersten und einen zweiten Bandabschnitt (14A, 14B) aufweist, von denen jeder mit einem Ende mit der Welle an im Abstand befindlichen Stellen (20A, 20B) verbunden und schraubenförmig auf die Welle aufgewickelt und von Ihr abgewickelt wird, um das Element zu bewegen, dadurch gekennzeichnet, daß der erste und der zweite Bandabschnitt getrennte Bänder aufweisen, die parallel mit einem gemeinsamen spitzen Winkel zu der Welle fluchtend ausgerichtet und auf den gleichen Winkelquerschnitt der Oberfläche der Motorwelle zwischen den im Abstand befindlichen Stellen aufgewickelt sind, wobei ein Band auf die Oberfläche angrenzend an den Teil aufgewickelt ist, der durch Abwickeln des anderen Bandes verbleibt, wodurch es der Welle möglich ist, sich um wenigstens 360° zu drehen.

2. Positioniervorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß das erste und das zweite Band (14A, 14B) wenigstens so lang wie die volle Länge des Laufs des Schlittens (17) sind.

3. Positioniervorrichtung nach Anspruch 1 oder Anspruch 2, dadurch gekennzeichnet, daß der Antriebsmotor (6) mit der Antriebswelle (12) senkrecht zu dem Aufzeichnungsmedium und zur Laufrichtung des Schlittens (17) positioniert und so ausgelegt ist, daß er um 360° oder mehr dreht, um sich über die Bahnlänge des Laufs des Schlittens zu erstrecken.

4. Positioniervorrichtung nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß das erste und das zweite Band (14A, 14B) an gegenüberliegenden Enden der drehbaren Antriebswelle (13) festgelegt (20A, 20B) sind, wobei eines der Bänder schraubenförmig auf die Wellenoberfläche zur Mitte der Welle hin abhängig von der Drehrichtung der Welle gleichzeitig zum Abwickeln des anderen Bandes von der Welle aufgewickelt wird, wobei die Mittellinien eines jeden der Bänder im wesentlichen parallel längs des Schlittens (17) liegen.

5. Positioniervorrichtung nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß die Bänder (14A, 14B) mit dem Schlitten (17) so verbunden sind, daß die von der Antriebswelle (12) abgewickelten Bandabschnitte auf dem Schlitten ruhen und davon abgestützt werden.

6. Positioniervorrichtung nach Anspruch 5 mit Einrichtungen (20A, 20B) zum Festlegen eines Endes eines jeden Bandes (14A, 14B) an der Antriebswelle (13), wobei der Schlitten (17) Aussparungen (17a) an den Rändern des Schlittens fluchtend ausgerichtet zu der Bewegungsbahn der Befestigungseinrichtungen aufweist, um es den Befestigungseinrichtungen zu ermöglichen, den Schlitten freizugeben, wenn sich die Antriebswelle um vollständige 360° dreht.

7. Positioniervorrichtung nach einem der vorhergehenden Ansprüche, bei welcher das bewegliche Element einen linear bewegbaren Schlitten (17) aufweist, der für die Aufnahme des Magnetkopfs (32) ausgelegt ist.

8. Positioniervorrichtung nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß das bewegliche Element einen Kopf tragenden Mechanismus aufweist, der für eine Drehbewegung über dem Aufzeichnungsmedium angebracht ist, und daß ein Antriebsarm (56) mit dem Kopf tragenden Mechanismus verbunden und um einen Schwenkpunkt (58) drehbar ist, wobei das distale Ende des Arms von dem Schwenkpunkt aus einen gekrümmten Endabschnitt (59) trägt, und daß Antriebseinrichtungen zum Drehen des Antriebsarms vorgesehen sind, die einen Antriebsmotor (50) mit einer Antriebswelle (10) aufweisen, die senkrecht zum Aufzeichnungsmedium und zur Laufrichtung des bandtragenden Mechanismus ist, wobei die Antriebswelle (51) gerade außerhalb des Kreisbogens angebracht ist, längs dessen der gekrümmte Endabschnitt (59) läuft, und mit dem Endabschnitt verbunden ist, um dessen Bewegung durch die flexiblen Bandeinrichtungen (53A, 53B) zu veranlassen, von denen jede ein Ende hat, das mit der Welle (51) verbunden ist, während das andere Ende mit dem Endabschnitt (59) des Arms verbunden ist.

Revendications

1. Appareil de positionnement destiné à positionner une tête magnétique par rapport à un support d'enregistrement, comprenant un élément mobile (17) destiné au montage de ladite tête magnétique (32) afin de déplacer ladite tête par rapport audit support d'enregistrement, des moyens d'entraînement comprenant un moteur d'entraînement (6) ayant un arbre tournant (12), et des moyens à bande flexible (14) reliés audit chariot et comprenant des première et seconde parties de bande (14A, 14B) ayant chacune une extrémité reliée audit arbre en des points espacés (20A, 20B) et enroulées en hélice sur ledit arbre, et déroulées de cet arbre pour déplacer ledit élément, caractérisé en ce que les première et seconde parties de bande comprennent des bandes séparées alignées en parallèle sous un angle aigu commun par rapport audit arbre et

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enroulées sur la même section transversale angulaire de la surface de l'arbre du moteur entre lesdits points espacés, une première bande s'enroulant sur la surface adjacente à la partie laissée par le déroulement des autres bandes, afin de permettre audit arbre de tourner sur au moins 360°.

2. Appareil de positionnement selon la revendication 1, caractérisé en ce que chacune desdites première et seconde bandes (14A, 14B) a une longueur au moins égale à la longueur maximale de la course dudit chariot (17).

3. Appareil de positionnement selon la revendication 1 ou la revendication 2, caractérisé en ce que ledit moteur d'entraînement (6) est disposé de façon que ledit arbre d'entraînement (12) soit perpendiculaire audit support d'enregistrement et à la direction de la course dudit chariot (17), et est conçu pour tourner sur 360° ou plus afin d'accroître la longueur du trajet de la course du chariot.

4. Appareil de positionnement selon l'une quelconque des revendications 1 à 3, caractérisé en ce que lesdites première et seconde bandes (14A, 14B) sont fixées (20A, 20B) à des extrémités opposées de l'arbre rotatif d'entraînement (13), une première desdites bandes étant enroulée en hélice sur ladite surface de l'arbre vers le centre dudit arbre suivant le sens de rotation dudit arbre, en même temps que l'autre bande est déroulée dudit arbre, les axes centraux desdites bandes s'étendant à peu près en parallèle le long du chariot (17).

5. Appareil de positionnement selon l'une quelconque des revendications 1 à 4, caracterisé en ce que lesdites bandes (14A, 14B) sont reliées audit chariot (17) afin que lesdites parties de bande se déroulent dudit arbre d'entraînement (12), reposent sur et soient supportées par ledit chariot.

6. Appareil de positionnement selon la revendication 5, comprenant des moyens (20A, 20B) destinés à fixer une extrémité de chacune desdites bandes (14A, 14B) audit arbre d'entraînement (13), ledit chariot (17) présentant des encoches (17a) situées sur les bords du chariot en alignement avec le trajet du mouvement des moyens de fixation pour permettre aux moyens de fixation de laisser le passage au chariot lorsque l'arbre d'entraînement effectue un tour complet de 360°.

7. Appareil de positionnement selon l'une quelconque des revendications précédentes, dans lequel l'élément mobile comprend un chariot (17) mobile linéairement, conçu pour le montage de la tête magnétique (32).

8. Appareil de positionnement selon l'une quelconque des revendications 1 à 6, caractérisé en ce que l'élément mobile comprend un mécanisme de support de tête monté de façon à effectuer un mouvement de rotation audessus dudit support d'enregistrement, et un bras d'entraînement (56) est relié au mécanisme de support de tête et peut tourner sur un point (58) de pivotement, l'extrémité distale dudit bras à partir dudit point de pivotement portant une partie extrême incurvée (59), et des moyens d'entraînement sont prévus pour faire tourner ledit bras d'entraînement, comprenant un moteur d'entraînement (50) ayant un arbre d'entraînement (10) perpendiculaire audit support d'enregistrement et à la direction de course dudit mécanisme de support de bande, ledit arbre (51) d'entraînement étant monté juste à l'extérieur de l'arc de cercle parcouru par ladite partie extrême incurvée (59) et étant relié à ladite partie extrême pour en provoquer un mouvement par lesdits moyens à bandes flexibles (53A, 53B), ayant chacun une extrémité reliée audit arbre (51) et l'autre extrémité reliée à ladite partie extrême (59) dudit bras.

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