Description

The invention relates to a magnetic tape drive, particularly of the cassette (cartridge) type. In the past, many different types of magnetic tape data memories have been devised or proposed, and at an earlier point in time such devices constituted the most widely used long-term storage medium for large quantities of data. A very frequently-encountered form of such a tape memory, used with large main-frame computers, utilizes relatively wide tape (on the order of one-half inch or 12.7 mm) which is used with large, open reels, in a reel-to-reel configuration.

With the increasingly widespread development and use of smaller types of data processing and/or word processing equipment, involving "stand-alone" desk-top processor devices comparable in physical size to the input terminals used in larger computer installations, there has been an increasing emphasis on the development of smaller forms of data storage devices. Thus, a significant advent in the development of "stand-alone" terminals (described in US-A-3 760 375) utilized tape cassettes of the nature typically used in audio equipment, embodying eighth-inch (3.18 mm) tape. Following that, the "floppy" disc ("diskette") was developed and has now come into widespread use, particularly in office-type or business computer applications. Also, many developments have taken place in "hard" disc drives and memory units to make them suitable for such use, e.g., development of "Winchester"-type drives.

In this increasing development, the two major underlying purposes are the need to obtain increased amounts of storage without corresponding increase in physical size, as well as the need to actually reduce the size of both the storage media and of the drive which utilises the same, Thus, "floppy" disc media and drives have become available in sizes on the order of one-half that of the initial such devices, and the same is certainly true of "hard" disc drives, in which the media diameter has been reduced to approximately five and one-quarter inches, 133 mm (for "mini" disc drives) and to on the order of three and three-quarter inches, 95.3 mm (and indeed, in some instances, three inches, 762 mm) in more recent units (often known as "micro" disc drives).

Accordingly, there is an increasing need for analogous developments in tape storage media and drives, particularly for longer-term storage, inasmuch as high storage capabilities may be achieved at relatively low cost by the use of tape media, and the use of tape as a storage media lends itself very admirably to "backup" or "archive" storage for the disc memories used as working or operating storage during entry or processing operations.

Document EP-A-0032660 discloses a track following system for a tape drive comprising a bidirectionally-operative transducer motor directly driving cam means having a smoothly and continuously sloping camming surface. Said cam means transmitting movement to the transducer across the path of the tape through a transducer-moving linkage to impart bidirectional movement thereto.

Document JP-A-58/200 454 discloses a tape drive comprising a tape drive motor of flat silhouette, having a height less than its width and a tape-driving member disposed in axial alignement with and rigidly coupled to the rotor of the drive motor for rotation thereby.

Document US-A-3 583 708 discloses a cartridge type tape drive for the recording and playing back of music on multi-tapes. The drive has a tape drive motor and a tape driving member for driving a cartridge type tape, a transducer guided for linear movement, a transducer positioning motor and rotary cam means driven thereby, and transducer moving linkage means extending between a cam follower guided by the cam means and the transducer; whereby movement of the cam means is imparted to the linkage means to position the transducer.

Although the device shown in this document may be admirable for music recording and replaying purposes, it is actually conceptually very different from the cartridge-type tape drive of the present invention. The specific field of the present invention is of cartridge-type tape drives for digital data storage use, and the prior drive referred to above would most certainly not be suitable for that purpose, neither could it at all easily be adapted for such a purpose. One of the requirements of today's digital data storage devices, are that they should be compatible with the half-high "mini-floppy" standard, and that they should be capable of distinguishing between and reading data tracks on the tape which may be extremely closely spaced.

It is only when one tries substantially to reduce the size of devices such as shown in US-A-3583708, and at the same time improve their performance characteristics to a level appropriate for data storage that one discovers severe problems: essentially, the requirements of very small size and a sufficiently high performance appear to be incompatible. The applicants have solved this problem by providing a novel structural organisation (componentry size and shape, and physical lay out), by which the essential performance criteria can be provided under these very severe space constraints. In addition, they have dealt with the problem of reading and writing very closely spaced data tracks on a tape by guiding and controlling the transducer in such a way that it may follow a recorded track extending lengthways along the

tape, even if that recorded track has transverse deviations. The use of a smoothly and continuously sloping camming surface to control the transducer position means that the transducer may be positioned substantially anywhere across the width of the tape. In addition, for optimal recording and replaying operation, the transducer positioning motor is bi-directionally operative so that the transducer may be rapidly moved in both directions.

According to the present invention there is provided a cartridge type tape drive for digital data storage use having those features which are set out in Claim 1.

Apparatus in accordance with the invention may, for example, be implemented in either of two known size classifications; i.e., either the now-standard "mini-floppy" package having a five and one-quarter inch (133 mm) "half-high" form factor, or the "micro-mini" package having a three and one-half inch (88.9 mm) form factor. In either case, the unit may be designed to be directly compatible with, and to use, the standard mini-floppy interface. The intended or most preferred form of tape media for use in the apparatus of the invention is the "mini-cartridge" which utilizes tape having a width of 0.150 inches (3.81 mm), for example of the type known commercially as the "DC-100" and, in a cartridge containing a 185-foot (56.4 metre) length of similar tape, apparatus in accordance with the invention will readily provide storage in excess of ten megabytes even in a formatted-type storage arrangement, i.e., of the order of from ten to twenty times the storage capacity typically encountered on one "mini-floppy" disc.

Preferably the transducer-moving linkage means includes pivotally mounted arm apparatus which includes a pivot suspension mounting disposed generally between the cam means and the transducer mounting and guiding means. This mounting may comprise a pair of oppositely-disposed and mutually-spaced pivot shaft extremities, and said main frame may carry a pair of spaced journals each disposed along an opposite side of the frame, said journals rotatably receiving said spaced pivot shaft extremities thereby pivotally supporting said arm apparatus. Preferably also, the arm apparatus includes arm portions extending from the pivotal axis towards the cam means (rearwardly with respect to the main frame), the portions extending convergently towards one another and being interconnected in the area of the cam means, where the cam follower is joined to the arm apparatus. The arm apparatus may include a forwardly-projecting portion (i.e. extending from the axis towards the transducer) and being operatively, and preferably pivotally, coupled with the transducer or the transducer mounting and guiding means. A biasing member may be provided which may act to maintain operative contact between the cam means and the cam follower; the projecting portion and the transducer or transducer-mounting and guiding means; or both of them.

The foregoing advantages and characteristics are obtained through the use of multiple recording tracks on the tape (e.g., eight such tracks on the type of tape indicated, approximately equivalent to track density on the order of 60 tracks per inch or 23.6 per cm), at recording densities on the order of 6,400 bits per inch (2500 per cm). Substantially enhanced performance is preferably achieved through use of "embedded servo" information recorded on the tape media, with closed-loop servo positioning of the transducer (head) in order to accurately follow (i.e., track) along the centerline of each of the multiple recording tracks on the tape, and also to accurately reposition the head at any desired track on the tape, start/stop and random access operation thus being entirely within the capabilities of the unit.

Particular advantageous attributes of the apparatus in accordance with the invention include, in an overall package of exceedingly small physical size, highly reliable and yet completely flexible transducer head-positioning apparatus capable of shifting the head in small increments for accurate positioning and tracking operation and yet capable of accurate and rapid track-to-track or multiple-track head positioning operation. At the same time, highly accurate and consistent tape transport is made possible by the componentry utilized and the component-placement in the physical configuration employed. Additionally, novel and unusual head-positioning arm components and suspension provide for desirable consistency and reliability in positioning and tracking operations.

The invention may be carried into practice in various ways and one specific embodiment will now be described with reference to the drawings, in which:

Figure 1 is an overhead perspective view of a tape drive in accordance with the invention, the electronics circuit-board having been removed to show internal details;

Figure 2 is a bottom plan view of the apparatus shown in Figure 1;

Figure 3 is a fragmentary, rear perspective view showing a portion of the apparatus depicted in Figure 2;

Figure 4 is a fragmentary, perspective view showing a portion of the apparatus depicted in Figure 1;

Figure 5 is an enlarged, overhead plan view of the head-positioning arm assembly utilized in the apparatus of the preceding Figures;

Figure 6 is a front elevational view of the positioning arm assembly shown in Figure 5;

Figure 7 is a right side elevation of the apparatus shown in Figures 5 and 6;

Figure 8 is a cross-sectional elevation taken through the plane VIII-VIII of Figure 5;

Figure 9 is a cross-sectional elevation taken through the plane IX-IX of Figure 5; and

Figure 10 is a cross-sectional elevation taken through the plane X-X of Figure 5.

Referring now in more detail to the drawings, the overall tape drive, designated by the numeral 10 (Figures 1 and 2) will be seen to comprise a generally rectangular main frame 12 which peripherally encloses, and on which is mounted, the various operating components of the drive, the largest of which are a tape-driving capstan motor 14 and a head-positioning stepper motor 16.

As illustrated, the capstan drive motor 14 is preferably located in the underside portion of the frame and generally centrally thereof, and mounted so that the tape-driving capstan 18, which is coupled directly to (or an integral part of) the output shaft of the drive motor 14, extends upwardly and is located in the upper portion of the frame, generally equidistant between the sides thereof and positioned directly behind the front face 20 of the drive, which defines a rectangular aperture 21 through which the tape cartridge is inserted. As will be understood, the tape cartridge is a relatively narrow rectangular object, and when inserted into the drive it is disposed generally coplanar with respect to the main frame 12 and located such that the tape drive access opening in the cartridge lies contiguous with the capstan, so that the latter may engage the tape or tape-driving wheel, within the cartridge. Upon engagement, the capstan motor is caused to pivot near or about its center of mass. Such pivoting is opposed by a spring acting against the motor, thus insuring positive engagement of the motor capstan to the driven wheel within the cartridge. The pivoting of the motor about its center of mass greatly reduces vibration.

The head-positioning stepper motor 16 is mounted and positioned in a manner generally opposite that of the capstan-drive motor 14, i.e., the body of the stepper motor is disposed in the upper portion of the main frame, with the drive shaft extending downwardly into the bottom portion of the frame enclosure. Stepper motor 16 is used to rotate a head-positioning cam 22 (Figures 2 and 3) which is mounted directly on the motor output shaft and which is physically disposed in a position behind the capstan drive motor 14.

The head-positioning cam 22 is preferably a rotary, single-face cam having a central hub portion 24 which receives the drive shaft of the stepper motor 16, and which has a radially-projecting helically-shaped cam face 26 preferably having approximately 300° of rotational surface. In a particular preferred embodiment, the stepper motor 16 provides 1.8° of output shaft rotation per step, and is driven in a "half-stepping" mode, so as to yield 0.9° of rotation each half-step. The rise of the cam face 26 is preferably such as to provide, as described below, one-half mil (0.005 inches or 0.127 mm) of transducer head movement relative to the tape for each such half-step of the stepper motor. With such a configuration, the total excursion of allowable head movement is somewhat greater than the nominal total width of the tape (0.150 inches or 3.81 mm), providing for complete placement and positioning of the head at any point along the width of the tape, commencing from a position alongside the edge of the tape (i.e., not in registry with the tape).

Referring to Figures 1 and 4, a transducer head 28 is fixedly mounted within a head-carrier or slide 30, and the latter is slidably mounted on a pair of cylindrical guide rods 32, 34 which pass through a set of complementary parallel passages in the head carrier 30. Preferably, the guide rods 32 and 34 depend from a retainer or mount 35 secured in place to a cross member 112 of the frame 12. With this arrangement, the head and its carrier remain in precisely-positioned orientation and location with respect to the tape path, immediately alongside the tape drive capstan 18; in this positional relationship, however, the head is shiftable across the width of the tape, as noted above.

The head-positioning motion of the cam 22 is imparted to the head carrier 30 and head 28 through a pivotal control arm 40 shown in operative position in Figure 2, with individual attributes being shown in Figures 2, 3, 5, 6, 7, 8, 9 and 10.

Referring more particularly to the Figures just noted, the control arm assembly 40 comprises a pivotal mounting shaft or axle 42 which is journaled in opposite sides of the main frame 12 at a point generally between the cam 22 and the head and head carrier 30, 28. Extending rearwardly from the axle 42 is a generally V-shaped (or U-shaped) follower portion 44 having a particular cross-sectional configuration to be described more fully hereinafter and carrying a cam follower 46 disposed generally at the apex of the V-shaped configuration and comprising, in effect, a projecting tab extending toward the axle 42. At the end extremity of the cam follower tab 46 is a rounded embossment or attached ball structure (cam contact) 48 which constitutes the element which actually contacts and slides along the inclined cam face 26 of cam 22. The cam contact 48 may actually be a rotatably-mounted ball bearing element if desired, but need not be a rotatable element if the cam face has at least moderately lubricious surface characteristics, as provided for example by polymeric materials such as acetal (which is preferred) or of

the general nature of those materials sold under the marks "Nylon" or "Delrin". Such materials also provide for efficacious manufacture of the cam itself, through injection molding techniques.

Projecting forwardly from one side of the rear portion 44 of the control arm 40 is a head-translating arm extension 50 (Figure 5), having a rounded or spherically-shaped contact element 52 which may be essentially similar to the contact element 48 at the rear portion of the control arm assembly, noted above. The forwardmost portion of the arm extension 50 projects under the transducer head carrier 30 (see Figures 3, 4 and 5), with the contact element 52 in contact with the underside of the head carrier 30 to raise the latter in accordance with downward movement imparted to the rear portion 44 of the control arm assembly 40 by the operation of cam 22 acting upon cam follower 46 through its contact member 48. Such upward head carrier motion is opposed, and returned, by an appropriate spring element 54 (Figures 1 and 4) disposed above the head carrier and mounted upon the frame cross member 112 so that a projecting end portion 55 of the spring bears downwardly against the top of the head carrier with sufficient force to overcome system friction and vibration, but with a small enough spring rate to avoid flexure of the arm.

As may be seen in Figures 5, 6, 7, 9 and 10, the forwardly-projecting arm extension 50 preferably carries an upwardly-concave embossment 56, which reinforces and strengthens the arm extension and thereby avoids flexure thereof in imparting motion to the head and head carrier in the manner noted just above. In this respect, it will be observed that arm extension 50 is preferably an integral portion of the arm structure 44, extending from a side 44b thereof as a curved projection (Figures 5, 7 and 9). This further augments the structural integrity of the overall arm assembly, and helps to avoid such flexure during head-translating actions. Such rigidity or non-flexure of the overall arm assembly is an important factor in the accurate operation of the device, bearing in mind the fact as stated above that it is desirable to accurately control head translation in movements of a half mil (0.127 mm) This performance is further enabled by providing the rear portion 44 of the control arm with a curved, somewhat channel-shaped cross section, particularly illustrated in Figure 8. In this manner, the structure of the overall arm assembly is made to be as light in weight as possible to reduce its susceptibility to vibration, and yet as rigid in performance as possible, while at the same time enabling inexpensive manufacture of the arm by way of a multiple-step stamping operation, commencing with an appropriately-configured flat, narrow strip of sheet metal. To even further augment the structural rigidity and performance of this member, and to further accommodate the severe space limitation imposed by the desired package size, the rearwardly-extending portion 44 thereof progressively narrows as it proceeds toward the cam follower portion 46, thus lending a somewhat trapezoidal configuration to the two sections 44a and 44b (Figure 6) and bringing their rolled or curved lower and upper edges 43 and 45 respectively, closer together in the vicinity of the cam follower projection 46.

Minimization of size and weight, without reduction in strength or performance, and indeed with maximized performance characteristics, will be seen to be carried throughout the design, configuration, and structural attributes of the apparatus in accordance herewith. The numerous attributes involved in the preferred embodiment of the control arm assembly 40 will be apparent from the preceding discussion. Similar considerations will also be apparent upon considering the structural nature of the main frame 12, which as illustrated in Figures 1 and 2 is preferably a double-walled, cross-ribbed structure manufactured by injection molding of a tough, rigid polymeric material such as for example glass-filled polycarbonate. In this manner, the use of a metal casting is avoided without attendant loss of structural rigidity and dimensional stability, and with probable improvement in cost and/or weight characteristics.

Other aspects also contribute significantly to the small size and compactness of the unit, as well as to its reliability and freedom from error-contributing factors. For example, even things as fundamental as the initial choice of the tape drive motor and the head-positioning motor are very important since the physical size and placement of these elements have such an important bearing on the nature and performance of other necessary structural elements. At the same time, however, such basic factors as high standards of performance, long operational life, high reliability, low cost, and of course reliable and plentiful sources of supply, are also of great importance. In this regard, the head-positioning stepper motor 16, as illustrated physically in Figure 1, is perhaps of surprising physical size in relation to the overall size of the tape drive itself, as a result of full consideration of the foregoing factors. To facilitate the very compact arrangement required by the extremely small physical size limitations imposed by the packaging requirements, as noted previously, both the drive motor 14 and the stepper motor 16 are preferably of "pancake" type, having substantially greater width (diameter) than thickness. The preferred stepper motor is a four-phase permanent magnet type which, in the size relation shown, will provide holding torque on the order of 400 grams per

centimeter minimum. As previously indicated, the desired step angle is 1.8° per whole step (0.9° per half step), with 300° of allowable motor rotation, preferably limited by an appropriate stop 27 (Figure 3) on the positioning cam 22, which is configured to come into abutting contact with one or the other side of a fixed stop 29 depending from a rear cross member 212 of the frame 12, one such position of abutment preventing movement beyond the cam position shown in Figure 3 and the other position of abutment performing a like function at the other extremity of cam rotation.

As also illustrated in Figures 1 and 2, the tape-transport drive motor 14 is also of relatively large physical size for such a small tape drive unit. Preferably, this is also a relatively flat pancake-style servo motor, which may be of the type carrying stator coils on a printed circuit-board with commutation by Hall-Effect switching devices. Final drive speed, at the edge of the drive capstan 18, is such that it provides a tape speed on the order of 39 inches per second (99 cms per second), for which a nominal motor output shaft speed of the order of about 1,300 rpm is desirable. This motor should be speed-controlled by closed-loop servo techniques, and thus the motor should employ or embody an integrated tach generator, which may desirably be optical (light-chopping) in nature.

As previously indicated, the cam 22 may simply be of the single-faced variety, with the cam face having a rise factor on the order of forty percent; thus, with 300° of allowable rotation, the overall length of transducer head movement provided by the cam will be on the order of 0.166 inches or 4.22 mms (thus, actually exceeding the total width of the intended tape). Also as previously indicated, both the cam and the tape drive capstan 18 are preferably direct-coupled to their respective motor output shafts, to further enhance precision control and eliminate error source.

The control arm 40, in the type of "architecture" or configuration illustrated, translates the rotational movement of the cam 22 from its location near the rear of the drive to the head carrier 30 and the head 28 mounted therein, which are located at a point relatively closer to the front of the drive, spaced inwardly from the front panel 20 thereof the extent necessary to permit full insertion of the intended tape cartridge, whose width thus corresponds generally to the spacing between the capstan and the front of the main frame.

To span this relatively substantial distance while precluding any significant torsion or bending effects, the control arm 40 has particular attributes of stiffness and rigidity, while at the same time preferably being extremely lightweight. Thus, the arm configuration shown in Figures 5 to 10 inclusive, while unconventional, is very desirable. In this respect, significant and preferable attributes of the arm assembly 40 include its generally pivotal nature and the location of pivot points between the cam and the transducer head, together with the various rolled and stamped shape attributes providing for the desired degree of structural rigidity already noted above. In this respect, it will be noted that the portion of the control arm disposed rearwardly of the pivot axis employs a high degree of structural reinforcement (i.e., rolled curves, bends, etc.), while the forwardly-projecting extension arm 50 includes the long embossment 56.

Although the particular nature of the transducer head 28 may take a number of different forms, the head-positioning components which have been described provide for accurate, incremental control motion sufficient to position a single channel or magnetic gap at any desired position across the entire width of the tape, and preferably alongside as well, for edge-locating procedures. Such a head may employ a one channel, bi-directional read/write magnetic structure, which preferably is of a wide-write, narrow-read character. The effective track width recorded by the head should be of the order of about 0.016 inches (0.41 mm), in order to obtain track densities on the order of about 60 tpi (or 23.6 per centimetre) as indicated above.

As will be understood, the overall operation of a tape drive in accordance herewith is intended to be under the overall control of a master controller constituting the user's primary processor, or operating as a function thereof. Notwithstanding this, a drive in accordance herewith is intended to include its own general operating electronics which, for purposes not particularly or directly involved in the present specification, desirably incorporates a micro-processor for such functions as servo-controlled track seek and centering utilizing embedded servo blocks recorded on the tape media, as well as a variety of other such functions. While the general attributes of such an operating system are well within the skill of the art, a more detailed description of a preferred type of control system is set forth in U.S. Patent 4,472,750, issued September 18, 1984. Preferably, the componentry which constitutes such an operating system is embodied in a PC board which may conveniently be secured atop the main frame, for example to internally-threaded stand-offs 12(a) - 12(d), inclusive (Figure 1), to in effect provide a closure therefor at the same time. Electrical connectors 60, 62 for making the necessary connections to such a circuitboard from the operative components of the drive may be nested within appropriate recesses defined by the frame 12, or otherwise secured with respect thereto. Also, the frame 12, as by its cross arm 112, may support an optical sensor block 64 for end-of-tape and beginning-of-tape sensing functions, as

well as supporting cartridge-present and write-protect switches 66, 68.

Claims

1. A cartridge-type tape drive for digital data storage use having track-seeking and track-following head-positioning capabilities and having an overall size of that of a half-high "mini-floppy" disc drive or smaller, the tape drive comprising in combination: a support frame (12) and means (21) defining a tape cartridge admittance opening; a tape-drive motor (14) of generally flat silhouette and having a height less than its width, the drive motor (14) being supported upon the frame (12); a tape-driving member (18) disposed in axial alignment with and rigidly coupled to an output shaft of the drive motor for rotation thereby, the member being located in coplanar alignment with the cartridge admittance opening so as in use to transport a tape ill a cartridge; a bidirectionally-operative transducer-positioning motor (16) of generally flat silhouette supported upon the frame (12), the positioning motor (16) and the tape-drive motor (14) being disposed generally one behind the other with respect to the cartridge admittance opening and being in mutual alignment therewith; cam means (22) having a smoothly and continuously sloping camming surface (26), the cam means (22) being coupled to the transducer-positioning motor (16) to be driven thereby so as to move the camming surface (26) in desired increments of motion; transducer-moving linkage means (40) extending lengthwise of the frame (12) from the cam means (22) to a location adjacent the tape-driving member (18) for coupling movements of the camming surface (26) to a transducer (28); and transducer-mounting and guiding means (30,32,34) adjacent the tape-driving member, for movably mounting the transducer at the said location and guiding movement of the transducer transversely across the path of a tape at the tape-driving member (18); the transducer-moving linkage means (40) being operatively coupled to the transducer (28) to impart bi-directional movement thereto guided by the transducer-mounting and guiding means (30,32,34); the transducer position being thereby minutely variable in either direction by means of a servo control excitation applied to the transducer-positioning motor (16) to enable the transducer to follow the position of a recorded track extending lengthwise along a tape but having generally transverse deviations; and the transducer further arranged to be controllably positioned at substantially any transverse location across the width of a tape.

2. A tape drive in accordance with Claim 1 wherein the tape-drive motor (14) is disposed in a location immediately adjacent the cartridge-admittance opening and the transducer-positioning motor (16) is disposed rearwardly of the tape-drive motor with respect to the cartridge-admittance opening; the transducer-moving linkage means (40) comprising an elongated member extending lengthwise of the frame past at least portions of the tape-drive motor (14) to a location generally adjacent the tape-driving member (18).

3. A tape drive in accordance with any one of the preceding claims wherein the cam means (22) comprises a rotary cam member.

4. A tape drive in accordance with any one of the preceding claims wherein the transducer-moving linkage means (40) includes pivotally-mounted arm apparatus.

5. A tape drive in accordance with Claim 4 wherein the arm apparatus includes a pivotal axis (42) disposed generally between the cam means (22) and the transducer (28).

6. A tape drive in accordance with Claim 4 or Claim 5, wherein the arm apparatus includes arm portions (44a, 44b) extending from the pivotal axis (42) towards the cam means (22), the arm portions extending convergently toward one another and being interconnected in the area of the cam means.

7. A tape drive in accordance with Claim 4 or Claim 5 or Claim 6 wherein the arm apparatus includes a portion (50) projecting forwardly of the axis (42) towards the transducer (28), and being operatively coupled to the transducer (28) or to the transducer-mounting and guiding means (30).

8. A tape drive in accordance with any one of the preceding claims including biasing means (54) to urge either the cam means (22) and the linkage means (40) together; or the linkage means (40) and the transducer mounting and guiding means (30) together; or both of these.

9. A tape drive in accordance with any one of Claims 4 to 8, wherein the arm apparatus comprises a member formed from sheet-like material having a plurality of integral longitudinally extending portions (56) which are angularly-disposed relative to one another, for



well as supporting cartridge-present and write-protect switches 66, 68.

Claims

1. A cartridge-type tape drive for digital data storage use having track-seeking and track-following head-positioning capabilities and having an overall size of that of a half-high "mini-floppy" disc drive or smaller, the tape drive comprising in combination: a support frame (12) and means (21) defining a tape cartridge admittance opening; a tape-drive motor (14) of generally flat silhouette and having a height less than its width, the drive motor (14) being supported upon the frame (12); a tape-driving member (18) disposed in axial alignment with and rigidly coupled to an output shaft of the drive motor for rotation thereby, the member being located in coplanar alignment with the cartridge admittance opening so as in use to transport a tape ill a cartridge; a bidirectionally-operative transducer-positioning motor (16) of generally flat silhouette supported upon the frame (12), the positioning motor (16) and the tape-drive motor (14) being disposed generally one behind the other with respect to the cartridge admittance opening and being in mutual alignment therewith; cam means (22) having a smoothly and continuously sloping camming surface (26), the cam means (22) being coupled to the transducer-positioning motor (16) to be driven thereby so as to move the camming surface (26) in desired increments of motion; transducer-moving linkage means (40) extending lengthwise of the frame (12) from the cam means (22) to a location adjacent the tape-driving member (18) for coupling movements of the camming surface (26) to a transducer (28); and transducer-mounting and guiding means (30,32,34) adjacent the tape-driving member, for movably mounting the transducer at the said location and guiding movement of the transducer transversely across the path of a tape at the tape-driving member (18); the transducer-moving linkage means (40) being operatively coupled to the transducer (28) to impart bi-directional movement thereto guided by the transducer-mounting and guiding means (30,32,34); the transducer position being thereby minutely variable in either direction by means of a servo control excitation applied to the transducer-positioning motor (16) to enable the transducer to follow the position of a recorded track extending lengthwise along a tape but having generally transverse deviations; and the transducer further arranged to be controllably positioned at substantially any transverse location across the width of a tape.

2. A tape drive in accordance with Claim 1 wherein the tape-drive motor (14) is disposed in a location immediately adjacent the cartridge-admittance opening and the transducer-positioning motor (16) is disposed rearwardly of the tape-drive motor with respect to the cartridge-admittance opening; the transducer-moving linkage means (40) comprising an elongated member extending lengthwise of the frame past at least portions of the tape-drive motor (14) to a location generally adjacent the tape-driving member (18).

3. A tape drive in accordance with any one of the preceding claims wherein the cam means (22) comprises a rotary cam member.

4. A tape drive in accordance with any one of the preceding claims wherein the transducer-moving linkage means (40) includes pivotally-mounted arm apparatus.

5. A tape drive in accordance with Claim 4 wherein the arm apparatus includes a pivotal axis (42) disposed generally between the cam means (22) and the transducer (28).

6. A tape drive in accordance with Claim 4 or Claim 5, wherein the arm apparatus includes arm portions (44a, 44b) extending from the pivotal axis (42) towards the cam means (22), the arm portions extending convergently toward one another and being interconnected in the area of the cam means.

7. A tape drive in accordance with Claim 4 or Claim 5 or Claim 6 wherein the arm apparatus includes a portion (50) projecting forwardly of the axis (42) towards the transducer (28), and being operatively coupled to the transducer (28) or to the transducer-mounting and guiding means (30).

8. A tape drive in accordance with any one of the preceding claims including biasing means (54) to urge either the cam means (22) and the linkage means (40) together; or the linkage means (40) and the transducer mounting and guiding means (30) together; or both of these.

9. A tape drive in accordance with any one of Claims 4 to 8, wherein the arm apparatus comprises a member formed from sheet-like material having a plurality of integral longitudinally extending portions (56) which are angularly-disposed relative to one another, for

augmenting beam strength and reducing flexure of the arm apparatus during transducer-moving operation.

Patentansprüche

1. Kassettenbandantrieb zur Verwendung beim Speichern digitaler Daten, welcher Spursuch- und Spumachführ-Kopfpositionicrungsfähigkeiten sowie eine Gesamtgröße eines halbhohen "Mini-Floppy"-Diskettenlaufwerkes oder kleiner aufweist, wobei der Bandantrieb in Kombination umfaßt: einen Trägerrahmen (12) und ein Mittel (21), welches eine Bandkassetteneinlaßöffnung begrenzt; einen Bandantriebsmotor (14) mit im allgemeinen flachen Umrissen und einer Höhe, die kleiner als seine Breite ist, wobei der Antriebsmotor (14) auf dem Rahmen (12) aufliegt; ein Bandantriebsglied (18), welches in axialer Ausrichtung mit und starrer Verbindung an einer Abtriebswelle des Antriebsmotors zum Antrieb von demselben angeschlossen ist, wobei das Glied in koplanarer Ausrichtung mit der Kassetteneinlaßöffnung angeordnet ist, um im Betrieb ein Band in einer Kassette zu transportieren; einen bidirektional wirksamen Signalumformerpositioniermotor (16) mit im allgemeinen flachen Umrissen, welcher auf dem Rahmen (12) aufliegt, wobei der Positioniermotor (16) und der Bandantriebsmotor (14) im allgemeinen in bezug auf die Kassetteneinlaßöffnung hintereinander und in gegenseitiger Ausrichtung mit dieser angeordent sind; ein Nockenmittel (22), welches eine glatt und kontinuierlich geneigte Eingriffsoberfläche (26) aufweist, wobei das Nockenmittel (22) an den Signalumformerpositioniermotor (16) gekoppelt ist, um von diesem zur Bewegung der Eingriffsoberfläche (26) in gewünschten Bewegungsschritten angetrieben zu werden; Signalumformerbewegungs-Verbindungsmittel (40), welche sich in Längsrichtung des Rahmens (12) vom Nockenmittel zu einer Stelle erstrecken, welche dem Bandantriebsglied (18) benachbart ist, zum Koppeln der Bewegungen der Eingriffsoberfläche (26) an einen Signalumformer (28); und Signalumformerbefestigungs- und -führungsmittel (30, 32, 34), welche dem Bandantriebsmittel benachbart sind, zum beweglichen Befestigen des Signalumformers an der genannten Stelle und zur geführten Bewegung des Signalumformers quer über die Bahn eines Bandes beim Bandantriebsglied (18); wobei das Signalumformerbewegungs-Verbindungsmittel (40) mit dem Signalumformer (28) operativ verbunden ist, um ihn mit bidirektionaler Bewegung zu beaufschlagen, welche durch die Signalumformerbefestigungs- und -führungsmittel (30, 32, 34) gelenkt wird; wobei die Position des Signalumformers dadurch in jeder Richtung mittels einer Servosteuererregung genauestens regelbar ist, die an den Signalumformerpoistioniermotor (16) angelegt wird, um zu ermöglichen, daß der Signalumformer der Position einer Aufnahmespur folgt, welche sich in Längsrichtung eines Bandes erstreckt, aber im allgemeinen Abweichungen in Querrichtung aufweist; und wobei der Signalumformer des weiteren angeordnet ist, um steuerbar an im wesentlichen jeder Position in Querrichtung über die gesamte Breite des Bandes positioniert zu werden.

2. Bandantrieb nach Anspruch 1, bei welchem der Bandantriebsmotor (14) an einer Stelle angeordnet ist, welche der Kassetteneinlaßöffnung unmittelbar benachbart ist, und der Signalumformerpositioniermotor (16) in bezug auf die Kassetteneinlaßöffnung hinter dem Bandantriebsmotor angeordnet ist; das Signalumformerbewegungs-Verbindungsmittel (40) ein längliches Glied aufweist, welches sich in der Längsrichtung des Rahmens zumindest vorbei an Abschnitten des Bandantriebsmotors (14) zu einer Stelle erstreckt, welche im allgemeinen dem Bandantriebsglied (18) benachbart ist.

3. Bandantrieb nach irgendeinem der vorangegangenen Ansprüche, bei welchem das Nokkenmittel (22) ein Drehnockenglied aufweist.

4. Bandantrieb nach irgendeinem der vorangehenden Ansprüche, bei welchem das Signalumformerbewegungs-Verbindungsmittel (40) eine drehbar gelagerte Armeinrichtung umfaßt.

5. Bandantrieb nach Anspruch 4, bei welchem die Armeinrichtung eine Drehachse (42) aufweist, welche im allgemeinen zwischen dem, Nokkenmittel (22) und dem Signalumformer (28) angeordnet ist.

6. Bandantrieb nach Anspruch 4 oder Anspruch 5, bei welchem die Armeinrichtung Armabschnitte (44a, 44b) aufweist, welche sich von der Drehachse (42) zum Nockenmittel (22) hin erstrecken, wobei sich die Armabschnitte konvergierend zueinander erstrecken und im Bereich des Nockenmittels miteinander verbunden sind.

7. Bandantrieb nach Anspruch 4 oder Anspruch 5 oder Anspruch 6, bei welchem die Armeinrich-

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tung einen Abschnitt (50) umfaßt, welcher von der Achse (42) zum Signalumformer (28) vorragt und operativ an den Signalumformer (28) oder an das Signalumformerbefestigungs- und -führungsmittel (30) gekoppelt ist.

8. Bandantrieb nach irgendeinem der vorangehenden Ansprüche, umfassend Vorspannungsmittel (54), um entweder das Nockenmittel (22) und das Verbindungsmittel (40) oder das Verbindungsmittel (40) und das Signalumformerbefestigungs- und -führungsmittel (30) oder beide zusammenzudrücken.

9. Bandantrieb nach irgendeinem der Ansprüche 4 bis 8, bei welchem die Armeinrichtung ein Glied aufweist, welches aus einem blattartigen Material gebildet ist, welches eine Vielzahl an angeformten, sich in Längsrichtung erstreckenden Abschnitten (56), welche in bezug zueinander winkelig angeordnet sind, zum Verstärken der Balkenfestigkeit und zum Senken der Durchbiegung der Armeinrichtung während der Signalumformerbewegungsfunktion aufweist.

Revendications

1. Lecteur de bande du type en cassette pour le stockage de données numériques comportant des moyens de positionnement d'une tête pour la recherche des pistes et pour le suivi des pistes et présentant une dimension hors tout égale à celle d'un lecteur de disquette "mini-floppy" de demi-hauteur ou une dimension inférieure, le lecteur de bande comprenant en combinaison : un bâti de support (12) et un moyen (21) délimitant une ouverture d'admission d'une cassette de bande; un moteur d'entraînement de bande (14) de silhouette généralement plate et d'une hauteur inférieure à sa largeur, le moteur d'entraînement (14) étant supporté sur le bâti (12); un organe d'entraînement de bande (18) disposé en ligne axiale avec un arbre de sortie du moteur d'entraînement et accouplé rigidement à celui-ci en vue d'être entraîné en rotation, cet organe étant en ligne dans le même plan avec l'ouverture d'admission de cassette de manière à transporter en service une bande dans une cassette; un moteur de positionnement de transducteur (16) pouvant opérer dans les deux sens, de silhouette généralement plate, supporté sur le bâti (12), le moteur de positionnement (16) et le moteur d'entraînement de bande (14) étant disposés en substance l'un derrière l'autre par rapport à l'ouverture d'admission de cassette et étant mutuellement en ligne avec celle-ci; une came (22) présentant une surface à effet de cane en pente douce et continue (26), la came (22) étant accouplée au moteur de positionnement de transducteur (16) en vue d'être entraînée par celui-ci de manière à déplacer la surface de came (26) selon des incréments de mouvement souhaités; une liaison mécanique de déplacement de transducteur (40) qui s'étend dans le sens longitudinal du bâti (12) depuis la came (22) jusqu'à un endroit adjacent à l'organe d'entraînement de bande (18) pour coupler des déplacements de la surface à effet de came (26) à un transducteur (28); et des moyens de montage et de guidage de transducteur (30, 32, 34) adjacents à l'organe d'entraînement de bande, pour monter le transducteur de façon mobile audit endroit et pour guider le déplacement du transducteur transversalement au trajet d'une bande au niveau de l'organe d'entraînement de bande (18); la liaison mécanique de déplacement de transducteur (40) étant activement accouplée au transducteur (28) pour lui communiquer un mouvement bidirectionnel guidé par les moyens de montage et de guidage de transducteur (30, 32, 34); la position du transducteur pouvant ainsi être modifiée peu à peu dans un sens ou dans l'autre à l'intervention d'une excitation de servocommande appliquée au moteur de positionnement de transducteur (16) afin de permettre au transducteur de suivre la position d'une piste enregistrée qui s'étend dans le sens longitudinal d'une bande, mais qui présente des déviations généralement transversales; et le transducteur étant, en outre, conçu de manière à être positionné de façon réglable en substance en n'importe quel endroit transversal dans le sens de la largeur d'une bande.

2. Lecteur de bande suivant la revendication 1, dans lequel le moteur d'entraînement de bande (14) est disposé en un endroit immédiatement adjacent à l'ouverture d'admission de cassette et le moteur de positionnement de transducteur (16) est disposé à l'arrière du moteur d'entraînement de bande par rapport à l'ouverture d'admission de cassette; la liaison mécanique de déplacement de transducteur (40) comprenant un long élément qui s'étend dans le sens longitudinal du bâti en regard d'au moins des parties du moteur d'entraînement de bande (14) vers un endroit généralement adjacent à l'organe d'entraînement de bande.

3. Lecteur de bande suivant l'une quelconque des revendications précédentes, dans lequel la

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came (22) est une came rotative.

4. Lecteur de bande suivant l'une quelconque des revendications précédents, dans lequel la liaison mécanique de déplacement de transducteur (40) comprend un dispositif à bras monté à pivotement.

5. Lecteur de bande suivant la revendication 4, dans lequel le dispositif à bras comprend un axe de pivotement (42) disposé d'une manière générale entre la came (22) et le transducteur (28).

6. Lecteur de bande suivant la revendication 4 ou 5, dans lequel le dispositif à bras comprend des parties de bras (44a, 44b) partant de l'axe de pivotement (42) et s'étendant en direction de la came (22), les parties de bras convergeant l'une vers l'autre et étant reliées l'une à l'autre dans la zone de la came.

7. Lecteur de bande suivant la revendication 4, 5 ou 6, dans lequel le dispositif à bras comprend une partie (50) qui s'étend vers l'avant de l'axe (42) vers le transducteur (28) et qui est couplée activement au transducteur (28) ou au moyen de montage et de guidage de transducteur (30).

8. Lecteur de bande suivant l'une quelconque des revendications précédentes, comprenant un moyen de rappel élastique (54) pour solliciter la came (22) et la liaison mécanique (40) l'une vers l'autre ou la liaison mécanique (40) et le moyen de guidage et de montage de transducteur (30) l'un vers l'autre ou les deux à la fois.

9. Lecteur de bande suivant l'une quelconque des revendications 4 à 8, dans lequel le dispositif à bras comprend un élément en tôle comportant plusieurs parties longitudinales qui en font partie intégrante (56) et qui sont disposées angulairement l'une par rapport à l'autre pour augmenter la résistance à la flexion et réduire la flexion du dispositif à bras pendant l'opération de déplacement de transducteur.