FLEX CIRCUIT HEAD MODULE WITHIN A TAPE DRIVE

Field of the Invention

The present invention relates to flex circuits. More particularly, the present invention relates to a flex circuit head module providing electronic signal paths between a positionable tape head array and a main circuit module of a digital linear tape drive.

Background of the Invention

Tape recording and reproducing systems for use as computer data storage devices are required to provide increasingly high data transfer rates and to perform a read verification upon all data being written to tape. Streaming tape drives are so named because multiple blocks of user data are typically written to tape in a single streaming operation, rather than as a series of start-stop operations. Digital linear tape drives are an improved species of streaming tape drives.

In order to increase data density in streaming tape drive systems, track widths are decreasing, while data transfer rates are increasing. It is practical to provide e.g. approximately 128 linear data tracks within a one-half inch wide tape with current technology. One way to increase track densities is to employ azimuth recording techniques in which the tape head structure is canted at a particular offset angle relative to longitude and direction of travel of the tape. At the same time, the digital linear tape drive should be backwardly compatible with tapes which may have been recorded with conventional longitudinal recording techniques. Azimuth recording technology, together with a continuing requirement for backward compatibility, has resulted in tape head structures which include a higher number of write elements, and has required a more complex head positioning mechanism which provides both transverse (up and down) as well as azimuth angle positioning of the tape head structure.

With a relatively high number of narrow-width data tracks, great care must be taken in accurately positioning the tape head structure and in providing efficient electronics for amplifying signals read back by read

elements from the tape, and for driving write head elements with signals to be written to the tape. Also, interconnecting read and write data signals between a tape head array and associated electronics poses several concerns. These concerns include susceptibility to electrical noise and crosstalk between channels, parasitic capacitance and inductance, mechanical forces unwantedly applied to the head positioning mechanism, cabling and manufacturing costs, head maintenance and upgrades, and availability of circuit board space.

Flex circuits have been used in the mass storage art to provide flexible electrical connections to magnetic recording/playback heads. Flex circuits have been frequently employed in hard disk drives to provide flexible circuit connections, as well as a mounting substrate for carrying discrete and integrated electronics circuitry in order to position playback preamplifier circuitry close to the read head elements in order to improve signal to noise ratios. One example of a flex circuit for a hard disk drive employing a rotary voice coil head positioner is given in U.S. Patent No. 5,055,969 to Putnam, entitled: "Servo/Data Actuator Arm Flexible Circuit", the disclosure being incorporated herein by reference.

Flexible substrates providing flexible circuit paths have also been proposed for use with tape recording systems. Examples include U.S. Patent No. 5,134,252 to Himeno et al., entitled: "Signal Line", and U.S. Patent No. 5,051,366 to Anderson et al, entitled: Electrical Connector". The Himeno et al. patent describes a flexible circuit carrying magnetically shielded signal paths between a rotary head drum of a digital audio tape recorder and external read preamplifier/write driver circuitry. The Anderson et al. patent describes a connector mechanism for interconnecting flexible circuits of a tape head module to flexible circuits extending from separate read and write circuit cards of e.g. an IBM 3490 Tape Drive. While these patents suggest the use of flexible circuits within tape drives, they do not overcome or suggest any solutions to a number of serious problems confronting streaming tape drives for azimuth as well as longitudinal recording, achieved with a multi-dimension positionable head structure.

Summary of the Invention with Objects

One object of the present invention is to improve performance of read preamplifier and write driver circuitry by reducing capacitance, by increasing resonance and data speed, and by reducing electrical noise with a flex circuit overcoming limitations and drawbacks of prior approaches.

Another object of the present invention is to provide a flex circuit which is transparent to a main circuit module, thereby enabling design flexibility over prior approaches, including performance improvement changes, cost reduction changes, and a number of versions for different types of heads whether ferrite core, thin film or magnetoresistive.

A further object of the present invention is to provide a flex circuit arrangement which may readily be improved and evolved to greater levels of circuit integration in order to improve performance, and to reduce costs and space requirements in a manner overcoming limitations of prior approaches.

One more object of the present invention is to reduce and make more uniform and controllable certain external forces applied to the head positioning mechanism by head structure circuit connections and thereby achieve an improved alternative to cables, which, in one embodiment disclosed hereinafter would otherwise comprise at least twelve shielded twisted wire triplets.

Yet another object of the present invention is to provide a complete, separately testable read preamplifier/write driver module upon a flex circuit for a tape drive in a manner enabling reduction of overall drive manufacturing and maintenance costs.

Still one more object of the present invention is to free up real estate on main circuit module for other circuit elements by providing a stand-alone flex circuit subassembly carrying connections to a head structure of a streaming tape drive and read preamplifier and write driver circuitry in a manner overcoming limitations and drawbacks of prior approaches.

Yet one more object of the present invention is to provide a flex circuit for a multi-track tape head module that does not require any special magnetic or electrostatic shielding.

In one aspect of the present invention, a flex circuit for a tape drive includes an elongated flexible printed circuit substrate carrying a pattern of electrical circuit interconnections and divided into three portions; namely, a read channel portion for direct connection to multiple read and write heads of a tape head array and carrying a plurality of read channel preamplifiers connected to receive read signals from a plurality of read heads; a write channel portion including an external connection region for enabling signal and power connections to be made with a host circuit module, the write channel portion including a plurality of write channel drivers for driving the write heads, and a dynamic flexing portion separating and interconnecting the read channel portion and the write channel portion, the dynamic flexing portion adjusting in contour as positional adjustments are made to the head array.

Within this aspect of the present invention, the flex circuit may further include head selection logic circuitry for selecting and enabling particular ones of the write heads in accordance with positional adjustments made to the head array and in accordance with a direction of tape movement during operations of the tape drive. Also, the flex circuit may include a mechanical reinforcement layer for mechanically stiffening and reinforcing the read channel portion and the write channel portion, thereby controlling flexure mechanics within the dynamic flexing portion.

In a related aspect of the present invention, a multi-track magnetic tape head assembly for a tape drive includes a head mounting plate, a head array secured to the head mounting plate and defining a plurality of write heads and a plurality of read heads, and an elongated flex circuit. The flex circuit has a first end attached to the head mounting plate and connected to the write and read heads. A second end of the flex circuit defines a connection region for connection of power, data, and control signals from and to a main electronics circuit module of the tape drive. The flex circuit

is divided into a read channel portion for direct connection to multiple read and write heads of the head array and for carrying a plurality of read channel preamplifiers connected to receive and amplify read signals from a plurality of read heads, a write channel portion including the second end connection region and including a plurality of write channel drivers for driving write heads in accordance with data signals to be written to a recording tape, and a dynamic flexing portion separating and interconnecting the read channel portion and the write channel portion, the dynamic flexing portion adjusting in contour as positional adjustments are made to the head array relative to a base of the tape drive.

In this aspect of the invention the flex circuit may further comprise head selection logic circuitry for selecting and enabling particular ones of the write heads in accordance with positional adjustments made to the head array and in accordance with a direction of tape movement.

In yet a further related aspect of the present invention, a magnetic tape drive includes a base and a tape take-up reel and cartridge receiver for receiving and engaging a single supply reel tape cartridge. The tape drive also includes a multi-track magnetic head array having a plurality of forward direction write elements located on one side of the array, a plurality of reverse direction write elements located on another side of the array, and a plurality of read elements located centrally between the forward direction write elements and the reverse direction write elements. The head array is secured to head mounting plate, and an elongated flex circuit has a first end attached to the head mounting plate and connected to the write and read heads, and has a second end defining a connection region for connection to a main electronics circuit module of the tape drive. The flex circuit is divided into a read channel portion for direct connection to the plurality of read elements and write elements of the head array and carrying a plurality of read channel preamplifiers connected to receive read signals from a plurality of read elements, a write channel portion including the external connection region and a plurality of write channel drivers connected to drive the plurality of write elements, and a dynamic flexing portion separating and interconnecting the read channel portion and the write channel portion, the dynamic flexing portion

adjusting in contour as positional adjustments are made to the head array relative to a base of the tape drive; and, a head positioning mechanism secured to the base including a receiver for receiving the head mounting plate in a predetermined relationship, for positioning the head array in at least a dimension substantially perpendicular to a major plane of the base.

In this aspect of the invention the head positioning mechanism may be adapted to position the head array at plural predetermined azimuth angles as well as in the perpendicular dimension. Also in this aspect of the invention the dynamic flexing portion separating and interconnecting the read channel portion and the write channel portion may follow a generally U-shape contour therebetween when the flex circuit is installed between the head plate and the main electronics circuit module of the tape drive.

These and other objects, aspects, advantages and features of the present invention will be more fully understood and appreciated upon consideration of the accompanying drawings in accordance with the following detailed description thereof.

Brief Description of the Drawings

In the Drawings:

Fig. 1 is a diagrammatic plan view of a digital linear tape drive including a flex circuit for connecting the read and write head array in accordance with principles of the present invention.

Fig. 2 is a diagrammatic flat planar view of the head connection flex circuit shown in Fig. 1 omitting reinforcing layers which contour the flex circuit for installation and use in the Fig. 1 tape drive.

Fig. 3 is an exploded diagrammatic view of the Fig. 2 flex circuit as formed with selective structural reinforcing layers to follow a desired operational orientation relative to a head array and plate structure of the Fig. 1 tape drive.

Fig. 4 is an enlarged view of a face of the tape head array shown in Fig. 3.

Fig. 5 is an electrical block diagram of the Fig. 2 flex circuit.

Fig. 6 an electrical schematic and block diagram of one read channel circuit within the Fig. 2 flex circuit.

Fig. 7 is an electrical logic and schematic circuit diagram of head select logic and a forward/reverse head write channel driver circuit of the Fig. 2 flex circuit.

Detailed Description of a Preferred Embodiment

Fig. 1 illustrates a digital linear tape drive 100 for receiving a single-reel tape cartridge 102. The tape drive 100 includes a multi-dimensional tape head actuator 104 for providing elevation and azimuthal adjustments to a magnetic read/write head structure 120. As shown in Fig. 3, the tape head actuator 104 includes an elevation mechanism 105 comprising e.g. a stepper motor 107 and lead screw 109, and an azimuth angle rotary adjustment mechanism 111 positioned by the elevation mechanism 105. The elevation mechanism 105 may be substantially in accordance with commonly assigned U.S. Patent No. 5,448,438 to Kasetty, entitled: "Head Actuator Having Spring Loaded Split Nut"; and the azimuth mechanism 111 may be substantially in accordance with commonly assigned U.S. Patent Application Serial No. 08/557,662 by Kasetty, filed on November 13, 1995, and entitled: "Head Tilting Mechanism for Tape Drives", the disclosures thereof being incorporated herein by reference.

As shown in Fig. 1 the tape drive 100 includes tape reel drive motors 106 and 108 (indicated in dashed outlines and lead lines) arranged to rotate tape reel cartridge 110 and internal take-up reel 112, respectively, to advance magnetic tape 114 back and forth across the head structure 120. The tape drive 100 also includes tape guide rollers 118 that define a generally arcuate tape path between reels 110 and 112 along which tape 114 travels as it moves across the magnetic head structure 120. The tape head actuator 104 operates upon commands decoded within the drive 100

to position the magnetic head structure 120 laterally for track selection, and angularly for azimuth angle recording and playback relative to the tape 114 during operation of the drive 100.

In accordance with aspects of the present invention, a flex circuit 122 is attached by two screws 124 to a head plate 126 of the head structure 120, the head plate 126 for mounting and aligning a read/write head array 128, shown in greater detail in Fig. 4. The head plate 126 is positioned by the elevation mechanism 105 and by the azimuth adjustment mechanism 111, and thereby positions the head array 128 in elevation (laterally) and angularly relative to the tape 114. The head array 128 is affixed to the head plate 126 by a suitable adhesive upon being precisely aligned thereto during assembly.

The flex circuit 122 includes three major structural and functional portions, a read channel portion 130, a dynamic flexibility portion 132, and a main head select/write channel portion 134. The read channel portion 130 is mounted directly adjacent to the head array 128 in order to minimize conductor lengths to read heads and to minimize capacitance, inductance and pickup of extraneous noise. The main head select/write channel portion 134 includes an edge connection region 136 which enables a direct connection to a tape drive main circuit board mounted below a base 140 via a zero insertion force (ZIF) connector. As shown in Fig. 1 the edge connection region 136 extends through a narrow slot defined in a wall of the base 140. Fig. 2 illustrates the flex circuit 122 in a layout or plan view, while Fig. 3 illustrates the flex circuit 122 in a reinforced, operational position relative to the head plate 126 and head array 128.

The head array 128 includes e.g. four relatively narrow read heads 142A, 142B, 142C and 142D which are spaced apart along a center transverse contour 144 of the head array 128. In this example, there are four read channels: channels 1, 2, 3, and 4. The head array also includes e.g. eight relatively wide write heads, with four write heads 146A, 146B, 146C and 146D located along a left transverse contour 148, and four write heads 150A, 150B, 150C, and 150D, located along a right transverse contour 152. The write heads 146A-D write data to tape traveling in a

forward direction from the supply reel 110 to the take-up reel 112, and the write heads 150A-D write data to tape traveling in a reverse or backward direction from the take-up reel 112 to the supply reel 110. In either direction of travel, the read heads 142 follow the selected write heads and thereby enable a read-after-write verification of data streamed to tape 114. In an azimuthal mode of operation the head 128 is tilted to a predetermined azimuth angle relative to the tape, and, depending on direction of tape travel, four write heads 146 or 150 and the four read heads 142 are active. In the azimuth mode, four tracks are simultaneously written and read during a single transport of the tape 114 past the head array 128.

For backward compatibility with tapes previously written in a non-azimuth, conventional longitudinal format, the head array 128 is oriented in a perpendicular alignment with the tape 114, and two write heads 146B and 146D, or heads 150B and 150D are active, and two read heads 142A and 142C are also active, so that two tracks may be written and read after write in accordance with the longitudinal format. Thus, the head array 128 requires a maximum of four active write channels and four active read channels during azimuthal operations. The head array 128 may be fabricated in accordance with commonly assigned U.S. Patent No. 5,475,553 to Saliba, entitled: "Tape Head with Self-Regulating Wear Regions"; and, in accordance with commonly assigned U.S. Patent Application Serial No. 08/507,618 by Saliba, filed on July 26, 1995, entitled: "Method and Apparatus for Multiple Channel Head", the disclosures thereof being incorporated herein by reference.

The flex circuit 122 provides e.g. four write driver channels feeding the 8 write elements 146A-D and 150A-D, and four read channels receiving signals from the four read elements 142A-D, as well a certain digital logic elements for head select in accordance with tape direction and azimuthal/longitudinal tape format. The read channel region 130 includes four single channel read preamplifier integrated circuits 160 and associated discrete components as well as an edge connection region 162 enabling short, direct signal connections to e.g. minute head wires leading from the read heads 142, as well as connections to e.g. minute head wires of the write heads 146 and 150. Alternatively, suitable bridge connections may

be formed between circuit traces defined on the head array 128 and aligned circuit traces of the connection region 162. Two pass-through openings 164 enable the screws 124 to pass through the flexible plastic film substrate of the flex circuit 122 and into threaded openings of the head plate 126 as shown in Fig. 3. At least one of the openings 164 includes a grounding signal trace which cooperates with one of the screws 124 to facilitate a signal ground point for the flex circuit to the conductive metal head plate 126.

The flexible dynamic portion 132 of the flex circuit 122 manifests a general U-shape following installation and during operation, as the head plate 126 moves up and down during track selection positioning operations of the elevational adjustment assembly 105, and from side to side during azimuth angle positioning operations of the azimuth angle control mechanism 111. The flexible dynamic portion 132, while being made of very flexible plastic film material, carries a multiplicity of signal and power connection paths between the read channel portion 130 and the main write channel portion 134. These paths include both write and read signal paths. The flexible dynamic portion 132 should be able to withstand at least one million flexural cycles before breakdown or failure.

In order to control precisely the application of bias force to the overall head structure 104, and to prevent the flex circuit 122 from being damaged by repeated head positioning operational cycles, the read channel portion 130 and including a generally trapezoidal segment 137 extending therefrom, and the main write channel portion 134 and including an angular segment 133, extend to both ends of the dynamic flex portion 132 and comprise a suitable integral backing substrate, such as a built-up laminar construction having a thin sheet aluminum alloy core. Fig. 3 illustrates a reinforcement layer 131 for the read channel portion 130 and segment 137, and a reinforcement layer 135 for the main write channel portion 134 and segment 133. The laminar construction may include alternating layers of thin (e.g. 1 mil thickness) polyimide plastic film (Kapton™), adhesive, copper circuit traces, plastic film insulation layer, and the aluminum core which provides desired rigidity to the reinforced portions 130 and 134. As formed, the flex circuit 122 follows a two layer

etched circuit pattern design. Reinforcement of the portions 130 and 134 ensures that only the flexible dynamic portion 134 actually flexes, and that it flexes in a known, controlled manner in response to head positioning movements of the head positioner 104. Also, reinforcement of the portions 130 and 134 provides protection of the electronics circuit elements during handling of the flex circuit 122 incident to installation into, or removal from, the tape drive 100.

The main head select/write channel portion 134 comprises a combination of discrete and integrated electronics circuit elements including digital selection logic elements 166 and write current sources 168. A bar-coded sticker 170 may be affixed along an upper edge of the main portion 134 to facilitate head/flex circuit subsystem assembly, test and tracking.

It will be appreciated upon consideration of Fig. 3, that the head plate 126 includes two side tabs 127 which enable precise registration with a receiver structure of the bi-dimensional head adjustment mechanism 104, thereby facilitating removal and replacement of the head plate 126, head array 128, and flex circuit 122 as a single modular unit. One important aspect of the present invention is that the flex circuit 122 may be fully assembled, checked out, connected to the head array 128 and tested as a completed head/front end electronics subassembly before being installed in the tape drive 100, thereby ensuring operability and increasing reliability and quality of the completed tape drive. Also, because the flex circuit 122 carries all of the "front end" read/write channel electronics, it, with the head plate 126 and head array 128, may be readily replaced and/or upgraded as a unitary module. In this manner, the head subassembly of the tape drive may be changed or replaced, depending upon head wear, or the desire to upgrade the head array 128 to accommodate future tape formats, emergent tape head technologies, etc.

Fig. 5 provides an electrical block diagram of the flex circuit 122. Therein, the edge connector 136 is shown providing connections for four differential read data signal paths, four logic signal paths, and four differential write data paths. The four read data signal paths lead from the

read channel portion 130 of the flex circuit, via the flexible dynamic portion 132 and main circuit portion 134. The four logical mode select signals include a mode select A signal for controlling a single-channel backward-compatibility multiplexer 172 located in the read channel portion, which selects heads 142A or 142C for earlier single-channel tape record formats, and which enables read heads 142A, 142B, 142C and 142D for four channel playback of azimuth angle record formats.

Mode select lines B, C and L control the mode select logic 166 such that four of eight write heads 146A-D or 150A-D are enabled during azimuthal bidirectional writing operations, while two of the eight write heads, e.g. heads 146B and 146D, or 150B and 150D, are enabled during longitudinal bidirectional writing operations. Not shown in the Fig. 5 block diagram, but present in the flex circuit 122 are appropriate power traces for supplying power to the various electronics elements carried on, and connected by, the flex circuit substrate.

Fig. 6 is a schematic circuit diagram of one of the four read preamplifier channel circuits carried on the read channel portion 130 of the flex circuit. Each channel includes a differentially connected operational amplifier 160, such as type TL592A, having power rails set at ground and at a +12 volt filtered DC levels. In this particular example each read head 142 includes a center tap connection which is connected to a voltage divider to provide amplifier bias current and to provide a common reference voltage, and thereby enable the amplifier 160 to operate in differential mode, thereby providing enhanced common mode noise rejection. Also, a ten ohm resistor and a 4.7 micro farad capacitor form a filter network for providing filtered 12 volt DC from a DC supply trace from the main electronics circuit module. This 12 volt DC filter located on the read channel portion 130 of the flex circuit 122 also provides a read signal single ground point at one of the screw openings 164, as previously noted.

Fig. 7 illustrates the logic circuits comprising the mode select logic 166, and one of the four current source/write driver circuits 168 formed and connected on the main circuit portion 134 of the flex circuit 122.

Each of the write drivers 168 includes circuitry for driving two of the eight write heads 146 and 150. In the example of Fig. 7, each one of heads 146A and 150 A are driven unidirectionally by three of six transistors forming dynamically and independently controlled current sources within each write channel driver circuit 168. In the Fig. 7 example one of the heads 146A or 150A is selected by a head select transistor connected to a head centertap. Transistor 174 selects head 146A, and transistor 176 selects head 150A. The transistors 174 and 176 are selectively enabled in accordance with control levels generated by the logic 166 in response to the incoming mode control signals B, C and L. So long as a +12 volt level is not present at the center tap of each head, it is effectively disconnected by diodes from the write driver circuitry. When either the transistor 174 or the transistor 176 is caused to conduct, 12 volts (less a voltage drop across the selected transistor 174 or 176) appears at the center tap of the selected head 146 or 150, and the current source completes a signal path through the head and the selected and conducting transistor, thereby energizing the selected write head in one current direction or another, and writing a desired magnetic flux pattern to the moving tape 114.

Thus, it will be apparent to those skilled in the art that the flex circuit 122 and its associated electronics has resulted in a front end module for a tape drive in which read and write circuit components associated with a head structure have been located as close as practical to the head cores via a one-piece, two layer, flexible printed circuit which provides for both component mounting and flexible interconnection at one end to a main circuit board. At another end, the flex circuit mounts directly to a detachable head structure and connects to the read and write head core windings. Connections of these most sensitive signals are kept extremely short, are balanced and are carefully laid out to minimize exposure to noise. Noisy signals and their return paths are carefully planned and routed. There are no low-level or high impedance signals entering or leaving the flex circuit edge connector 136. As explained, all of the read preamplifiers, write current sources and drivers and write coil selection logic circuitry is included and fully contained on the flex circuit 122.

As described above, the flex circuit 122 enables four channels of simultaneous writing and reading with an unshielded flexible interconnect circuit, while minimizing both electrostatic and electromagnetic noise coupling. The flex circuit 122 reduces stray capacitance and increases electrical resonance frequency without sacrificing output levels or waveshapes.

The flex circuit 122 reduces and makes consistent the mechanical bias forces being applied to the head structure 120 and positioning mechanism 104. By employing a single dynamic flex portion 132, the flex circuit 122 provides for two-dimensional head movements: vertical stepping for track positioning, and rocking or tilting for azimuth recording. Both the vertical motion and the angular rocking motion are translated into a single rolling motion by the dynamic flexible portion 132, thereby reducing mechanical complexity and improving consistency and quality in the completed tape drive 100.

The flex circuit 122, when married structurally and electrically to the head plate 126 and attached head array 128, provides a self-contained tape head module enabling ready removal and replacement, as well as the use of different head technologies with a high degree of transparency to the host electronics and tape drive user. Since all of the circuitry directly associated with each head array is contained on the flex circuit 122, it is practical to have multiple head/circuit design combinations which are hardware-compatible at the interconnect 136 to the main circuit board electronics. Thus, advancing head technologies, including thin film inductive elements, and inductive write/magnetoresistive read elements may be supported by appropriate circuitry on a flex circuit like the circuit 122 and thus be compatible without substantial hardware modification of the main circuit board of the tape drive.

Having thus described an embodiment of the invention, it will now be appreciated that the objects of the invention have been fully achieved, and it will be understood by those skilled in the art that many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and

scope of the invention. The disclosure and the description herein are purely illustrative and are not intended to be in any sense limiting.

What is claimed is:

1. A flex circuit for a tape drive comprising:

an elongated flexible printed circuit substrate carrying a pattern of electrical circuit interconnections and divided into three portions:

a read channel portion for direct connection to multiple read and write heads of a tape head array and carrying a plurality of read channel preamplifiers connected to receive read signals from a plurality of read heads,

a write channel portion including an external connection region for enabling signal and power connections to be made with a tape drive circuit module, the write channel portion including a plurality of write channel drivers, and

a dynamic flexing portion separating and interconnecting the read channel portion and the write channel portion, the dynamic flexing portion adjusting in contour as positional adjustments are made to the head array.

2. The flex circuit set forth in claim 1 further comprising head selection logic circuitry for selecting and enabling particular ones of the write heads in accordance with positional adjustments made to the head array and in accordance with a direction of tape movement.

3. The flex circuit set forth in claim 1 further comprising mechanical reinforcement means for mechanically stiffening and reinforcing the read channel portion and the write channel portion.

4. A multi-track magnetic tape head assembly for a tape drive, the assembly comprising:

a head mounting plate,

a head array secured to the head mounting plate and defining a plurality of write heads and a plurality of read heads, and

an elongated flex circuit having a first end attached to the head mounting plate and connected to the write and read heads, and having a second end defining a connection region for connection to a main electronics circuit module of the tape drive, the flex circuit being divided into three portions including:



a read channel portion for direct connection to multiple read and write heads of the head array and carrying a plurality of read channel preamplifiers connected to receive and amplify read signals from the plurality of read heads,

a write channel portion including an external connection region for enabling signal and power connections to be made with a host circuit module, the write channel portion including a plurality of write channel drivers for driving the plurality of write heads, and

a dynamic flexing portion separating and interconnecting the read channel portion and the write channel portion, the dynamic flexing portion adjusting in contour as positional adjustments are made to the head array relative to a base of the tape drive.

5. The multi-track magnetic tape head assembly set forth in claim 4 wherein the flex circuit further comprises head selection logic circuitry for selecting and enabling particular ones of the write heads in accordance with positional adjustments made to the head array and in accordance with a direction of tape movement.

6. The multi-track magnetic tape head assembly set forth in claim 4 further comprising mechanical reinforcement means for mechanically stiffening and reinforcing the read channel portion and the write channel portion.

7. A magnetic tape drive including a base and a tape take-up reel and cartridge receiving means for receiving and engaging a single supply reel tape cartridge,

a multi-track magnetic head array including a plurality of forward direction write elements located on one side of the array, a plurality of reverse direction write elements located on another side of the array, and a plurality of read elements located centrally between the forward direction write elements and the reverse direction write elements,

a head mounting plate to which the multi-track magnetic head array is secured,

an elongated flex circuit having a first end attached to the head mounting plate and connected to the write and read heads, and having a

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second end defining a connection region for power, control, data and amplified head signal connections to a main electronics circuit module of the tape drive, the flex circuit being divided into three portions including:

a read channel portion for direct connection to the pluralities of read elements and write elements of the head array and carrying a plurality of read channel preamplifiers connected to receive and amplify read signals from the plurality of read elements,

a write channel portion including the connection region and including a plurality of write channel drivers for driving the plurality of write elements, and

a dynamic flexing portion separating and interconnecting the read channel portion and the write channel portion, the dynamic flexing portion adjusting in contour as positional adjustments are made to the head array relative to a base of the tape drive, and

a head positioning mechanism secured to the base including a receiver for receiving the head mounting plate in a predetermined relationship, for positioning the head array in at least one dimension substantially perpendicular to a major plane of the base.

8. The magnetic tape drive set forth in claim 7 wherein the head positioning mechanism positions the head at plural predetermined azimuth angles as well as in the perpendicular dimension.

9. The magnetic tape drive set forth in claim 8 wherein the flex circuit further comprises head selection logic circuitry for selecting and enabling particular ones of the write elements in accordance with positional adjustments made to the head array and in accordance with a direction of tape movement and azimuth angle.

10. The magnetic tape drive set forth in claim 7 wherein the dynamic flexing portion separating and interconnecting the read channel portion and the write channel portion defines generally a U-shape therebetween when the flex circuit is installed between the head plate and the main electronics circuit module of the tape drive.



11. The magnetic tape drive set forth in claim 7 wherein the write channel portion lies substantially parallel with a plane perpendicular to the base, wherein the external connection region passes through an elongated opening slot defined in a wall of the base in order to connect to the tape drive circuit module, and wherein the dynamic flexing portion extends away from the write channel portion at a predetermined acute angle.

12. The magnetic tape drive set forth in claim 7 further comprising mechanical reinforcement means for mechanically stiffening and reinforcing the read channel portion and the write channel portion

