# THREE ROLLER TAPE GUIDE

## FIELD OF THE INVENTION

The present invention relates generally to magnetic recording tape guide assemblies, and more particularly, to a compact and low cost tape guide assembly which provides minimized lateral tape motion without tape damage.

## BACKGROUND OF THE INVENTION

Magnetic media are used for storage of data generated by computers. Typically a magnetic medium is presented to a magnetic head which ordinarily can either read or write data on the medium. Magnetic storage disks, commonly referred to as hard disks, are presently the preferred storage medium for use in computer systems where fast access time and substantial storage capacity are of interest. However, because of their portability, compactness and storage capacity, magnetic tapes are also used for data storage.

One advantage which tapes have over hard disks is that once the data is recorded on a magnetic tape, the tape and its container (commonly referred to as a cartridge) can be removed from the computer and stored in a secure location or can be used for carrying or mailing data to a remote location. This removable feature allows tape and tape drives to be used as archival storage and/or backup systems for hard disks. However, the data error rate must be quite low to allow use as archival and/or backup storage devices.

As demand for tape storage has increased, so has the need for a reduced form factor and low cost tape drive that provides precise high density tape guiding.

In order to increase storage density for a given cartridge size, thinner tape may be employed. One popular tape drive assembly, known generally as a five and one quarter inch (i.e., 5-1/4") tape drive, is typically five and three quarters inch wide by three and one quarter inches high by eight inches deep (i.e., 5-3/4"X3-1/4"X8"). This drive typically receives a five and one quarter inch cartridge which is about four and one tenth inches square and one inch high. Typically, 1800 feet of one half inch wide and 0.3 millinch thick tape is wound onto a three and six tenth inch diameter supply reel in a four inch square cartridge

for data storage use in a five and one quarter inch tape drive. The storage capacity of a five and one quarter inch cartridge, however, can be increased by lengthening the tape.

Another way to increase the storage density for a given cartridge size is to write the bits on the tape in smaller areas and on a plurality of parallel longitudinal tracks. As more tracks are recorded on a tape, each track then becomes narrower and the tape must now be constrained from shifting up or down (called lateral tape motion) in a direction perpendicular to the tape travel path as the tape passes by the magnetic head in order to maintain proper alignment of the head and tracks on the tape. Constraining the tape to minimize lateral tape motion prevents data retrieval errors.

Lateral tape motion is defined as the peak-to-peak distance of the undesirable movement (in-plane) of the tape perpendicular to its prescribed longitudinal direction of motion past the head. Lateral tape motion is a major limiting factor in determining the minimum width of a track and the minimum spacing between tracks on the tape. Thus, as lateral tape motion is reduced, more tracks may be stored on the tape and the tape density increases accordingly.

Prior tape guide systems have typically employed six roller guides to minimize lateral tape motion. One such tape guide system is described in commonly assigned U. S. Patent No. 5,173,828, entitled "Compact Multiple Roller Tape Guide Assembly". U. S. Patent No. 5,173,828 employs six identical rollers R1 - R6 arranged within a tape drive as shown in FIG. 1.

Another prior tape guide system is described in commonly assigned U.S. Patent No. 5,414,585 entitled "Rotating Tape Edge Guide". U.S. Pat. No. 5,414,585 also describes a six roller tape guide system in a similar arrangement illustrated in FIG. 1. As shown in FIG. 2, this tape guide system employs two tape roller guide assemblies, each adjacent one side of the head 70. The first assembly comprises reference rollers RR1, RR2 and adjustment roller AR1. The second assembly comprises reference rollers RR3, RR4 and adjustment roller AR2. As illustrated in FIG. 2, each adjustment roller is mounted between the reference rollers, while the head 70 is mounted between the two roller guide assemblies to minimize lateral tape motion as the tape 68 streams across a transducing face 72 of the head 70.

The drawback of a six roller tape guide system is that it is not cost effective for low cost systems. In addition, a reduced form factor tape drive would not physically accommodate six roller guides.

Another prior tape guide system employs fixed post guides. One such tape guide system is described in U.S. Patent No. 4,447,019 entitled, "Magnetic Tape Cartridge with Resilient Belt Driving Means and Separate Tape and Belt Idlers". As shown in FIG. 3, fixed post guides, referred to as "idlers", 14, 16, 18, 20, 22 and 24 guide the streaming tape 12 from the supply reel 6 to the take-up reel 4. However, these fixed post guides are more susceptible to wear, than roller guides, over a period of time and are thus limited to low duty cycle applications .

Thus, a hitherto unsolved need has remained for a low cost tape guide system suitable for precise high density tape guiding.

## SUMMARY OF THE INVENTION

In accordance with the present invention, a roller tape guide assembly includes two spaced apart reference roller guides and an adjustment roller guide. The first reference roller is mounted adjacent to one side of the tape head, between the take-up reel and the head. The adjustment roller and the second reference roller are mounted adjacent to the other side of the head such that the adjustment head is located between the head and the second reference roller, which is located between the adjustment roller and the supply reel of the tape cartridge. Each of the reference rollers has a surface for engagement with a first longitudinal tape edge where both surfaces are planarly aligned with a predetermined tape travel path and mounted for movement with the first tape edge to guide the first tape edge along the tape travel path. The adjust mechanism has a surface for engagement with the second longitudinal tape edge. The adjustment surface is parallel to and laterally offset from the reference surfaces and mounted for movement with the second tape edge. Additionally, the adjustment surface is mounted in such a way and in a position effective to urge the first tape edge into contact with the reference surfaces to minimize movement of the tape in a direction perpendicular to the reference surfaces and the adjustment surface during tape advancement. With such an arrangement, an increased number of data tracks may be stored on a magnetic tape media by virtually eliminating lateral tape motion.

The present invention thus provides for a low cost and reduced form factor tape drive. In addition, the present invention also provides minimized lateral motion for extremely high data and track densities and enables tapes to run at high performance and to be drive interchangeable, with very little tape degradation caused by the drive. This is very important because tapes are frequently recorded in one drive and played back in a different drive. Furthermore, the use of very thin and fragile tape such as 0.3 millinch recording tape is enabled through the very gentle surfaces provided by the present invention.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a prior tape guide assembly.

FIG. 2 is a side plan view of a prior tape guide assembly.

FIG. 3 is a side plan view of a prior tape guide assembly.

FIG. 4 is a side cross-sectional view of the tape guide in accordance with principles of the present invention.

FIG. 5 is a side cross-sectional view of an alternative tape guide in accordance with principles of the present invention.

FIG. 6 is a plan view of a tape guide assembly shown in FIG. 4.

FIG. 7 is a plan view of an alternative tape guide assembly in accordance with principles of the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention is directed toward a tape roller guide assembly which reduces the cost of fabricating an 8 inch form factor tape drive. At the same time, the present invention also minimizes the amount of lateral movement, relative to the tape head, experienced by the tape, thereby enabling the tracks to be narrower and spaced closer together and thus, increasing the number of tracks stored on the tape.

Referring now to FIG. 4, a cross-sectional view of a roller guide assembly according to the present invention is shown. There are two reference rollers R1, R3 and one adjustment roller R2 mounted for rotation with the tape 170 as the tape advances in the direction 81 of tape travel on a support structure 82 of the tape drive assembly 10 (shown in FIG. 6). As shown, tape head 11 is mounted

within the tape drive 10, such that the head 11 is located between reference roller R1 and adjustment roller R2 and along the tape travel path.

Essentially, each tape guide roller is an identical machined cylinder. Each roller includes a tape support surface 22. The tape support surface 22 is uniformly flat, extending parallel to the roller shaft axis, and preferably lies on the circumference of a 0.6 inch diameter D.

Each roller employs two opposite facing flanges. Roller R1 includes flanges 84 and 84' and roller R3 includes flanges 86 and 86' which are planarly aligned with flanges 84 and 84', respectively. Roller R2 includes flanges 88 and 88', the planes of which are parallel, but vertically offset by a distance L, from the plane of the flanges of the reference rollers. In the preferred embodiment, L is approximately 2 millinches. Each reference roller has a surface 84a and 86a for contacting a first longitudinal tape edge 90, while the adjustment flange 88 has a surface 88a for contacting the second longitudinal tape edge 92. The two flange roller may also be useful if the tape drive assembly loses power to prevent the tape from drooping between rollers. Moreover, many available rollers come with two flanges and it may be less expensive to use these rollers than to construct a roller with only one flange.

Although the invention preferably requires that each roller have two flanges, in an alternative embodiment shown in Fig. 5, each roller may have only one flange. Aside from the rollers, all other parts shown in FIG. 5 are identical to those of FIG. 4. Thus FIG. 5 employs the same reference numbers. Similar to the FIG. 4 embodiment, the flange on reference rollers R1 and R3, 84a and 88a, are planarly aligned to contact the first tape edge 90. The adjustment roller flange 88 is also vertically offset from the relative vertical position of the reference roller by a distance L.

In either embodiment, the laterally offset position of the adjustment roller R2,, creates a "channel" 120 for guiding the tape 170 along its tape travel path to minimize lateral tape movement. The width of channel 120, which is defined by the distance between flange 88 of reference roller R3 and flange 86 of adjustment roller R2, is preferably slightly less than the maximum width of the tape 170. This arrangement ensures that the tape 170 maintains contact with the roller flanges, thereby eliminating lateral tape movement.

The reference rollers R1, R3 may also include small coil springs 30 and washers 32 and are mounted on a preloaded ball bearing (not shown). The adjustment roller R2 may include a biasing coil spring 94 and a light weight washer 96. The biasing coil 94 and washer 96 permit movement of the adjustment roller R2 and hence, movement of adjustment flange 88 in a direction parallel to the roller shaft axis 28.

The basic dimensions of the rollers of the present invention are similar to the rollers described in commonly assigned U.S. Pat. No. 5,414,585, the contents of which are hereby incorporated by reference. The roller guide assembly of this preferred embodiment is an improvement over the roller guide assembly described in the above referenced patent.

Referring now to FIG. 6, a tape drive assembly 10 is shown incorporating the tape roller guide assembly of the present invention. In FIG. 6, cartridge 112 is shown inserted into assembly 10, which also includes a motor 115 (shown in dotted outline) for driving the cartridge supply reel 110 and motor 105 (shown in dotted outline) for driving take-up reel 100. Proper balance of the opposing torque of the two motors produces the required tape tension and also produces tape motion either in to or out of cartridge 112. Hence, the tape 170 may be driven in either forward direction 114 or reverse direction 116 to write data on or read data from the tape 170 in cooperation with the drive 10. Motors 105 and 115 are controlled by a motor controller circuit (not shown) under the direction of a processor (not shown). The tape 170 is rewound back onto supply reel 110 before tape cartridge 112 is removed from tape drive assembly 10.

As the tape 170 is wound from the supply reel 110 to the take-up reel 100, any lateral tape motion introduced, as the tape streams across the head 11, will be repeated when the tape is re-wound back onto the cartridge 112 supply reel 110. In other words, the magnitude of lateral tape motion, introduced during the winding process, will be "stored" onto the take-up reel 100 and repeated during the rewind. Therefore, in the preferred embodiment, reference roller R3 and adjustment roller R2 are adjacently located on the side of the head 11 where the tape 170 is introduced from the cartridge 112. Thus, lateral tape motion is minimized as the tape 170 is wound onto take-up reel 100, thereby minimizing any lateral tape motion during re-winding.

While the preferred embodiment described herein and illustrated in FIG. 6 is shown with the adjustment roller R2 located between the head 11 and reference roller R3, in an alternative embodiment, the adjustment roller may also be located between the head 11 and reference roller R1, as shown in FIG. 7.

Referring back to FIG. 6, the distance between rollers R2 and R3 is also a significant factor in controlling lateral tape motion. To the extent that the tape 170 can be thought of as a fairly rigid beam, adjacent rollers R2 and R3 control the position and angle of the beam, but if the distance in between the pair is too small, angular accuracy is lost. However, if the pair of adjacent rollers is too widely separated, the beam-like stiffness is lost, and the tape can deviate from straightness. In general, two rollers that are too close together (nearly adjacent) do not have much improvement over a single roller, but if the rollers are more than about four tape widths apart, then the tape is allowed too much free play, and tracking suffers. The preferred spacing of rollers R2 and R3 in the present invention is based on the performance of other functions. For example, the mounting position of R3 must provide optimum buckling between a take up leader (not shown) and a cartridge leader (not shown). Like wise, the mounting position of R2 must provide maximum tape contact with the head.

The rollers and flanges are preferably formed with the following dimensions, spacings and tolerances: the roller body is six tenths inches in diameter, the flange separation of the Fig. 4 rollers is nominally 8 millinches larger than the mean tape width, and the separation tolerance is +/- 2.5 millinches.

The three roller magnetic tape guide system described herein is suitable for low cost tape drives and has demonstrated high storage capabilities per cartridge by enabling the use of narrow tracks spaced closely together. The interaction of the three rollers and their respective flanges essentially eliminates lateral tape motion, while each flange exerts only a small lateral force on the tape so as not to damage or wear the tape edges.

To those skilled in the art, many changes and modifications will be readily apparent from consideration of the foregoing description of a preferred embodiment without departure from the spirit of the present invention, the scope thereof being more particularly pointed out by the following claims. The descriptions herein and the disclosures hereof are by way of illustration only and should not be construed as limiting

the scope of the present invention which is more particularly pointed out by the following claims.

What is claimed is:

1. A tape guide assembly for presentation of a magnetic tape along a predetermined tape travel path from a first side of a magnetic head to a second side of the head in contact with an intermediate transducing face of the head and transverse to a lateral axis of the head, such that lateral movement of the tape spooling between a respective supply reel and a take-up reel is minimized, the assembly comprising:

a first rotatably mounted reference roller located adjacent to a first side of the head and having a first reference flange for engagement with a first longitudinal tape edge, the first reference flange being planarly aligned with the tape travel path and mounted for movement with the first tape edge to guide the first tape edge along the tape travel path;

a second rotatably mounted reference roller located adjacent to a second side of the head and having a second reference flange for engagement with the first tape edge, the second reference flange being planarly aligned with the first reference flange and the tape travel path and mounted for movement with the first tape edge to guide the first tape edge along the tape travel path;

a rotatably mounted adjustment roller located adjacent to the first side of the head, between the first reference roller and the head, and having an adjustment flange for engagement with the second longitudinal tape edge, the adjustment flange being in a plane parallel to the plane of the first and second reference flanges, being mounted for movement with the second tape edge, and being in a position effective to urge the first tape edge into contact with the first and second reference flanges to minimize lateral movement of the tape during tape advancement through a portion of the tape travel path between the supply reel and the head;

wherein the adjustment roller in combination with the first and second reference rollers are mounted on a support structure in such a way that the tape travel has an arcuate shape which runs essentially perpendicular to the head lateral axis.

2. The tape guide assembly according to claim 1, wherein the adjustment flange is mounted such that a distance between the plane of the adjustment flange and the plane of the first and second reference flanges is fixed, the fixed distance being slightly less than a tape width such that a portion of the tape parallel to the second tape edge provides a springing mechanism to urge the first tape edge into contact with the first and second reference flanges.

3. The tape guide assembly according to claim 1, wherein the adjustment flange is mounted for movement in a direction perpendicular to the plane of the reference flanges.

4. The tape guide assembly of claim 1, wherein the first reference roller and the adjustment roller are located between the supply reel and the head.

5. The tape guide assembly of claim 4 wherein the second reference roller is located between the take-up reel and the head.

6. The tape guide assembly of claim 1, wherein the first reference roller and the adjustment roller are located between the take-up reel and the head.

7. The tape guide assembly of claim 8 wherein the second reference roller is located between the supply reel and the head.

8. A method of presenting a recording tape to a magnetic head with the tape constrained from excess lateral movement perpendicular to tracks recorded on the tape as the tape streams across the front of the head, for rendering the tape interchangeable between various tape drives of interest for repeatedly accurate tracking at high data and track densities, the method comprising the step of:

providing in each tape drive of interest an arcuate tape travel path across a set of three spaced apart rotatably mounted rollers where a first and a third rotatably mounted roller is a reference roller, each reference roller being located on opposite sides of the head and each having a reference flange for engagement with a first longitudinal tape edge, the reference flanges being planarly aligned with a predetermined tape travel path and mounted for movement with the first tape edge to guide the first tape edge along the tape travel path, and where a second rotatably mounted roller is an adjustment roller located in between the first reference roller and the head, the adjustment roller having an adjustment flange for engagement with the second longitudinal tape edge, the adjustment flange being in a plane parallel to the plane of the reference flanges. being mounted for movement with the second tape edge to guide the second tape edge along the tape travel path, and the second tape edge in a direction perpendicular to the plane of the reference flanges to urge the first tape edge into contact with the reference flanges to minimize lateral movement of the tape perpendicular to tracks recorded on the tape during tape advancement; and

fixing a distance between the reference flanges and the adjustment flange to be slightly less than a width of the tape.