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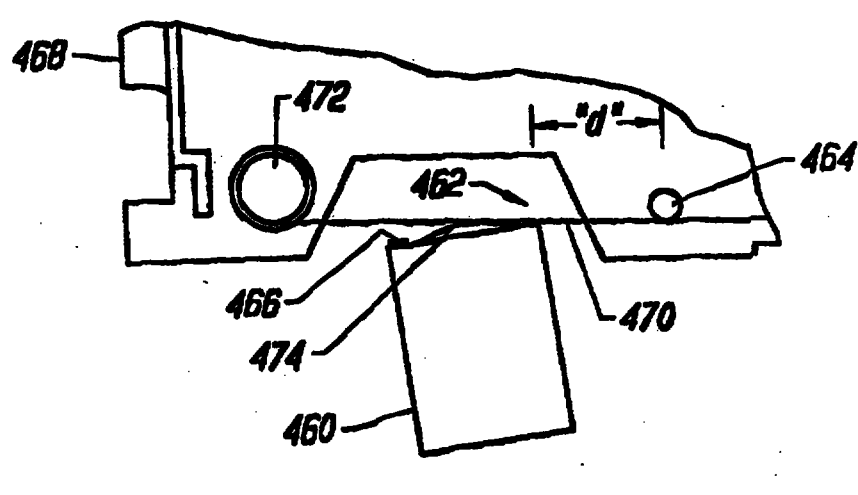
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(54) Title: TAPE SUPPORT SYSTEM FOR ARCUATE SCAN ROTATING HEAD (57) Abstract The present invention relates to a method and apparatus for engaging a magnetic tape with a transducer at a read/write zone for achieving consistent head-to-tape coupling throughout the intended recording location, especially at the edges of the tape. The transducer, located on the end face of the rotating transducer carrier, reads and writes arcuate information tracks generally laterally across the tape. The transducer traces a substantially circular transducing path through the read/write zone with the axis of rotation corresponding substantially to the center of the transducing path. A tape support system generally adjacent to the read/write zone positions the tape so that the transducer penetrates into a tape surface along a read/write location. 		

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TAPE SUPPORT SYSTEM FOR ARCuate SCAN ROTATING HEAD

Background of the InventionField of the Invention

5 The present invention relates to a method and apparatus for selectively engaging a transducer located on the end face of a rotating transducer drum of an Arcuate Scan Head Assembly (ASHA) with a magnetic tape, and more particularly, a tape support system for achieving consistent head-to-tape coupling throughout the intended recording location, especially at the edges of the tape.

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Description of the Related Art

Many commercial magnetic tape drive systems utilize a reel-to-reel transport system for passing magnetic tape past a substantially stationary read/write head. Information is typically placed on the tape in the form of a plurality of parallel tracks extending along the longitudinal axis of the tape. The stationary read/write head may have either a single channel or multiple channels. The read/write head may move laterally to read different tracks on the tape, but during the read/write operation the head is essentially stationary. Recording and playback is achieved by moving the tape longitudinally past a read/write zone. Since the read/write head is stationary, achieving good head-to-tape contact is relatively well known. For example, the tape may wrap around the head.

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Another widely used tape drive uses a Vertical Helical Scan (VHS) head in which one or more heads are

located on the outside of a rotating cylinder or drum. The tape moves over the side surface of the cylinder, wrapping partially around the surface of the cylinder. The cylinder is inclined with respect to the tape path so that each head traces a helical path along the tape. Again, contact between the head(s) and the tape can easily be maintained by wrapping the tape partially around the side surface of the cylinder.

The newly developed arcuate scanning tape drives (see PCT published application WO 93/26005, which is hereby incorporated by reference) utilize a rotating transducer drum with a generally planar end face containing transducers that engage with the tape plane as the tape moves past. In contrast to VHS drives, the axis of rotation of the transducer drum passes through the tape plane. Each transducer therefore reads/writes a sequence of arcuate tracks generally laterally across the tape, hence the name Arcuate Scanning Head Assembly, or ASHA.

With an ASHA, wrapping the tape around the end face of the drum means that the transducers are continuously engaged with the tape along the entire transducing path. This configuration results in accelerated wear on the tape and the read/write heads. Additionally, even though the read/write heads are switched off during a portion of the path opposite the intended recording zone traced by the transducers, the engagement of the heads with the tape results in signal cross-talk that creates noise in the system.

The front face of the transducer drum, which engages with the tape surface, rotates between approximately 7,500 to 15,000 rpm. Even higher speeds

may be used in the future. If the end face of the drum is inserted into the tape plane, this rotation of the transducer drum against the tape plane creates opposing forces generally perpendicular to the longitudinal axis of the tape. In particular, one edge of the rotating drum creates a force transverse to the longitudinal axis of the tape while the opposite edge of the drum creates a force in the opposite direction, resulting in a tendency to twist the tape in the direction of drum rotation. Consequently, it is extremely difficult to achieve intimate head-to-tape contact, particularly at the edges of the tape.

Additionally, the transducers typically extend slightly above the end surface of the transducer drum, e.g., 0.0005 inches (0.0127 mm). If the end face of the transducer drum has the read/write heads located at a diameter larger than the width of the tape, which is generally the case, the read/write heads may impact on the edges of the tape, potentially causing premature tape failure and damage to the read/write heads.

Summary of the Invention

The present invention relates to a method and apparatus for implementing a tape support system adjacent to a read/write zone for positioning a tape on an ASHA drive so that a transducer penetrates into a tape surface along a read/write location to achieve consistent head-to tape coupling.

One embodiment of the tape support system has at least one tape support having a tape support surface

generally extending laterally across the tape. A portion of the tape support surface may be convex or concave. The tape support may be an arm structure located adjacent to the read/write location. The tape support surface may flex the tape into a shape generally complementary to the shape of the transducer carrier so that longitudinal tape tension is generally uniform at the read/write zone.

The tape support surface may be located either above or below a datum plane defined by the transducer. The tape support system may include a second tape support on the opposite side of the transducer carrier. The tape support surface of the second tape support may be located above the transducer datum plane.

The magnetic tape may be contained in a cartridge. The tape support system may include a curved tape guide attached to the cartridge. The tape guide may be a curved or an asymmetrical surface. A curvilinear wrap pin may also be attached to the cartridge.

In one embodiment, the axis of rotation of the transducer carrier is in a non-orthogonal relationship with the tape plane such that the read/write location is adjacent to the wrap pin. In order to achieve optimum transducer/tape interface, the distance between the read/write location and the wrap pin is approximately 0.1" and 0.4". A conical or spherical end face on the transducer carrier may be combined with the right-hand tribology configuration described above.

The cartridge may also include a tape support pad located behind the tape in the read/write zone. The tape support pad may be constructed of a compliant or rigid material. Alternatively, the tape support pad may include a curved slot corresponding to the path traversed by the transducer along the read/write location.

Alternatively, the tape support system may include a tape support on the end face of the transducer carrier, extending above the datum plane of the transducer and providing support for the tape adjacent to the read/write location. In one embodiment, the tape support is a curvilinear end face. Alternatively, the tape support may be a ridge around the periphery of the end face which extends below the datum plane of the transducer.

In yet another embodiment, the tape support system comprises at least one tape support having a tape support surface. The inner and outer surfaces of the tape support may either be straight or curved. In one embodiment, the tape support has a curved inside surface adjacent to the transducer carrier and a straight outside edge facing away from the transducer carrier. The inside surface is curved to generally conform to the shape of the transducer carrier and the straight outside edge is perpendicular to the longitudinal axis of the tape so that a generally planar tape surface is maintained through the read/write zone.

In another embodiment, the tape support system comprises a tape support platform interposed between the end face of the transducer carrier and the tape.

The tape support platform has a tape support surface extending generally across the end face of the transducer carrier. A circular transducer slot is provided in which the transducers travel. A
5 transducer opening is provided to permit engagement between the transducers and the tape.

The tape support surface may include a straight transition edge perpendicular to the longitudinal axis of the tape. The tape support platform may include
10 upper and lower tape guides generally parallel to the longitudinal axis of the tape.

In any of the disclosed embodiments, the end face of the transducer carrier may include an opening. A low pressure mechanism is provided for creating a low
15 pressure condition between the tape and the end face of the transducer carrier. A low pressure distribution channel in fluid communication with the opening may be provided in the end face for distributing the low pressure condition across the end
20 face. Preferably, the low pressure distribution channel is located adjacent to the transducer. Alternatively, the tape support platform may include a low pressure distribution channel in fluid communication with the opening for drawing the tape
25 against the support surface.

The low pressure mechanism may include a shroud having an inner surface extending around the transducer carrier forming a chamber between the carrier and the inner surface of the shroud. A seal
30 is positioned between the transducer carrier and the inner surface of the shroud to minimize the movement of air into the chamber while permitting free rotation

of the carrier relative to the shroud. A transducer drum air vent is provided between the opening and the chamber to allow air to move between the center opening and the chamber. The drum air vent is located on the side of the seal opposite the front face. Blades are attached to the transducer carrier to promote air flow through the center opening in the transducer drum to create the low pressure condition between the tape and end face of the transducer carrier.

One method for engaging a magnetic tape with a transducer at a read/write zone comprises bending the tape along two orthogonal intersecting axes using any of the disclosed tape support systems to achieve consistent head-to-tape contact, especially at the edges of the tape. The various tape support systems disclosed herein are designed to control tape tension or stiffness at the read/write location to optimize edge coupling with the transducers.

In one embodiment, an arcuate scanning tape drive has a rotating transducer carrier with an end face containing at least one transducer. The transducer penetrates into the tape at a read/write location. The end face causes a first bend in the tape proximate the read/write location. A tape support system proximate to the read/write location creates a second orthogonal bend in the tape that intersects with the first bend at the read/write location. The intersection of the first and second bends increase tape tension at the read/write location. The tape

support system may either be adjacent to the transducer carrier or located on the end face.

5 The claimed tape drive includes any of the disclosed tape supports, together with the elements normally found in a drive to control movement of the tape past the read/write zone. The tape drive may also include a tape registration system that includes a registration arm which mechanically engages with a tape guide on a tape cartridge. Finally, it is
10 contemplated that the above embodiments may be freely combined to create a comprehensive tape support system.

Brief Description of the Drawings

Figure 1 is a side view of a tape support system including support arms and a tapered end face
15 structure for isolated engagement of the magnetic tape with the read/write location of the circular transducing path. Figure 2 is a side view of an alternate tape support system including tape supports and a curved end face structure for engaging the
20 magnetic tape with the read/write location of the circular transducing path.

Figure 3 is a side view of another alternate tape support system including support arms and an end face
25 structure which is tipped in relation to the longitudinal axis of the tape so that the transducers engage with only the read/write location of the circular transducing path.

Figure 4 is a perspective view of a tape support
30 system which may be used with a generally planar transducer end face.

Figure 5 is a schematic illustration of the read/write location of the transducer path and its relation to a tape support system.

5 Figure 6 is a perspective view of an alternate transducer drum in which a portion of a tape support system is an integral part of the end face.

Figure 7 is an alternate embodiment of the transducer drum illustrated in Figure 6 in which the transducers are located in slots around the perimeter
10 of the end face.

Figure 8 is a perspective view of a tape guide structure which may be interposed between the end face of a transducer and a magnetic tape.

Figure 9 is a perspective view of a cartridge for
15 holding the magnetic tape in which curved tape supports are attached to a cartridge housing.

Figure 10 is a perspective view of a cartridge for holding the magnetic tape in which tapered or chamfered tape supports are attached to the cartridge
20 housing.

Figure 11 is a side view of a rotary head transducer assembly with a center opening for transmitting a reduced pressure condition to the tape to promote engagement with the transducers.

25 Figure 12 is an end view of one embodiment of a rotary transducer assembly illustrating low pressure distribution slots in communication with the center opening.

30 Figure 13 is a side view of an alternate rotary head transducer assembly in which a slot is provided behind the transducer carrier for promoting the transmission of air through the end face.

Figure 14 is an end view of an alternate end face in which air may be drawn through a plurality of holes adjacent to the transducers to promote engagement with the magnetic tape.

5 Figure 15 is a perspective view of a cartridge for holding a magnetic tape in which a cylindrical tape support and a curved wrap pin are attached to the cartridge housing.

10 Figure 16 is a perspective view of an exemplary arcuate scanning tape drive.

Figure 17 is a side view of an alternate transducer drum with a tape support integrally formed in the end face and a tape support arm.

15 Figure 18 is an end view of an alternate transducer drum with a tape support integrally formed in an end face and transducers located in recessed mounting slots.

Figure 19 is a side view of an alternate tape support arm with a concave tape support surface.

20 Figure 20 is a side view of an alternate tape support arm with a convex tape support surface.

Figure 21 is an end view of a rotary transducer with a tape guide structure having low pressure distribution slots.

25 Figure 22 is a perspective view of a cartridge for holding the magnetic tape with an asymmetrical tape guide.

Figure 23 is a perspective view of a cartridge with a tape support pad behind the magnetic tape.

30 Figure 24 is a perspective view of a mechanical registration system for a tape cartridge.

Figure 25 is a side view of a registration arm for a tape cartridge.

Figure 26 is a top view of a transducer drum and tape cartridge in a right-handed configuration.

5 Detailed Description of the Preferred Embodiments

The present invention relates to a method and apparatus for selectively engaging a transducer located on the end face of a rotating transducer drum with a magnetic tape. A variety of tape support
10 systems are disclosed for positioning the tape so that the transducers penetrate into a tape surface along a read/write location.

Successful implementation of an arcuate-scan recording system requires consistent head-to-tape
15 coupling across the width of the tape. Since the end face of the transducer drum penetrates into the tape surface, variation in the longitudinal tension across the web at the read/write zone causes amplitude variations in the reproduced signal, especially at the
20 tape edges. Consequently, it is important to achieve consistent penetration of the read/write heads into the tape.

The penetration stiffness (force per unit tape deflection) is typically lower at the edges of the
25 tape than at the center. The various tape support systems disclosed herein are designed to control tape tension to optimize edge coupling with the transducers. One method of controlling the tension of the tape at the
30 read/write location is to create a compound bend in the tape. In particular, the tape is bent both

laterally and longitudinally, so that the tape is semi-rigid at the intersection of the lateral and longitudinal bends. The lateral and longitudinal bends may be created by the various tape support structures discussed herein.

5 An arcuate scanning tape drive may have a rotating transducer carrier with an end face containing at least one transducer. The transducer penetrates into the tape at a read/write location. 10 The end face causes a first bend in the tape proximate the read/write location. A tape support system proximate to the read/write location creates a second orthogonal bend in the tape that intersects with the first bend at the read/write location. The 15 intersection of the first and second bends increase tape tension at the read/write location. The tape support system may either be adjacent to the transducer carrier or located on the end face.

It will be understood that the embodiments 20 disclosed herein may represent components of an overall tape support system for an arcuate scanning tape drive, and as such may be freely combined. It also will be understood that the size of the angles and displacements of the tape, transducers, and drum 25 in the drawings have been greatly exaggerated for clarity of description. For example, a typical transducer penetrates less than 0.0015" (0.0381mm), and preferably between 0.00051 (0.0127 mm) and 0.001" (0.0254 mm) into the tape surface.

30 Figure 1 illustrates a side view of a rotary head transducer 20 with a pair of tape support arms 22 and 24. The tape support arm 22 (the passive support arm)

is slightly longer than the tape support arm 24 (the active support arm), so that a separation 26 is created between the tape 28 and the portion of the end face 30 of the transducer drum 32 closest to the support arm 22. Consequently, rotating transducers 34 will only contact the tape 28 along a read/write location 36 of the generally circular transducer path (see Figs. 4 and 5). The separation 26 prevents the transducer 34 from engaging the tape 28 during a non-contact or passive segment 38 of the transducing path, thus limiting head and tape wear in this area.

The datum of the active tape support arm 24 may be slightly below that of the transducers 34 on the drum 32, resulting in improved head-to-tape contact near the physical edges of the tape 28 and more consistent recording performance throughout the arc of the transducers 34 across the tape 28. Additionally, the forces between the transducers 34 and the tape 28 may be maintained at a relatively low level, thus increasing tape and head life.

For example, the difference in the datum of the transducers 34 and the active tape support arm 24 preferably is less than 0.025 mm (0.000984 inches). A 0.025 mm gap has been shown to allow adequate read/write performance to within 0.25 mm (0.00984 inches) of the physical edge of the tape 28. The above example corresponds to a tape support surface 44 which is straight and parallel to the end face 30 of the transducer drum 32. However, it will be understood that this example represents a general principle that may apply to a variety of end face and tape support configurations.

The support arms 22 and 24 are integrally formed as part of an outer shroud 40 which surrounds the transducer drum 32 (see e.g., Fig. 4), although it will be understood that they may be fixed relative to the transducer drum 32 in a variety of ways. The support arms 22 and 24 have curved tape support surfaces 42, 44, respectively, along the direction of tape travel, which minimizes the wear on the tape 28 and improves the head-to-tape contact at the edges.

The support arm 22 causes the tape 28 to be introduced to the transducer drum 32 at a slight angle such that the generally circular end face 30 of the drum 32 penetrates further into the center of the tape than at the edges. This penetration results in the tape 28 being longer in the center due to stretching.

As will be discussed in detail below, in some circumstances the end face 30 of the transducer drum 32 has a non-planar shape. The end surface 30 of the transducer drum 32 is shaped to provide additional support to the tape immediately adjacent to the read/write location 36. As illustrated in Figure 1, the end face 30 has taper points 46 adjacent to the transducers 34. Consequently, the tape 28 is supported by the taper point 46 on one side of the read/write location 36 and the support surface 44 on the other. The close proximity of the tape support locations 46, 44 results in improved head-to-tape coupling.

In an alternative embodiment illustrated in Figure 2, the end face 30' of the transducer drum 32' has a curved, conical or spherical shape which supports the tape 28 at a location 48 adjacent to the

transducers 34'. The curved, conical or spherical surface has the added advantage of reducing the likelihood that the rotating transducer drum 32' will damage the tape. While Figure 2 illustrates a generally uniform curve, it will be understood that an asymmetrical curve may enhance head-to-tape coupling. For example, the end face 30' may be high adjacent to the transducer 34' to increase tape tension through the read/write location. One embodiment of the conical end face 30' has a radius of curvature in the range of approximately 4.5" to 5.0", with a slightly larger radius of curvature in the center of the end face, and a smaller radius of curvature along the edges.

Figure 3 is an alternate embodiment of the embodiment illustrated in Figure 1 in which the support arms 22", 24" are substantially the same length. However, the transducer drum 32" is tipped at an angle relative to the tape 28 so that a separation 26" is formed proximate the non-contact segment 38" of the transducer path. Consequently, the transducer 34" penetrates into the tape 28 along the read/write location 36". It will be understood that it is possible to combine the tapered or curved end faces 30, 30' with the tipped transducer drum structure 32" illustrated in Figure 3.

As discussed above, the separations 26, 26', 26" result in the tape 28 engaging the transducer drum at a slight angle resulting in greater head penetration at the center of the tape and possible variation in the longitudinal tension across the tape. Depending on the degree of head penetration, the head-to-tape coupling may be inconsistent, especially at the edges.

A curved or contoured tape support may increase the longitudinal tension along the edge of the tape. Additionally, a contoured support may cup or pre-shape the tape to engage more favorably with the transducer drum end face 30, 30', 30".

Figure 19 illustrates a side view of an alternate tape support arm 360 with a concave tape support surface 362 which increases head-to-tape penetration toward the center of the tape (not shown). By reducing the relative penetration of the transducer drum 366 near the edges of the tape, the recorded arcs can be extended closer to the tape edge. The trade off is reduced head-to-tape contact pressure at the edges of the tape, which results in a lower output signal and an increased error rate. However, away from the tape edges the more effective head-to-tape penetration gives greater contact pressures and thus better overall electromagnetic performance. Thus, the concave tape support 362 optimizes recording performance throughout most of the arc, while simultaneously extending the usable arc length closer to the tape edges.

Figure 20 is a side view of an alternate tape support arm 350 with a convex tape support surface 352. The tape support surface 352 is curved to flex the tape (not shown) into a shape that is complementary either to the end face 354 of the transducer drum 356 or to the circular edge 358 of the drum 356. The convex support 352 tends to hold the middle portion of the tape (not shown) farther away from the end face 354 of the drum 356 and bends the edges of the tape toward the end face 354. Contoured

tape support 352 has proven especially effective when used in combination with the non-planar end face structures 20, 20' disclosed in Figures 1 and 2.

It will be understood that it is possible to combine the convex, concave or straight tape support surfaces on a single transducer assembly. For example, a convex tape support may be used adjacent to the read/write location and a straight tape support may be used on the opposite side of the transducer drum.

Figure 16 is a perspective view of an exemplary arcuate scanning tape drive 300. A frame 302 receives a double-reel belt-driven cartridge 304. The tape drive 300 includes a conventional cartridge loading mechanism 306 which receives the cartridge 304, opens a tape cover 312 to expose tape 308, and positions the tape 308 for recording and playback. The tape 308 is driven longitudinally when a force is applied to a tape capstan roller 310. The cartridge includes a tape guide (not shown) attached to the cartridge 304. (see discussion of Figs. 9, 10, and 15, below). The tape 308 travels left to right through a read/write zone 314, where it engages with transducers on the end face (see e.g., Fig. 4) of a rotary head transducer assembly 322.

The force for longitudinally advancing the tape is applied to the capstan roller 318 by a transmission assembly 316. For purposes of this exemplary illustration, the transmission assembly 316 includes a capstan roller 318 which engages the tape capstan 310, causing the tape 308 to advance through the read/write zone 314. It will be understood that a

variety of transmission devices are suitable for this purpose and the above illustration in no way limits the scope of the present invention.

5 As the tape 308 advances through the read/write zone 314, data is recorded ("written") or read ("played back") from the tape by means of a rotary head transducer assembly 322. The rotary head transducer assembly 322 is fixed to the frame 302 by means of a mounting flange 320.

10 Figure 4 is a perspective view of a rotary head transducer assembly 60 with a pair of tape supports 62, 64 adjacent to the end face 66. The transducer drum 68 rotates in an outer shroud 70 so that the transducers 72 trace a circular transducing path 74.

15 The tape supports 62, 64 have curved support surfaces 76, 78 that extend along the longitudinal axis "L" of the tape 28. The inner surfaces 80, 82 of the tape supports 62, 64 are contoured to the shape of the transducer drum 68 to minimize the gap therebetween. As will be discussed in connection with
20 Figure 5, the gap 84 between the tape supports 62, 64 and the transducer drum 68 preferably is uniform and small.

25 Straight outer edges 86, 88 of the tape supports 62, 64 are oriented perpendicular to the longitudinal axis "L" of the tape 28. The straight outer edges 86, 88 maintain the tape 28 in a generally planar configuration as it passes past the generally planar end face 66 of the transducer drum 68. It will be
30 understood that it may be desirable to maintain the

tape 28 in a generally planar configuration for engagement with a non-planar end face. (see Figs. 1 and 2).

5 The tape support 62 extends above the end face 66 of the transducer drum 68 so that a separation 90 is formed proximate the non-contact segment 92 of the transducer path 74. Tape support 64 is sized so that the transducer 72 contacts the tape 28 at the read/write location 94 of the transducer path 74.

10 As will be discussed in connection with Figures 11 and 12, the transducer drum 68 has a center hole 100 which is connected to a low pressure source (not shown). A series of low pressure distribution slots 102 in fluid communication with the center hole 100
15 are provided in the end face 66 to distribute the low pressure condition proximate to the transducers 72 to enhance tape-to-head contact.

Figure 5 is a schematic illustration of the theoretical maximum read/write location 94 of the transducer path 74. It will be understood that as a
20 practical matter, a portion of the tape edges will be unused. For example, in one embodiment 0.007" (0.1778 mm) of each edge was unused. On a standard quarter inch tape (6.35mm), the unused portion represents 6.0%
25 of the tape width. While this fact results in under utilization of the tape, it is preferred that the transducer drum not intersect directly with the edges of the tape due to possible tape damage and wear to the transducers 72.

30 Since the end face 68 has a diameter larger than the width 96 of the tape 28, the angle α is less than 180°, and preferably between 30-60°. The gap 84

between the perimeter of the end face 68 and the inner surface 82 of the tape support 64 is small so that the tape 28 receives maximum support. Additionally, if the gap 84 is uniform, cross-web tension variations are minimized.

Figure 6 is a perspective view of an alternate transducer drum 120 with a tape support surface or ridge 122 extending above the datum of the surface 128 of the end face 124. Transducer mounting slots 126 are provided along the tape support surface 122 for retaining transducers (not shown). The transducers protrude above the surface 122 by less than about 0.0015" (0.0381 mm). Because the protrusion of the head is fixed relative to the surface 122, penetration of the transducers into the tape is fixed, resulting in good head-to-tape penetration over a longer portion of the read/write location of the transducer path. The surface 122 may be planar, curved or some other suitable shape. The support surface 122 rotates with the transducers to provide a stable surface which rides on the surface of the tape (not shown). When the drum 120 is rotating and the surface 122 is pushed into the plane of the tape, tape tension causes the tape to be flattened against the surface 122. The surface 122 is made of a hard material, or provided with a coating to resist wear and tape friction. In an embodiment for use with a 0.25" (6.35mm) wide tape, the surface 122 preferably is approximately 0.218" (5.537 mm) wide, with an overall diameter of 0.70" (17.78 mm).

Figure 7 is an alternate modified transducer drum 150 in which the tape support surface 152 extends

above a datum plane 156 of end face 158. Mounting slots 154 are provided for the transducers. In an embodiment for use with a 0.25" (6.35 mm) wide tape, the surface 152 is approximately 0.78 (19.81 mm) wide, and has an overall diameter of 0.56" (14.22 mm). The surface 152 may be planar, curved or some other suitable shape.

Figure 17 is a side view of an alternate transducer drum 370 with an active tape support surface 372 integrally formed on the outer periphery of the end face 374. A passive tape support arm 376 is provided on one side of the drum 370 to lift the tape 28 out of contact with the adjacent transducer 378. The transducers 378 engage the tape 28 along a read/write location 379, opposite the passive tape support arm 376. The tape 28 may also rest on the end face 374 in some applications.

The datum of active tape support surface 372 is slightly below the transducers 378 by a few microns (0.001 to 0.005 mm). This configuration improves head-to-tape contact near the physical edges of the tape 28 and allows for more consistent recording performance throughout the arc of the transducers across the tape. Figure 18 is an end view of an alternate transducer drum 380 with an active tape support surface 384 integrally formed around the periphery of the end face 382. Transducers 386 are located in recessed mounting slots 388 cut into the periphery of the drum 380. The slots 388 are deeper than those shown in Figure 7 so that the transducers 386 can be located further away from the passive tape support arm 390.

Figure 8 illustrates a tape support system comprising a tape support platform 170 attached to the outer shroud 70. The tape support platform 170 is interposed between the tape 28 and the end face 66 of the transducer drum 68. Outer tape support surfaces 172, 174 have straight tape transition edges 176, 178 which are perpendicular to the longitudinal axis "L" of the tape 28.

The tape support platform 170 has a circular transducer slot 180 which allows the transducers 72 to rotate freely along the transducer path 74. A pair of inner tape support surfaces 182, 184 are provided adjacent to the outer tape support surfaces 172, 174, respectively. A transducer opening 186 is located between the inner and outer tape support surfaces 172, 174, 182, 184. The extensive tape support surfaces 172, 174, 182, 184 provide enhanced mechanical stability of the tape 28 relative to the transducers 70.

As is discussed in connection with the above embodiments, the tape support surfaces 172 and 182 are raised so that the tape 28 does not engage the transducers 72 along the non-contact segment 190 of the transducer path 74. Alternatively, the transducer drum 68 may be tipped relative to the tape support platform 170 to achieve the same result. Upper and lower tape edge guides 196, 198 add mechanical stability to the tape support platform 170. It will be understood that the distance between the upper and lower tape edge guides 196, 198 may be greater than the width of the tape. However, in some circumstances the upper and lower guides 196, 198 may actually guide

the tape 28. As will be discussed, in greater detail below, a center hole 192 is provided for transmitting a reduced pressure condition to the tape 28 to enhance contact between the transducers 72 and the tape 28 at the read/write location 194 of the transducer path 74.

The tape support platform 170 provides more mechanical stability to the tape 28, allows for higher pressures between the transducers 72 and the tape 28, increases the signal strength by providing good head-to-tape contact across substantially the full width of the tape 28, is less sensitive to transducer penetration differences that occur during mass production, and provides tape edge guides that may reduce vertical movement and the need to servo the rotary head transducer.

Figure 9 illustrates a tape 200 retained in a cartridge 202 for engagement with a rotary head transducer. In this alternate embodiment, a tape guide 204 and wrap pin 206 are attached to the cartridge 202 on opposite sides of the read/write zone 208. The tape guide 204 and wrap pin 206 do not rotate. As discussed above, the tape supports 204, 206 may be curved or contoured to flex the tape into a shape that is complementary to the end face of a rotary transducer (not shown). Figure 10 illustrates a chamfered tape guide 210 and wrap pin 212 with curved center portions 214, 216 and straight edge portions 218, 220. In one embodiment, the contour of the tape guide 204 is constant, with a depth of 0.005" (0.127 mm) at the center of the guide 204. In another embodiment, the tape guide 210 has a chamfer extending 0.015" (0.381 mm) from the top and the

bottom flanges, and has a depth of cut of 0.005" (0.127 mm) at the center of the guide.

5 However, the tape edges may be damaged if the tape guides 204, 210 are tapered because of the large strain induced in the tape due to the pre-shaping of the tape in combination with the wrap angle of more than 90° around the tape guides 204, 210. In particular, the tape guides 204, 210 impose compound curves on the tape 200, which accelerates tape wear. 10 On the other hand, the small wrap angle around the wrap pins 206, 212 causes significantly less tape wear.

Figure 15 illustrates an embodiment in which a tape guide 222 has straight edges 224. A wrap pin 226 15 with a curvilinear or chamfered shape is provided for flexing the tape 200. The advantage of the contoured wrap pin 226 is that the small wrap angle at the pin 226 minimizes tape strain.

Figure 22 illustrates an embodiment with a nonrotating asymmetrical tape guide 410. The tape 20 guide 410 has a straight edge 412 for the majority of the wrap angle to minimize tape strain and a curvilinear edge 414 adjacent to the read/write zone 208 to cup or pre-shape the tape 200 to achieve improved coupling with the end face of a rotary 25 transducer (not shown). A symmetrical wrap pin 416 may be used with the asymmetrical tape guide 410.

Figure 26 illustrates a right-handed tribology embodiment wherein the yaw of a transducer drum 460 is 30 tipped (see also Figure 3) so that a read/write location 462 is defined approximately a distance "d" from a wrap

pins 464 on a tape cartridge 468. The distance "d" is approximately between 0.1" and 0.4".

5 If the yaw of the transducer drum 460 is reversed so that the read/write location 462 is adjacent to the tape guide 472, the tape wrap angle formed between the corner tape guide 472 and end face 474 increase rapidly. There is a limited range of tape wrap angle for achieving good transducer 466 to tape 470 coupling. The configuration shown in Figure 26
10 permits transducers 466 to penetrate more deeply into the tape 470 for improved transducer-to-tape interface and greater tolerance to manufacturing variations. Additionally, moving the read/write location 462 further from the tape guide 472 presents a greater
15 span of tape 470 to couple with the transducer drum 460, thereby minimizing the impact of axial runout of the drum 460. Right-hand tribology is preferably combined with a curved, conical or spherical end face 474 on the transducer drum 460 (see also Figures 1 and
20 2). It will be understood that if the span "d" between the read/write location and the wrap pin exceeds 0.5", additional penetration into the tape plane may be required, which can cause the tape to wrap around the inactive side of the transducer drum.

25 Figure 23 illustrates a cartridge 420 in which a tape support pad 422 is located behind the tape 200 in the read/write zone 208. The tape support pad 422 may optionally include a curved slot 424 corresponding to the path traversed by the transducer along the
30 read/write location. The transducer heads may protrude into the curved slot 424, so that the tape 200 wraps around the transducer heads. The tape

support pad 422 may be constructed of a compliant materials, such as for example felt or some other fibrous material. Alternatively, the pad 422 may be constructed of a rigid material, such as for example plastic.

5 A tape cartridge may be registered to a tape drive by engaging the base plate of the cartridge with mechanical stops on the tape drive. Figures 24 and 25 illustrate an alternate tape registration system 430
10 for registering a tape cartridge 432 with a rotary head transducer assembly 322 (see Figure 16). A registration arm 434, preferably mounted to the mounting flange 320 (see Figure 16), engages a lower flange 436 on a tape guide 438. Mounting the
15 registration arm 434 on the mounting flange 320 minimizes tolerance build-up between the tape guide 438 and the transducer assembly 322. Alternatively, the registration arm 434 may be mounted to any suitable
20 surface proximate the rotary head transducer assembly 322.

A distal end 440 of the registration arm has a curved or angled surface 442 which permits smooth engagement and disengagement with the lower flange 436
25 on the cartridge 432. The end face 444 also has a vertically oriented V-shaped or curved contour 452 which approximates the circular profile of the flange 436. As is shown in Figure 25, end face 444 of the registration arm 434 does not extend past the flange
30 436 far enough to contact a tape 446, so that movement of the tape 446 in the cartridge 432 is not interrupted. It will be understood that the end face

444 of the registration arm 434 may be configured to engage with top flange 450, or both flanges 436, 450 simultaneously. The registration system 430 is engaged by sliding the cartridge 432 into a loading mechanism (see Figure 16). The loading mechanism opens the tape cover 448 to expose the tape 446. Upon complete insertion, the lower flange 436 of the tape guide 438 mechanically engages with the surface 442.

Figure 11 is a sectional view of a rotary head transducer 230 having a center hole 232 in fluid communication with a transducer drum air vent 234 leading into a chamber 236. An outer shroud air hole 238 is provided for releasing pressure buildup in the chamber 236. Seals 240 are placed between the inside surface of the outer shroud 242 and the transducer drum 244. Blades 246 are attached to the outside surface of the transducer drum 244 to draw air through the center hole 232 according to the arrows 248.

The blades 246 use the shroud 242 as a stator to create sub-ambient pressure at the interface between the end face 258 and the tape (not shown). As is shown in Figure 12, low pressure distribution slots 256 in the end face 258 route the airflow through the center hole 232 so that the sub-ambient pressure occurs adjacent to the transducers 72.

Figure 12 illustrates an alternate tape support platform 250 which substantially covers the end face 258 of the transducer drum (not shown). Since the end face 258 is substantially enclosed by the tape support platform 250, the reduced pressure condition is concentrated generally proximate the transducer opening 254. Consequently, the tape 28 is drawn to

the opening 254 for improved engagement with the passing transducers 72.

Figure 21 is an end view of another alternative tape support platform 400 which substantially covers the end face of the transducer drum (not shown). A center hole 404 and low pressure distribution slot 406 proximate the transducer opening 408 are cut into the tape support surface 402 of the tape support platform 400. The low pressure condition draws the tape 28 against the tape support surface 402 to enhance engagement of the transducer 72 with the tape 28 at the transducer opening 408.

Figure 13 is a sectional view of an alternate rotary transducer drum 270 in which a transducer plate 272 has a plurality of air holes 274 connected to an air gap 276 for drawing air 278 from the end face 272 out through the air gap 276. Figure 14 is an end view of the transducer plate 272 containing eight transducers 280 and a plurality of air holes 274 adjacent thereto.

While the above embodiments disclose various quantities of transducers, it should be understood that the number of transducers in the exemplary embodiments in no way limits the scope of the invention.

Other modifications of the invention will be apparent to those skilled in the art in view of the foregoing descriptions. These descriptions are intended only to provide specific examples of embodiments which clearly disclose the present invention. Accordingly, the invention is not limited to the described embodiments or to the use of specific

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elements, dimensions, materials or configurations contained therein. All alternative modifications and variations of the present invention which fall within the spirit and broad scope of the appended claims are covered.

5



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We claim:

1. An apparatus for engaging a magnetic tape in a cartridge with a transducer at a read/write zone, the cartridge being mountable in the apparatus with a longitudinal axis of the magnetic tape passing through the read/write zone, the cartridge having a tape guide adjacent to a first side of the read/write zone and proximate a corner of the cartridge, and a wrap pin adjacent to a second side of the read/write zone, the apparatus comprising:

a rotating transducer carrier with an end face proximate the read/write zone, the transducer carrier having an axis of rotation which forms an oblique angle with the tape, defining a read/write location adjacent to the wrap pin; and

at least one transducer for reading and writing arcuate information tracks generally laterally across the tape located on the end face of the rotating transducer carrier so that the transducer traces a substantially circular transducing path through the read/write zone, the read/write location being located at least 0.1" from the wrap pin.

2. The apparatus of claim 1 wherein a distance between the read/write location and the wrap pin comprises 0.1" to 0.4".

3. The apparatus of claim 1 wherein the end face comprises a conical surface.

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4. The apparatus of claim 1 wherein the at least one transducer penetrates into the tape surface by less than about 0.0015".

5 5. The apparatus of claim 1 wherein the at least one transducer extends between 0.0005" and 0.001" above the end face.

10 6. An apparatus for engaging a magnetic tape with a transducer at a read/write zone, the magnetic tape being mountable in the apparatus with a longitudinal axis passing through the read/write zone, the apparatus comprising:

15 a rotating transducer carrier with an end face proximate the read/write zone, the transducer carrier having an axis of rotation which passes through the tape at the read/write zone;

20 at least one transducer for reading and writing arcuate information tracks generally laterally across the tape located on the end face of the rotating transducer carrier so that the transducer traces a substantially circular transducing path through the read/write zone with the axis of rotation corresponding substantially to the center of the transducing path, the transducing path having a read/write location; and

25 a tape support system generally adjacent to the read/write location for positioning the tape so that the at least one transducer penetrates into a tape surface by less than about 0.0015" along the read/write location, the tape support system
30 comprising at least one tape support having a tape





support surface engaged with the tape and extending generally laterally across the tape, at least a portion of the tape support surface being curved.

5 7. The apparatus of claim 6 wherein the at least one transducer extends between 0.0005" and 0.001" above the end face.

10 8. An apparatus for engaging a magnetic tape with a transducer at a read/write zone, the magnetic tape being mountable in the apparatus with a longitudinal axis passing through the read/write zone, the apparatus comprising:

15 a rotating transducer carrier with an end face proximate the read/write zone, the transducer carrier having an axis of rotation which passes through the tape at the read/write zone;

20 at least one transducer for reading and writing arcuate information tracks generally laterally across the tape located on the end face of the rotating transducer carrier so that the transducer traces a substantially circular transducing path through the read/write zone with the axis of rotation corresponding substantially to the center of the transducing path, the transducing path having a read/write location; and

25 a tape support system generally adjacent to the read/write location for positioning the tape so that the at least one transducer penetrates into a tape surface by less than about 0.0015" along the read/write location, the tape support system
30 comprising at least one tape support having a tape

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support surface engaged with the tape and extending generally laterally across the tape, the tape support surface having straight outer edges perpendicular to the longitudinal axis of the tape.

5 9. The apparatus of claim 8 wherein the at least one transducer extends between 0.0005" and 0.001" above the end face.

10 10. An apparatus for engaging a magnetic tape with a transducer at a read/write zone, the magnetic tape being mountable in the apparatus with a longitudinal axis passing through the read/write zone, the apparatus comprising:

15 a rotating transducer carrier with an end face proximate the read/write zone, the transducer carrier having an axis of rotation that forms an oblique angle with the tape at the read/write zone;

20 at least one transducer for reading and writing arcuate information tracks generally laterally across the tape located on the end face of the rotating transducer carrier so that the transducer traces a substantially circular transducing path through the read/write zone with the axis of rotation corresponding substantially to the center of the transducing path, the transducing path having a read/write location; and

25 a tape support system proximate to the read/write zone for positioning the tape so that the at least one transducer penetrates into a tape surface by less than 0.0015" along the read/write location, the tape support system comprising a tape support on the end

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face extending above a datum plane defined by the at least one transducer for supporting the tape.

11. The apparatus of claim 10 wherein the tape support end face comprises a generally conical shape.

5 12. The apparatus of claim 10 wherein the at least one transducer extends between 0.0005" and 0.001" above the end face.

10 13. A method for engaging a magnetic tape in a cartridge with a transducer at a read/write zone, the cartridge being mountable in the apparatus with a longitudinal axis of the magnetic tape passing through the read/write zone, the cartridge having a tape guide adjacent to a first side of the read/write zone and a wrap pin adjacent to a second side of the read/write zone, the method comprising the steps of:

15 positioning a rotating transducer carrier with an end face proximate the read/write zone, the transducer carrier having an axis of rotation which forms an oblique angle with the tape, defining a read/write location adjacent to the wrap pin; and

20 providing at least one transducer for reading and writing arcuate information tracks generally laterally across the tape located on the end face of the rotating transducer carrier so that the transducer traces a substantially circular transducing path through the read/write zone, the wrap pin being located at least 0.1" from the read/write location.

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14. The method of claim 13 wherein a distance between the read/write location and the wrap pin comprises 0.1" to 0.4".

5 15. The method of claim 13 wherein the end face comprises a conical surface.

16. The method of claim wherein the at least one transducer penetrates into the tape surface by less than about 0.0015".

10 17. The method of claim 13 wherein the at least one transducer extends between 0.0005" and 0.001" above the end face.

18. An arcuate scanning tape drive comprising:
a loading mechanism for receiving a container
15 holding a magnetic tape and for positioning the magnetic tape at a recording location, the container having a tape guide proximate a corner of the container and adjacent to a first side of a read/write zone, and a wrap pin adjacent to a second side of the
20 read/write zone;

transport means for transporting the magnetic tape longitudinally past the read/write zone;

a rotating transducer carrier with an end face proximate the read/write zone, the transducer carrier
25 having an axis of rotation which forms an oblique angle with the tape, defining a read/write location adjacent to the wrap pin; and

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- 5 at least one transducer for reading and writing arcuate information tracks generally laterally across the tape located on the end face of the rotating transducer carrier so that the transducer traces a substantially circular transducing path through the read/write zone, the read/write location being located at least 0.1" from the wrap pin.

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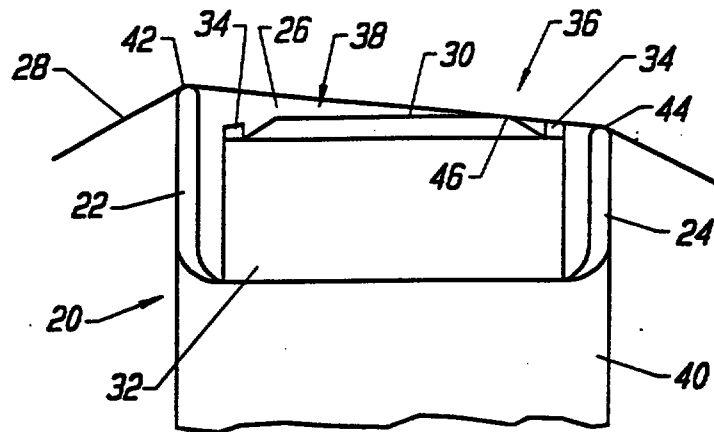


FIG. 1

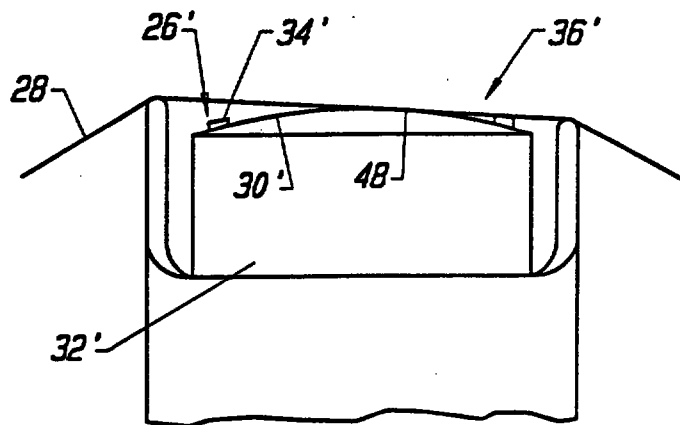


FIG. 2

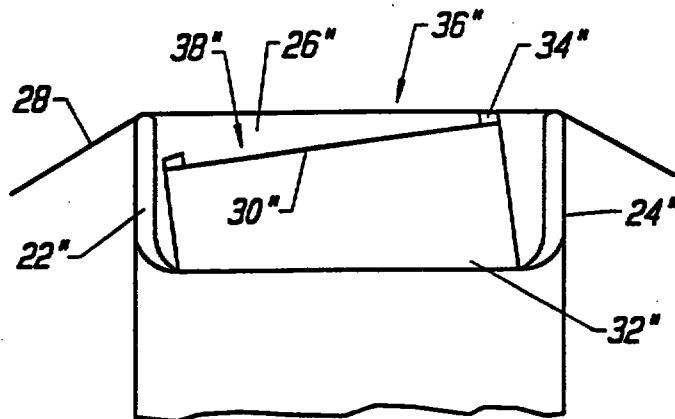


FIG. 3

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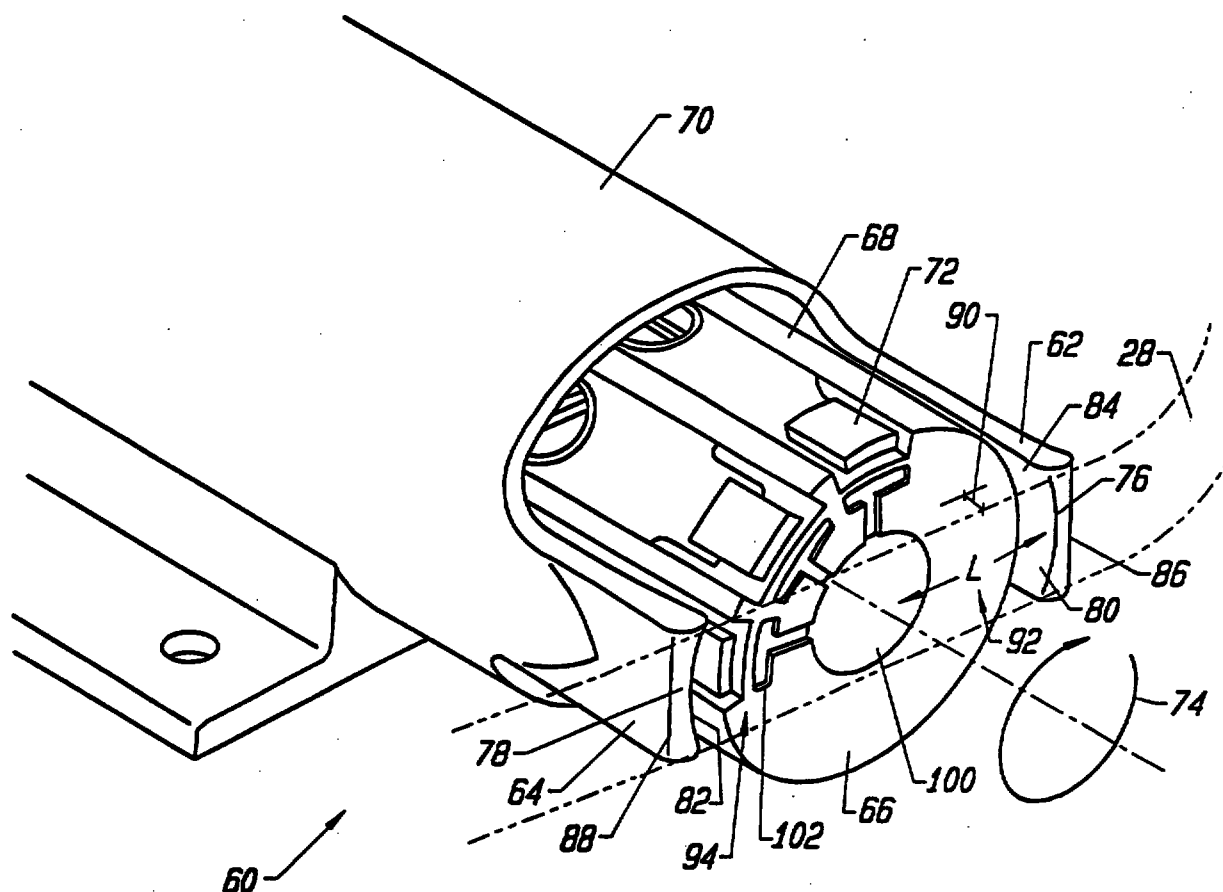


FIG. 4

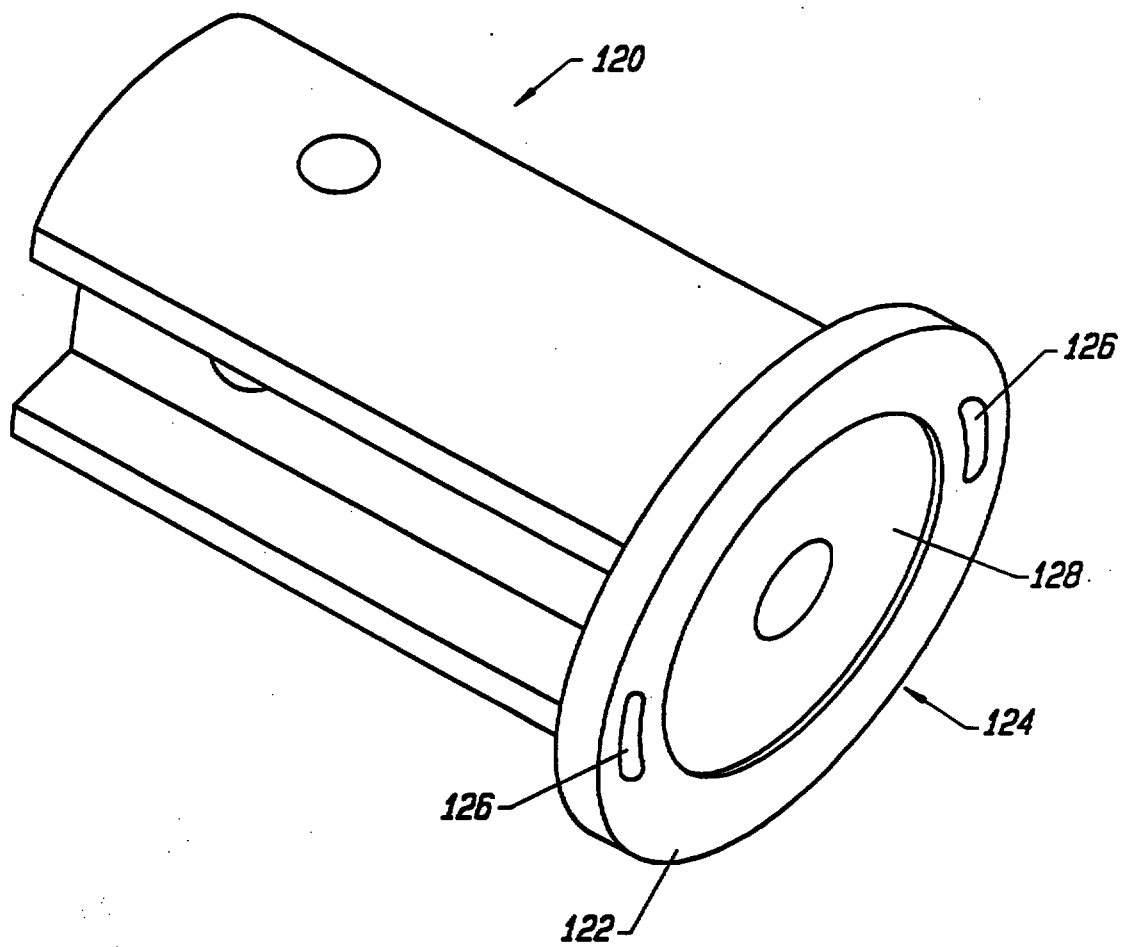


FIG. 6

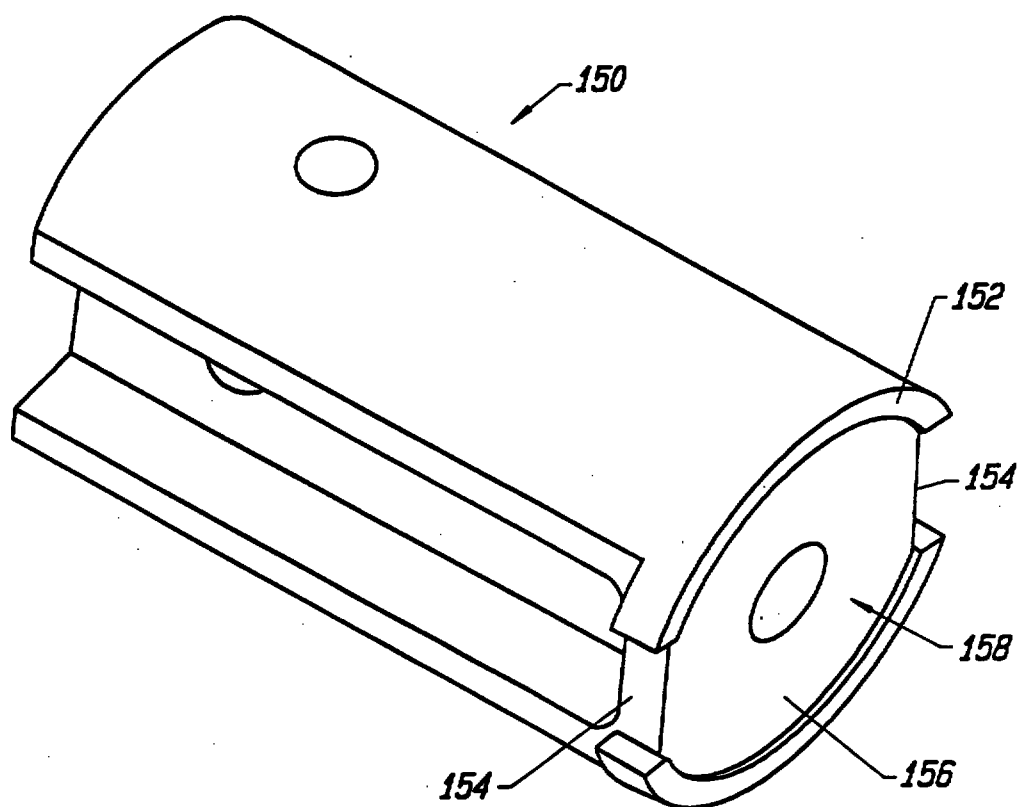


FIG. 7

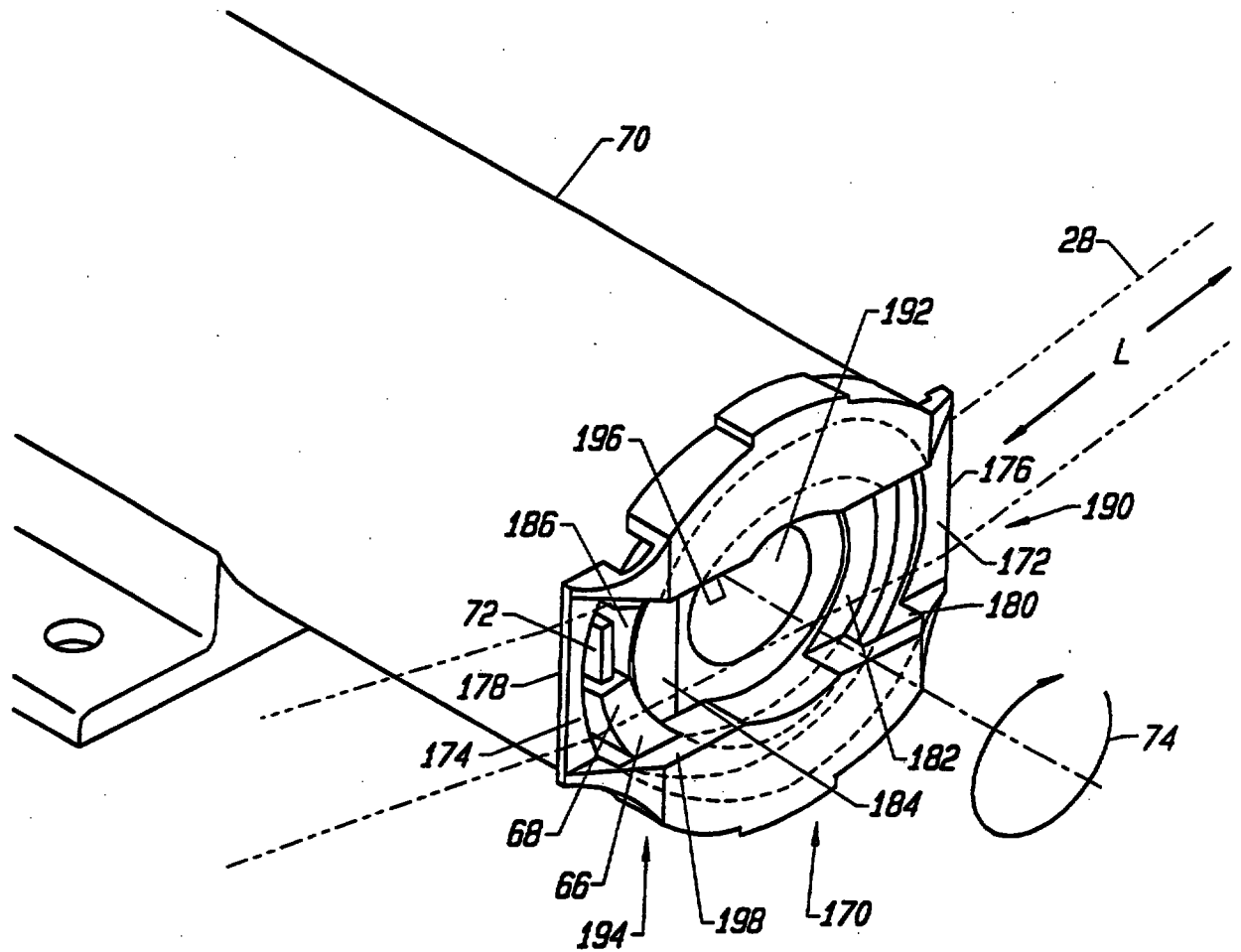


FIG. 8

FIG. 9

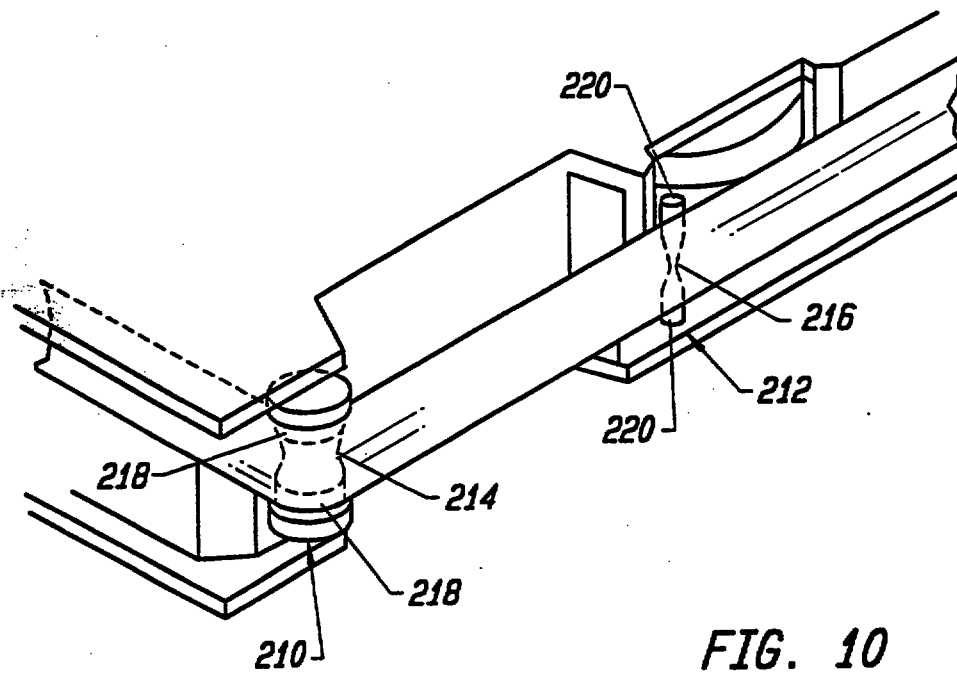
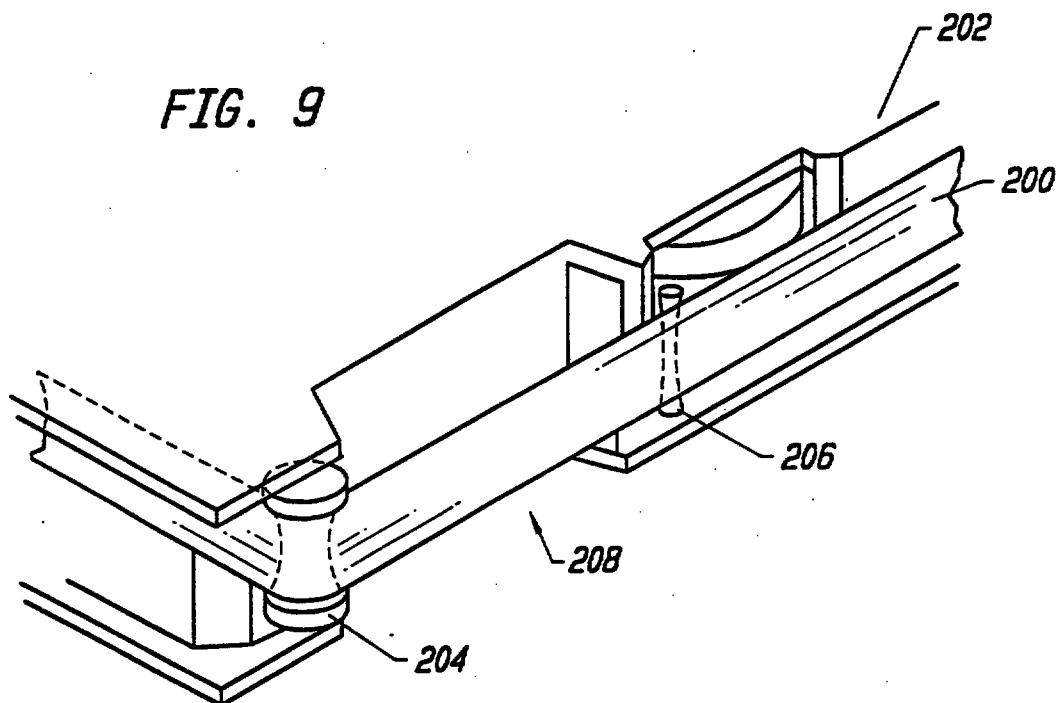


FIG. 10

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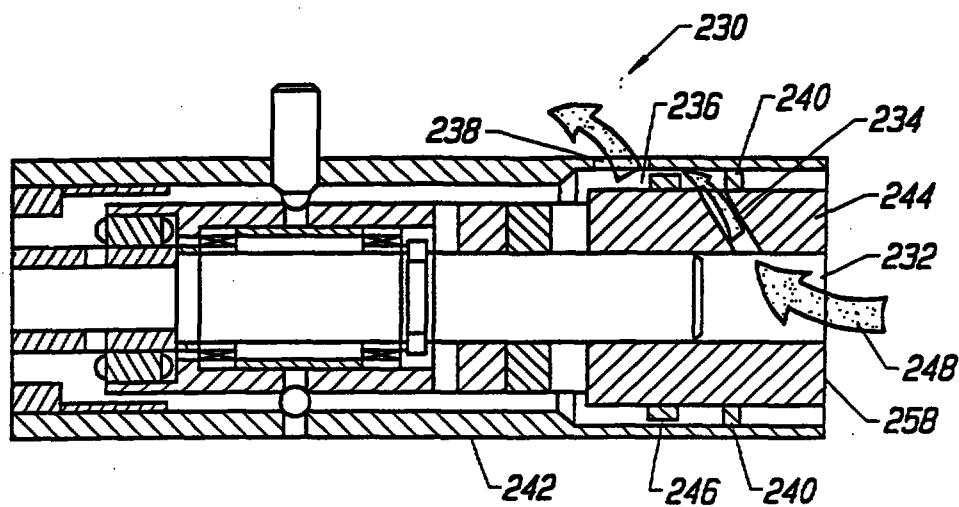


FIG. 11

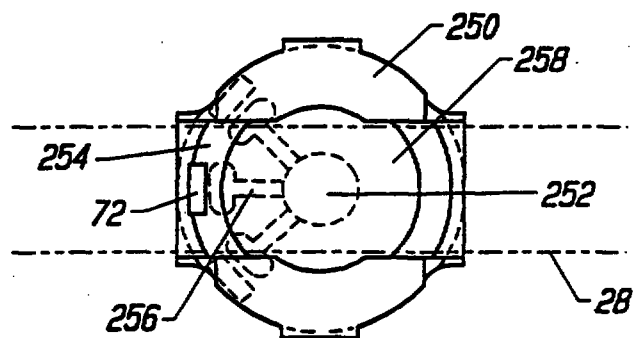


FIG. 12

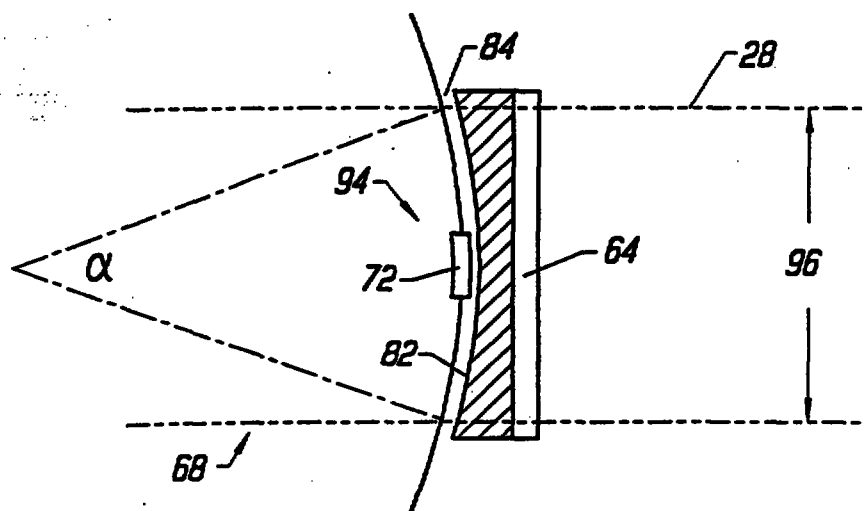
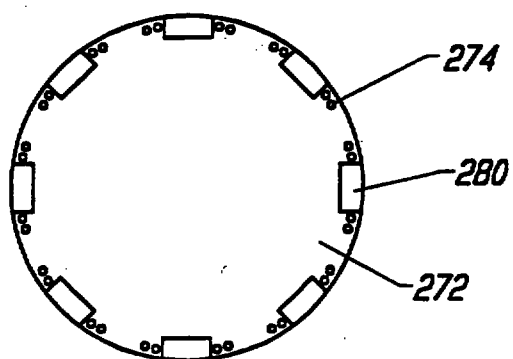
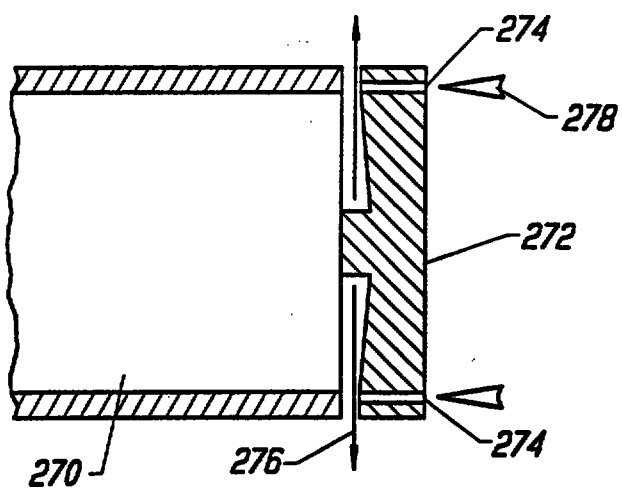


FIG. 5

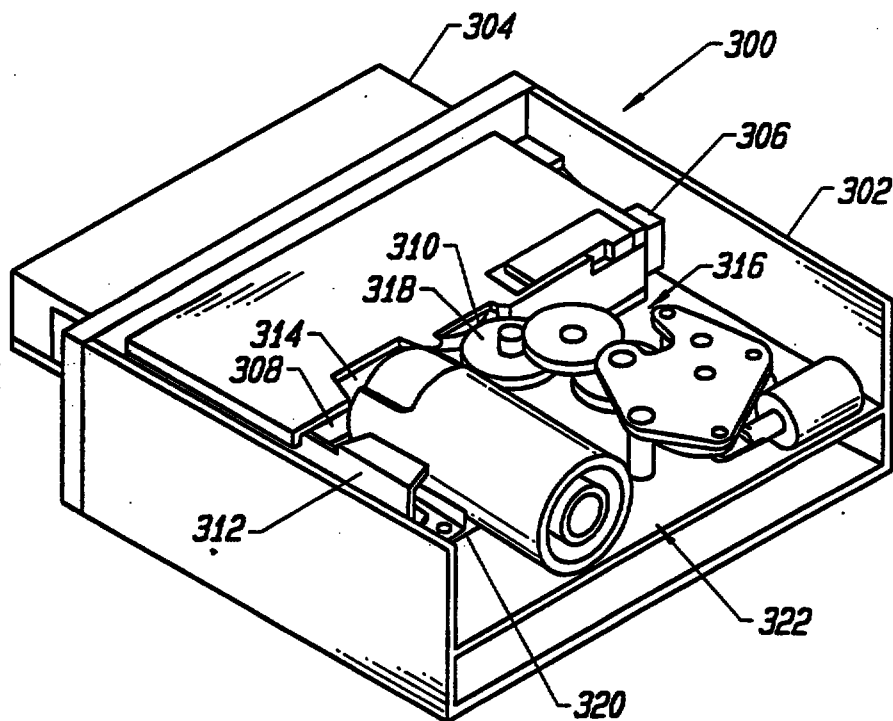
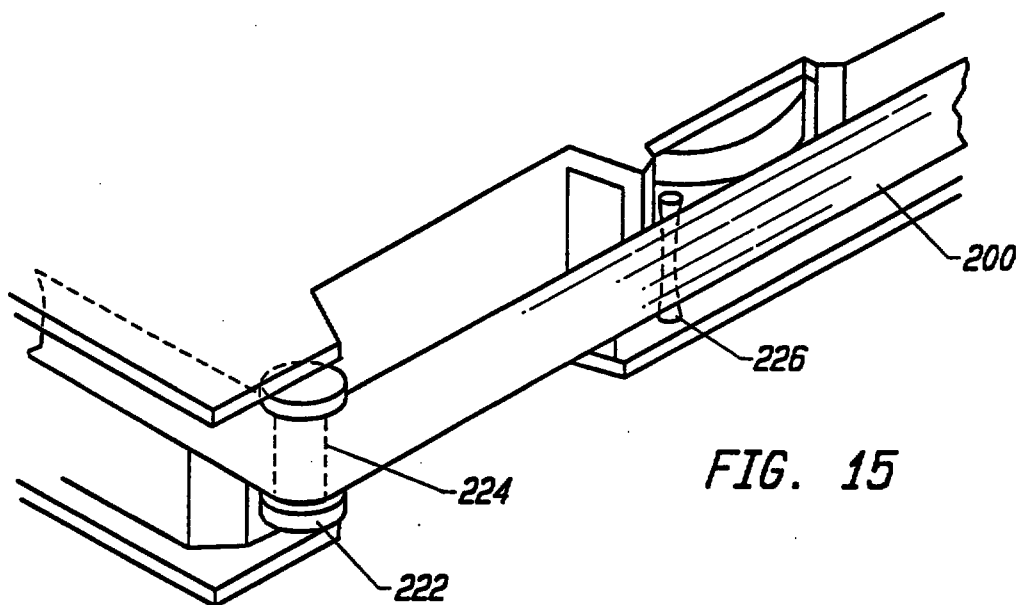
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*FIG. 14**FIG. 13*

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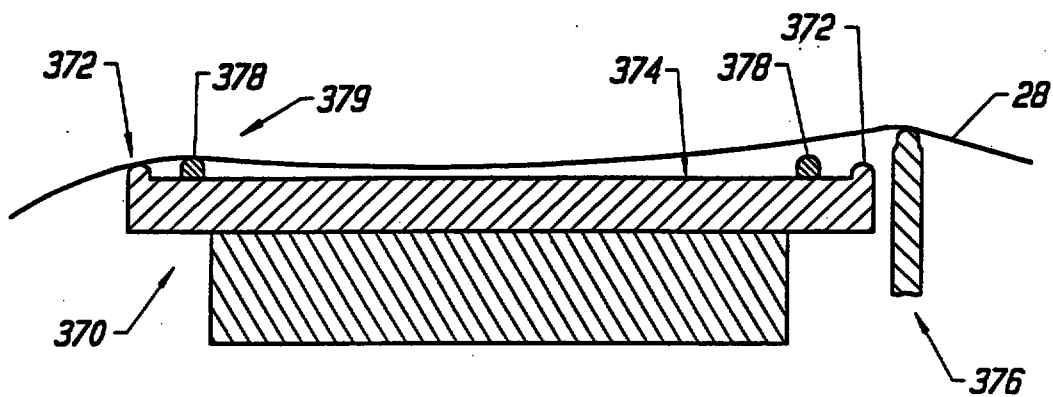


FIG. 17

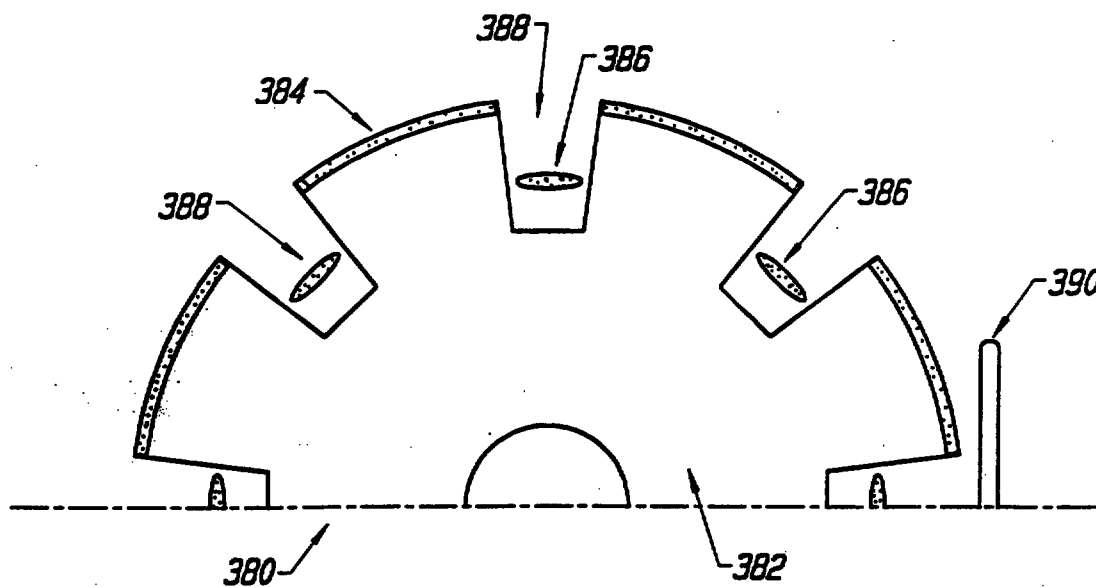


FIG. 18

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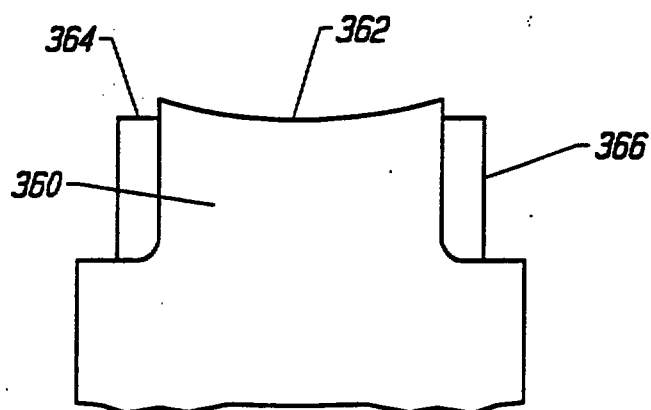


FIG. 19

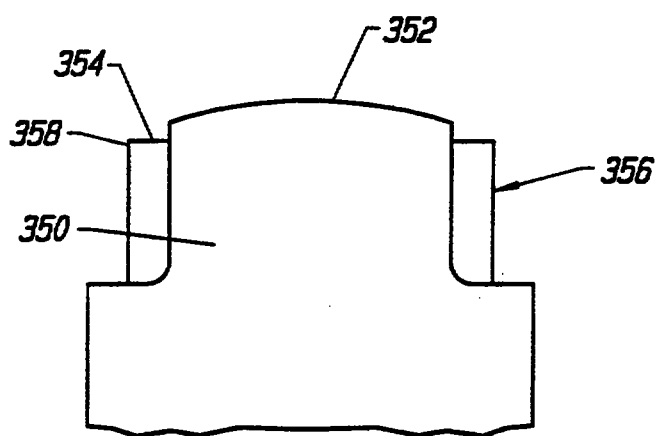


FIG. 20

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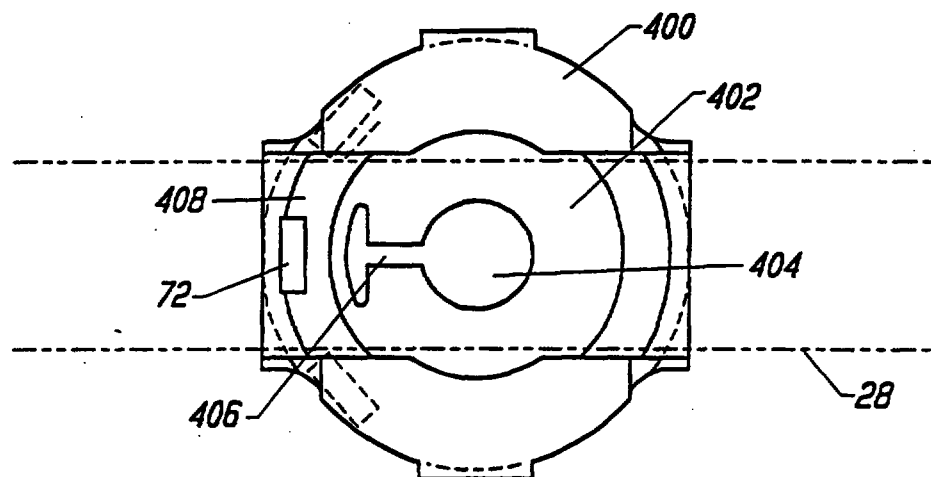


FIG. 21

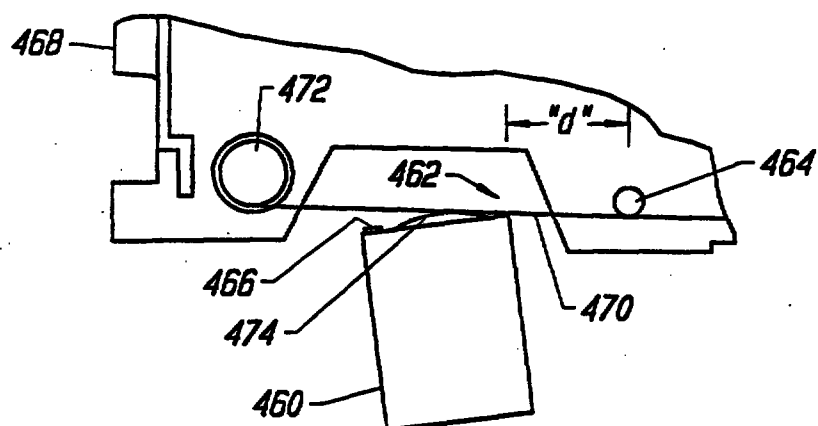


FIG. 26

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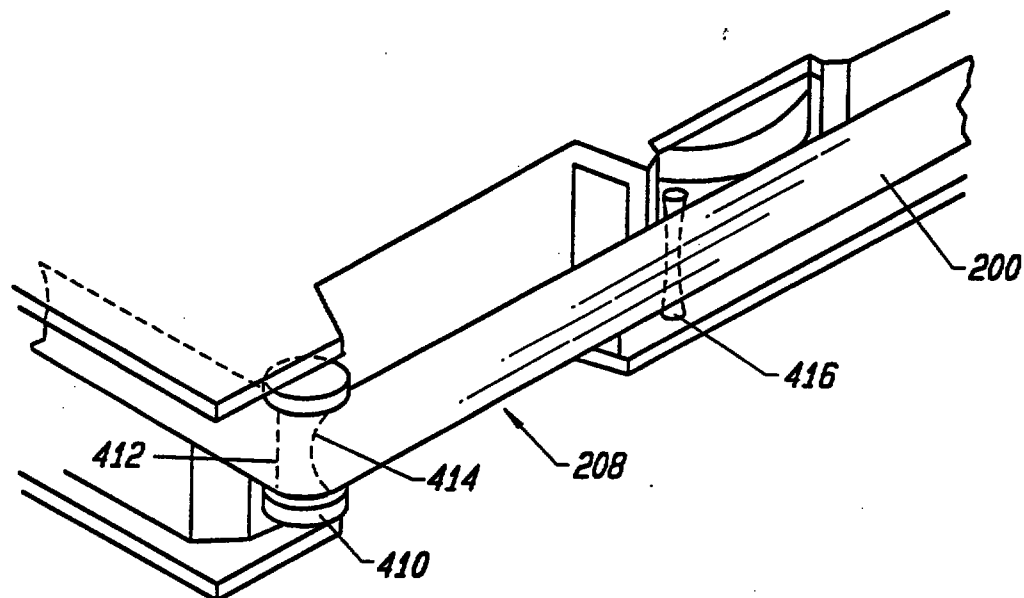


FIG. 22

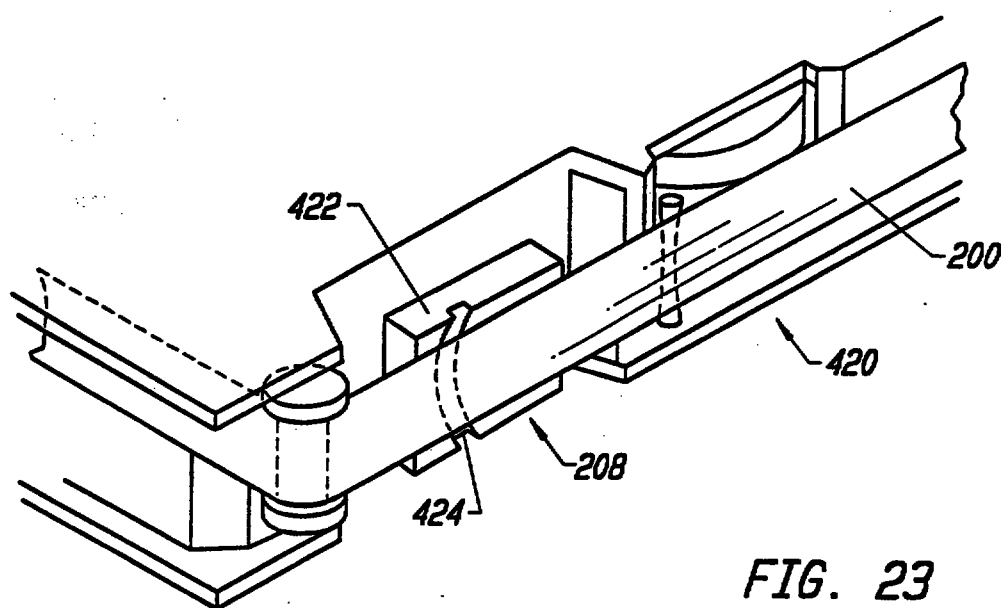
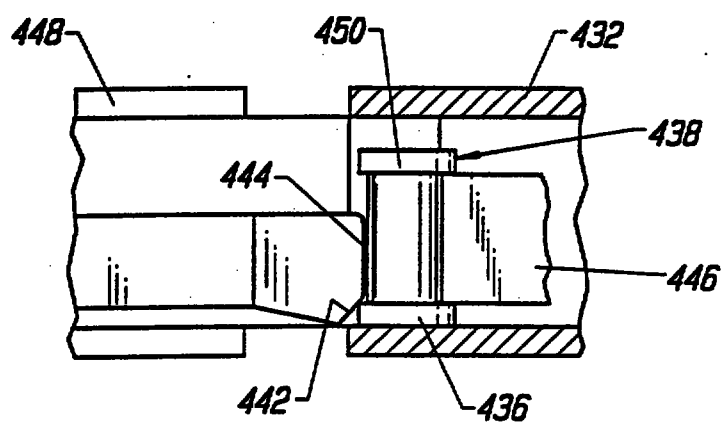
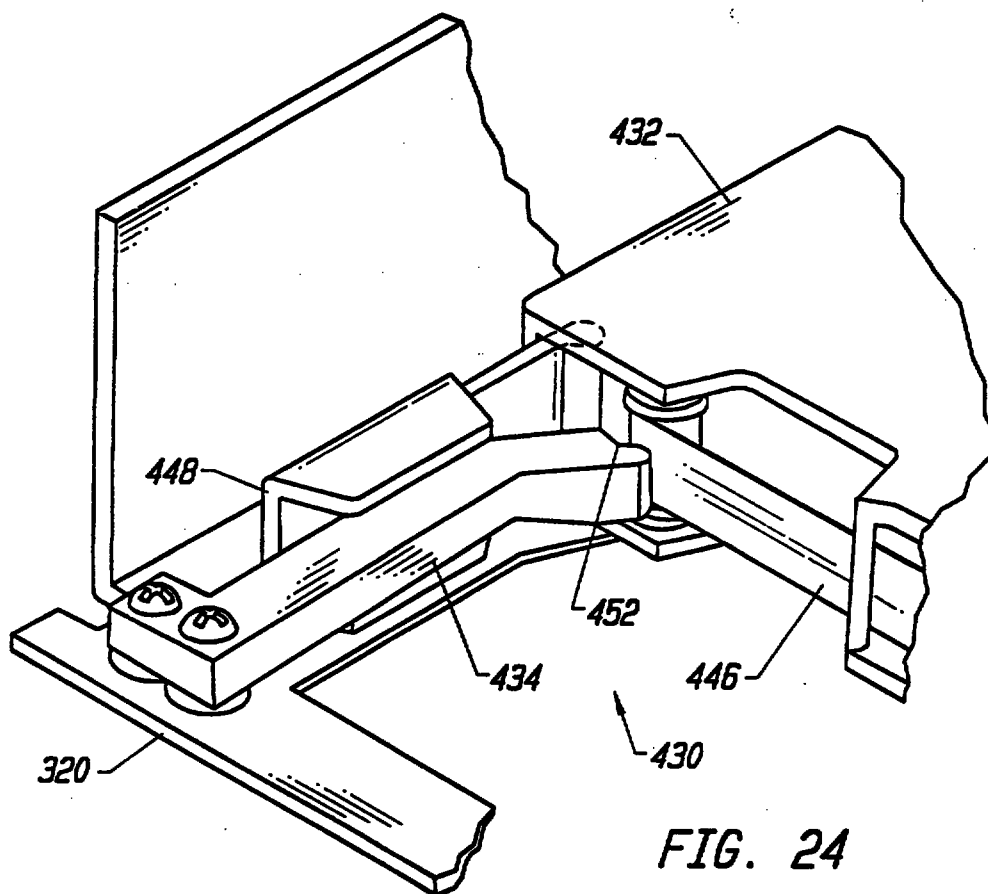


FIG. 23



SUBSTITUTE SHEET (RULE 26)



WE CLAIM:

1. An apparatus for engaging a magnetic tape in a cartridge with a transducer at a read/write zone, the cartridge being mountable in the apparatus with a longitudinal axis of the magnetic tape passing through the read/write zone, the cartridge having a tape guide adjacent to a first side of the read/write zone and proximate a corner of the cartridge, and a wrap pin adjacent to a second side of the read/write zone, the apparatus comprising:

a rotating transducer carrier with an end face proximate the read/write zone, the transducer carrier having an axis of rotation which forms an oblique angle with the tape, defining a read/write location adjacent to the wrap pin; and

at least one transducer for reading and writing arcuate information tracks generally laterally across the tape located on the end face of the rotating transducer carrier so that the transducer traces a substantially circular transducing path through the read/write zone, the read/write location being located at least 0.1" from the wrap pin.

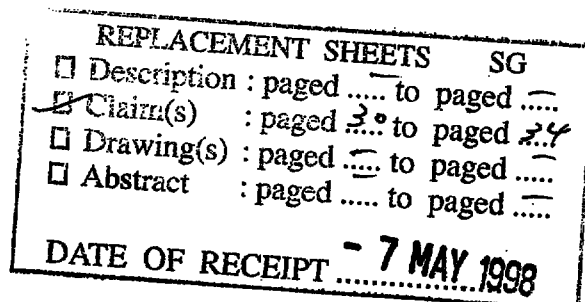
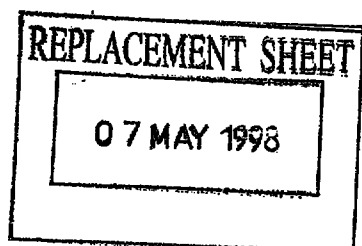
2. The apparatus of claim 1 wherein a distance between the read/write location and the wrap pin comprises 0.1" to 0.4".

3. The apparatus of claim 1 wherein the end face comprises a conical surface.

4. The apparatus of claim 1 wherein the at least one transducer penetrates into the tape surface by less than about 0.0015".

5. The apparatus of claim 1 wherein the at least one transducer extends between 0.0005" and 0.001" above the end face.

6. An apparatus for engaging a magnetic tape with a transducer at a read/write zone, the magnetic tape being mountable in the apparatus with a longitudinal axis passing through the read/write zone, the apparatus comprising:





a rotating transducer carrier with an end face proximate the read/write zone, the transducer carrier having an axis of rotation which passes through the tape at the read/write zone;

at least one transducer for reading and writing arcuate information tracks generally laterally across the tape located on the end face of the rotating transducer carrier so that the transducer traces a substantially circular transducing path through the read/write zone with the axis of rotation corresponding substantially to the center of the transducing path, the transducing path having a read/write location; and

a tape support system generally adjacent to the read/write location for positioning the tape so that the at least one transducer penetrates into a tape surface by less than about 0.0015" along the read/write location, the tape support system comprising at least one tape support having a tape support surface engaged with the tape and extending generally laterally across the tape, at least a portion of the tape support surface being curved.

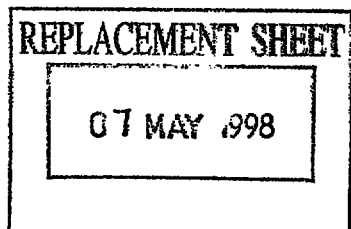
7. The apparatus of claim 6 wherein the at least one transducer extends between 0.0005" and 0.001" above the end face.

8. An apparatus for engaging a magnetic tape with a transducer at a read/write zone, the magnetic tape being mountable in the apparatus with a longitudinal axis passing through the read/write zone, the apparatus comprising:

a rotating transducer carrier with an end face proximate the read/write zone, the transducer carrier having an axis of rotation which passes through the tape at the read/write zone;

at least one transducer for reading and writing arcuate information tracks generally laterally across the tape located on the end face of the rotating transducer carrier so that the transducer traces a substantially circular transducing path through the read/write zone with the axis of rotation corresponding substantially to the center of the transducing path, the transducing path having a read/write location; and

a tape support system generally adjacent to the read/write location for positioning the tape so that the at least one transducer penetrates into a tape surface by less than about





0.0015" along the read/write location, the tape support system comprising at least one tape support having a tape support surface engaged with the tape and extending generally laterally across the tape, the tape support surface having straight outer edges perpendicular to the longitudinal axis of the tape.

9. The apparatus of claim 8 wherein the at least one transducer extends between 0.0005" and 0.001" above the end face.

10. An apparatus for engaging a magnetic tape with a transducer at a read/write zone, the magnetic tape being mountable in the apparatus with a longitudinal axis passing through the read/write zone, the apparatus comprising:

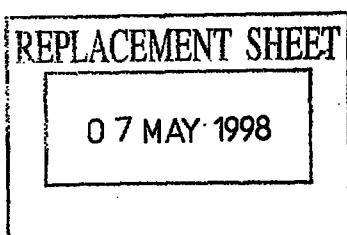
a rotating transducer carrier with an end face proximate the read/write zone, the transducer carrier having an axis of rotation that forms an oblique angle with the tape at the read/write zone;

at least one transducer for reading and writing arcuate information tracks generally laterally across the tape located on the end face of the rotating transducer carrier so that the transducer traces a substantially circular transducing path through the read/write zone with the axis of rotation corresponding substantially to the center of the transducing path, the transducing path having a read/write location; and

a tape support system proximate to the read/write zone for positioning the tape so that the at least one transducer penetrates into a tape surface by less than 0.0015" along the read/write location, the tape support system comprising a tape support on the end face extending above a datum plane defined by the at least one transducer for supporting the tape.

11. The apparatus of claim 10 wherein the tape support end face comprises a generally conical shape.

12. The apparatus of claim 10 wherein the at least one transducer extends between 0.0005" and 0.001" above the end face.





13. A method for engaging a magnetic tape in a cartridge with a transducer at a read/write zone, the cartridge being mountable in the apparatus with a longitudinal axis of the magnetic tape passing through the read/write zone, the cartridge having a tape guide adjacent to a first side of the read/write zone and a wrap pin adjacent to a second side of the read/write zone, the method comprising the steps of:

positioning a rotating transducer carrier with an end face proximate the read/write zone, the transducer carrier having an axis of rotation which forms an oblique angle with the tape, defining a read/write location adjacent to the wrap pin; and

providing at least one transducer for reading and writing arcuate information tracks generally laterally across the tape located on the end face of the rotating transducer carrier so that the transducer traces a substantially circular transducing path through the read/write zone, the wrap pin being located at least 0.1" from the read/write location.

14. The method of claim 13 wherein a distance between the read/write location and the wrap pin comprises 0.1" to 0.4".

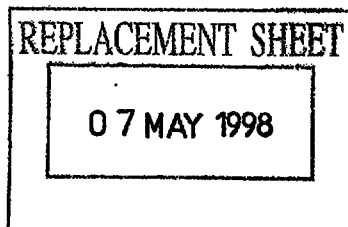
15. The method of claim 13 wherein the end face comprises a conical surface.

16. The method of claim wherein the at least one transducer penetrates into the tape surface by less than about 0.0015".

17. The method of claim 13 wherein the at least one transducer extends between 0.0005" and 0.001" above the end face.

18. An arcuate scanning tape drive comprising:

a loading mechanism for receiving a container holding a magnetic tape and for positioning the magnetic tape at a recording location, the container having a tape guide proximate a corner of the container and adjacent to a first side of a read/write zone, and a wrap pin adjacent to a second side of the read/write zone;





transport means for transporting the magnetic tape longitudinally past the read/write zone;

a rotating transducer carrier with an end face proximate the read/write zone, the transducer carrier having an axis of rotation which forms an oblique angle with the tape, defining a read/write location adjacent to the wrap pin; and

at least one transducer for reading and writing arcuate information tracks generally laterally across the tape located on the end face of the rotating transducer carrier so that the transducer traces a substantially circular transducing path through the read/write zone, the read/write location being located at least 0.1" from the wrap pin.

