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Lass et al.

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[45] **Date of Patent: Jun. 22, 1999**

[54] **TAPE DRIVE WITH BEZEL HAVING CARTRIDGE EJECTION RETARDING PROJECTIONS**

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[73] Assignee: **Exabyte Corporation**, Boulder, Colo.

[21] Appl. No.: **08/497,460**

[22] Filed: **Jun. 26, 1995**

[51] **Int. Cl.**[6] **G11B 5/008**

[52] **U.S. Cl.** **360/96.5**; 360/92

[58] **Field of Search** 360/96.5, 96.6, 360/92

[56] **References Cited**

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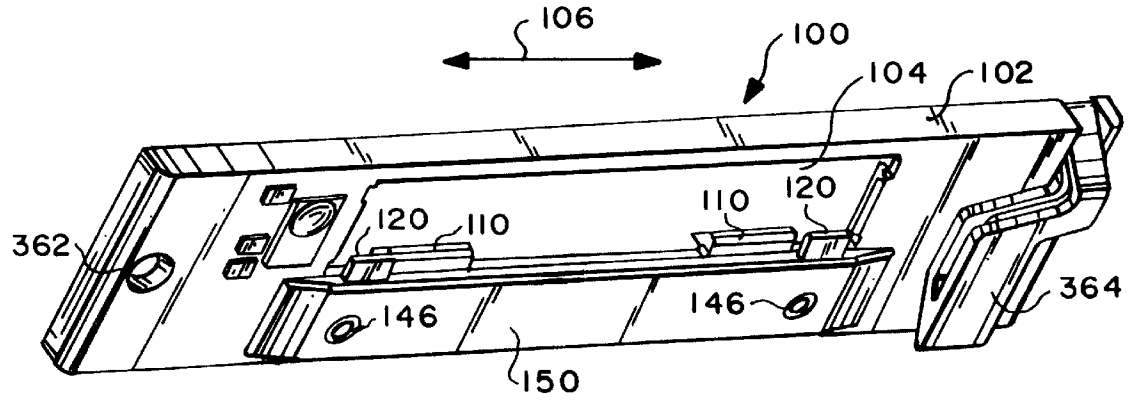
Primary Examiner—John H. Wolff

Attorney, Agent, or Firm—Nixon & Vanderhye, P.C.

[57] **ABSTRACT**

A bezel **(100)** mitigates cartridge over ejection from a tape drive, the tape drive receiving and ejecting a cartridge of magnetic tape for performing recording and reading operations with respect to the magnetic tape. The bezel **(100)** comprises both a bezel plate **(102)** and a pair of cartridge braking projections **(120)** attached thereto. The cartridge braking projections partially extend into a cartridge slot **(104)** and retard motion of a cartridge travelling through the slot. The cartridge braking projections **(120)** are resilient and bidirectionally flexible, preferably being formed of cellular urethane. The cartridge braking projections **(120)** extend into the slot by a predetermined distance above a lower cartridge plane **(115)**. In one embodiment, the bezel **(100)** is attached to a rack which accommodates the tape drive.

11 Claims, 5 Drawing Sheets



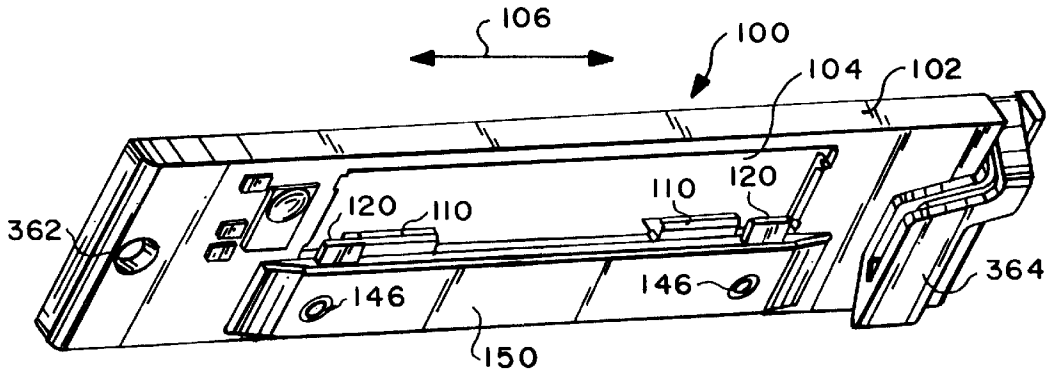


Fig. 1

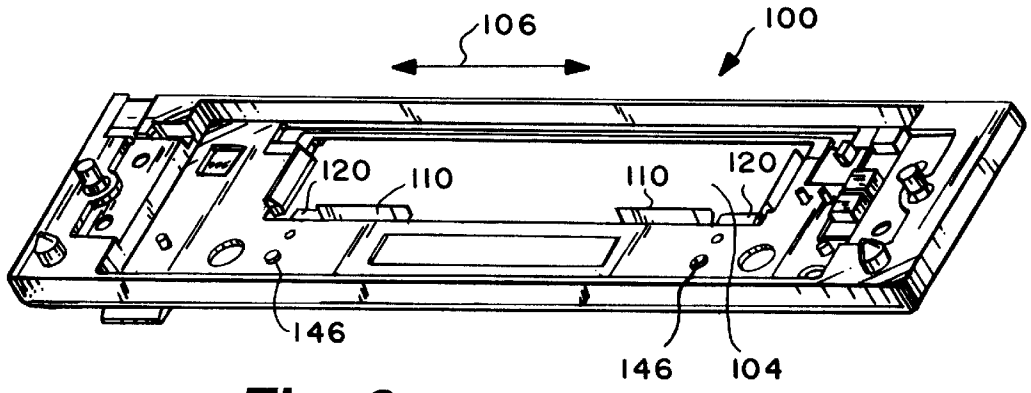


Fig. 2

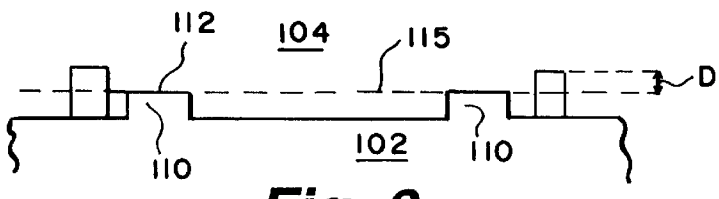


Fig. 6

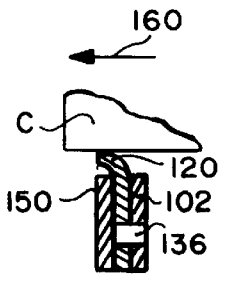


Fig. 7

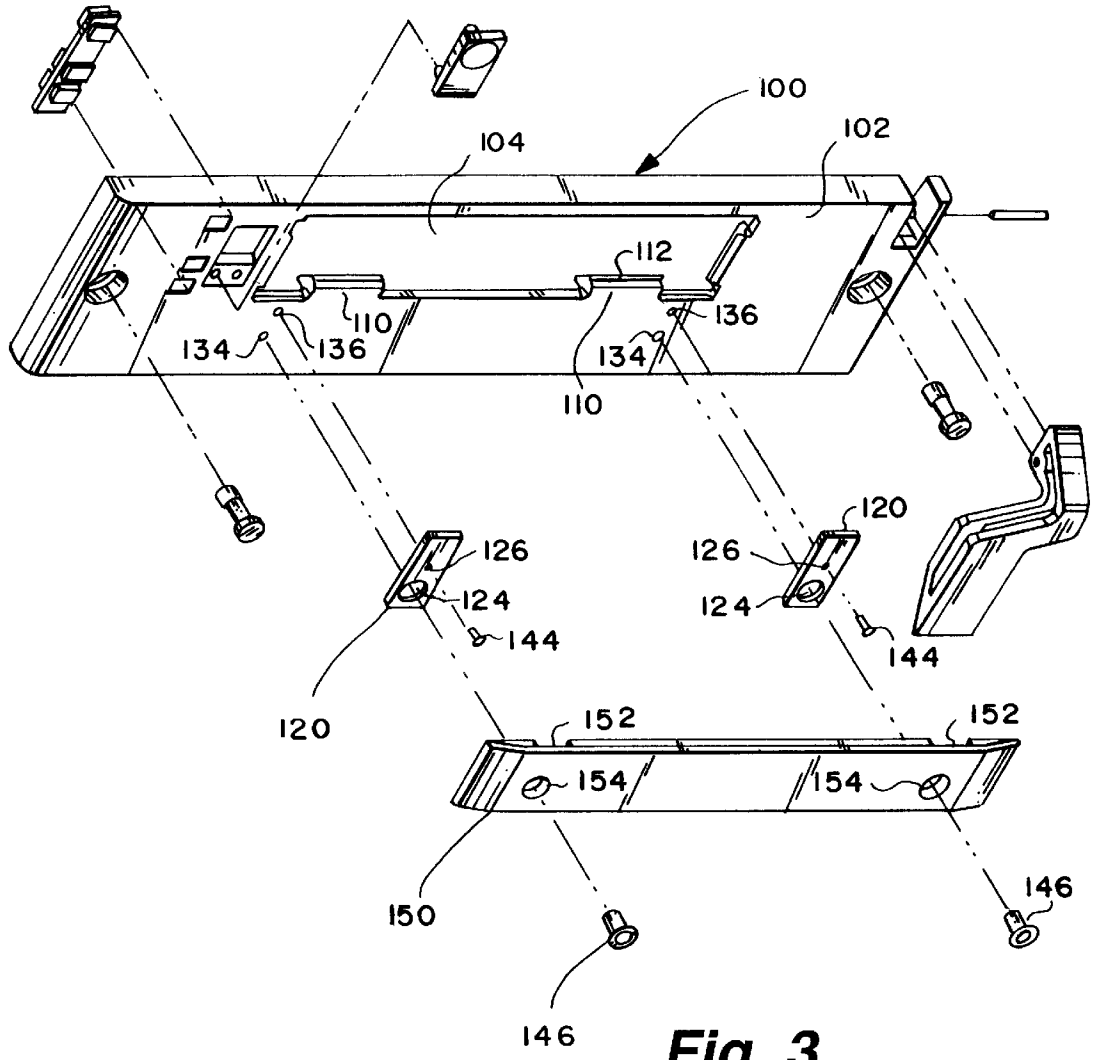

100
102
104
112
110
136
134
136
134
110
120
126
126
124
124
144
144
120
152
152
154
154
150
146
146

Fig. 3

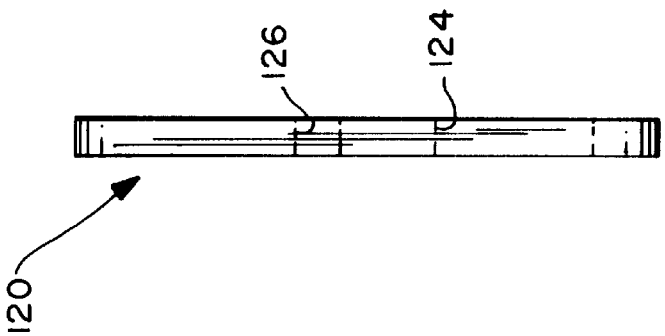


Fig. 5

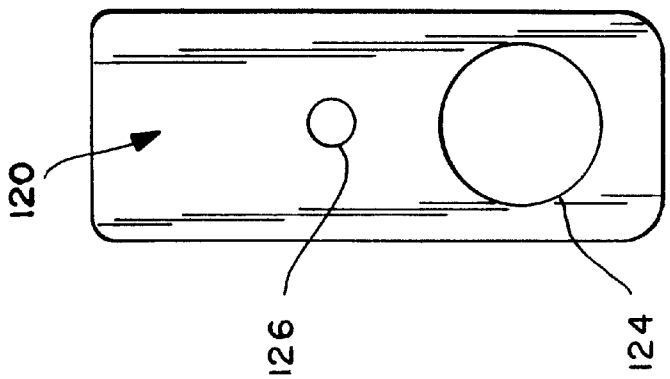


Fig. 4

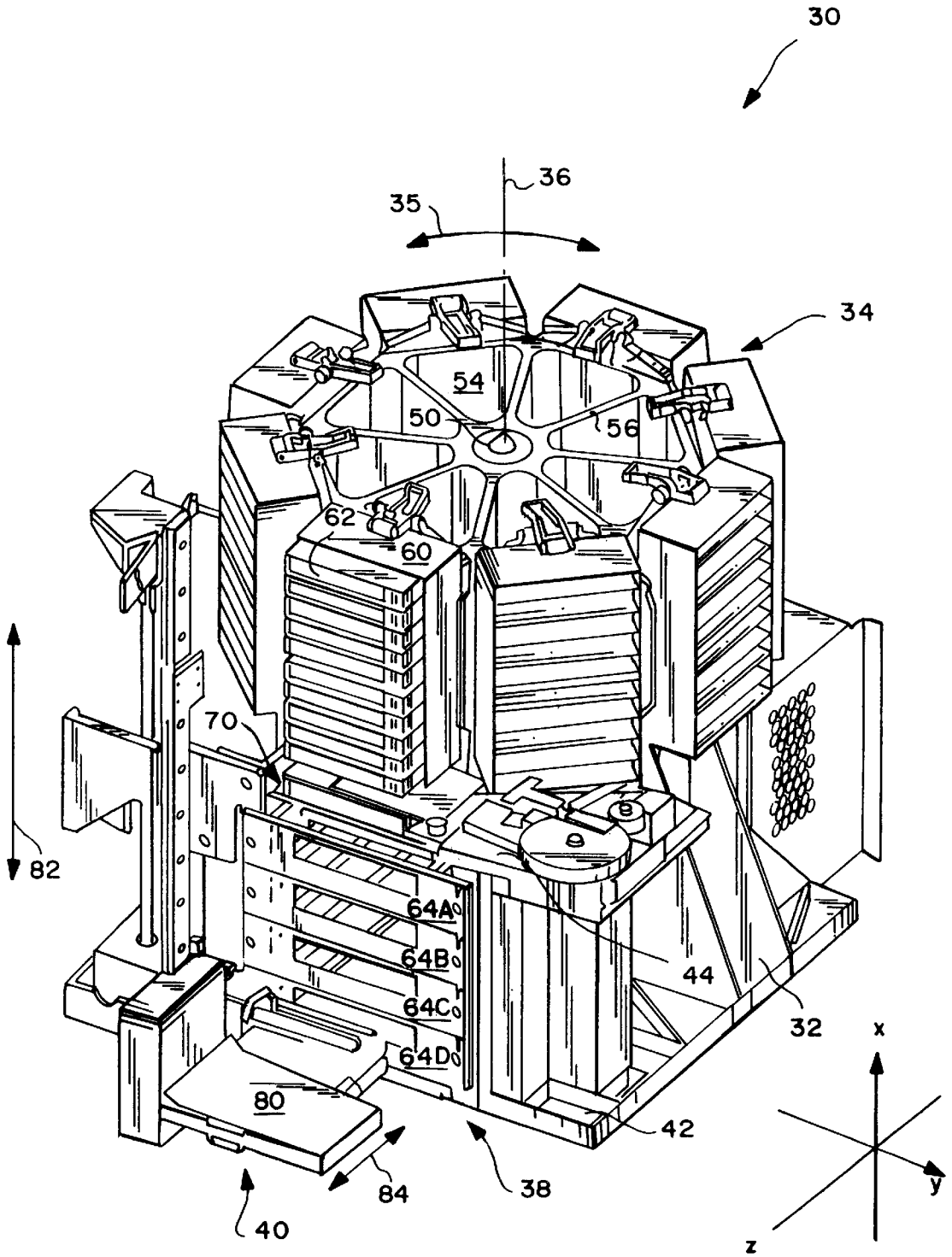

30
36
35
34
54
50
56
62
60
70
82
64A
64B
64C
64D
44
32
80
42
84
38
40
x
y
z

Fig. 8

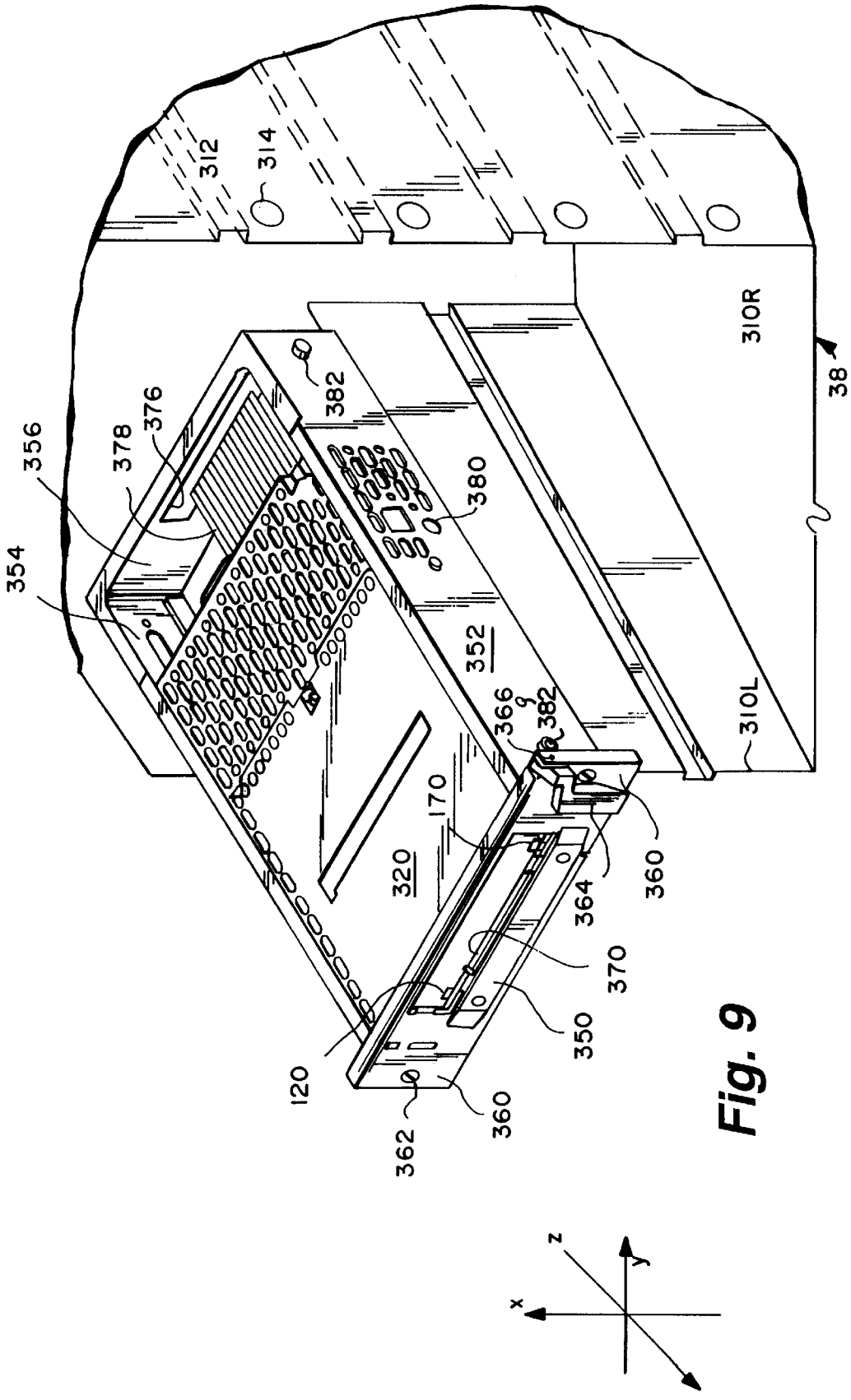

312
314
310R
38
382
376
378
356
354
380
352
366
382
310L
170
320
360
364
370
350
120
360
362
z
y
x

Fig. 9

TAPE DRIVE WITH BEZEL HAVING CARTRIDGE EJECTION RETARDING PROJECTIONS

BACKGROUND

1. Field of Invention

This invention pertains to drives which transduce information to and from magnetic tape, and particularly to drives which accommodate tape-containing cartridges.

2. Related Art and Other Considerations

For decades magnetic tape has served as a medium for recording and storage of information. More recently, for such purposes magnetic tape has been housed in cartridges or cassettes. To perform recording and reading operations with respect to the tape, the cartridge is inserted into a device variously names as a tape drive, tape recorder, or tape deck. Examples of a cartridge-utilizing tape drives are the 8200 and 8500 family of helical scan recorders produced by Exabyte Corporation.

Typically a tape drive includes a frame wherein are housed various components and subsystems. For a helical scan recorder, for example, such components include cartridge loading/ejecting apparatus, apparatus for extracting tape from the cartridge into a tape path; and, a rotating drum proximate the tape path. The drum has one or more heads which transduce information relative to the tape.

Some drives tend to experience a phenomena known as over ejection. Over ejection occurs when the drive's loading/ejecting apparatus too vigorously or forcefully discharges a cartridge from the drive. Over ejection results in the ejected cartridge travelling too far out of the drive, perhaps with the cartridge even being launched totally out of the drive.

One particular cartridge, a 4 mm cartridge, is fashioned with a physical feature for mitigating the over ejection phenomena. Such 4 mm cartridge has a small circular depression or detente on a surface thereof which is engaged by a spring-like member internal to the drive slot. Engagement of the cartridge depression by the drive's spring-like member serves to lessen over ejection potential. Other standard tape cartridges, such as an 8 mm tape cartridge, do not have over ejection-combating physical features.

Over ejection is particularly problematic when a drive is incorporated into automated information handling systems such as a cartridge library. In a cartridge library, a cartridge transport device (sometimes referred to as a cartridge picker or gripper or end effector) removes an ejected cartridge from its nominal ejection position in a drive. In the nominal ejection position, the ejected cartridge extends partially from the drive slot by a predetermined protrusion distance. Cartridge transport devices assume that a cartridge to be extracted from a drive protrudes from the drive slot by the predetermined protrusion distance with only slight tolerance.

Consequently, over ejection foils a library's assumption regarding cartridge location, and can result in numerous problems including cartridge grip failure.

Tape drives typically have a drive frame, a front portion of which is commonly termed a bezel. The bezel has an elongated, essentially rectangular slot through which the cartridge travels as the cartridge is inserted into and ejected from the drive. During cartridge insertion and ejection, a housing or case of the cartridge typically contacts or even scrapes a lower perimeter of the bezel's slot. Such contact tends to scrape off small particles of the cartridge case, resulting in dirt or debris. Such dust can dislodge and enter

either the interior of the cartridge or the interior of the drive, and thereby contaminate the tape. Tape contamination, in turn, endangers tape transducing integrity.

What is needed, therefor, is apparatus for combating the over ejection problem of tape drives. Advantageously such apparatus should not contribute to dust generation or tape contamination.

SUMMARY

A bezel mitigates cartridge over ejection from a tape drive, the tape drive receiving and ejecting a cartridge of magnetic tape for performing recording and reading operations with respect to the magnetic tape. The bezel comprises both a bezel plate and a pair of cartridge braking projections attached thereto. The cartridge braking projections partially extend into a cartridge slot and retard motion of a cartridge travelling through the slot. The cartridge braking projections are resilient and bidirectionally flexible, preferably being formed of cellular urethane. The cartridge braking projections extend into the slot by a predetermined distance above a lower cartridge plane. In one embodiment, the bezel is attached to a rack which accommodates the tape drive.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features, and advantages of the invention will be apparent from the following more particular description of preferred embodiments as illustrated in the accompanying drawings in which reference characters refer to the same parts throughout the various views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

FIG. **1** is a front perspective view of a bezel according to an embodiment of the invention.

FIG. **2** is a rear perspective view of the bezel of FIG. **1**.

FIG. **3** is an exploded front view of the bezel of FIG. **1**.

FIG. **4** is a front view of a braking projection included in the bezel of FIG. **1**.

FIG. **5** is a side view of the braking projection of FIG. **4**.

FIG. **6** is a schematic front view of a portion of the bezel of FIG. **1**.

FIG. **7** is a schematic side cross sectional view of the bezel of FIG. **1**.

FIG. **8** is a front perspective view of a cartridge library.

FIG. **9** is a front perspective view of a drive rack included in the library of FIG. **8**.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** and FIG. **2** show front and rear faces, respectively, of a bezel **100** for an unillustrated tape drive. Bezel **100** includes a substantially rectangular bezel plate **102**. As described hereinafter, bezel plate **102** fits over a front surface of a tape drive and can be, for example, part of a drive-accommodating rack assembly.

Bezel plate **102** has numerous features, including a cartridge-receiving slot **104**. As shown in FIG. **1**–FIG. **3**, slot **104** is essentially rectangular and has a slot major dimension which extends parallel to arrow **106**. Bezel plate **102** has two gateway ramps **110** formed thereon to extend into slot **104** from a bottom peripheral horizontal surface defining slot **104**. As shown in FIG. **6**, top surfaces **112** of gateway ramps **110** define a lower cartridge plane **115**. As a cartridge is inserted into or ejected from the drive, a bottom surface of the cartridge case rides along top surfaces **112** of gateway ramps **110** and thereby lies in lower cartridge plane **115**.

Bezel **100** also has two cartridge braking projections or brakes **120** attached thereto. As shown in FIG. **1** and FIG. **2**, each cartridge braking projection **120** is situated along the slot-defining bottom horizontal peripheral surface, and particularly between a slot-defining vertical peripheral surface and a gateway ramp **110**. The cartridge braking projections **120** are spaced apart along the slot-defining bottom horizontal peripheral surface in the direction of the slot major dimension (which is parallel to arrow **106**).

As shown in more detail in each of FIG. **3**, FIG. **4**, and FIG. **5**, cartridge braking projections **120** are each a substantially rectangular piece of resilient or flexible material. While cartridge braking projections **120** are preferably formed of a cellular urethane, and more preferably the cellular urethane marketed by Rogers Corporation of East Woodstock, Conn., as PORON® 4701, it should be understood that other materials performing the same function as described herein are also usable. Such other materials include, for example, mylar and neoprene.

As shown in FIG. **4** and FIG. **5**, cartridge braking projections **120** each have a width (in the direction of arrow **160**) on the order of 0.300 inches, a height of 0.740 inches, and a width of 0.050 inches. Moreover, as shown not only in FIG. **4** and FIG. **5** but also in FIG. **3**, cartridge braking projections **120** have two apertures **124** and **126** formed therein. The first and larger aperture **124** is formed below the second (smaller) aperture **126**. As shown in FIG. **3**, brake apertures **124** and **126** are aligned with corresponding apertures **134** and **136** in bezel plate **102**.

Each cartridge braking projection **120** is secured to bezel plate **102** by two fasteners **144** and **146**. As shown in FIG. **3**, fastener **144** extends through brake aperture **126** and is anchored into bezel aperture **136**. Bezel plate **102** carries a cover member **150**. An inside surface of cover member **150** has vertical notches **152** (see FIG. **3**) positioned and sized so that cartridge braking projections **120** can be sandwiched between cover member **150** and bezel plate **102**. As shown in FIG. **3**, cover member **150** has a pair of cover apertures **154**, each cover aperture **154** being aligned with brake aperture **124** and bezel aperture **134**, so that fastener **146** can extend through all three apertures for anchoring in bezel plate **102**.

When assembled in the manner shown in FIG. **3**, cartridge brake projections **120** extend in cantilever fashion into slot **104** by a distance D=0.034 inch beyond lower cartridge plane **115** (see FIG. **6**). As such, upon ejection of a cartridge such as cartridge C shown in FIG. **7**, cartridge brake projection **120** deflects outwardly from the drive, thereby moderating or retarding motion (e.g., momentum) of cartridge C travelling in an ejection direction **160** through slot **104**. Accordingly, cartridge C extends partially from the drive slot by a predetermined (nominal) protrusion distance.

In stating herein that bezel **100** is a bezel for a drive, it is meant that bezel **100** covers a front surface of the drive. Such covering can occur in several ways. For example, bezel **100** can be attached to the drive frame or form a part of a rack which accommodates a drive frame. The bezel forming part of such a rack is particularly understood in terms of a rack employed in a cartridge library, as hereinbelow described.

FIG. **8** shows portions of a cartridge handling library **30**. In general, library **30** includes a library frame **32**, a drum-like member or hub **34** mounted on frame **32** for rotational motion (e.g., in the direction shown by arrow **35**) about a drum or hub axis **36**; a drive drawer section **38** formed in frame **32**; and, a cartridge transport assembly **40**. Library frame **32** has a frame lower support surface **42** formed near its bottom and a frame upper support surface **44** provided at its top.

Hub **34** has hub faces **52** upon which cartridge racks **60** (also known as cartridge packs or receptacles) are selectively mounted. In the illustrated embodiment, each cartridge rack **60** houses ten cartridges. The term data storage unit or "unit" is used interchangeably herein for "cartridge", which is also known in the industry as "cassette".

In the illustrated embodiment, drive drawer section **38** of frame **32** houses four drive drawers racks **64A–64D** In the ensuing discussion, reference to "rack **64**" is a generic reference to any one of the drawers or racks in drive drawer section **38**. Drive drawer section **38** of library frame **32** is described in more detail below in connection with FIG. **8** and FIG. **9**. FIG. **8** shows that drive drawer rack **38** is situated in the lower front portion of library frame **32**.

Cartridge transport assembly **40** includes a cartridge picker mechanism **80** (hereinafter also referred to as the "picker" or "end effector") which is displaced both in a vertical or "X" direction (e.g., along arrow **82** shown in FIG. **8**) and in a picker approach/retreat direction or "Z" (e.g., along arrow **84** shown in FIG. **8**). Picker **80** selectively moves a cartridge from the active cartridge rack **60** to a selected one of the drives in drive drawer section **38**. Conversely, picker **80** removes a cartridge from a designated one of the drives in driver drawer section **38** and stores the removed cartridge in the active cartridge rack **60**.

FIG. **9** shows drive drawer section **38** of library frame **32** in more detail. Drawer section **38** includes two vertical walls **310**R and **310**L formed in a casting constituting library frame **32**. Each wall **310**R, **310**L has four slots or rack alignment channels **312** formed therein to extend in the Z direction as shown in FIG. **9** and spaced apart in the manner described below for accommodating the drawers **64**. On its front surface (e.g., a surface in the XY plane), drawer section **38** has fastener receiving apertures **314** provided thereon, two apertures **314** for each drive.

As mentioned above, drive drawer section houses four drive racks or drawers **64A–64D**. Each rack modularly encloses an I/O drive **320**, such as a helical scan tape drive. One example of such a drive is EXB-8505 manufactured by Exabyte Corporation, which (among other things) performs data input and output operations with respect to magnetic tape media.

A rack **64** is illustrated in FIG. **9** as being generally of rectangular shape and including a rack front wall **350**; a rack right side wall **352**; a rack left wall **354**; and, a rack rear wall **356**. At their bottoms, each of the walls have a ledge formed thereon, thereby collectively providing a support ledge **358** for supporting the I/O drive **320**.

As seen in FIG. **9**, rack front wall **350**, also known as bezel plate **102**, has a greater extent across the width of rack **64** than other portions of rack **64**. In particular, rack front wall **350** has laterally protruding edges **360**. Each edge **360** has a fastener-receiving aperture **314** formed therein. As understood with reference to FIG. **8** and the drive rack illustrated therein, unillustrated fasteners extend through apertures **362** and into apertures **314** in rack **38** for securing rack **64** to the drive rack **38**.

At its upper right hand corner as seen in FIG. **8**, rack front wall **350** has an ejection lever **364** pivotally mounted about pivot pin **366**. Lifting a distal end of ejection lever **364** upwardly causes lever **364** to pivot about pin **366**, thereby wedging a proximal end of lever **364** between the back surface of front wall **350** and the front wall of rack **38**, which serves to partially eject rack **64** from drive rack **38**.

Rack front wall **350** also has a cartridge entry slot **370** (the same as slot **104**) extending therethrough, thereby permit-

ting selective insertion and removal of cartridges from the drive **320** housed in rack **64**. Slot **370** of rack **64** is aligned with a comparable cartridge-receiving slot in its corresponding drive **320**. Rack side walls **352** and **354** have a plurality of ventilation apertures **380**. Apertures **380** serve to allow air to circulate around the drive **320** housed in rack **64**. In addition, each rack side wall **352** and **354** have a pair of alignment pins **382** provided thereon for slidable insertion into channels **312** formed in drive rack **38**.

Rack section **38** and racks **64** modularly installed therein facilitate efficient installation and removal, as well as interchange, of I/O drives **320**. A drive rack **64** can easily be removed from rack section **38** by unfastening the rack fasteners, pivoting the rack ejection lever **364**, and, sliding the rack out of its slots **312**. Installation involves converse operations. Further details of racks **64** are understood with reference to U.S. Pat. No. 5,498,116, entitled CARTRIDGE LIBRARY AND METHOD OF OPERATION, commonly assigned herewith and incorporated herein by reference.

Advantageously, bezel **100** of the present invention minimizes any over ejection problem. Moreover, the resilient and flexible nature of cartridge brake projections **120** tend to prevent wear of a cartridge case, thereby minimizing scraping and dust generation, which in turn, lessens opportunity for tape contamination.

While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that various alterations in form and detail may be made therein without departing from the spirit and scope of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A tape drive which receives a cartridge of magnetic tape for performing recording and reading operations with respect to the magnetic tape, the tape drive including a drive frame and a bezel plate which at least partially covers a front surface of the drive frame, the drive frame having a cartridge-receiving cavity therein wherein lies a lower cartridge plane, the bezel plate having a cartridge-receiving slot formed therein, the bezel plate further having a projection attached to the bezel plate and partially extending upwardly into the cartridge slot beyond the lower cartridge plane for retarding motion of a cartridge being ejected from the slot.

2. The apparatus of claim **1**, wherein the bezel is attached to a rack which accommodates the drive frame.

3. The tape drive of claim **1** wherein the projection deflects outwardly from the drive in an ejection direction to modulate momentum of a cartridge being ejected from the slot.

4. A cartridge library comprising:

a library frame;

a plurality of cartridge storage locations mounted on the library frame;

at least one drive rack mounted in the library frame;

a drive mounted in the drive rack, the drive having a cartridge-receiving cavity therein wherein lies a lower cartridge plane;

a cartridge transport device for transporting cartridges between the storage locations and the drive;

wherein the drive rack includes a bezel, and wherein the bezel comprises:

a bezel plate, the bezel plate having a cartridge-receiving slot formed therein;

a projection attached to the bezel plate and partially extending upwardly into the cartridge slot beyond the lower cartridge plane for retarding motion of a cartridge being ejected from the slot.

5. The cartridge library of claim **4**, wherein the projection deflects outwardly from the drive in an ejection direction to modulate momentum of a cartridge being ejected from the slot.

6. The apparatus of claims **1** or **4**, wherein the bezel comprises two projections spaced apart along a major dimension of the slot.

7. The apparatus of claims **1** or **4**, wherein the projection is resilient.

8. The apparatus of claim **7**, wherein the projection is formed of cellular urethane.

9. The apparatus of claim **4**, wherein the projection extends into the slot by a distance of 0.034 inches above a lower cartridge plane.

10. The apparatus of claim **4**, wherein the bezel is attached to a rack which accommodates the tape drive.

11. The apparatus of claim **1**, wherein the projection extends into the slot by a distance of 0.034 inches above the lower cartridge plane.

* * * * *