Dec. 27, 1966 J. A. WHITELEY 3,294,330

WEB GUIDE

Filed May 1, 1963 3 Sheets-Sheet 1

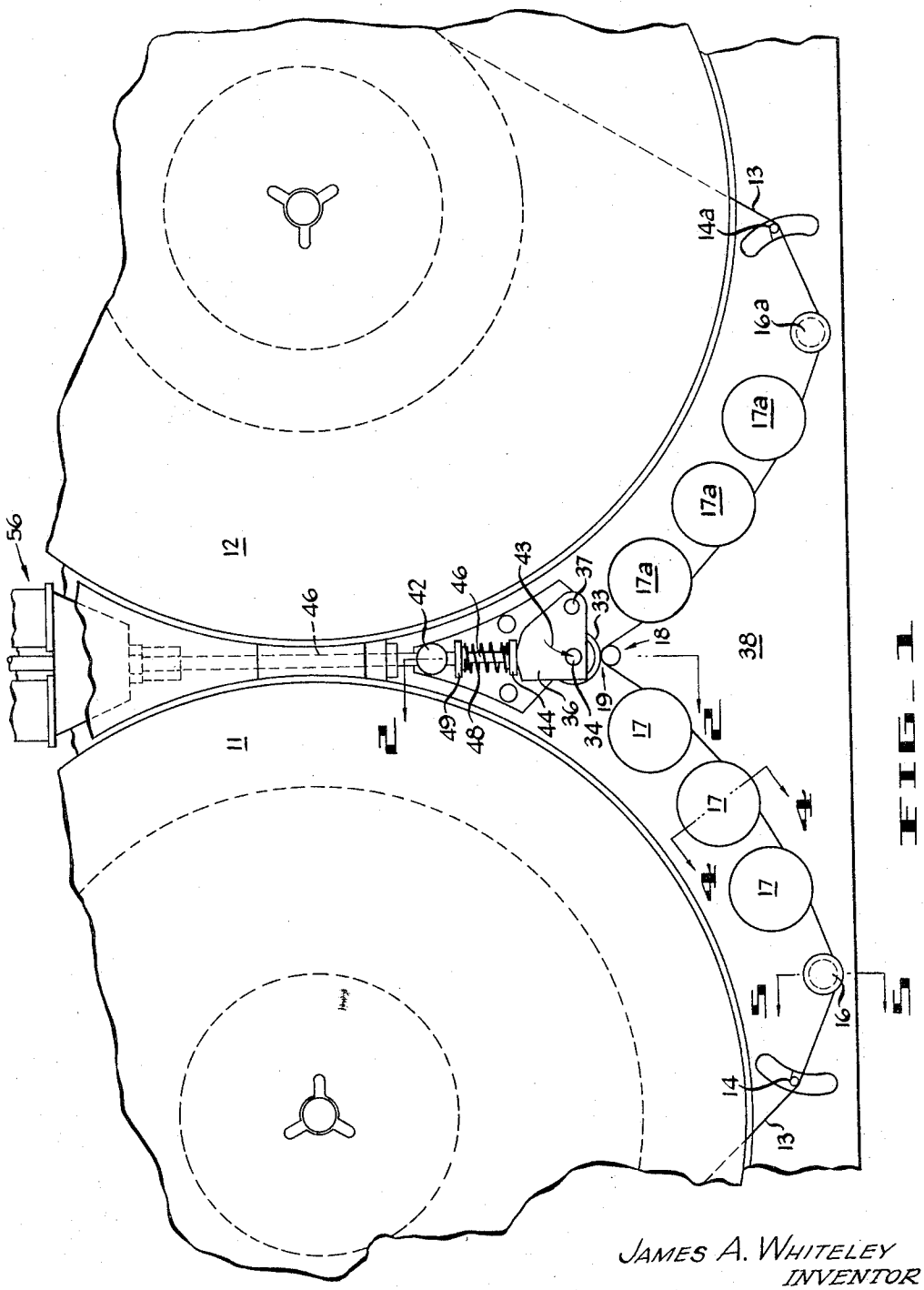


FIG. 1

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WEB GUIDE

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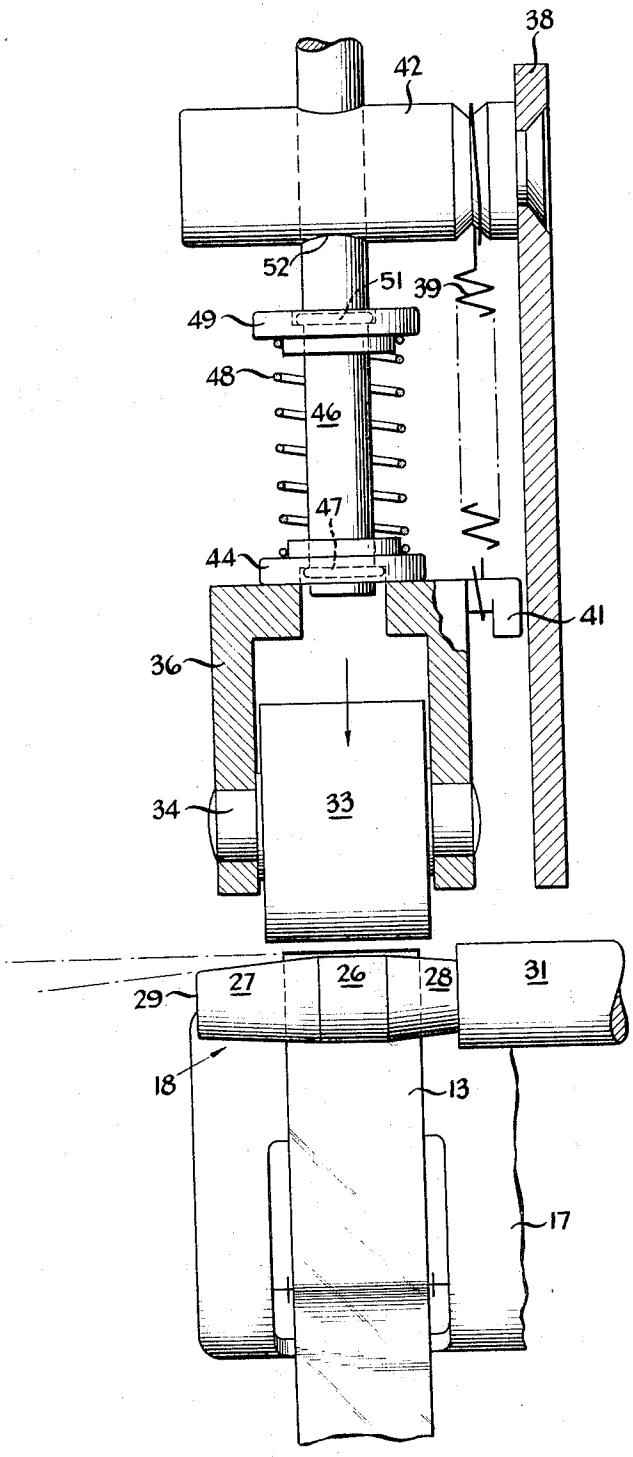


FIG. 2

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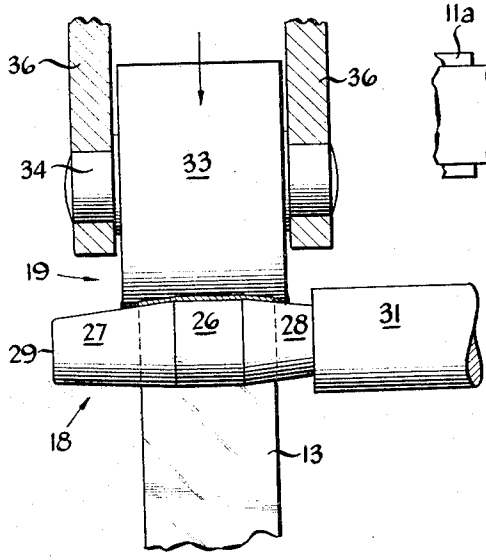


FIG_3

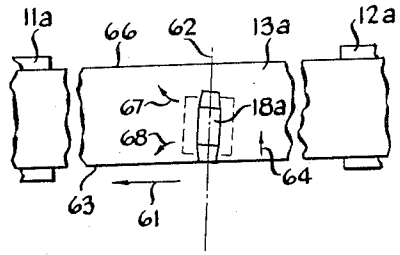


FIG_6

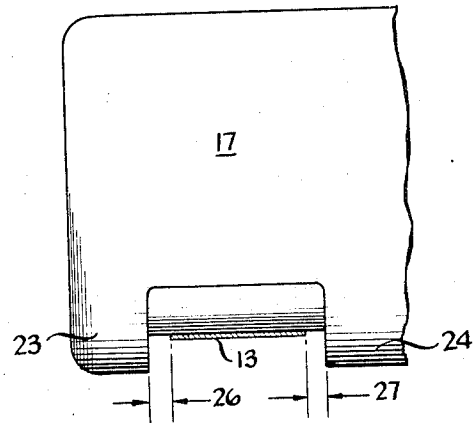


FIG_4

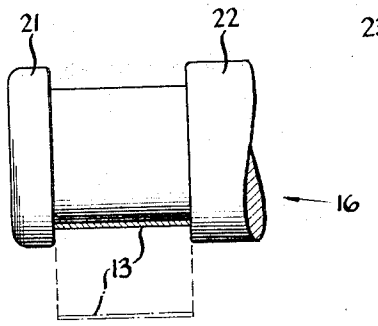


FIG_5

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United States Patent Office 3,294,330
Patented Dec. 27, 1966

3,294,330

WEB GUIDE

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Filed May 1, 1963, Ser. No. 277,334
8 Claims. (Cl. 242—55.12)

This invention relates to web guides and particularly to guides adapted to center a web in passage thereover.

Previously in the art, web guiding and centering has been accomplished by means of flanged edge-guiding members, and alternatively by means of crowned pulleys. However with crowned pulleys it has been generally understood that an essential condition for successful operation is that the web must be under substantial tension and must have a substantial angle of wrap around the pulley. It is well known that an untensioned web, or a web under only very slight tension, will ride off the end of such a pulley, and a web without wrap will not be affected by the pulley at all. Consequently, for such webs, edge guiding has usually been considered the only solution, even though such guiding has grave disadvantages such as curling and wearing of the web edges.

Now it has been discovered that crowned members can be adapted to center guide a web even when the web is not under appreciable tension.

Accordingly, it is an object of this invention to provide a centering guide for a moving web.

It is a further object of this invention to provide a guide as above described and functioning independently of web tension.

It is a still further object of this invention to provide a guide as above described and functioning without wearing or fraying the edges of the web.

It is another object of this invention to provide a guide as above described and functioning also as a drive for said web.

A web guide in accordance with the invention makes use of a crowned roller, particularly a capstan, in association with web transport means that provides either no web tension, or only slight tension that is insufficient for causing the web to frictionally engage the capstan across the entire width of the web. A resilient surfaced pinch roller is also provided for pressing the web against the capstan so as to insure the desired frictional engagement of the web with the capstan at least at one edge of the web and preferably across the entire width of the web. This frictional engagement, supplied independently of the web tension, ensures the centered guiding desired.

A better understanding of the invention may be had by reference to the following description, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 is a plan of a portion of a magnetic tape transport including the apparatus of the invention;

FIGURE 2 is an enlarged section taken along the plane of lines 2—2 of FIGURE 1;

FIGURE 3 is an enlarged section similar to that of FIGURE 2 and showing the apparatus in a different operating position;

FIGURE 4 is an enlarged section taken along the plane of lines 4—4 of FIGURE 1;

FIGURE 5 is an enlarged section taken along the plane of lines 5—5 of FIGURE 1; and

FIGURE 6 is a partly schematic view of a variation of the invention.

Referring now to the drawing and particularly to FIGURE 1 thereof, there is shown a portion of a tape transport including a pair of reels 11 and 12, and a magnetic tape 13 stretched therebetween. In this transport, the reels each operate alternately as supply and takeup reels,

so that for example when the reel 11 is operating as a supply reel and tape 13 is moving generally from left to right as shown in the drawing, the reel 12 is operating as the takeup reel. The tape 13 is engaged by a compliance arm 14, a guide post 16, a number of transducing heads 17, a capstan 18 and pinch roller 19, a number of heads 17*a*, a guide post 16*a*, and a compliance arm 14*a*. While the tape is intended to be driven mainly by the capstan 18, the reels 11 and 12 are each supplied with torque from a pair of torque motors, not shown, each coupled to a respective reel, and the torque supplied to each reel may be regulated as by means well known in the art but not here shown, so that each of the reels exerts an equal or nearly equal pull on the ends of the tape. Even if the torques are not regulated they are such that the differential pull of the reels is not great enough to move the tape against the frictional engagement of the capstan. Thus the tape, if it is not driven in one direction or the other by the capstan 18, remains stationary.

It is to be noted that the guide posts 16 and 16*a* as shown in FIGURE 5 have flange portions 21 and 22 spaced apart for substantially the same distance as the width of the tape 13, so as to provide edge guiding for the tape 13. However in the illustrated device the transducing heads 17 and 17*a*, as shown in FIGURE 4 do not provide such edge guiding for the tape, because the accurate alignment of a large number of such edge guides is difficult and expensive. Accordingly the projecting portions 23 and 24 of the housing of the transducing heads are spaced apart for distances substantially greater than the width of the tape. Particularly as shown in FIGURE 4, a pair of spaces 26 and 27 normally are left between the edges of the tape 13 and the corresponding projecting portions 23 and 24 of the transducing head housings.

Referring to FIGURE 1 it will be noted then that there is no edge guiding for the tape on its path between the guide posts 16 and 16*a*, other than that provided in the vicinity of the capstan 18. For the purpose of saving space, and also for the purpose of reducing edge wear on the tape, it is desired to provide central guiding for the tape in the vicinity of the capstan 18 without the use of guide posts such as the posts 16 and 16*a*. Accordingly the capstan 18 is crowned, as is shown in somewhat exaggerated angle in FIGURE 2. As shown in this figure, the capstan has a central right cylindrical section 26, and two conically tapered end sections 27 and 28, tapering convergingly away from the central section 26. The tapered section 27 terminates in a truncated end 29, and the tapered section 28 terminates in a shaft 31, by which the capstan is driven.

Now it will be understood that the essential condition for centered guiding of a tape by a crowned member is that the tape be frictionally engaged with the crowned member, at least at the edges of the tape, and preferably across the entire width of the tape. In the prior art, such engagement has been provided by means of tension in the tape, which causes the tape to stretch and to conform to the barrel-shaped surface of the crowned member. However, in the present invention there is not sufficient tension to cause such stretching, and the frictional engagement desired is provided by means of the pinch roller 19, as explained in greater detail following.

The illustrated transport is intended for continuous playing over very long periods of time without attention, and must therefore use an extremely thin tape so that a greater length can be stored on the reels, which requirement in turn dictates that the tension applied to the tape must be extremely slight. In actual practice the tension applied is considerably less than one ounce. The tension is applied as previously described by the opposite balanced pull of the two reels, and this tension is so slight

that, as shown in FIGURE 2, it leaves the tape in its wrap around the capstan conforming essentially only to the right cylindrical section **26** and not touching or frictionally engaging the two tapered sections **27** and **28**. With such an engagement, the capstan **31** may be rotated, and will drive the tape. This is so because even though the tension in the tape is very slight and the frictional engagement of the tape with section **26** is of low strength, nevertheless this frictional engagement is enough to cause the tape to move in either direction at the slightest movement of the capstan.

However even though the tape may be driven in such a fashion, the centering action of the capstan would not be effective so long as the tension is so slight that it does not pull or stretch the tape into frictional engagement with the tapered sections **27** and **28**. Accordingly the pinch roller **19** is also provided, in this combination not primarily for enabling the capstan to move the tape, but rather to enable the capstan to center guide the tape. The capstan has a resilient surface layer **33** made for example of rubber, and is mounted on a shaft **34** that is in turn mounted in a U-shaped bracket **36**, and the bracket is pivoted on a pin **37** (FIGURE 1) extending from the top plate **38** of the tape transport. In the inoperative position, the pinch roller **19** is held away from engagement with the capstan as by means of a tension spring **39** (FIGURE 2) stretched between an extension **41** of the bracket and a stud member **42** extending from the top plate **38**. In order to pivot the bracket **36** in such a direction (illustrated by the arrow **43** in FIGURE 1) that it engages the tape and capstan, a bearing collar **44** is provided, the collar being mounted for sliding movement on a rod **46** and being retained thereon as by means of a snap ring **47**. The collar **44** is urged in a direction to engage the bracket **36** as by means of a compression spring **48** coaxially mounted on the rod **46**, and engaging a second collar **49** retained on the shaft as by means of a snap ring **51**. The rod **46** extends for guided sliding movement through a hole **52** in the stud member **42**, and is operated in the engaging direction of the pinch roller as by means of a solenoid assembly **56** (FIGURE 1). When the solenoid is energized, as during certain of the operating modes of the transport, the pinch roller is resiliently pressed in the direction of the capstan **18**, and presses the tape firmly against the capstan as illustrated in FIGURE 3.

As a very important feature of the invention, illustrated in FIGURE 3, the tape is thus pressed against the capstan in such a way that both edges of the tape are brought into frictional engagement with the corresponding tapered portions **27** and **28** of the capstan.

The reason why such engagement causes central driving of the tape is believed to be that the varying diameters, and in consequence the varying peripheral velocities, of the different portions of the tapered sections **27** and **28** provide frictional forces that tend to skew the tape in opposite directions. For example the tapered section **27** tends to skew the tape in such a direction that it is driven toward the opposite section **28**, while the section **28** tends to skew the tape in such a direction that it is driven toward the opposite direction **27**. So long as an equal width (i.e., area) of tape is frictionally exposed to each of the tapered sections, the result is a balanced arrangement in which the tape is not driven toward either end of the capstan but moves smoothly along in a correct central guided path. If for any reason the tape is skewed artificially or is moved from its centered position, then a greater width (area) of tape is exposed to the frictionally driving engagement of one of the tapered sections, and the skew force provided by that section is temporarily greater than the skew force provided by the other section, with the consequence that the tape is immediately skewed in an opposite direction so as to be driven back towards its centralized position.

It is to be noted that the positions and effects of the edges of the tape are of great significance. Thus, in the explanation given above, if the tape were edgeless, i.e., infinitely wide, then lateral displacement or skewing of the tape, artificially introduced, would have no effect in instigating a restoring action, because the respective widths (areas) of tape frictionally engaged with the tapered portions **27** and **28** would never change and would therefore always remain equal. Only when an edge of tape comes between the pinch roller **19** and the adjacent tapered portion of the capstan does the tape width (area) that is frictionally engaged with the tapered portion suffer a decrease, resulting in the unbalance of skew forces necessary to cause restoring action. This is the reason why, for centered guiding, the essential condition is that the pinch roller be formed so to be able to hold both edges of the tape in frictional engagement with the capstan. The simplest form for the pinch roller therefore is that shown in FIGURE 3, in which the pinch roller is wider than the tape and holds the entire width of tape in frictional engagement with the capstan. However other configurations are possible. For example, the pinch roller could be cut away in the central portion so as not to engage the tape in contact with the capstan central portion **26**, and the tape would still be center guided, because the essential condition is preserved, that both edges of the tape remain in frictional engagement with the tapered portions of the capstan. Likewise, the central portion **26** of the capstan could be eliminated, leaving only two tapered rollers **26** and **27**, in effect, and center guiding would still result. Likewise, the center portions of both the pinch roller and the capstan could be eliminated without destroying the center guiding effect.

It is to be noted that so long as the above conditions are satisfied, center guiding will result even when there is absolutely zero tension in the tape, and no matter whether the roller **18** is a driven capstan or merely a rotating idler; and additionally any pressure means can be used in place of the pinch roller, including e.g., a pressure pad or pneumatic suction or pressure.

The term "center guiding" has been used above in its accepted sense to mean guiding in which the tape or web is centered on a symmetrical rotating member. However, the principle of the invention may equally well be applied to guiding of sorts that would not be covered by the term "center guiding." For example, there is illustrated in FIGURE 6 a tape **13***a* moving in the direction of arrow **61** between a pair of reels **11***a* and **12***a*. The tape **13***a* is considerably wider than the crowned capstan (or guide idler) **18***a* and pinch roller **19***a*. Assuming first that the roller **18***a* is a driven capstan, and that the reels **11***a* and **12***a* do not apply any tension whatsoever to the tape, it will be seen that the tape will tend to follow a direction normal to the axis **62** of the capstan and will never be driven off the end of the capstan, although it will not necessarily be "centered" on the capstan. If the lower edge **63** of the tape moves upward in the direction of arrow **64**, such movement must stop when the edge **63** comes between the capstan and pinch roller as previously described. If conversely the tape moves downward, such movement must stop when the upper edge **66** comes between the capstan and pinch roller. The tape edges are thus in a sense the limiting factors that keep the tape on the capstan, but the exact position of the tape on the capstan is another matter. In effect, the tape is free to wander laterally from side to side across the capstan, each excursion in a particular lateral direction being brought to an end by encounter of a tape edge with the capstan and pinch roller. In practice, the tape tends to establish itself with one edge or the other more or less permanently in contact with the capstan and pinch roller. Thus this arrangement may be termed one for "edge guiding" the tape. Which edge the tape is to be guided by may be predetermined by slightly canting the axis of the capstan and/or pinch roller as illustrated in exaggerated angle in FIG-

URE 6. Some small tension must also be applied to the tape, so that it tends to travel generally in the direction of arrow **61**, though this tension need not be so great as to cause transverse conformity of tape and capstan. Alternatively, if the tape is traveling in a plane (e.g. the plane of the paper) at the capstan, so as to have a zero angle of wrap on the capstan, it is clear that no amount of tension would cause tape-capstan conformity, and the pinch roller **19***a* is still needed. With these conditions, it will be seen that the tape will be guided always with the lower edge **63** in contact with the capstan and pinch roller, because the inclination of the axis of the capstan tends to cause driving of the tape upward in the direction of arrow **64**, while the unbalance of skewing forces (represented by arrows **67** and **68**) tends to skew the tape clockwise (arrow **67**) and to cause driving of the tape downward. In practice the tape seeks a position in which these opposing forces are balanced, with edge **63** in permanent contact with the capstan.

It has also been found, and should be noted, that in all arrangements in which tension is applied to a tape, including arrangements with or without pinch rollers, and with the tape traveling either in a plane at the capstan or in a wrap around the capstan, the tension must not be excessive. There is always some unavoidable cant in any capstan, and if the tension is sufficiently great, the tape is caused to be driven willy-nilly off the end of the capstan despite all the forces that might otherwise tend to cause restoration.

Thus there has been described a web guide that makes use of a crowned roller, particularly a capstan, in association with web tensioning means that provide sufficient frictional engagement between the capstan and web for driving the web, but insufficient for causing the web to frictionally engage the capstan across the entire width of the web. A resilient surface pinch roller is also provided for pressing the web against the capstan so as to insure the desired frictional engagement of the web with the capstan at least at one edge of the web.

What is claimed is:

1. A web guide comprising:

a rotating member having an axial dimension at least as great as the width of said web and having a crowned portion engaging at least the edge portions of said web, said member being made of rigid material; and

a pinch roller having an axial dimension at least as great as the width of said web and having a resilient peripheral layer engaging at least said edge portions of said web and holding said edge portions in pressurized frictional engagement with said crowned portion of said rotating member.

2. A web guide comprising:

a capstan having an axial dimension at least as great as the width of said web and having a crowned portion engaging the entire width of said web, said capstan being made of rigid material;

a pinch roller having an axial dimension at least as great as the width of said web and having a resilient peripheral layer engaging the entire width of said web with sufficient pressure to hold said web in frictional contact with said crowned portion of said capstan across the entire width of said web; and

means for driving said capstan to move said web.

3. A web guide comprising:

a rotating member having an axial dimension at least as great as the width of said web and having a crowned portion engaging the entire width of said web, said member being made of rigid material;

a pinch roller having an axial dimension at least as great as the width of said web and having a resilient peripheral layer engaging the entire width of said web; and

means for causing said roller to press against said web and member with sufficient pressure to hold said web in frictional contact with said crowned portion of said member across the entire width of said web.

4. In a low-tension tape transport of the class including a pair of supply and take-up reels, a transducing head means, and a tape stretched between said reels and across said transducing head means, the combination comprising:

a capstan having an axial dimension at least as great as the width of said tape and having a crowned portion engaging the entire width of said tape between said reels for moving said tape;

means for applying torque to said reels to tension said tape across said capstan, with the tape tension being less than that needed to cause said tape to conform transversely to the crowned shape of said capstan; and

a pinch roller having an axial dimension at least as great as the width of said tape and engaging the entire width of said tape and holding said tape in frictional contact with said crowned portion of said capstan across the entire width of said tape.

5. In a low-tension tape transport of the class including a pair of supply and takeup reels, a transducing head means, and a tape stretched between said reels and across said transducing head means, the combination comprising:

a capstan having an axial dimension at least as great as the width of said tape and having a crowned portion engaging the entire width of said tape between said reels for moving said tape;

means for applying torque to said reels to tension said tape across said capstan, with the tape tension being less than that needed to cause said tape to conform transversely to the crowned shape of said capstan; and

a pinch roller having an axial dimension at least as great as the width of said tape and having a resilient layer engaging the entire width of said tape and holding said tape in frictional contact with said crowned portion of said capstan across the entire width of said tape.

6. In a low-tension tape transport of the class including a pair of supply and takeup reels, a transducing head means, and a tape stretched between said reels and across said transducing head means, the combination comprising:

a capstan having an axial dimension at least as great as the width of said tape and having a crowned portion engaging the entire width of said tape between said reels for moving said tape;

said capstan crowned portion having a central right cylindrical portion of axial length substantially smaller than the width of said tape, and two end portions of conical shape tapering convergingly toward the ends of said capstan;

means for applying torque to said reels to tension said tape across said capstan, with the tape tension being less than that needed to cause said tape to conform transversely to the crowned shape of said capstan and to engage said conical end portions of said capstan; and

a pinch roller having an axial dimension at least as great as the width of said tape and having a resilient peripheral layer engaging the entire width of said tape and holding said tape in frictional contact with said crowned portion of said capstan across the entire width of said tape, so as to cause said tape to engage said right cylindrical and said conical end portions of said capstan.

7. In a low-tension tape transport of the class including a pair of reels, a transducing head means, and a tape stretched between said reels and across said transducing head means, the combination comprising:

a capstan having an axial dimension at least as great as the width of said tape and having a crowned

portion engaging the entire width of said tape between said reels for moving said tape;

said capstan crowned portion having a central right cylindrical portion of axial length substantially smaller than the width of said tape, and two end portions of conical shape tapering convergingly toward the ends of said capstan;

said transducing head means including a plurality of transducing heads positioned between said capstan and each of said reels;

a pair of flanged tape edge guide posts each positioned on said tape path between said heads and one of said reels;

said heads being positioned to obtrude into the path of said tape between said capstan and said guide posts so as to cause said tape to engage said heads when tensioned;

means for applying torque to said reels to tension said tape across said capstan and heads, with the tape tension being less than that needed to cause said tape to conform transversely to the crowned shape of said capstan and to engage said conical end portions of said capstan; and

a pinch roller having an axial dimension at least as great as the width of said tape and having a resilient peripheral layer engaging the entire width of said tape and holding said tape in frictional contact with said crowned portion of said capstan across the entire width of said tape, so as to cause said tape to engage said right cylindrical and said conical end portions of said capstan.

8. In a low-tension tape transport of the class including a pair of reels, a transducing head means, and a tape stretched between said reels and across said transducing head means, the combination comprising:

a capstan having an axial dimension at least as great as the width of said tape and having a crowned portion engaging the entire width of said tape between said reels for moving said tape;

said capstan crowned portion having a central right cylindrical portion of axial length substantially smaller than the width of said tape, and two end portions of conical shape tapering convergingly toward the ends of said capstan;

a reversible motor coupled to said capstan for driving same alternately in opposite directions;

said transducing head means including a plurality of transducing heads positioned between said capstan and each of said reels;

a pair of flanged tape edge guide posts each positioned on said tape path between said heads and one of said reels;

said heads being positioned to obtrude into the path of said tape between said capstan and said guide posts so as to cause said tape to engage said heads when tensioned;

means including a pair of reel motors for applying torque to said reels to tension said tape across said capstan and heads, with the tape tension being less than that needed to caue said tape to conform transversely to the crowned shape of said capstan and to engage said conical end portions of said capstan;

a pinch roller having an axial dimension at least as great as the width of said tape and having a resilient peripheral layer engaging the entire width of said tape and holding said tape in frictional contact with said crowned portion of said capstan across the entire width of said tape, so as to cause said tape to engage said right cylindrical and said conical end portions of said capstan; and

a solenoid coupled to said pinch roller for engaging and withdrawing said pinch roller from said capstan.

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