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SHEET CONVEYOR

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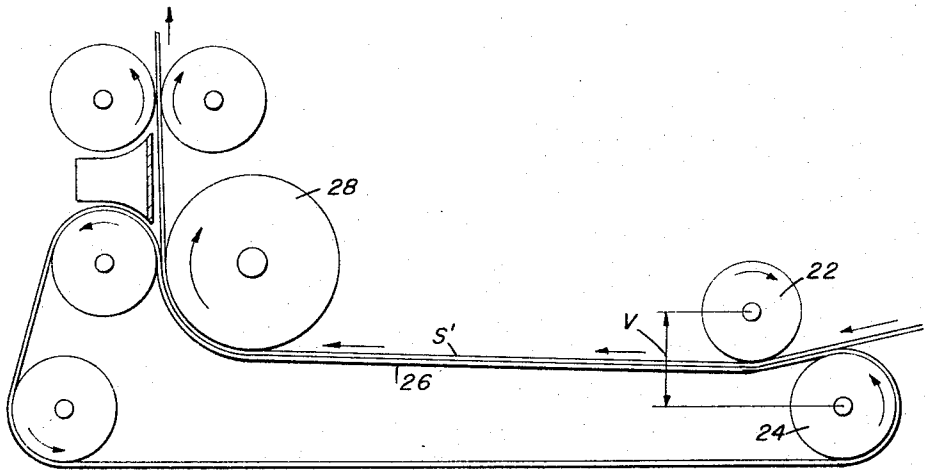


FIG. 2

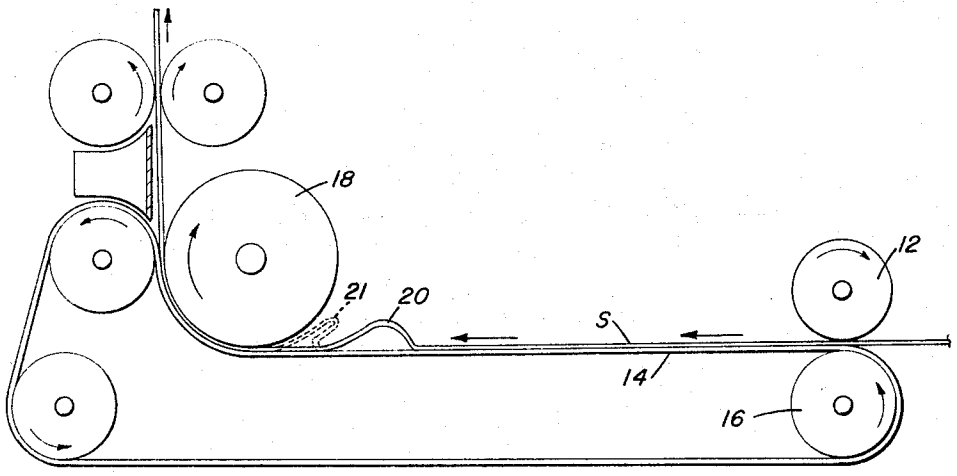


FIG. 1
PRIOR ART

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SHEET CONVEYOR

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The present invention relates to conveyors, and more particularly, to a belt conveyor for holding a sheet taut as the sheet is being transported thereby along a winding path.

In numerous types of apparatus in which a belt conveyor is utilized for moving an article, it is useful to transport the article in a winding path through the apparatus. For example, in apparatus in which a sheet is moved through one or more stations at which different operations are performed, it is generally desirable to position the stations along a winding path in order that the apparatus be kept compact. Because of variations in surface speed of the spaced members with which a sheet being transported is in contact at any one time, the sheet may be crumpled between sandwiching members. The present invention comprises a conveying mechanism which eleminates or substantially reduces crumpling of conveyed sheets by compensating for these variations in surface speed through a novel arrangement of selectively sized feeding members which hold the sheet taut as it moves between these members.

One object of the present invention is to provide an improved sheet conveying apparatus.

Another object of the present invention is to provide a sheet conveying device which eliminates or substantially reduces crimping damage occurring to the conveyed sheets.

Yet another object of the present invention is to provide a conveyor for changing the direction of movement of a sheet, while preventing the buckling and consequent crimping of the sheet as a result of a differential in surface speeds of successive members with which the sheet is in contact at any one time.

Still other objects and advantages of the present invention will become readily apparent to those skilled in the art from the following description, with reference to the accompanying drawings in which like characters denote like parts, and in which:

FIG. 1 is a schematic elevation view representing a typical conveyor of the known prior art; and

FIG. 2 is a schematic elevation view representing a conveyor incorporating the present invention.

The present invention can best be illustrated by reference to the drawings, in which is shown part of a conveying apparatus along which a sheet is transported in the direction indicated by the arrows. As illustrated in FIG. 1, which shows a typical known conveyor, the sheet S is initially fed into the bite of idler roller **12** and a flexible feed belt **14** which passes between roller **12** and a driven roller **16**. The respective axes of rollers **12** and **16** are located in a plane which is substantially at right angles to the plane of movement of the sheet S. The sheet is carried by the belt into the bite of, and around, driving roller **18** for the purpose of changing the direction of movement of the sheet. If the sheet is sufficiently long to be simultaneously engaged by both roller **12** and roller **18**, the sheet will tend to buckle, as shown at **20**, because of the different in surface speeds of these respective rollers. If this buckling is excessive, this buckle will enter the bite of roller **18**, as shown at **21**, and the sheet will be crimped thereby. This damage can best be explained by a brief explanation of its cause. Although the pitch speed of the belt, at the neutral axis thereof, can be assumed constant throughout the length of the belt, the respective surface speeds of the belt as it is moved around a roller are not equal because of the finite thickness of the belt. The surface of the belt which is in contact with a roller as the belt follows the contour of the roller for a part of the circumference thereof, such as around roller **16** or **18**, is in compression and moves at a speed which is less than the speed at the neutral axis of the belt. Accordingly the other surface of the belt, for example that surface of the belt which is spaced from roller **16** and in contact with roller **12**, is in tension and therefore moving faster than the speed at the neutral axis. A roller in contact with one of the belt surfaces moves at the same speed as that surface. As a consequence, where a sheet is moving from a faster moving roller to a slower moving roller a buckle often forms in the sheet and the sheet may be crumpled by the bite of the slower moving roller.

In FIG. 2, there is shown a conveyor which incorporates the present invention. An idler roller **22** and a driven roller **24**, between which a sheet S' is carried on belt **26**, are longitudinally spaced along the belt, with the vertical distance V between the axes of rotation of the respective rollers being less than the sum of the radii of these rollers. This disposition of members places an arcuate portion of the periphery of roller **22** in frictional contact with the belt. Thus, as a sheet is fed between roller **22** and the belt **26**, the sheet is in contact with and moved by that surface of the belt which is in compression. Because the degree of compression of the belt is a direct function of the radius of an arc around which the belt is moved, the successive curves of the system can readily be sized to minimize the problem of buckling and crimping. By selectively sizing roller **22** so that it has a smaller radius than the radius of roller **28** around which the belt moves to change the direction of movement of the sheet being transported, the leading edge of a document is moved by roller **28** at the same or a faster speed, depending on design, than the trailing part of the sheet is fed between the initial offset upper roller **22** and the belt **26**. Accordingly, a document is not buckled between these feeding points.

The following examples, which are given merely for purposes of illustration, are set forth to provide a comparison between the present invention and the prior art. It should be noted that a flexible belt, such as one made from cloth, leather or the like, does not have the same physical characteristics in tension and in compression, but for simplicity of illustration it is assumed in the following examples that the neutral axis of the belt remains at its midpoint of thickness. It is also assumed for simplicity of illustration that any slippage in the system is negligible, and that the thickness of a sheet is negligible compared to the belt thickness. Accordingly, a roller surface moves at the same speed as the belt in contact therewith.

Example I

In this example, assume that the idler roller **12** and the driven roller **16** between which sheet S is moved, are in vertical alignment as shown in FIG. 1. The relationship between the speed at the neutral axis of the belt and the surface speed of roller **18** can be defined as follows:

$$D=\frac{BR}{R+\frac{T}{2}}$$

Where

D=surface speed of roller 18;
R=radius of roller 18;
B=speed of belt **14** at the neutral axis thereof;
T=belt thickness.

Likewise, the surface speed of roller **16**, represented by Q, can be defined by the following equation:

$$Q=\frac{Br}{r+\frac{T}{2}}$$

Where r=radius of roller **16**.

The surface speeds of both roller **18** and roller **16** are less than B because both rollers are in contact with that part of the belt which is in compression, and which is therefore moving slower than the speed of the belt at the neutral axis thereof. The surface speed of roller **12**, represented by M, can therefore be expressed with relation to roller **16**:

$$M=Q\left(\frac{r+T}{r}\right)$$

By substitution:

$$M=\frac{Br}{r+\frac{T}{2}}\left(\frac{r+T}{r}\right)=\frac{B(r+T)}{r+\frac{T}{2}}$$

Now arbitrarily assigning values:

Let

$R=0.70$;
$T=0.02$;
$r=0.38$;

And solving:

$$D=\frac{0.70B}{0.70+\frac{0.02}{2}}=0.986B$$

$$M=\frac{(0.38+0.02)B}{0.38+\frac{0.02}{2}}=\frac{0.40}{0.39}B=1.026B$$

By using these relationships and the assigned values, the initial infeed speed of the document at roller **12** is 104% of the feeding speed around driving roller **18**:

$$\text{Percent}=\frac{1.026B}{0.986B}=1.04$$

Example II

By offsetting roller **22** as described hereinabove, and assuming that the radius of roller **28** is equal to the radius of roller **18**, the relative surface speed of roller **22** can be defined in the same manner as was used in Example I to define surface speeds. If the radius of roller **22** is assumed to be (r), its surface speed (W) is equal to the surface speed (Q) of roller **16** because they are both driven by equally compressed surfaces of the belt. Therefore:

$$W=Q=\frac{Br}{r+\frac{T}{2}}=\frac{0.38B}{0.38+\frac{0.02}{2}}=0.974B$$

This speed is slightly less than the surface speed of roller **18** as determined in the previous example, and would place the sheet under a slight tension between rollers **22** and **28**.

Although arbitrary figures have been assigned for purposes of illustration, it is readily apparent that numerous combinations of values could be used within the scope of the invention. For example, if it is assumed that $R=r$, a sheet would be fed at the same speed at both rollers. It should be appreciated from the above description that this novel conveyor, by the relative disposition of selectively sized rollers, represents an improvement in the art of sheet feeding along a winding path in that the undesirable crimping of sheets transported by the conveyor is substantially reduced or eliminated. Although the invention has besen described with particular reference to a

preferred embodiment thereof, it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

Having now described our invention, what we desire to secure by Letters Patent of the United States and what we claim is:

1. A conveyor for transporting and changing the direction of movement of a sheet having a predetermined length, comprising:

(a) a moving endless belt for supporting such sheet and defining a path of travel of said sheet;

(b) a first member having a curved surface in peripheral contact with said belt, whereby said sheet, when moving on said belt and in contact with said curved surface, has a speed relative to said curved surface which is different from the speed of the belt at the nueutral axis of said belt by virtue of the deformation of said belt as it moves along said curved surface; and

(c) compensating means for arcuately deforming said belt, at a point in said path ahead of said first member relative to the movement of said belt, said belt being deformed by said compensating means in such a manner as to cause the sheet contacting surface of said belt in the area of contact with said compensating means to move at a speed not greater than the speed of the sheet relative to said curved surface;

(d) the distance of said path between said first member and said compensating means being less than said predetermined length;

(e) whereby when said sheet is moving in simultaneous contact with said first member and said compensating means the speed of the portion of the sheet in contact with said curved surface is at least as great as the speed of the portion of the sheet which is in contact with said compensating means, the sheet thereby being held in a taut condition as it moves in said path.

2. A conveyor according to claim **1** wherein said curved surface is convex and said compensating means comprises a second member having a convex surface for contacting said belt and the sheet on said belt.

3. A conveyor according to claim **1** wherein said first member and said compensating means respectively comprise first and second rollers each of which rotates at the speed of the surface area of said belt respectively in contact therewith.

4. A conveyor according to claim **3** wherein said second roller is operatively arranged relative to said belt for gripping said sheet therebetween and feeding said sheet toward said first roller, and wherein said first and second rollers are disposed on the same side of the sheet contacting surface of said belt.

5. A conveyor according to claim **4** wherein the radius of said first roller is greater than the radius of said second roller whereby said sheet is in a taut condition when under the influence of both of said rollers.

6. A conveyor for transporting along a given path and for changing the direction of movement of a sheet having a predetermined length, comprising:

(a) an endless belt generally conforming to and positioned adjacent to said given path for supporting said sheet in said path, said endless belt being movable along said path;

(b) a first member having a first curved portion in peripheral contact with said belt and defining a first arcuate section of said path;

(c) a second member having a second curved portion which has a greater radius of curvature than said first curved portion in peripheral contact with said belt and defining a second arcuate section of said path;

(d) the centers of curvature of said first curved portion and said second curved portion being on the same side of a line which is tangent to both said first and second curved portions, the distance along said path between the respective points of tangency of said line

with said first and second curved portions being less than said predetermined length;

(e) means for driving said belt to move said sheet through said first and second arcuate sections of said path in surface contact with said first and second curved portions;

(f) the curvature of said first curved portion thereby compensating for the surface deformation of said belt as it moves around said second curved portion to cause the leading edge of said sheet to be fed through said second arcuate section at least as fast as the trailing edge of said sheet passing through said first arcu-

ate section, whereby said sheet is held taut as it is transported through said first and said second arcuate sections of said path.

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