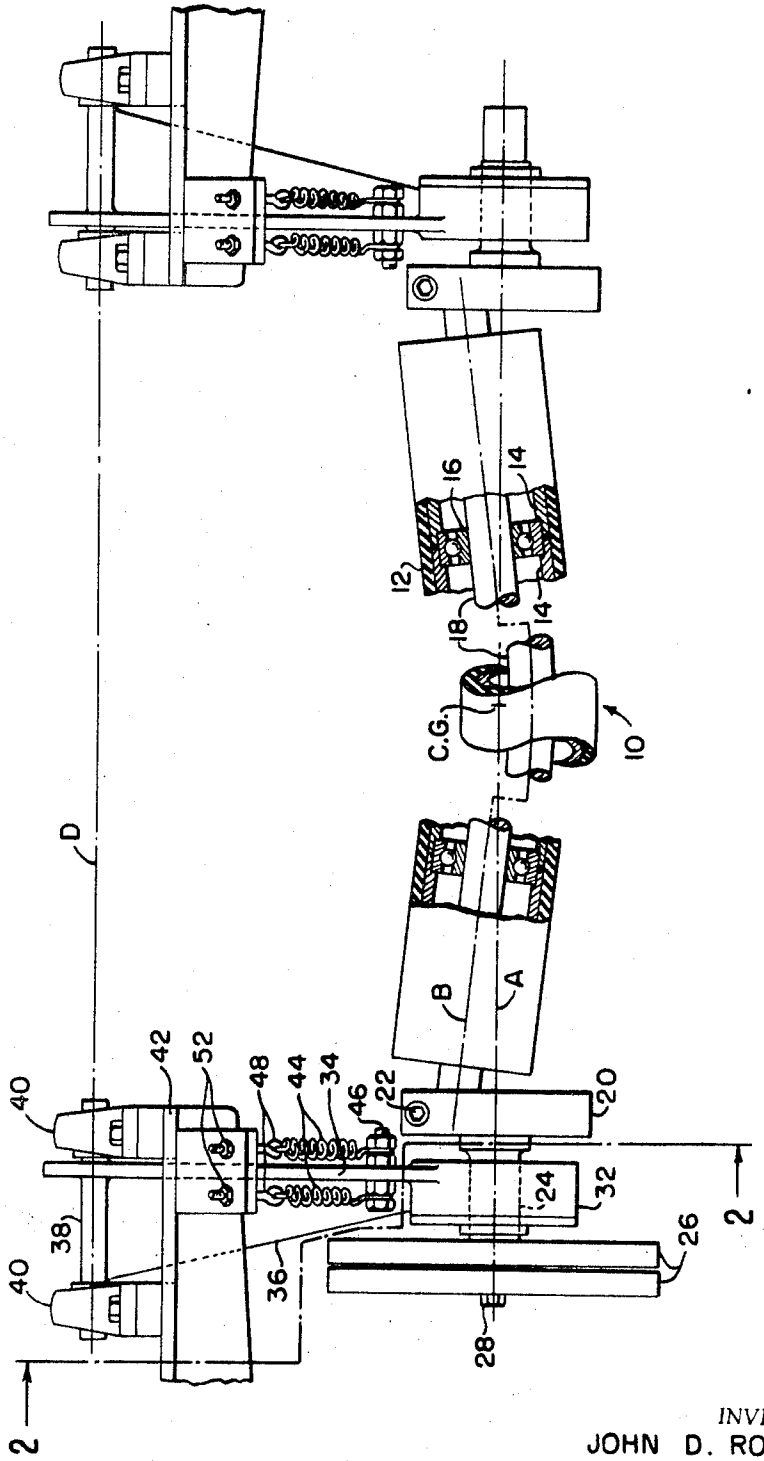
Oct. 7, 1969 J. D. ROBERTSON 3,470,592

SLACK ELIMINATING DEVICE FOR SHEET-FEEDING APPARATUS

Filed Sept. 29, 1966 3 Sheets-Sheet 1

FIG. 1



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SLACK ELIMINATING DEVICE FOR SHEET-FEEDING APPARATUS

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FIG. 2

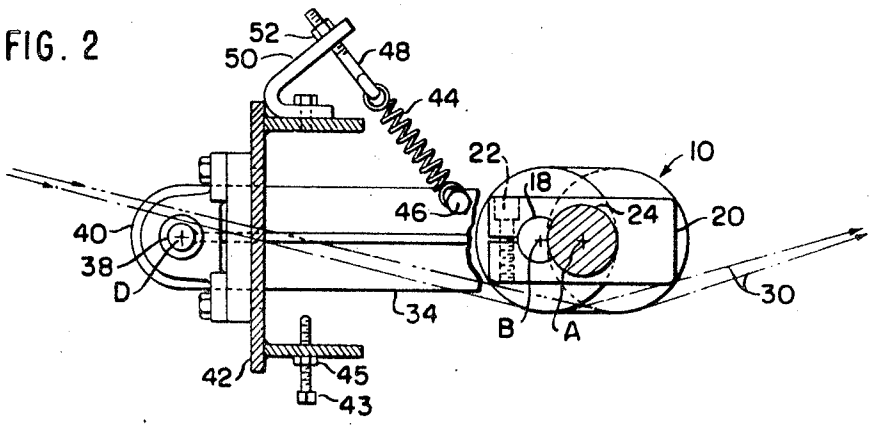


FIG. 3

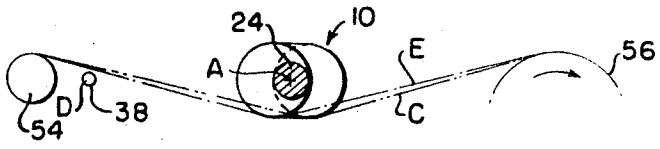


FIG. 4

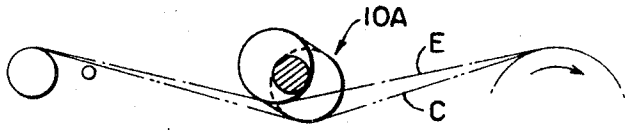


FIG. 5

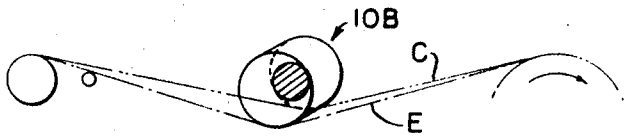
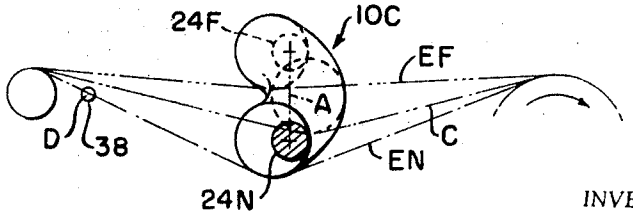


FIG. 6



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FIG. 7

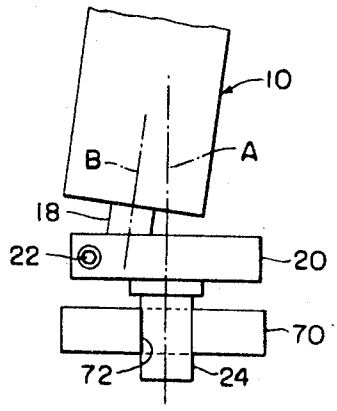
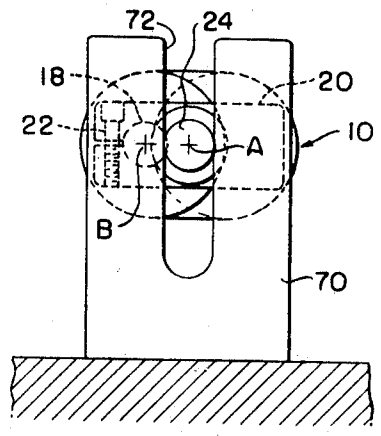


FIG. 8



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SLACK ELIMINATING DEVICE FOR SHEET-FEEDING APPARATUS

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U.S. Cl. 26—63 9 Claims

ABSTRACT OF THE DISCLOSURE

The invention is a curved roll and mounting means therefor, for automatically removing slack from a travelling web of material. Each end of the roll axle is mounted in first bearings so as to be rotatable about a straight axis intersecting the curved axle of the roll, with each of the first bearings also being independently mounted by means of second bearings so as to be movable in a direction having a component perpendicular to the direction of travel of the sheet.

This invention relates to an improved device for eliminating slack in sheets travelling longitudinally through sheet feeding apparatus. In many processes for treating running lengths of paper, textiles, and other sheet or web materials, differential tension or differential shrinkage causes the sheet to become slack at either or both edges, or in the center. This causes various problems, as related to the particular process in question; wrinkles occur, which may result in creases when winding, uneven application of material when coating, and irregularly cut edges when shearing.

It has previously been proposed to mount the ends of a straight roll on independently pivoted arms, and to bias the roll resiliently into a travelling sheet in an effort to obtain uniform tautness and eliminate slack regions. The straight roll may be followed, in the downstream direction of sheet travel, by one or more expander rolls mounted on fixed axes, to spread the sheet laterally and thus draw out wrinkles. This solution is not highly effective unless the slack condition increases rather uniformly from one edge to the other, which is often not the case.

It is the primary object of the present invention to provide an improved slack eliminator which is more effective to eliminate slack from any local region across the width of a traveling sheet. Further objects and advantages will become apparent as the following description proceeds.

Briefly stated, I provide a curved roll which is rotatable about a normally-stationary longitudinally-curved axle; the axle is mounted in support means which permit angular displacement about a longitudinal rectilinear axis, for turning the convex face of the roll more or less into a sheet travelling over the roll. The support means also allow the axle to tilt endwise; in one form, they comprise arm means pivotally mounted for independent movement of the opposite ends of the axle about an axis parallel to but offset from the roll. In another form, the ends of the axle are simply supported for sliding movement in slots of a frame, as described below. The roll is biased into the sheet, by gravity or otherwise.

A difference in tension as between the opposite edges of the sheet, as when one edge is slack, causes the axle to tilt end-wise in a manner to eliminate the slackness of the loose edge. To this extent, the action is similar to that of prior devices previously described.

However, if relative slackness occurs as between the center and the edges of the sheet, the reaction moments

of the sheet acting on the roll about the rectilinear axis become unbalanced, and the axle will be turned to a position which corrects the slack condition; that is, the convex face of the roll will turn into or out of the center of the web in a manner to equalize roll contact between the center and edges of the sheet.

It is preferred that the rectilinear axis of axle support pass substantially through the center of gravity of the roll, so that the axle may turn freely to vary the convexity of the roll surface portion engaging the sheet. Since a certain amount of torque must be applied by the travelling sheet to rotate the roll continuously about its curved axle, it is also desirable to provide counterweighting means on the axle to balance this torque. In the absence of counterweighting, the applied torque would tend to rotate the convex face of the roll out of the sheet, which would cause the edges to become tighter than the center. Indeed, in working with very stretchy sheet material, or with low sheet tension, a counterweight may be necessary to prevent continuous rotation of the axle.

It is also desirable, though not necessary in all cases, to partially counterbalance the gravitational or other bias of the roll into the sheet, by means of springs, counterweights, pneumatic cylinders or the like. These counterbalancing means may be adjustable, so that for a given level of sheet tension, the roll will deflect the sheet to the extent necessary to produce a desirable wrap angle. As is well known in the art, the most desirable wrap angle depends on the amount of lateral expansion or wrinkle removal required.

While the specification concludes with claims particularly pointing out the subject matter which I regard as my invention, it is believed that a clearer understanding may be gained from the following detailed description of a preferred embodiment thereof, with reference to the appended drawings, in which:

FIGURE 1 is a fragmentary plan view, partially in section, of a preferred embodiment of the improved slack eliminator;

FIGURE 2 is a fragmentary sectional view taken along line 2—2 in FIGURE 1, looking in the direction of the arrows;

FIGURES 3–6 are schematic views looking from an end of the curved roll, showing it in various operative positions;

FIG. 7 is a plan view of an end portion of an alternate embodiment; and

FIG. 8 is an end elevation of the FIG. 7 embodiment.

A curved roll **10** of conventional construction is provided, having a flexible sleeve **12** of elastomeric material received circumferentially about an axially-spaced series of spools **14**; the spools are in turn mounted upon a series of bearings **16** for rotation about a longitudinally-curved axle **18**. Rolls of this type are well known in the art, and are widely used for lateral expansion or contraction of sheet or web materials, for correction of weft distortions in woven materials, and for other purposes.

The ends of the axle **18** are secured in angularly-adjusted relation within split clamping blocks **20** by means of set screws **22**, and the clamping blocks extend into a pair of stub shafts **24** which are aligned on a rectilinear axis A. The elements **18**, **20**, and **24** combine to form axle means for the roll. The axis A preferably passes substantially through the center of gravity C.G. of the roll, so that the roll and axle means are balanced for turning about the axis A to vary the convexity of the portion of the roll face engaging a travelling sheet **30** (See FIGURE 2).

A pair of counterweight disks **26** are mounted in angularly-adjustable relationship on one of the stub shafts **24**, being secured in place by a screw **28**. Each of the

counterweights may be eccentric, so that the amount of counterweight imbalance, and its angular position relative to the axle **18**, may be adjusted independently. The sheet **30** passes over the roll in the direction shown by the arrow in FIGURE 2, and a certain amount of torque is required to turn the roll continuously on its axle; the counterweights **26** balance this torque. When handling very stretchy sheet materials, or when a very low tension is applied to the sheet, lack of counterweighting might result in the axle **18** turning continuously about the axis A, which would render the device ineffective. In other situations, the torque required to turn the roll may tend to rotate its concave face into the sheet, making the edges of the web tighter than the center. More or less counterweighting should be applied and centered angularly, as necessary to offset this tendency.

The stub shafts **24** are rotatably supported in a pair of self-aligning bearings **32**, which permit the roll and axle to tilt endwise. The inner race of one of these bearings is loose on the corresponding stub shaft **24**, to permit the relative axial movement entailed in the tilting motion. The housings of the bearings are secured to a pair of pivot arms **34**, which have stiffening webs **36**. The arms terminate in pivotal axles **38**, which are rotatably supported in pillow blocks **40** to define an offset axis D common to both arms **34**; the axis D is offset from, and normally parallel to, the axis A. The entire structure is supported upon a suitable machine framework **42**, as may be adapted to the particular installation. A pair of stop screws **43** having lock nuts **45** are threaded through the framework, each to limit the angular movement of one of the arms **34**.

In a preferred orientation of the apparatus, the arms **34** extend with a horizontal component of direction as shown in FIGURE 2, so that the weight of the roll and the arms biases it downwardly into the sheet **30**, passing beneath the roll. It is generally desirable to counterbalance this weight at least partially, and this is accomplished in the illustrated embodiment by means of pairs of tension springs **44**, attached by threaded fasteners **46** to the arms **34**, and by threaded hooks **48** to angle brackets **50** affixed to the mounting structure. The degree of pressure of the roll against the sheet is adjustable by means of nuts **52**. If the sheet is passed over the top or sides of the roll, the springs are arranged to bias the roll into the sheet. It will be apparent that other yieldable biasing means can be used in place of springs, such as counterweights, pneumatic cylinders, and the like.

The sheet **30** is guided by appropriate means over the roll **10**, illustrated in FIGURES 3–6 as a straight idler roll **54** and a winding roll **56**. These means are arranged to give the sheet a suitable wrap angle about the periphery of the roll **10**. As is well understood in the art, the most desirable wrap angle depends upon thet amount of lateral spreading action or wrinkle removal required. The tension of the counterbalancing springs **44** may be adjusted by the nuts **52** to apply the amount of unbalanced roll, axle, and arm weight to the sheet necessary to deflect the sheet to the desired wrap angle, in the existing state of sheet tension. It should be noted that the convex face of the roll **10** normally faces downstream in the direction of sheet travel, so that it tends to spread the sheet laterally and remove wrinkles.

The operation of the device is best illustrated in FIGURES 3–6. A normal condition is shown in FIGURE 3, the edges E and center C of the sheet being equally taut, with no appreciable slack. The convex face of the roll faces downstream, and the axis A is parallel to the rolls **54** and **56** and the axis D. Therefore there is equal contact of the roll with the center and both edges of the sheet. It should be noted in FIGURE 1 that the axis A interests the axis B at points falling between the center and either end of the roll; therefore, opposite moments are applied upwardly by the sheet against the middle of the roll and its ends, acting about the axis A on which the axles **24** are aligned.

In the event that the central portion of the sheet becomes slack while the edges remain taut, the edge portions will exert an unbalanced moment upwardly on the end portions of the roll **10**, acting about the axis A as a center. This rotates the axle of the roll **10**, which assumes a position as shown at **10A** in FIGURE 4, turning its convex face into the sheet, and thus pressing the middle of the roll further into the center C while partially withdrawing the ends of the roll from the edges E. The angular movement ceases when uniform contact is made across the width of the roll, and the slack in the center is correspondingly eliminated.

Should the edges of the sheet become slacker than the center, an opposite rotation of the roll axle arises from the unbalanced moment applied upwardly by the sheet against the central part of the roll, and the roll assumes a position **10B** as shown in FIGURE 5. The convex face of the roll tilts up and out of the sheet, relieving the pressure on the center C while increasing the tautness of the edges E, until a uniform degree of contact is obtained and the slack edges are eliminated.

In each of the ofregoing hypothetical situations, the axis A of the roll remains parallel to the axis D, since the opposite edges of the sheet are assumed to be equally taut or slack. However, in the event that one of the sheet edges becomes slack relative to the other, the unequal reaction of the sheet tilts the roll endwise, with corresponding opposite pivotal movements of the two stub axes **24** about the axis D, as illustrated at **24N** and **24F** in FIGURE 6. The axis A is tilted and no longer parallel to the axis D. It is assumed in the drawing that the near edge EN has become slack while the far edge EF remained taut. The tautness of the center C is unchanged by the corrective action, but EN and EF are equalized to remove the slack from EN. It follows that the tension in EF is correspondingly reduced, but sufficient initial sheet tension will prevent it actually becoming slack.

In a sense, the roll curvature provides lever arms lying on opposite sides of the rectilinear axis. A pair of first lever arms is provided by the curved end portions of the roll which lie on one side of the axis. A second lever arm is provided by the curved center portions of the roll which lie on the other side of the axis. A thrust of the web edges upwardly (as viewed in FIG. 4) tends to act against the first lever arms to rotate the roll clockwise about the axis. A thrust upwardly of the center portion of the web acts against the second lever arm upwardly to rotate the roll counterclockwise about the axis (see FIG. 5).

The more the tension at the edges, the greater the upward thrust of the edges (as compared to the thrust of the web center) and clockwise rotation of the roll about the axis. The greater the tension at the center, the greater the thrust at the center (as compared to the thrust at the edges) and counterclockwise rotation of the roll.

In practice, various combinations of the illustrated slack conditions occur; it will be understood that the angular movement and the endwise tilting movement of the roll axle are independently operative to correct any such variations.

In an alternative embodiment, the arms **34** are replaced by other support means which permit endwise tilting movement of the roll and its axle, ,independent of angular movement of the axle about the axis A. For example, the stub shafts **24** may be slidably received in slots formed in a supporting frame and extending with a component of direction normal to the surface of the sheet. The axles would preferably be biased into the sheet by its own weight and/or by means such as springs, pneumatic cylinders, or counterweights, or the like, which may be adjustable. It will be understood that this modified embodi-

ment operates in substantially the same fashion as the illustrated device.

Referring now to FIGS. 7 and 8 for an illustration of an alternative embodiment, at each end of the apparatus is provided a slotted upright plate **70**, the slot **72** therein being of sufficient width to receive in sliding manner the stub shafts **24** at each end of the roll which define the axis A. The roll structure is the same as described for the first embodiment, the stub shafts being fastened to the clamping blocks **20**, and each end of the axle **18** is held in the aforesaid angularly-adjusted relation within the split clamping blocks **20** by means of the set screws **22**, all as described above. Thus, each end of the rectilinear axis defined by the stub shafts **24** is free to move up and downwardly in slots **72** with respect to the sheet traversing the roll independently of the other end of the roll, and the roll itself is adapted to turn about the axis A.

While I have described a preferred embodiment of my invention by way of illustration, it will be apparent to those skilled in the art that additional changes and modifications may be made therein without departing from the true spirit and scope of the invention. For example, the counterweight disks **26** might be omitted, and the axis A offset from the center of gravity C.G. of the roll enough to counterbalance the axle **18** against rotating or turning with the roll **10**.

What I claim is:

1. A slack eliminating device for use in a sheet-feeding apparatus, comprising in combination:

a curved roll having longitudinally-curved axle means and rotatable about a curved axis of said axle means for engagement with a sheet travelling under longitudinal tension and partially wrapped about the surface of said roll;

first support means at each end of the roll constructed and arranged for supporting the ends of said axle means for angular displacement about a rectilinear axis parallel to a straight line connecting the ends of said axle means, said first support means and said roll applying turning moments at least partially by gravity about said rectilinear axis to said axle means;

second support means mounting each of said first support means for independent motion to provide for endwise tilting movement of the roll;

said roll being adapted to lie across the width of said sheet with said end portions contacting edge portions of the sheet and said center portion contacting the center portion of the sheet;

said rectilinear axis being positioned relative to the sheet and said axle means so that tension evenly distributed between the center and edges of the sheet applies reaction moments of tension about said rectilinear axis to said roll which balance said turning moments to hold said axle means in neutral equilibrium; tension unevenly distributed as between central and edge portions of the sheet applies reaction moments of tension about said rectilinear axis which do not balance said turning moments, thereby displacing said axle means angularly about said rectilinear axis so as to secure equal contact of said roll with said central and edge portions; and tension unevenly distributed as between opposite edge portions of the sheet applies unbalanced reaction moments of tension acting on the opposite end portions of said roll about an axis normal to said rectilinear axis to tilt said axle means endwise so as to secure equal contact of said roll with said edge portions.

2. A slack eliminating device as recited in claim **1**, together with means constructed and arranged for biasing said axle means to apply a desired level of pressure of said roll against the travelling sheet.

3. A device as recited in claim **2** in which said biasing means are adjustable to vary the pressure applied by said roll to the sheet.

4. A slack eliminating device as recited in claim **1**, together with means constructed and arranged to pass the travelling sheet to and from said roll and to engage said sheet with said roll about a predetermined normal wrap angle dependent on the position of said roll.

5. A device as recited in claim **4**; together with means adjustably biasing said roll into the travelling sheet for adjustment of the wrap angle.

6. A slack eliminating device as recited in claim **1**; in which said axle means comprise a longitudinally-curved central axle and a pair of stub shafts one affixed to each end of said axle in eccentric relation, said stub shafts being aligned with one another and rotatably mounted in said support means to define said rectilinear axis.

7. A slack eliminating device as recited in claim **1**, in which said rectilinear axis intersects said curved axis at two points each one spaced between the longitudinal center and an end of said roll, whereby the reaction moment of the sheet against said roll intermediate said two points acts about said rectilinear axis in a sense opposite to the reaction moments of the sheet against said roll between said points and the corresponding ends of the roll.

8. A slack eliminating device as recited in claim **1**, in which said second support means comprise arm means supporting opposite ends of said axle means for independent pivotal movement about an axis offset from said rectilinear axis and extending parallel thereto in a normal untilted position of said roll.

9. A slack eliminating device as recited in claim **1**, in which said first support means include counterweight means for applying a turning moment about said rectilinear axis.

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ROBERT R. MACKEY, Primary Examiner

U.S. Cl. X.R.

226—21, 180