APPARATUS FOR CONTROLLING THE TENSION OF A MOVING WEB OF MATERIAL

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ABSTRACT OF THE DISCLOSURE

An apparatus for eliminating tension fluctuations in a moving web of material as it travels from a supply roll to a point remote therefrom. The web passes back and forth over a plurality of dancer rolls carried by pivotally mounted arms biased in opposite directions at a predetermined pressure. Pivotal movement of the arms corresponds to changes in the tension of the web and such movement effects operation of a mechanism for adjusting a braking force applied to the supply roll.

Background of the invention

The invention relates to machines of the class wherein a wide web of paper is drawn from a supply roll, slit in a plurality of narrow ribbons, which ribbons then are wound into individual rolls. The web is drawn from the supply roll by one or more pull rolls driven at a constant speed. Often, the supply roll has an eccentric configuration, thereby resulting in fluctuations of the web tension, which fluctuations adversely affect the slitting and rewinding operations.

Various arrangements are available to compensate for tension fluctuations in the web as it is drawn from the supply roll. Certain prior arrangements comprise electrical apparatus which controls the speed of rotation of the supply roll in accordance with changes in a sensing element responsive to changes in the speed and/or tension of the moving web at a selected control point. Such apparatus is complex and costly. Other prior apparatus comprises a dancer roll carried by a resilient support and interposed between two fixed idler rollers. The web is passed over the dancer roll which is displaced in one or the other direction in correspondence with changes in the web tension. The inertia of the dancer roll becomes large at high web speeds so that it cannot respond, motionally, to rapid fluctuations in the web tension as, for example, when such fluctuations are caused by an eccentric, small diameter supply roll rotating at a speed of 10 revolutions per second.

Summary

The apparatus comprises two pairs of pivotally-mounted arms which are mechanically coupled together for simultaneous angular movement in opposite directions. Each pair of the arms carries a pair of dancer rolls which are freely rotatable about individual axes parallel to the pivot axes of the arms. The web passes back and forth over the dancer rolls as it travels from the supply roll to a pull roll, in such manner that the tension of the web tends to draw the arms toward each other in opposition to a predetermined opposing force tending to spread the arms apart. Such arrangement provides a mechanical advantage of 3:1 so that each dancer roll is displaced laterally only approximately 1/3 of the web oscillation movement due to an essentially wound supply roll. This results in a considerable reduction in the inertia effect, a reduction in the friction effect upon the movable members and, also, greatly increases the capacity of the dancer roll assembly.

An object of this invention is the provision of apparatus for removing tension fluctuations in a moving web of material as it is drawn from a supply roll.

An object of this invention is the provision of apparatus for controlling the tension of a moving web of material as it is drawn from a supply roll by a power driven pull roll, which apparatus comprises two pairs of arms pivotally mounted for simultaneous angular movement in opposite directions about parallel axes, a plurality of dancer rolls carried by each set of arms and over which the web passes in a back and forth manner as it travels from the supply roll to the pull roll, means applying a constant biasing force tending to spread the sets of arms apart, and means responsive to angular movement of the sets of arms for controlling the speed of rotation of the supply roll.

The above-stated and other objects and advantages of the invention will become apparent from the following description when taken with the accompanying drawings. It will be understood, however, that the drawings are for purposes of illustration and are not to be construed as defining the scope or limits of the invention, reference being had for the latter purpose to the claims appended hereto.

Description of the drawings

In the drawings wherein like reference characters denote like parts in the several views:

FIGURE 1 is a front elevational view of apparatus made in accordance with this invention, with certain parts omitted and the pivotally mounted arms shown rotated toward each other to the maximum extent;

FIGURE 2 is a rear elevational view, with certain parts omitted and showing the pivotally mounted arms rotated apart to the maximum extent;

FIGURE 3 is, essentially, a side elevational view with certain parts shown in cross-section and including only portions of the various rolls; and

FIGURE 4 is a diagrammatic representation showing the operative relationship between certain mechanical components and the pneumatic control system.

Description of preferred embodiment

Reference is now made to FIGURES 1—3. The apparatus is supported on front and rear mounting plates 10 and 10', respectively. These plates have generally rectangular openings 11, 11' formed therein and outwardly directed flanges 12, 12' welded to the lower ends thereof, which flanges are provided with holes for receiving bolts by means of which the apparatus can be bolted to the floor. The two mounting plates are secured together by two channel beams 15 and 16 having individual rectangular, flat plates 17, 17' and 18, 18' welded to the ends thereof, each plate having tapped holes for receiving the fastening bolts 20 passing through clearance holes formed in the mounting plates. Aligned bearing plates 21, 21' are bolted to the inner facing surfaces of the mounting plates, said plates carrying bearings 22, 22' supporting the shaft 23 of a pull roll 24. A pulley 25 is secured to one end of this shaft. The mounting plates are provided with aligned clearance holes for the bolts 26, which bolts are threaded into the ends of a shaft 27 carrying an idler roll 28.

Formed in the lower portions of the mounting plates are two sets of aligned holes, one set of holes accommodating the bearings 30, 30' and the other set of holes ac-
commodating the bearings 31, 31'. A first metal ballast cylinder has reduced-diameter ends 32, 32' passing through the bearings 30 and 30', respectively, and a second similar cylinder has reduced-diameter ends 33, 33' passing through the bearings 31, 31'. This construction and assembly will be described below. For the present, it is pointed out that two, relatively long arms 35 and 36, constituting a first pair of pivot arms, have ends secured to the first ballast cylinder rotatable in the bearings 31 and 31'. Similarly, two relatively short arms 37 and 38, constituting the second pair of pivot arms, have ends secured to the second ballast cylinder rotatable in the bearings 30 and 30'. Each of these arms is a sturdy tubular member of rectangular cross-section.

The construction and assembly of the pivot arms and ballast cylinders will best be understood by reference to FIGURE 3 which is essentially a side elevational view as viewed from the left side of FIGURE 2. This figure, however, shows only portions of the pull roll 24, idler roll 28 and the four dancer rolls 40-43, and only a portion of one of the long pivot arms 36. The other long pivot arm has been omitted from this view in order to show the assembly of the short pivot arms 37 and 38 to the ballast cylinder 45 having its reduced-diameter ends 32 and 32' passing through the bearings 30 and 30' carried by the mounting plates 10, 10', respectively. Secured to shoulders formed at opposite ends of the cylinder 45 are rectangular, flat end plates 46 and 47 bolted by bolts 48, each such plate lying in a plane normal to the paper and extending toward the viewer. A tie plate 49 is secured to the pivot arm 37, by bolts 50, the lower end of this plate having an arcuate end surface abutting the cylinder and welded thereto. The other arm 38 is similarly secured to the cylinder by means of the tie plate 51. It will now be apparent that the two short arms 37 and 38, constituting the above-mentioned second pair of pivot arms, the end plates 46 and 47, and the ballast cylinder 45, are rotatable as a unit about the axis of the cylinder. Secured to the projecting reduced-diameter end 32' of this cylinder is a cam 53, see also FIGURE 2, the purpose of which will be described below.

In FIGURE 3, the two long arms, constituting the first pair of pivot arms, would lie forwardly of the pair of short arms 37 and 38. The lower ends of these arms are secured to a second ballast cylinder in the same manner as has been described with reference to the short pivot arms 37 and 38 and the cylinder 45, such cylinder also having secured thereto a pair of rectangular, flat plates similar to the plates 46 and 47. The latter plates, however, extend away from the viewer, that is, the plates carried by the two cylinders extend toward each other. As shown in FIGURE 2, the flat plate 46, rotatable with the shaft 32', has a bifurcated end carrying wear plates 54 and 55. The corresponding plate 56, rotatable about the shaft 33, underlies the plates 46 and carries a cam follower 57, the peripheral surface of which is engaged by the wear plates. As shown in FIGURE 2, the flat plate 47, rotatable with the shaft 33', has a bifurcated end carrying wear plates and underlying the flat plate 58 which carries a cam roller 59 and is rotatable with the shaft 33'. It will now be apparent that the described arrangement results in the simultaneous rotation of the two pairs of arms in opposite directions.

The maximum extent to which the pairs of pivot arms can be rotated toward or away from each other is defined by suitable stop members. Referring to FIGURE 1, one stop member comprises a bolt secured to the upper end of the short pivot arm 37 and carrying a coiled spring 61 aligned with the long pivot arm 35, thereby serving as a bumper to limit angular movement of these arms toward each other. A similar stop member comprising a coiled spring 62, see FIGURE 2, is carried by the other short pivot arm 38 for engagement by the other long pivot arm 36. The maximum extent to which the pairs of arms can be rotated away from each other is defined by two chains 63 and 64 having ends secured to the aligned pivot arms of each pair, as shown.

The first pair of pivot arms carries the dancer rolls 40, 42 and the second pair of pivot arms carries the dancer rolls 41, 43, each roll being rotatable about individual shafts as will now be described with specific reference to FIGURE 3. In FIGURE 3, the lower dancer roll 43, carried by the short pivot arm 37, is shown in cross-section. One end of a hollow shaft 68 is supported by an end bushing 69 which is secured to the pivot arm 37 by the screw 70, such bushing being accessible through a hole 71 formed in the pivot arm, see also FIGURE 1. The shaft carries a bearing 72 having its outer face secured to the roll 43 by a plurality of bolts 73. The other end of the dancer roll 43 is similarly supported by the other short pivot arm 38. All four of the dancer rolls 40-43 are similarly constructed and arranged for free rotation about their respective supporting shafts, the rolls 40 and 42 being carried by the first pair of relatively long pivot arms and the rolls 41 and 43 being carried by the second pair of relatively short pivot arms. As seen in FIGURE 2, the web 75, coming from a supply roll, is directed around the pull roll 24, around the idler roll 28, back and forth around the four dancer rolls 40-43 and around another pull roll 76, the latter pull roll rotatably mounted in FIGURE 1. As seen in FIGURE 2, the two pull rolls 24 and 76 are coupled together by a belt 77 passing over the pulleys 25 and 78. Although not shown in the drawings, those skilled in this art will understand that the pull roll 78 is power driven in synchronism with one or more other pull rolls of the associated machine as, for example, a pull roll which draws the web through the slitting station.

During the web-threading operation, the two pairs of pivot arms are in the positions shown in FIGURE 1. Thereafter, a biasing force of predetermined magnitude, is applied to the similarly aligned arms of each pair, such force tending to spread the pairs of arms apart and opposed by the tension generated by the moving web. This biasing force is developed by a pair of air cylinders mechanically coupled to the pivot arms. Referring to FIGURE 2, one of the air cylinders 80 has a piston arm 81 pivotally coupled to a rod 82 passing through a bearing bushing 83 welded to a plate 84, which plate is secured to the pivot arm 36 by bolts 85. A plate 86, secured to the cylinder case, is provided with a hole receiving a rod 87, which rod passes through a bearing bushing 88, said bushing being secured to the short pivot arm 38 in the same manner as has been described with reference to the bushing 82. It will be apparent that air pressure applied to the cylinder will tend to spread apart the pivot arms 36 and 38. A second air cylinder is mechanically coupled to the other corresponding pivot arms of each pair, the center line of such second cylinder being shown in FIGURE 1 and identified by the numeral 89. The air cylinders have been omitted in FIGURE 3.

A first shock absorber 90, FIGURE 1, is secured to the inner surface of the front mounting plate 10 and has a pivotal crank arm 91 connected to the long pivot arm 35. A second shock absorber 92, FIGURE 2, is secured to the inner surface of the rear mounting plate 10' and has a pivoted crank arm 94 connected to the other long pivot arm 36.

From the above description it will be clear that the apparatus comprises two pairs of pivotally-mounted arms simultaneously rotatable in opposite directions, each pair of arms carrying a pair of freely-moving dancer rolls mounted around which the web is passed in a back and forth manner. These arms have applied thereto a biasing force tending to rotate the arms to spread them apart. An opposing force tending to rotate the pairs of arms toward each other comprises the tension of the moving web. Such arrangement has a mechanical advantage of 5:1 so that each dancer arm 40-43 is displaced, laterally, only about 1/5 of the web oscillation movement due to changes in tension upon rotation of an eccentrically wound supply roll, so reducing the translatory movement of the dancer rolls.
the inertia effect is reduced considerably. The large mechanical advantage also reduces the effect of friction on the dancer rolls and, also, greatly increases the web storage capacity of the dancer roll assembly. Fluctuations in the web tension result in angular movement of the two pairs of pivot arms in one or the other direction. Such angular movement of the arms is utilized to control a braking action applied to the supply roll as will now be described. Referring to FIGURE 2, a conventional air pressure regulator 96 is carried by a support plate 97 secured to the rear mounting plate 10' and having an offset end. Also secured to the mounting plate is a pivoted arm 98 carrying an adjustable screw 99 engaging the operating plunger of the regulator. The plunger remains in engagement with the end of the screw in response to air pressure applied to the regulator, thereby causing the lever 98 to remain in contact with the cam 53 secured to and rotatable with the shaft 32'. Thus, angular movement of the pivot arms results in an axial movement of the plunger, thereby controlling the pressure of the air leaving the regulator.

References now is made to FIGURE 4 which is a diagrammatic representation showing the relationship of the mechanical components to the control elements of the pneumatic system. The pair of pivot arms having lower ends secured to the ballast cylinder 45 carry the dancer rolls 41 and 43 and the other pair of pivot arms, having lower ends secured to the ballast cylinder 45', carry the dancer rolls 40 and 42. The supply roll 100 is carried by a conventional unwind stand and its speed of rotation is controlled by a conventional air-operated brake 101. The web passes around the pull roll 24 and idler roll 28 and then back and forth around the dancer rolls to the pull roll 76. Normally, the pivot arms are drawn toward each other, by the spring 65, to an extent determined by the bumper spring 61. The air cylinder 80, mechanically coupled to the pivot arms, is connected to a compressed air source 102 through the ballast tank 45', air pressure regulator 103 and filter 104, said regulator being conventional construction and adjustable to provide a predetermined air pressure in the air cylinder 80, thereby applying a biasing force of predetermined magnitude to the pivot arms. The pressure regulator 103 is mounted on a control panel along with other members for controlling the apparatus of the particular machine. These pivot arms rotate, simultaneously, toward and away from each other in correspondence with changes in tension of the moving web. Such movement of the pivot arms results in an increase in the braking action applied to the supply roll.

Having now described the invention, those skilled in the art will be able to make various changes and modifications without departing from the spirit and scope of the invention as recited in the following claims.

I claim:

1. Apparatus comprising,
   (a) two pairs of spaced arms, each pair mounted for simultaneous angular movement in opposite directions about parallel pivot axes,
   (b) dancer rolls carried by each pair of arms and freely rotatable about individual axes parallel to the said pivot axes,
   (c) spring means connected to each pair of arms and tending to draw them toward each other,
   (d) means limiting the angular extent to which the pairs of arms can be drawn toward and away from each other, and
   (e) air cylinders mechanically coupled to each pair of arms and connected to an air pressure source through an adjustable pressure-reducing valve, said air cylinders applying a predetermined biasing force to each pair of arms in a direction tending to spread them apart.

2. Apparatus for compensating for tension fluctuations of a moving web of material as it is drawn from a supply roll by a power driven pull roll, which apparatus comprises,
   (a) a pair of spaced mounting plates,
   (b) first and second cylindrical members carried by the mounting plates and rotatable about parallel pivot axes,
   (c) a first pair of spaced arms having ends secured to the first cylindrical member,
   (d) a second pair of spaced arms having ends secured to the second cylindrical member,
   (e) a plurality of dancer rolls rotatably carried by the said first pair of arms,
   (f) a plurality of dancer rolls rotatably carried by the said second pair of arms,
   (g) coupling means mechanically coupling together the said cylindrical members for simultaneous rotation in opposite directions,
   (h) pressure means for applying a predetermined biasing force in a direction tending to spread apart the said pairs of arms,
   (i) air-operated braking means controlling the speed of rotation of the supply roll, and
   (j) control means responsive to rotation of the said cylindrical members and controlling the said braking means.

3. The invention as recited in claim 2, wherein the said pressure means comprises a pair of air cylinders mechanically coupled to the said first and second pairs of arms, a source of air under pressure, and connecting lines including a pressure-reducing valve connecting the air cylinders to the said source.

4. The invention as recited in claim 3, wherein the said control means comprises a pressure-adjusting valve having an operating plunger, connecting lines connecting the said pressure adjusting valve between the said source and the said air-operated braking means, and a camming mechanism actuating said plunger in correspondence with rotation of the said cylindrical members.

5. The invention as recited in claim 4, wherein the said camming mechanism comprises a cam secured to one of the said mounting plates and engaging the said cam, and an adjustable member carried by said pivot plate and in engagement with the said plunger.

6. The invention as recited in claim 2, including first stop means defining the angular extent to which the said pairs of arms can rotate apart, and second stop means defining the angular extent to which said pairs of arms can rotate toward each other.

7. The invention as recited in claim 6, wherein the said first stop means comprises chains having ends secured to corresponding arms of each pair of arms, and wherein the said second stop means comprises coiled springs carried by the one pair of arms and having ends aligned with the other pair of arms.

8. The invention as recited in claim 2, wherein the said coupling means comprise a first end plate secured to one of the said cylindrical members, a pivot lever rotatably carried by said first end plate, a second end plate secured to the other cylindrical member and having a bifurcated end spanning said cam follower, and wear plates secured to the said second end plate and engaging the peripheral surface of said cam follower.

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