July 23, 1963

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3,098,284







United States Patent Office

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3,098,284 Patented July 23, 1963

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3,098,284 ROLL SUBJECT TO DEFLECTION Lloyd Hornbostel, Beloit, Wis., assignor to Beloit Iron Works, Beloit, Wis., a corporation of Wisconsin Filed Aug. 22, 1961, Ser. No. 133,150 3 Claims. (Cl. 29–113)

This invention relates to a structure for a roll whose axis is subject to deflection in response to a load applied to such roll, and more particularly, to a structure for a 10 roll that is subjected to a load tending to effect central deflection of the roll axis.

Although the instant invention may be useful in a number of arts, it is particularly useful in the paper making art and will be described primarily in connection 15 therewith. In paper machines there are a number of different types of rolls of substantial size which are subjected to loads tending to deflect such rolls centrally. For example, wire return rolls in a Fourdrinier paper machine are subject to a load tending to effect central 20 deflection thereof by virtue of the weight of the rolls themselves and of the Fourdrinier wire carried by the rolls, the tension on the Fourdrinier wire, and, in the case of a driven roll, the force component resulting from the resistance or reaction of the wire itself to the driving 25 force. These forces tend to deflect the roll downwardly in the middle and this results in an undesirable guidance of the traveling wire, which it has been found advantageous to avoid by counteracting the tendency for downward deflection of the return roll in one manner or an- 30 other.

In addition, in the case of plastic forming wires and also in the case of felts, a deflection away from the "plane" of the traveling wire or felt is often undesirable. The crowning of a roll to compensate for deflection is, 35 likewise, often undesirable because it tends to cause differences in peripheral speeds laterally across the roll and thus differences in the speeds of various portions of the plastic wires or felts.

The instant invention affords a simple and unique roll 40structure for a roll subject to a load tending to cause deflection of its axis, whether or not this load is merely the weight of the roll or is an additional load applied via a forming wire, etc. that is supported and driven by the roll. In the instant roll structure the crowning of the roll may be varied without rebuilding the roll or refinishing the surface thereof. The crowning of the roll may be varied from a positive to a negative crown, depending upon the operating needs. The crowning of the roll is 50effected by fluid pressure control means which are actuated outside of the roll itself by the use of conventional pressure control devices. The fluid pressure maintained within the roll is the fluid pressure which determines the outer peripheral dimensions of the roll (whether it be a 55positive or negative crown) in a predetermined manner.

In the instant invention, a supporting generally cylindrical roll body is provided to carry the bulk of the load which tends to deflect the axis of the roll. Under ordinary use, of course, the weight of this supporting body 60 plus any load applied to the roll will tend to cause some deflection of the centroidal axis. The instant invention may provide for compensation of this tendency to deflect by imparting a crown or a slightly increased peripheral dimension to the central portion of the roll. Alter- 65 natively, the instant invention may provide no crown or even a negative crown, i.e. a slightly decreased peripheral dimension to the central portion of the roll. The cylindrical body of the roll is wrapped by an expansible hose, which preferably is provided with a larger fluid pressure 70 passageway in the central region of the roll, so that the variations in crown may be selected by variations in pres2

sure. When the hose is subjected to increased interior fluid pressure, the hose will expand to a greater extent in the central portion of the roll than it does at the ends, thus causing a positive crown. On the other hand, as the pressure in the hose is decreased, the crown decreases; and finally when the pressure is reduced to a sufficient extent a slightly negative crown is obtained by virtue of the fact that the hose portion with the larger fluid passageway in the central region of the roll is capable of collapsing under moderate loads to a greater extent than the hose portions at the ends of the roll (having smaller fluid passageways therein). The extent of such fluid pressure determines the extent of the crowning of the roll. It will be appreciated that such hose means may have a number of forms in order to accomplish the ends herein described, and such hose may be designed so as to effect crowning or a greater peripheral dimension in regions of the roll other than the central portion. In this respect, it will be appreciated that the axis of practically any roll is subject to some deflection in response to a load, but the instant invention is not necessarily limited to "correction" of the effect of such deflection of the axis, since it permits other variations in the overall peripheral dimensions of the roll and, therefore, the contour of any operating surface thereof.

The instant invention has a number of advantages resulting from the fact that the crown or variations in peripheral dimensions of the roll may be controlled within certain limits by variations in actuating fluid pressure. Such fluid pressure would control the dimensions of the crown independently of temperature changes and other variables known to exist in the operation of rolls of this type in paper machines or other machinery. Moreover, fluid pressure is very easily controlled and the overall operation is accordingly simplified.

It is, therefore, an important object of the instant invention to provide an improved roll structure.

It is another object of the instant invention to provide an improved structure for a roll whose axis is subject to deflection in response to a load applied to the roll, by providing the roll structure with selectively inflatible means of variable response to fluid pressure, and further providing means for varying the fluid pressure.

Yet another object of the instant invention is to provide a roll whose axis is subject to deflection in response to a load applied to the roll, said roll comprising a supporting cylindrical body, solid elastomer hose means wrapped peripherally about the outer surface of said body and presenting an outer peripheral surface for said roll, said hose means defining a central fluid pressure receiving bore surrounded by a solid elastomer body of predetermined cross-sectional area of lesser size at the central portion of said body than at the ends thereof, and means for selectively introducing fluid under pressure into said hose means to effect maintenance of a greater outer peripheral dimension for the roll at its center than at its ends and withdrawing fluid from said hose means to effect maintenance of a smaller outer peripheral dimension for the roll at its center than at its ends.

Other and further objects, features and advantages of the present invention will become apparent to those skilled in the art from the following detailed disclosure thereof and the drawings attached hereto and made a part hereof. On the drawings:

FIGURE 1 is an essentially diagrammatic elevational view showing a roll embodying the instant invention wherein a positive crown is maintained;

FIGURE 2 is a view corresponding to FIGURE 1, but showing a roll embodying the instant invention wherein a negative crown is maintained during operation;

FIGURE 3 is an elevational view of a roll assembly

embodying the invention, with the roll itself shown in section and parts shown diagrammatically;

FIGURE 4 is an enlarged fragmentary detail view of the encircled area indicated at IV in FIGURE 3;

FIGURE 5 is a view comparable to that of FIGURE 4 5 of the encircled area designated V in FIGURE 3; and

FIGURE 6 is a view comparable to FIGURES 4 and 5, but showing another embodiment of the instant invention.

As shown on the drawings: In FIGURE 1, a roll embodying the instant invention 10 indicated generally by the reference numeral 11 is shown mounted on suitable bearings 12 and 13 which are in turn firmly secured to a fixed mounting such as the floor F. The roll 11 is provided with a left hand stub shaft or shaft element 11a which is rotatably received by the left hand 15bearing 12 and a right hand stub shaft 11b which is rotatably received by the right hand bearing 13. As will be noted, the axis X-11 for the roll 11 is deflected downwardly below a horizontal or center line C-11 at the middle of the roll 11 and this is caused by the load applied to the roll 11 by virtue of the weight thereof and any other forces which might be applied downwardly thereto. The deflection X-11 is, of course, exaggerated for purposes of simplification.

In addition, the roll 11 has a slight positive crown indi- 25 roll 21. cated at R-11 on the top of the roll 11, which is loaded to some extent by a plastic forming wire W-1 traveling over the roll 11. The plastic forming wire W-1 could also be replaced by a felt. It will be noted that the downward deflection D-11 at the bottom of the roll 11 is some-30 what greater than the crown R-11 at the top, because no load is applied to resist this downward deflection D-11. Particularly in the case of conventional metallic forming wires, it is desirable to avoid forces which tend to compact the wire laterally and which may tend to cause the wire to fold upon itself and create imperfections therein. For this reason, the embodiment shown in FIGURE 1 may be particularly useful as a return roll for a conventional metallic forming wire, tending to cause the wire (here shown at W-1) to spread out laterally rather than com- 40 pact laterally as it passes over the roll 11. In some instances, this type of control on the lateral spreading or the lateral compacting of plastic wires and felts is desirable; but in other instances it may be desirable to cause the plastic wire or felt to be subjected to neither compact- 45 ing or spreading forces (as would be the case with the substantially horizontal roll surface presented at the top of the roll in FIGURE 3); and in other cases it may be desirable to effect slight lateral compacting of the plastic 50wire or felt, as is the case in the embodiment shown in FIGURE 2.

Referring now to FIGURE 2 specifically, it will be seen that there is shown a roll 14 having a left hand stub shaft 14a suitably mounted in bearing 15 and a right hand stub 55shaft 14b suitably mounted in a bearing 16. Again, the roll 14 is subjected to the load of its own weight (as well as any other load applied thereto) so that the axis thereof X-14 is deflected downwardly slightly from the theoretical center line C-14. In the embodiment of FIGURE 2, how-60 ever, a negative crown is applied to the roll 14 by control of the fluid pressure in the manner which will be described hereinafter, and the plastic wire W-2 (or felt) passing over the top of the roll 14 is subjected to a slight lateral compacting force in substantially the plane of the plastic wire 65 W-2 (i.e. generally tangent to the top of the roll 14).

Referring now to FIGURE 3, it will be seen that there is shown generally a roll 21 embodying the instant invention which is mounted with conventional allochiral heads and stub shafts 22, 23 rotatably carried in bearings 24, 7025. The roll 21 comprises a generally cylindrical supporting body or shell 26 of metal or similar structural material secured to the heads 22, 23. The outer surface 26a of the shell 26 is wrapped peripherally with expansible hose means, indicated generally at 27. The hose 75means 27 may comprise a plurality of hose elements

connected to each other or connected to a common source of fluid under pressure (not shown); but in any event the hose means 27 preferably defines an overcoat on the shell 26 of substantially uniform annular thickness when the hose is in unexpanded form. Preferably, also, the hose layer 27 is covered by a protective shell or overcoat 29 which presents an outer peripheral surface 29a for the roll 21. The outer layer or cover 29 is preferably made of vulcanized rubber or other solid elastomer, which is adequate to protect the roll and wear satisfactorily against the wire or whatever part of the machine it will engage, but which is also sufficiently yieldable to respond to the expansion of the hose means 27 (in the manner hereinafter described).

The roll 21 in its unloaded condition would, of course, have a centroidal axis C-21 along the theoretical center line indicated in FIGURE 2; but in the position shown in FIGURE 2 wherein the roll is supported at its extremities by the bearings 24, 25, the weight of the roll will cause a central deflection represented in exaggerated manner by 20the dashed line $B-2\hat{1}$. In addition, any load (other than the weight of the roll itself) applied to the top of the roll (here represented diagrammatically by arrows 30a, b, c) would add to the deflection of the centroidal axis of the

In the unexpanded form of the hose means 27, this would result in a slight downward deflection of the outer peripheral surface 29a of the roll 21 in the region of the central load arrow 30b. The present invention provides means for compensating for this type of deflection so as to obtain a substantially horizontal top peripheral surface 29a of the roll 21 or even a centrally crowned surface, depending upon the desired operation. This is accomplished because of the particular form of the hose means 27, which will be described in detail, and by virtue of the application of fluid under pressure to the hose 27. The fluid under pressure such as air under pressure may be fed from a suitable source S through a pressure control valve V-21 (both represented diagrammatically), through a conduit 31 generally axially aligned with the hollow head and stub shaft 23 and then through a radially aligned conduit 32 passing through the structural shell 26 and feeding into the hose 27. In conventional manner, a stationary fixture 33 rotatably receives the conduit 31 and affords communication therebetween and the source of fluid under pressure S.

Referring now to FIGURES 4 and 5, it will be seen that the solid elastomer (i.e. rubber) hose means 27 comprises a plurality of adjacent wraps, with some near the end of the roll indicated at 27a, 27b and 27c in FIGURE 4 and some near the middle of the roll indicated at 27dand 27e in FIGURE 5. These helical wraps 27a through e have in their unexpanded form substantially the same overall cross-sectional area and shape. But the portions of the hose 27 near the ends of the roll 21, i.e. the wraps 27a, b, c have central fluid pressure receiving passageways 34a, b of relatively small peripheral dimension (or circumference in the cross-sectional view of FIGURE 4), whereas the hose wraps 27d, e near the center of the roll 21 have central fluid pressure receiving passageways 34d, e of substantially greater peripheral dimension. Expressed in other terms, the cross-sectional area of the solid elastomer body of the hose wrap 27a is substantially greater than the cross-sectional area of the solid elastomer body of the central hose wrap 27d. Moreover, since substantially the same fluid pressure is present in each of the passageways 34a, b, d, e during operation the expanding force per unit area is the same in each of the passageways 34a, b, d, e, but the total force is greater (because of the greater area to which the fluid pressure is exposed) in the case of the larger passageways 34d and e. The net result is that the same fluid pressure in all of the passageways will result in a substantially greater expansion of the hose means 27 in the central portion of the roll 21, and this results in predetermined increase

in the overall peripheral dimension of the roll 21 in the central portion thereof. The increase is predetermined by the fluid pressure applied in the passageways 34a, b, c, d, e, which in turn is controlled by the valve V-21.

5 It will thus be apparent that under certain conditions of the load, a predetermined pressure will provide the desired peripheral dimension or crown in the central portion of the roll 21 (or any other portion of such roll, if the hose form is changed); whereas a different fluid pressure in the hose 27 will result in a different central peripheral dimension for the roll 21, which may be found to be particularly desirable for a different condition of load on the roll 21. It will also be apparent that, if the hose 27 is evacuated or fluid pressure is withdrawn therefrom, for 15 example, by means of an evacuating pump V via the valve V-21a, then the hose elements 27d and 27e having the larger fluid passages therein will tend to collapse more readily than the hose elements 27a, 27b having the smaller fluid passageways therein. The evacuation of pres- 20 sure in the hose 27 may thus be carried out depending upon the nature of the load 30a, 30b, 30c so that such load may tend to collapse the hose portion 27 in the central part of the roll and thus bring about the formation of a negative crown, as demonstrated in FIGURE 2. 25 The valve means V-21 and V-21a thus provide means for selectively varying the fluid pressure in the hose 27 in order to selectively vary the relative peripheral dimensions for the roll at its center and at its ends.

As previously indicated, the wraps 27a, 27b, etc. of 30 the hose 27 are so closely placed together that they will present a relatively even outer surface, but it is preferable to employ a covering layer 29. In the embodiment of FIGURE 6, it will be seen that the cross-sectional shape of hose wraps 27'a and 27'b may be altered so as to pre- 35 sent a smoother outer surface indicated generally at 35. In FIGURE 6 elements corresponding to those shown in FIGURE 3 are indicated by the prime of the same reference numeral. The essential difference in FIGURE 6 resides in the rectangular or substantially square overall 40 cross-sectional shape of the hose wraps 27'a and 27'b, so as to present a substantially smooth outer or operating surface 35 which may be used without an overcoat. In other respects, the hose means 27' functions in the manner already described. 45

In the preferred embodiment of the instant invention, the peripheral dimension of the smaller passageways 34ais substantially smaller than that of the larger passageways 34d, so as to obtain an appreciable difference in expansion or contraction effect, which is not directly proportional to such differences in peripheral dimensions of the passageway. In general, the larger peripheral dimensions (i.e. for the passageway 34d) should be within the range of about $1\frac{1}{2}$ to 5 times the peripheral dimensions of the smaller passageways (i.e. the passageway 34a).

An additional feature of the invention resides in the correction of felt travel in situations when the felt seam tends to lag behind in the central portion of the felt. In such situations the central portion of the instant roll may be inflated so that the resultant peripheral speed of the roll is increased in the center and the "lagging" central portion of the felt seam will tend to "catch up" to the edges of the felt seam. (Deflation of the roll, of course, is used to cause a normally "leading" central portion of a felt seam to fall back in line with the edges of the felt seam.)

It will be understood that modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the present invention.

I claim as my invention:

1. A roll whose axis is subject to deflection in response to a load applied to the roll, said roll comprising a supporting generally cylindrical body, an expansible hose of generally uniform cross-sectional area wrapped helically about the outer surface of said body to present an outer surface of substantially uniform peripheral dimension when the hose is in unexpanded form, cover means surrounding the outer periphery of the hose and presenting an operating roll surface, said hose having a central fluid pressure receiving passageway of substantially greater peripheral dimension at the central region of the roll than at the roll ends, and means for selectively introducing fluid under pressure into said hose means to effect relatively greater expansion of said hose in the central region of said roll and withdrawing fluid from said hose means to effect maintenance of a smaller outer peripheral dimension of the roll at the central region of the roll.

2. A roll as claimed in claim 1 wherein the overall cross sectional shape of the hose is substantially rectangular so as to present a smooth outer surface for engaging said cover means.

3. A roll as claimed in claim 1 wherein the overall cross sectional shape of the hose is generally annular and the peripheral dimension of the passageway of the hose in the central region of the roll is within the range of $1\frac{1}{2}$ to 5 times the peripheral dimension of the smaller fluid pressure receiving passageways in the hose at the ends of the roll.

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