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3,230,604

REVERSE DEFLECTION CONSTANT SPEED ROLL

Filed May 16, 1962

2 Sheets-Sheet 1

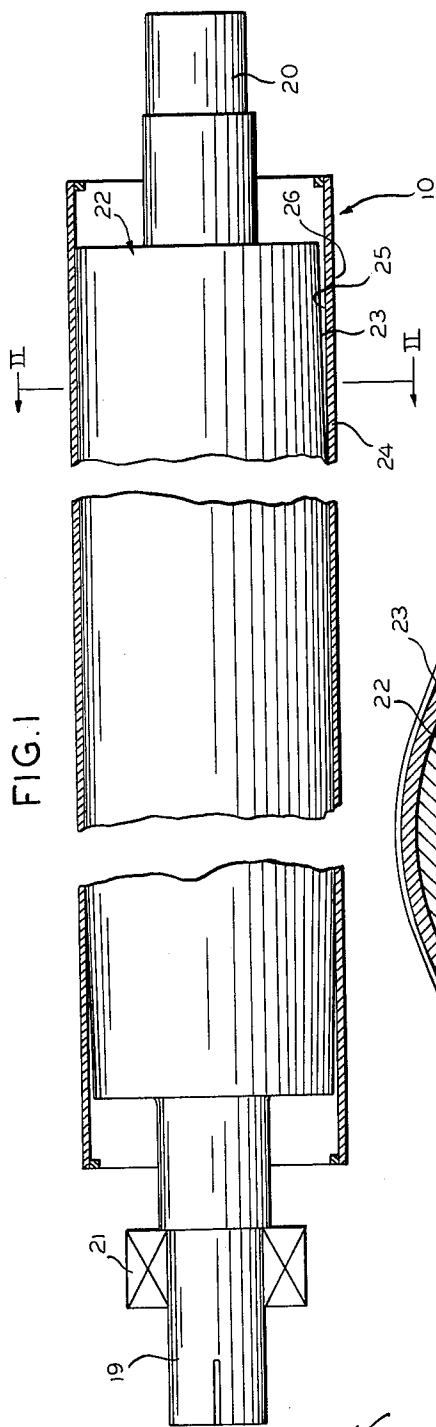


FIG. 1

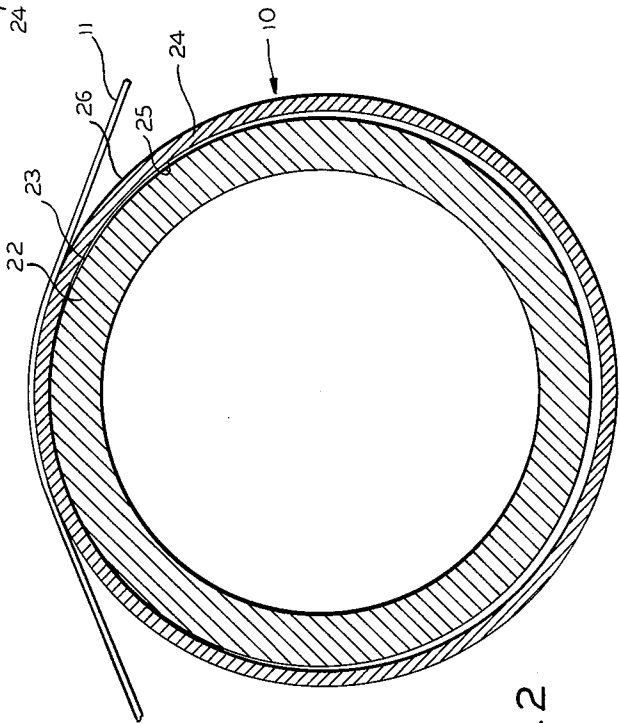


FIG. 2

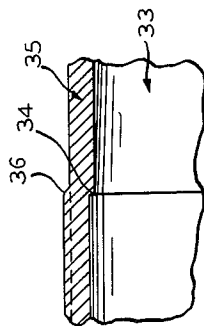


FIG. 4

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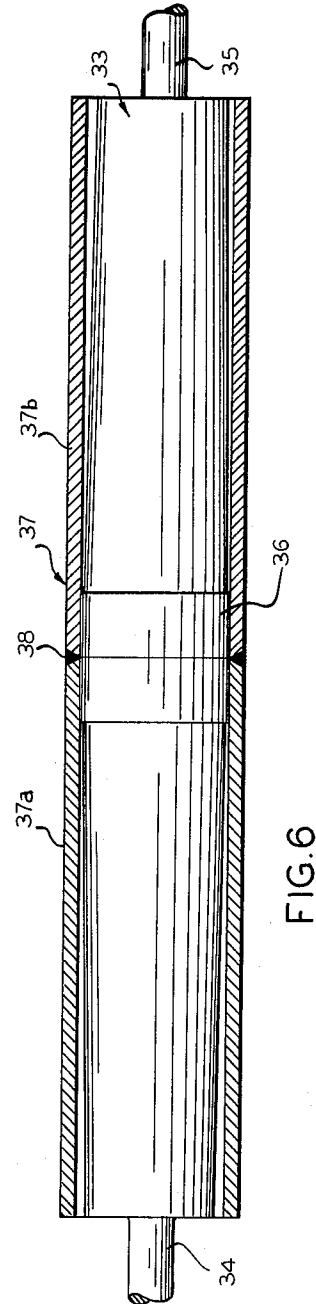
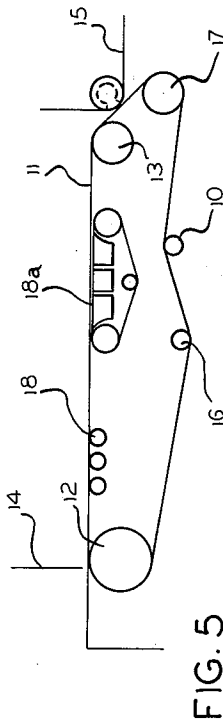
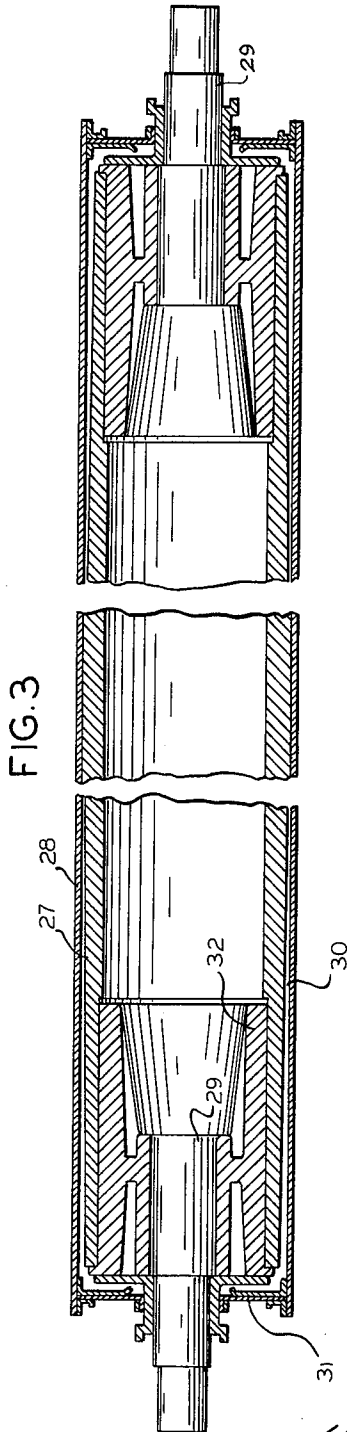
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REVERSE DEFLECTION CONSTANT SPEED ROLL

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2 Sheets-Sheet 2



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REVERSE DEFLECTION CONSTANT SPEED ROLL
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The present invention relates to improvements in anti-deflection rolls and more particularly to a roll suited for use as a Fourdrinier wire guide roll having an effective crown to compensate for deflection with load but avoiding the differential surface speeds which result from the usual crowned rolls.

The invention embodies a roll assembly including an inner roll member rotatably supported on journals at its ends and having its outer diameter finished in accordance with a desired deflection curve as conventionally determined. A tubular outer shell member is telescoped over the inner roll member and has a straight cylindrical outer surface and a cylindrical inside bore and rotates with the inner roll member. With load the inner roll deflects in accordance with the inner roll design usually to provide a substantially straight line at the location of radial load, and the outer shell will be supported on the inner roll but will provide a constant diameter throughout its length and thus has the same peripheral speed everywhere along its length.

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 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 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 force. These forces tend to deflect the roll downwardly in the middle and this results in an undesirable guidance of the travelling wire, which it has been found advantageous to avoid by counteraction of the tendency for downward deflection of the return roll in one manner or another.

In addition, in press couples, etc., the web passes through a nip between a pair of superimposed rolls whereat the web is subjected to pressures. The pressures thus applied at such nip tend to load the lower roll and deflect the same centrally downwardly. Such deflection results in an undesirable application of forces across the nip and other undesirable operating features; and such deflection is often corrected in paper machines by "crowning" of the rolls. The crowning of the roll requires accurate and expensive finishing of the roll surface so as to obtain a slightly greater roll diameter in the central portion of the roll. Conventional crowning of rolls often does not afford satisfactory operation for many different types of operating conditions.

In other arts relating to paper machines, such as the coating of paper or fabrics with plastic materials, pressure or calender rolls are also used. Also, paint mixing roll systems or the like are subject to the buildup of forces in the central portion of pressure nips which tend to cause central deflection of the rolls and result in non-uniform and/or other undesirable conditions across the width of such press nips.

Crowned rolls have certain inherent disadvantages which are avoided by the present invention. In conventional crowned rolls it is impossible to produce a crown that accommodates progressive wear. Crowns also give

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higher sheet and felt and wire speeds at the center, and this adversely affects paper quality, felt and wire drainage, and felt and wire life. This also causes skewing of felts and wires which tends to close the weave.

In crowned rolls pressure characteristics at the roll center are different from those at the ends rendering uniform action along the pressure nip between rolls difficult. A substantial disadvantage of crowned rolls exist due to the fact that circumferential speeds at the corresponding points of the roll at different axial locations are different, causing friction and slippage of elements carried on the roll or engaging therewith. The crowned rolls are finished by grinding, and each roll grinding operation produces a definite type of crown curve for a particular operating condition.

Accordingly, it is an important objective of the present invention to provide a roll that has a predetermined deflection characteristic with load which avoids disadvantages inherent in conventional crowned rolls.

A further object of the invention is to provide a roll assembly having a member with a greater diameter at the center than at the ends to compensate for deflection with load, and which provides for the same distance of travel of the outer surface of the roll assembly with each rotation thereof, or in other words, provides uniform speeds of travel at all axial locations of the outer surface of the roll.

A further object of the invention is to provide a roll assembly wherein a predetermined load-deflection relationship along the roll length can be obtained (such as a uniform nip pressure along the nip at a given nip load), and a desired circumferential speed characteristic along the roll, independent of the load-deflection characteristic can be obtained (such as a uniform surface speed along the roll), and desirable features of each of these characteristics can be obtained for a particular environment independent of each other in the same roll.

Other objects, advantages and features will become more apparent with the teaching of the principles of the invention in connection with the disclosure of the preferred embodiments thereof in the specification, claims and drawings, in which:

FIGURE 1 is a sectional view, with parts broken away, of a roll assembly constructed in accordance with the principles of the present invention;

FIGURE 2 is a vertical sectional line taken substantially along line II—II of FIGURE 1;

FIGURE 3 is a fragmentary sectional view showing the ends of a roll assembly of modified form;

FIGURE 4 is a fragmentary diagrammatic illustration showing a method of constructing a roll assembly;

FIGURE 5 is a schematic view of a wet end forming section of a paper machine; and

FIGURE 6 is a sectional view, with a portion being shown in full, of a roll assembly of modified construction.

As shown on the drawings.

A roll embodying the principles of the invention is well suited to many environments and is well adapted for use in a paper machine, and particularly for use as a wire guide roll in a Fourdrinier section of a paper making machine. Such a section is illustrated schematically in FIGURE 5 with a return roll 10 supporting a looped travelling Fourdrinier wire 11 passing over a breast roll 12 and a couch roll 13. A web of paper is formed on the Fourdrinier wire 11 in the usual manner with paper stock being fed to the wire from a head box 14, and the web of paper taken off the wire by a felt 15. The wire passes over a return roll 17 and over the guide roll 10 and an additional guide roll 16. The upper run of the Fourdrinier wire 11 passes over the usual table rolls 18 and suction box assembly 18a. Details of the wire guide rolls 10 are illustrated in FIGURES 1 and 2.

The guide roll assembly 10 includes an inner roll member 22 having journal ends 19 and 20 rotatably supported in bearings such as 21.

The inner roll 22 has an outer surface 23 which has a different diameter along its length to obtain the desired deflection characteristic with load. In a preferred construction the inner roll 22 is crowned at its center so that when it deflects as a beam due to radial load the load line created by a nip or by a partial wrap of a travelling band such as the wire 11, extends in a straight line parallel to the axis of the roll. The crown of the inner roll is computed by conventional means dependent upon the weight of the roll, which causes deflection, and the load of the member engaging the roll.

In an ordinary crowned roll arrangement the wire is supported directly on the surface of the roll; due to the difference in diameters of a roll at the center and the end the circumferential speed of the surface at different points along the roll will be different. This will create a stress which must be accommodated by slippage between the load and the roll surface. The center of the roll is travelling at a faster rate than the ends, and the center section will have a tendency to get ahead of the edge sections which must be taken care of by a backward slip in the wire relative to the roll surface. This uncontrollable and unpredictable slip may cause the wire to run with different tensions at different areas across the wire, resulting in unevenly worn rolls and ridges on the wire in the sheet direction, diagonal wrinkles, curled edges and slack wire areas. These problems are avoided with the present invention.

Telescoped over the inner roll 22 is a relatively thin outside shell member 24 which has a straight cylindrical outside surface 26. The shell is of uniform thickness and has an inner surface 25 which rides on the outer surface 23 of the inner roll, and the shell 24 is fitted over the roll 22 so that for a short length at the center of the roll 22, which is at the maximum crown diameter, an interference fit is developed to drive the shell in rotation with the inner roll 22. The remainder of the shell 24 outwardly of the center is extended axially straight when unloaded to be free of the roll 22, and to rest on the roll when the roll deflects with the load. The shell is of sufficient flexibility to insure that it is continually supported along its entire length by the inner roll 22 with load deflection of the roll 22 if the roll varies in deflection. In this way the line load created by a nip or by a partial wrap of a traveling band is communicated to the roll 22 through the shell 24. The shell 24 has a constant diameter throughout its length, and being deflected as a beam it will assume the contour of the desired crown at the load line, but has the same peripheral speed everywhere along its length.

In order to avoid the undesirable features of a common crowned roll different expedients have been attempted including the use of inside wire rolls which are rather heavy but which are relatively flexible. With this previous type of roll the weight deflection is so much greater than the wire tension deflection that the net result is a stretching of the center of the wire downwardly. This gives a lengthening to the center of the wire rather than a shortening. However this previous type of wire length balancing cannot be applied to the breast, couch, and return rolls since the weight and tension components of deflection are essentially in the same direction. The solution to the problems with respect to wire distortion must result in the ability of a point at the middle of the wire being able to make one revolution around the Fourdrinier, and arrive in the same relative position it had at the start with respect to a point on the edge of the wire which has also made one revolution around the Fourdrinier. This is accomplished with the construction embodying the principles of the present invention.

The present invention also contemplates use with an

inner roll which is forcibly bowed or bent in a direction opposite to the direction of applied forces on the outer periphery of the roll body, such as by applying bending forces to the journals at the end of the inner roll. Such arrangement is found in U.S. Patent 3,082,685, L. A. Moore. The use of an outer shell member with a uniform outer diameter still maintains a load contacting surface which travels at uniform speed throughout the axial length thereof.

FIGURE 1 illustrates at the left end of the drawing the position of the outer shell 24 with respect to the inner roll 22 when the roll is unloaded. The right end of FIGURE 1 illustrates the relative positions of the inner roll 22 and the outer shell 24 when the roll assembly is supporting a load which is applied to the top of the roll assembly as viewed at the right end of FIGURE 1. The outer shell 24 is supported along its entire length on the inner roll at the point of load and separates from the inner roll at a location diametrically opposite the application of load.

FIGURE 3 illustrates ends of a construction embodying the principles of the present invention, wherein an inner roll member 27 supports an outer shell member 28. The inner roll 27 has a crowned center and the outer shell has an interference fit with the crowned center and is shown at its end in FIGURE 3 before loading. The roll has journal ends 29 to be supported in suitable bearings, and constructed so that the inner roll 27 may be formed in a tubular shape. Between the roll and shell is a suitable lubricant, such as oil or molybdenum disulfide. The lubricant accommodates slipping between the inner surface of the shell and the outer surface of the roll at locations axially outwardly of the roll center. To prevent the loss of lubricant and to prevent water or other foreign materials from entering between the roll 27 and the shell 28 a flexible seal 31 is positioned at the end, in the form of an annular flexible diaphragm secured at its inner edge to the roll 27 and at its outer edge to the shell 28. The shell member 28 and roll member are shown in their relative unloaded positions in FIGURE 3, with a space 30 therebetween outwardly of the center.

As illustrated in FIGURE 3 the inner roll 27 is constructed in the form of a tube with a head 32 supporting the tube end and rotatable on the stationary journals 29.

The outer shell is fitted over the inner roll so that the outer shell engages the crowned center of the inner roll with an interference fit, in both the arrangements of FIGURES 1 and 3. As may be expected, this will cause a bulging or an increase in diameter at the point of interference fit. This diameter increase may be as little as 0.003" and will be ground smooth after the shell is in place to provide a uniform diameter over the length of the shell. This is illustrated in FIGURE 4, and the inner roll 33 is crowned at the center, and at a length chosen for the interference fit a slight increase in diameter will be formed creating a definite shoulder 34 which will mark the end of the interference fit between an outer shell and the inner roll 33. This creates a slight bulge 36 in the material of the shell and the bulge is ground off along the dotted line shown in FIGURE 4 so that the shell 35 has uniform diameter.

In brief summary, the roll assembly includes an inner roll such as illustrated at 22 in FIGURE 1, with the inner roll being crowned. Over the inner roll is an outer shell 24 of uniform outer diameter. When running unloaded, the shell and inner roll have the relationship shown on the left side of FIGURE 1, and when loaded (with the load being applied from above as illustrated in FIGURE 1) the shell rides along its length on the inner roll 22 as shown to the right in FIGURE 1.

This roll arrangement is also adaptable for use in a press couple. The advantage obtained will be a press roll with a constant peripheral speed throughout its length. It is often necessary to vary working nip loads in press couples due to changes in grade or caliper of paper and

other factors. Since in this case such a change of working nip would require a change in crown on the inner roll, the inner roll may be equipped with anti-deflection means such as by application of the variable controlled cantilever forces to the journals at the ends of the inner roll which bow the inner roll upwardly a controlled amount as shown in Patent 3,082,685.

A preferred embodiment of the invention employs a crowned inner roll which will deflect a predetermined amount with a given load so that the roll will be straight at the load line with the application of load. The shell has a uniform outer diameter along its length. However in some environments it is possible to achieve a special effect at the load line by provision of an inner roll which is round and which has a predetermined varied circumferential characteristic along its length (such as diminishing substantially uniformly outwardly of the center) or which will accomplish bending to give a desired load line not necessarily straight, with load on the roll. The preferred embodiment also achieves the advantages of uniform surface speed by employing an outer shell of uniform outer diameter along its length, but again special effects may be accomplished if desired by selection of the shell with a round outer surface of a predetermined diametrical characteristic along its length which will provide a desired surface speed along the length not necessarily uniform.

Thus I have provided an improved roll assembly which meets the objectives and advantages above set forth. The construction permits obtaining a straight load line along a long heavily loaded roll without limitations and size heretofore necessary, and avoids the disadvantages of crowned rolls and permits obtaining uniform surface speed along a long crowned roll subject to deflection.

The inner roll member is preferably formed of steel with the outer shell being formed of bronze and this provides a good bearing relationship to permit slippage at the ends. The arrangement is well adapted to use in new machines or for replacement in existing conventional machines for replacement of presently crowned conventional rolls. The arrangement permits the flexibility of other rolls and can be used if necessary in drive rolls, and can sustain axial movement during rotation. The expense of manufacture is only slightly more than conventional crowned rolls and avoids the necessity of auxiliary force applying equipment heretofore used in some installations in an attempt to maintain a straight load line along a roll. With the present arrangement it has become possible to use smaller rolls with greater crowning since the disadvantages of previous crowning have obviated. While the preferred materials involve the use of steel for the inner roll and brass for the outer shell, other combinations of materials are contemplated, and in some environments fiber glass may be employed for the outer shell.

FIGURE 6 illustrates another arrangement for placing an outer shell on an inner shaft, with an inner shaft having journals at the end and having a crowned center portion. The crowned center portion has an enlarged center area and an outer shell is formed in first and second parts which are placed over the central portion of the inner roll and abutted together at their center. This may be accomplished by heating of the shell and sliding of it into position. The two halves will then be joined by a weld at the center which may be formed by grinding out the shell ends in a V-shape and filling the V with weld material and grinding the material smooth. This eliminates heating the entire outer shell which is necessary for the usual interference fit inasmuch as only the inner ends of the two shell halves need be heated. It also makes it easier to handle shell parts of one-half the length of the total shell, and the manufacturing cost becomes less for shorter lengths.

The drawings and specifications present a detailed disclosure of the preferred embodiments of the invention, and

it is to be understood that the invention is not limited to the specific forms disclosed, but covers all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by the invention.

I claim as my invention:

1. A roll structure comprising, an inner rotatable roll member tapered toward the ends and having a larger center portion with shoulders at the ends of said center portion, and a cylindrical shell telescoped over said roll member with an interference fit over said center portion increasing the inner diameter of the shell, the outer diameter having material removed over the area opposite said center portion so that the outer surface of the shell will have a uniform diameter and a uniform cylindrical shape.

2. A roll structure comprising an inner rotatable roll member, an outer shell member telescoped over the roll member and supported thereon, said shell member having a cylindrical outer surface and said roll member tapering outwardly from the center in round outer surfaces of diminishing diameter, said shell member being sufficiently flexible to rest along its length on the outer surface of the roll member with load applied to the outer surface of the shell member, the outer ends of said shell member being free to move radially to seat on said roll member, and lubricant seal means at the axial outer ends of said members preventing the escape of liquid lubricant between said members, said seal means accommodating appreciative relative radial movement between the outer ends of said members and accommodating the seating of the ends of the shell member on the ends of the roll member as the ends of the outer shell member are supported on the ends of the roll member due to said load.

3. A roll structure comprising an inner rotatable roll member, an outer shell member telescoped over the roll member and supported thereon, said shell member having substantially uniform outer and inner diameters along its length, said roll member gradually decreasing in diameter toward the ends from a maximum center diameter and having a round outer surface, said shell member resting along its length on the outer surface of the roll member with load applied to the outer surface of the shell member, the inner surface of the shell member and the outer surface of the roll member having relative rotational sliding movement at their line of contact when rotated under load due to the difference in circumferential length, a fluid lubricant between said members reducing frictional loss due to said relative sliding movement between said members, and means at the ends of said members preventing the axial escape of lubricant from between the members.

4. A roll structure in accordance with claim 3 wherein said outer shell member is formed of first and second separate tubular portions closely fitted over the roll member from opposite ends and welded together at their inner coaxial ends and secured to the central portion of the roll member.

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