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This invention relates to improvements in curved or straight rolls of the type which are used for treating sheet or web materials. The invention has particular utility in curved rolls of a kind used for expanding and contracting flexible sheet materials, and for other purposes. The invention affords an improvement in a sectional roll described and claimed in the co-pending application of John D. Robertson filed August 21, 1962, Ser. No. 218,330, which is entitled "Sectional Curved Roll," now U.S. Patent No. 3,213,513, and assigned to the assignee in this application.

The aforementioned application teaches the sub-division of a flexible sleeve, which is received about a series of spools, in turn rotatably mounted in axially-gapped relation on a curved axle. Each sleeve section overlaps a gap between spools, and is permanently attached to one spool only in a narrow circumferential band. Adjacent sleeve sections are separately joined by waterproof seams to provide a continuous surface. The invention achieves two principal objects. First, it makes it practical to replace individual worn sections of the sleeve without replacing the remaining sections. Secondly, it distributes the expansive action of the roll on a treated web more uniformly than had previously been attained by an expander roll having a surface sleeve; the cyclical expansion and contraction of the sleeve as it rotates about the curved axle is uniformly distributed through each section, but is not permitted to accumulate through the entire sleeve toward the center of the roll, as would be the case if a unitary sleeve were used, which can be attached to the roll only at its ends. It may be noted that a sleeve secured to the spools over its entire length could expand only at the gaps between spools, and would fail at these points very rapidly.

Individual sleeve sections of such a sectional curved roll may be replaced readily without discarding sections which are in good condition, simply by cutting or grinding away the attachment of the worn section from the adjacent sections.

The present invention has as one of its objects the increased reinforcement of the joints between sleeve sections made according to the aforementioned patent, which reinforcement will nevertheless permit individual sections to be replaced with a minimum of difficulty and with simple tools. It is another object of this invention to provide a curved or straight roll having improved operating characteristics, particularly as to the maintenance of a highly uniform diameter in the region of the joints between sleeve sections, when running at high rotational speeds under corresponding centrifugal stresses. Other objects and advantages of the invention will become apparent as the following description proceeds.

Briefly stated, a preferred embodiment of the invention includes three or more flexible annular sleeve sections, mounted upon an axially-gapped series of spools, and abutting one another intermediate the gaps between spools. Preferably, an end of one section in each abutting pair is secured to an underlying spool surface; this may be limited to a narrow circumferential region to permit later separation of the spool when replacement is necessary. The spools are serially mounted on a curved axle, each on its own bearing. The sleeve sections are then slid into place, and joined together by waterproof seams to provide a continuous peripheral sleeve surface.

The abutting ends of each pair of adjacent sleeve sections are shaped to form a circumferential recess which lies internally of the sleeve surface; a reinforcing ring is seated in this recess so as to axially overlap the joint, and is bonded to each of the adjacent sleeves. To make the sleeve surface impermeable to dirt, lint, and moisture, the abutting sections are joined outwards by the reinforcing ring by means of a flexible cement which can be separated readily by cutting when it is desired to disassemble the sleeve.

The joint between sections may assume a variety of forms; in one, the abutting ends of adjacent sleeve sections are provided with a pair of axially-overlapping circumferential lips, one spaced about the other, to form a recess between them for receiving the reinforcing ring, which is bonded to the respective lips about its inner and outer peripheries. Separation for replacement of a worn section requires only that the outer lip be cut or ground away from the outside diameter of the reinforcing ring. The sections toward the end of the curved roll generally wear much more rapidly than the central sections; for this reason it is preferred that that sleeve section of each pair which is more remote from the roll's center have the outer lip so that the inner lip formed in the more central section will not be destroyed by the separation.

In another embodiment, the ring comprises two threadedly-connected portions, one bonded to each of an adjacent pair of sleeve sections; the sleeve can be disassembled merely by unscrewing the sections, without any cutting or grinding operation. However, the threads may not provide so secure a joint as that in the preceding embodiment, especially where the roll is to be driven by a sleeve at one end.

The use of reinforcing rings is of special advantage with sleeve sections which have reinforcing cords to restrain them against swelling in high-speed operation, since the necessary interruption of the reinforcing cords at the joints between sections might otherwise permit some radial swelling of the sleeve material adjacent these joints, deleterious to the sleeve and to its action on the treated web. However, the combined result of reinforcement at the joints while facilitating replacement of worn sections, is highly advantageous whether reinforcing cords are used in the sleeve or not.

While the specification concludes with claims particularly pointing out the invention which is regarded as the invention, it is believed that a clearer understanding may be gained from the following detailed description of preferred embodiments thereof, referring to the accompanying drawings, in which:

FIG. 1 is a plan view of the improved sectional roll;
FIG. 2 is a fragmentary sectional view in elevation of the roll; and
FIG. 3 is a fragmentary sectional view in elevation of a modified form of the roll.

Referring to FIGS. 1 and 2, a first embodiment of the improved roll includes a bowed axle 10, which may be given a fixed curvature in a single plane as in FIG. 1, or may be adjustably curved in a manner well known in the art. It should be understood that the invention may also be applied to a roll having a straight axle. A series of spool assemblies generally indicated at 12 are received in axial array on the shaft; each assembly includes an annular spool 14 or 15, mounted approximately at its axial center upon the outer race 18 of a ball bearing unit 16. Because of the curvature of the axle, it is necessary to space the spools apart with intervening gaps 22, whose local width varies cyclically as the spools rotate about the axle. To obtain the proper spacing, a series of annular spacer rings 23 are interposed between adjacent inner races 24 of the bearings.
A resilient flexible sleeve 38 is received over the spools for engaging a web which is to be expanded or otherwise treated with the roll. As described by the aforementioned copending application Serial No. 218,330, the sleeve is made up of a series of annular sleeve sections 40, 42, of which section 40 at each end of the roll is formed with a radial end surface to provide a cemented seam 44 in abutting relation to an end cap 47. This seam retains the sections 40 against torsional, radial, or axial movement with respect to the end caps, but can be readily severed for disassembly. Each end cap 47 has a cylindrical bore 45, which is received in an end spool 46 and secured by machine screws 60, which can be removed by sliding back the sleeve section 40 when the seams has been severed.

The mutually-abutting ends of each pair of adjacent sleeve sections are formed with a circumferentially-extending recess 108 internal to the sleeve surface, and a reinforcing ring 110 is placed in the recess, in a position which axially overlaps each of the abutting sleeve ends. In the embodiment of FIG. 2, axially-overlapping lips 104 and 106 terminate the sections, and are circumferentially spaced apart to form the recess 108. It is preferred that the lip of a section more closely to the center of the roll be internal to the lip of an abutting section more remote from the center, as shown, so that the more remote section may be removed without injury to the other. It has been found in practice that sleeves less located toward the center of the roll wear much more rapidly than the central sections, and require relatively frequent replacement, because of the scrubbing action of the edges of the treated web.

The ring 110, which may be of metal, is permanently bonded by means such as cement to the lip 106 about its outer diameter, and to the lip 104 about its inner diameter. A small axial gap is preferably left between the inner lip 104 and the section 40 as shown, so that excess cement will not form a bond in this region. Holes 111 may be drilled about the ring to serve as a reservoir for excess cement, and may also increase the strength of the bond somewhat. In the illustrated embodiment, the sleeve section 42 is permanently secured at each end to a spool 15 only in a narrow circumferential band 50. The ends of abutting sleeve sections do not coincide axially with the ends of adjacent spools, but terminate at intermediate points.

In the general case, whether there are only three sleeve sections as shown or a greater number, it is preferred that only one of each abutting pair of ends of the sleeve section be secured to an underlying spool. This prevents inter-section transmission of the cyclical expansions of each section, thereby facilitating the individual sections for replacement, without requiring removal of the spool assemblies from the axle. However, it is quite feasible to secure each section at various places to only one spool, if they are of comparable length, and to replace them as an integral unit.

There are only three sections in the illustrated roll; the central section wears very slowly, and it may be desired not to subdivide it. The center section 42 is therefore substantially longer than either of the end sections 40, as shown in FIG. 1, and is mounted on a plurality of spools 15. The center section is bonded at each of its ends by a seam 50 to one of the spools 15, while the end sections 40 are secured at their outer ends with seams 44, and to the center section by means of the rings 110. This proves satisfactory because the center section does not wear rapidly and will not often require replacement, while the end sections must be replaced at relatively frequent intervals.

To assemble the roll, the spool assemblages, including spools and bearings, are slid onto the axle alternately with the spacers 23. Then the retaining rings 52 are set by tightening their screws 54 through holes 55. The sleeve sections are then slid in serial order over the spools, interspersed with the reinforcing rings 110. Cement is applied to the inner and outer diameters of the rings before they are telescoped between the lips 104. The end caps 47 are then attached; their screws 60 are set by pushing back the section 40 along the spool, after which the cement 44 is applied. Finally, a seal ring 90 is attached at either end of the roll by means of a key 82, which is secured in a key-way 28, and a screw 78. As the seal ring 90 is fixed to the spool 86, while a port 88 with grooves 94 in the end caps 47, the greases flowing axially over resilient O-rings 92. A seal guide 74 is secured by a clamp ring 76, and rides in a groove 72 in the radial face 56 of the end cap.

In the assembly, the reinforcing rings serve to hold the sleeve sections together more securely, by providing a strong cement bond which is stressed in shear; and also increase the reinforcement of the sleeve at the joint, where the reinforcing cords 49 are interrupted and are not in themselves completely effective to restrain the sleeve from swelling under centrifugal forces at high rotational speeds. It is not essential that the sleeve be lined with cords, but this is preferable.

When it is desired to replace a worn end section 49 of the sleeve, it is only necessary to cut the section radially to free it, though the lips of the end caps 47 and 50 are then cut or grurred the outer lip 106 away from the ring. The worn section can then be slid off the axle and replaced. If it becomes necessary to replace the center section, it can be ground away from the spools at the bonds and replaced at either end. In other embodiments in which a plurality of center sections are used, it is preferred to only one spool, or where the roll has a straight axle, it may be desirable to remove the spools as well, with individual sections remaining attached to different spools.

A modified embodiment of the improved roll is shown in FIG. 3, in which parts similar to those of the preceding embodiment are similarly numbered. The reinforcing ring is in this case formed in two portions 113 and 114 which are threaded connected at 116, and the lips 104 and 106 overlap in an area axially coextensive with the threads 116. The portions 113 and 114 of the ring are received in a mated recess 112 and individually bonded to the sleeve sections 40 and 42, respectively, so that the sections may be parted from one another simply by unscrewing the two portions of the ring, after first cutting through the seam 62 of flexible cement. The limitation of this form is that it does not provide so secure a joint as the preceding embodiment, in that the cement applied between the various sections might tend to loosen the threaded joint. Rolls are driven in some applications by means of a sleeve at one end, and this might apply such relative torque. However, this type of joint will prove advantageous in many other applications, because of the rapidity of disassembly which it affords.

It will be understood that various changes and modifications may be made in the illustrated embodiments by those skilled in the art, without departing from the true spirit and scope of the invention. For example, the abutting ends of the sleeve sections may not be provided with overlapping lips, but may join in radial faces, which are nevertheless recessed in such manner that the reinforcing ring axially overlaps the seam. I intend to define the invention in the appended claims without limitation to the details of the foregoing illustrative embodiments.

What I claim is:

1. A curved roll comprising, in combination; a curved axle, a series of annular spool assemblies rotatably mounted in axially-gapped end-to-end relation on said axle, a plurality of annular sleeve sections received over said spools in axially-abutting end-to-end relation with one another to provide a continuous peripheral sleeve surface, said sections abutting at points axially intermediate the gaps between said spools, only one of each pair of adjacent ends of said sections being secured to a corresponding one of said spools only in a narrow circumferential region, and a plurality of reinforcing rings, each pair of adjacent ends of said sections being formed.
with a pair of axially-overlapping circumferential lips one spaced about the other to form therebetween a circumferentially-extending recess internal to said sleeve surface, each said recess receiving one of said rings in axially-overlapping relation to each of said pair of lips, said ring being bonded to said pair of lips.

2. A roll as recited in claim 1, said sections being provided internally with reinforcing cords extending circumferentially thereabout and being continuous throughout at least substantially that portion of the length thereof which is unoccupied by reinforcing rings.

3. A curved roll as recited in claim 1, in which the inner lip of each said pair is free of direct attachment to the adjacent sleeve section, whereby separation of the corresponding ring from the outer lip of each said pair frees said adjacent sleeve section for disassembly.

4. A curved roll as recited in claim 1, in which that one of the mutually-abutting ends of a pair of adjacent sleeve sections which is spaced toward the axial center of said roll with respect to the other, is formed with said inner lip, and said other is formed with said outer lip, whereby said outer lip may be cut away to remove its corresponding sleeve section without damaging said inner lip.

5. A curved roll as recited in claim 1, each of said rings being formed in two axially-overlapping portions threadedly connected, each of said portions being bonded only to a different one of the receiving pair of adjacent sleeve sections.

6. A curved roll comprising, in combination; a curved axle, a series of annular spool assemblies rotatably mounted in axially-gapped end-to-end relation on said axle, a plurality of annular sleeve sections received over said spools in axially-abutting end-to-end relation with one another to provide a continuous peripheral sleeve surface, said sections abutting axially intermediate the gaps between said spools, only one of each pair of adjacent ends of said sections being secured to a corresponding one of said spools only in a narrow circumferential region, and a plurality of reinforcing rings, each pair of adjacent ends of said sections forming a circumferentially-extending recess internal to said sleeve surface and receiving one of said rings to axially overlap said adjacent ends, each of said rings being bonded in the receiving recess, said sections being provided internally with reinforcing cords extending circumferentially thereabout and being continuous throughout at least substantially that portion of the length thereof which is unoccupied by reinforcing rings, each of said reinforcing rings being formed in two portions separably attached, each of said portions being bonded only to a different one of the receiving pair of adjacent sections for separation of the sections by detachment of the portions of a ring.

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