Oct. 26, 1965 J. D. ROBERTSON 3,213,513

SECTIONAL CURVED ROLL

Filed Aug. 21, 1962

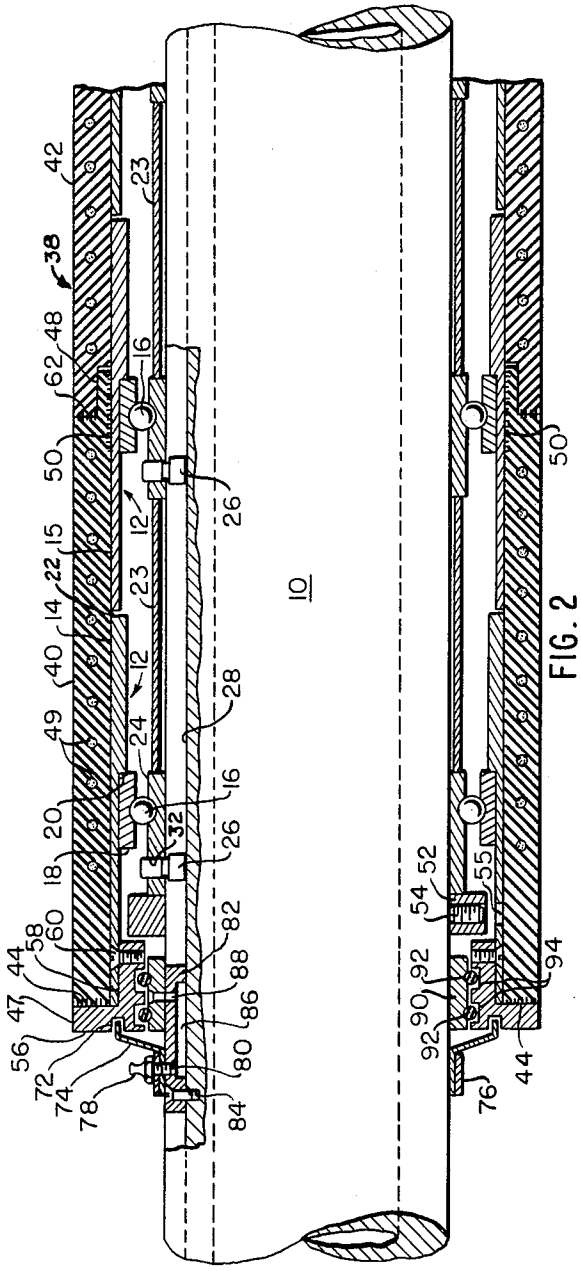


FIG. 2

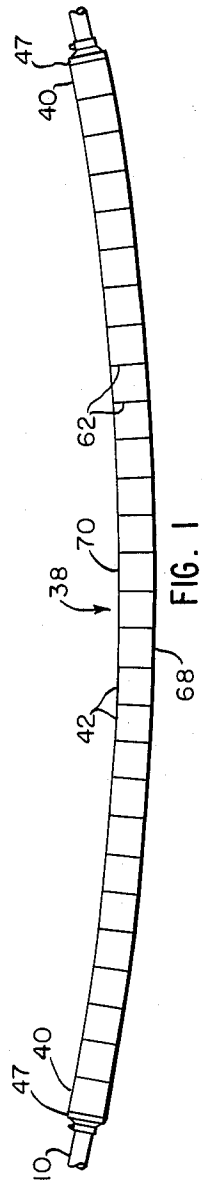


FIG. 1

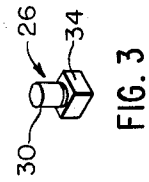


FIG. 3

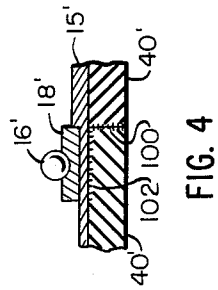


FIG. 4

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SECTIONAL CURVED ROLL

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4 Claims. (Cl. 26—63)

This invention relates to improvements in curved rolls for expanding and contracting flexible sheet materials. Such rolls may have a fixed curvature, such as shown and described, for example, in Patent No. 2,393,191, issued January 15, 1946; or the curvature may be adjustable, as in United States Patent No. 2,689,392, issued September 21, 1954, both to John D. Robertson. Such rolls are used for stretching or contracting webs crosswise of their length, and also for removing wrinkles from webs traveling over them.

A curved roll of the type to which the invention relates includes a surface of resiliently flexible material, engaged over a series of spool assemblies which are rotatably mounted on a curved axle. The axle is supported at its ends in such a manner that when a traveling web passes over the roll surface in a direction generally parallel to the plane of curvature of the axle, approaching at the concave side and leaving at the convex side of the curvature, the web becomes expanded laterally through the reaction of the sleeve thereon, since longitudinal elements of the web tend to pass over the roll in directions perpendicular to the local rotational axis; also, the web is expanded with the flexible surface as the surface passes from the compressed concave side to the expanded convex side of the roll. The reverse motion of the web and roll will produce crosswise contraction of the web.

Curved rolls of the prior art are ordinarily provided with unitary surface sleeves extending the length of the rolls, necessitating replacement of the entire sleeve when any part of it has worn excessively. This operation cannot be performed with the equipment ordinarily available in the factory of a roll user, and therefore requires that the roll be returned to the manufacturer, with attendant expense, loss of productive time, and risk of damage in transit.

It has previously been proposed to provide an open-spool expander in which the surface is formed by a series of separate spools of metal or other wear-resistant non-flexible resilient material spaced apart along the axle. However, such spool expanders are no longer in widespread use, partially because of the fredom of dirt, lint, and lubricants to pass into and out of the roll between the axially-spaced spools, both contaminating the lubricant of the spools, and soiling, cutting, or otherwise damaging the handled web. In these respects, a unitary sleeve is greatly superior, and has been almost universally accepted for this reason, in spite of the difficulty and high economic cost of sleeve maintainance.

An additional disadvantage of a unitary surface sleeve is that such a sleeve may be secured fixedly to the roll assemblies only in the immediate vicinity of its ends. As a result, the axial thrust component induced in the sleeve in reaction to the stretched web accumulates throughout the length of the roll, and attains a maximum value at its center. Therefore, a non-uniform stretching action takes place across the width of the web. However, if the sleeve were secured along its full length to the spools, the necessary stretching could take place only at the gaps between spools, and therefore would be non-uniform.

It is the primary object of the present invention to provide an improved sectional curved roll which combines the advantage of facile replacement, found in prior non-resilient surfaced open-spool curved rolls, with the

advantages of cleanliness and prevention of damage to a treated web or to spool bearings, found in prior unitary sleeve curved rolls.

It is a further object of my invention to provide an improved curved roll which applies a more uniform crosswise tension to a web engaged therewith by distributing the contraction and expansion of the surface sleeve uniformly over its length. It is still another object of my invention to provide an improved curved roll which features a sleeve assembly in which a series of sleeve sections are joined to provide a continuous sleeve surface over the full length of the roll, but which may be readily disassembled into individual sections for replacement. Further objects and advantages of the invention will become apparent as the following description proceeds.

Briefly stated, I may carry out my invention in a preferred embodiment by providing a series of flexible resilent annular sleeve sections each of which is mounted upon a spool assembly and secured thereto as a unit. Preferably, each sleeve section is substantially equal in length to the axial length of its associated spool, plus the length of a gap established between adjacent spools when assembled in end-to-end relation on the axle. Each sleeve section is slid only partially along the length of a spool, so that it terminates approximately at the mid-point of the spool and extends axially to overhang one end thereof. These assemblies are then serially slid onto the curved axle in end-to-end relation, so that the adjacent sleeves axially abut to form a continuous sleeve surface along the outer surfaces of all of the spools, but the spools are axially gapped from one another. The gaps between the spools are staggered intermediate the abutting ends of the sleeve sections, and each sleeve is therefore supported upon a pair of adjacent spool assemblies.

Preferably, each spool assembly includes a single bearing located approximately at its axial center, and radially aligned with the abutting ends of sleeve sections; however, each spool may be supported on a plurality of bearings if desired. A weak cement is applied to the joints between the sleeve sections, such as to provide a continuous liquid-impervious sleeve surface over the length of the roll, which will prevent seepage of dirt or lubricant between the interior and exterior of the sleeve, and thus prevent injury to the bearings or to the treated web. However, these joints may be readily separated, as by means of a solvent for the cement, assisted if desired by a knife, to disassemble any sleeve section for replacement.

According to another feature of the invention, each sleeve segment is secured, as by cement, only immediately adjacent to one end thereof to an associated spool assembly, rather than being cemented over the full length of its engagement with the spool. As a result, the stretching and compression cyclically applied to the sleeve sections as they rotate about the curved axle is uniformly distributed over the entire length of each section and of the assembled roll, affording a highly uniform and therefore smooth spreading action on the web. This action may be contrasted to that which would take place if each sleeve were cemented over the entire length of the associated spool, in which case all of the stretching or compression of the sleeve sections would be confined to the short axial gap between spools. On the other hand, a unitary surface sleeve can be secured to the spool assemblies only at the ends of the sleeve; the compression of the sleeve increases towards the center, and this results in slipping of the sleeve on the spools from the ends toward the center of the roll, which produces a distinct reduction in stretching action across the width of the web.

The joints between adjacent sleeve sections may be simple butt joints lying in radial planes, or the ends of the sections may be axially stepped to form overlapping joints; the latter arrangement has the advantage that if

reinforcing cord is embedded in the sleeve, it will extend across the lapped joint, thus restraining those portions of the sleeve adjacent the joint from distending radially under centrifugal forces generated by high-speed rotation.

It may be advantageous to precompress the assembled surface sleeve axially from its ends, so that the cemented joints are never subjected to tension as the sleeve rotates, but only to varying degrees of compression. This arrangement will permit cement of very low strength to be utilized in the butt joints so that they may be more readily severed, but will nevertheless provide a liquid-impervious barrier.

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 preferred embodiments thereof, referring to the accompanying drawing, in which:

FIG. 1 is a plan view of an improved curved expander roll;

FIG. 2 is a fragmentary sectional view in elevation of the roll;

FIG. 3 is a pictorial view of a key utilized in the assembly of FIG. 2; and

FIG. 4 is a fragmentary sectional view showing a modified form of joint between adjacent sleeve sections.

Referring to FIGS. 1–3, a preferred embodiment of the improved expander roll includes a bowed axle **10**, which is shown as a permanently deformed tubular member whose axis is arched or bowed in a single plane, being the plane of the paper in FIG. 1. However, the invention is also applicable to adjustably bowed axles, and to axles of solid cross-section, as will be apparent to those skilled in the art. A series of spool assemblies generally indicated at **12** are received in axial end-to-end relation on the shaft; each assembly includes an annular cylindrical spool **14** or **15**, of which the spools **14** at either end of the roll are of slightly modified form. Each spool is rotatably mounted upon a single ball bearing unit **16**, although each may be mounted upon a plurality of bearings if desired. In practice, the end spools **14** are frequently provided with two bearings each. The outer races **18** of the bearings are received and positioned against internal shoulders **20** formed in the spools, to locate the bearings at the centers of the spools, and are held in place by a force fit, or alternatively by internal snap rings (not illustrated).

It will be apparent that inasmuch as the axes of rotation of the spools differ somewhat from spool to spool, it is necessary to space the spools axially apart on the bowed axle with intervening gaps **22**. To this end, a series of annular spacer rings **23** are interposed between adjacent bearing races **24**. It will be apparent that as the spools rotate about the curved axle, the gaps **22** will vary in length. To prevent the inner races of the bearings **16** from rotating with respect to the axle **10**, the races **24** are axially extended beyond the outer races **18**, and each receives a spacer key **26** for engagement in a rectangular cross-section keyway **28**, which extends longitudinally of the axle. As more clearly shown in FIG. 3 each spacer key **26** includes a cylindrical pin portion **30** which is received in a hole **32** in each bearing race **24**, and a rectangular head **34** for engagement in the keyway.

For engagement with a web which is to be expanded or contracted by the roll, a resilient flexible sleeve **38** is received axially over the spool sections for rotation with the spools as a unit. According to the present invention, the sleeve is made up of a series of annular sleeve sections **40**, **42**, of which sections **40** at the ends of the roll are formed with radial end surfaces to form a seam **44** in abutting relation to end caps **47**. A layer of a relatively weak cement forms the seam **44**; this cement retains the sections **40** against torsional, radial, or axial movement with respect to the end caps, but can be readily severed for disassembly.

In the embodiment shown, the axially inner ends of the sections **40** and both ends of each intermediate section **42**, are stepped or rabbeted to form axially overlapping joints **48**. The purpose of the overlap is to insure that reinforcing cord **49** which is preferably molded into the bodies of the sleeve sections, will extend over the full length of the assembled sleeve, including the joints.

Prior to mounting on the axle, the spools, bearings, and sleeve sections are formed into a series of assemblies, each having a sleeve section secured to a spool. Each sleeve section is permanently cemented, as by epoxy resin or the like, only in a narrow band **50** to the central portion of one of the spools **15**, the bands **50** being axially aligned with the supporting bearings. In this manner, unitary assemblies are provided which may be removed from the roll and individually replaced. In each assembly of a sleeve section and a spool **15**, one end of the sleeve section terminates axially intermediate the ends of the spool, and the opposite end extends axially beyond the spool, for overlapping an adjacent spool and an intervening gap.

The resulting series of assemblies, together with the end spools **14** and the spacer rings **23**, are mounted on the axle by axial sliding from the ends. The end sleeve sections **40** slide axially over the spools **14** into abutment with the end caps **47**. Retaining rings **52** are positioned on the axle and secured by set screws **54** threaded therein, to locate the bearings of the end spools **14**. An opening **55** is provided in the spool **14** for insertion of a suitable tool into engagement with the set screws **54**. Subsequently, the end caps **47**, each of which includes a radial flange portion **56** and an annular cylindrical portion **58**, are brought from the ends of the axle into abutment with the ends of the spools **14**, and secured thereon by means of circumferentially-spaced rows of screws **60**.

Prior to abutting the sleeve sections against one another, however, a seam **62** is formed at the joint **48** between each section, by applying a relatively weak cement which can be easily severed, but which will nevertheless provide a liquid-impervious barrier between the exterior and interior surfaces of the assembled sleeve. The seams **44**, previously described, are similarly formed. In this manner, a continuous sleeve or sleeve surface without interruptions is formed, and passage of dirt or lubricant to or from the bearings and the exterior surface of the roll is prevented. Together with the cement bands **50**, the seams **44** and **62** serve to secure the sleeve and the spools as a unitary roll, against axial, radial, and circumferential loadings. While the roll is in most applications driven by the web passing over it, it may be driven by sheaves, especially for handling delicate web materials. In either case, driving loads must be transmitted the length of the roll, and twisting of the roll must also be prevented.

Preferably, the total length of the sleeve sections is slightly greater than the total length of the spools plus that of the gaps established therebetween by the spacer rings **23**, so that the end caps **47** axially compress the sleeve therebetween. The difference in length may be such that there is substantially no compression along the convex side **68** of the roll (FIG. 1), while the compression attains a maximum along the concave side **70**. This precompression insures that the seams **62** are not subjected to axial tension at any point in the rotation of the sleeve, and therefore permits a relatively weak cement to be used.

The end caps **47** are each formed with a circumferential groove **72** rotatably receiving the lip of a frusto-conical seal guard **74**, secured on the axle **10** by a clamp ring **76**. To supply grease to the O-ring grease seals **92**, a grease nipple **78** having a stud **80** is threaded through the ring **76** and seal guard **74**, and into a rectangular-sectioned fitting **82** which is snugly received in the keyway **28** and secured therein by a screw **84**. This fitting forms a channel **86** for passage of grease through a port **88** formed at its opposite end, and extending outwardly through a seal ring **90** having a pair of O-ring grease seals **92** seated

thereon. Grease flows axially of the seals **92** through circumferential grooves **94**, formed in the end cap **47** to receive the seals **92**.

In operation, the improved roll provides all the advantages of a unitary sleeve, because a liquid-imprevious barrier is provided over the full length of the assembled sleeve. However, the attachment of each sleeve section to its supporting spool assembly insures that the reaction in tension upon the web does not accumulate from section to section, but is localized in the individual section; the reaction being transmitted from each section by the bond **50** to the associated bearing. Therefore, a greater spreading action of the web occurs, because the reaction of the cross-wise tension of the web decreases the stretch of the web only to the extent of its compression effect on one section-length of roll surface; this is contrasted with the cumulative compression effect on the full length of a unitary sleeve.

Furthermore, the attachment of each section at only one of its ends permits its own expansion and contraction to be distributed uniformly over its entire length, rather than being confined to the gap extending between spools, as would be the case if the sleeve were cemented to the spools over the entire length.

For the replacement of any worn sleeve section, it is merely necessary to sever the seam **44** at the end cap, to remove the end cap and its associated elements from one end of the roll, to sever the cement in the intervening seams **62**, and to slide the intervening sections off the axle, together with the spool assemblies secured thereto. Any worn section may be individually replaced in this manner, and the operation can be performed at the site with a minimum of difficulty, expense, and loss of production time.

A modified sleeve section joint is shown in FIG. 4, in which parts similar to those in the preceding embodiment are similarly numbered. In this case, each sleeve section **40'** terminates in a radial plane surface, to form a simple butt joint or seam **100**. A cement band **102** is once again formed between only one of the abutting sleeve sections and the spool **15'**, and is centered with the bearing **16'**; the seam **100** is consequently offset somewhat from the center of the bearing. This construction is simpler than the rabbeted overlapping joints of the previous embodiment, but reinforcing cord which may be contained in the sleeve sections does not extend in overlapping relation to the joints between sections.

Various changes and modifications may readily occur to those skilled in the art without departing from the true spirit and scope of the invention, which I therefore intend to define in the appended claims without limitation to specific details of the preferred embodiments herein described by way of illustration.

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; and a series of annular sleeve sections received over said spools in axially abutting end-to-end relation with one another, each gap between spools being overlapped by a single one of said sections; said sections being joined together by separable seams to form in assembled relation a continuous liquid-impervious sleeve; said sleeve being directly secured to certain of said spool assemblies in narrow circumferential regions lying adjacent axial ends of said sleeve sections and intermediate the axial ends of said spool assemblies, to form individually-replaceable units of single sleeve sections and spool assemblies.

2. 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; and a series of annular sleeve sections received over said spools in axially abutting end-to-end relation with one another, each gap between spools being overlapped by a single one of said sections; said sections being joined together by separable seams to form in assembled relation a continuous liquid impervious sleeve; said sleeve being directly secured to certain of said spool assemblies only in narrow circumferential regions adjacent to said seams and to the axial ends of said sections, intermediate the axial ends of said spool assemblies.

3. A curved roll comprising, in combination: a curved axle, a series of annular spool assemblies each including a spool and bearing means rotatably mounting said spool on said axle, said spool assemblies being mounted in axially gapped end-to-end relation on said axle, and a series of annular sleeve sections received over said spools in axially abutting end-to-end relation with one another, said sections being jointed together by separable seams to form in assembled relation a continuous liquid-impervious sleeve, the abutting ends of said sections lying axially intermediate the ends of the spools, such that each gap between adjacent spools is overlapped by a sleeve section, said continuous sleeve being secured to certain of said spools only in a narrow circumferential region, the mutually-abutting ends of said sleeves axially coinciding approximately with the centers of said spools, and said bearing means rotatably supporting said spools approximately at said centers.

4. 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, and a series of annular sleeve sections received over said spools in axially abutting end-to-end relation with one another, said sections being jointed together by separable seams to form in assembled relation a continuous liquid-impervious sleeve, each of said sections being secured to one of said spools only in a narrow circumferential region, said sleeve sections including circumferentially-extending reinforcing cords, and adjacent sleeve sections being formed with external and internal axially-overlapping end portions to form rabbet joints, the external end portions each including said reinforcing cords.

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