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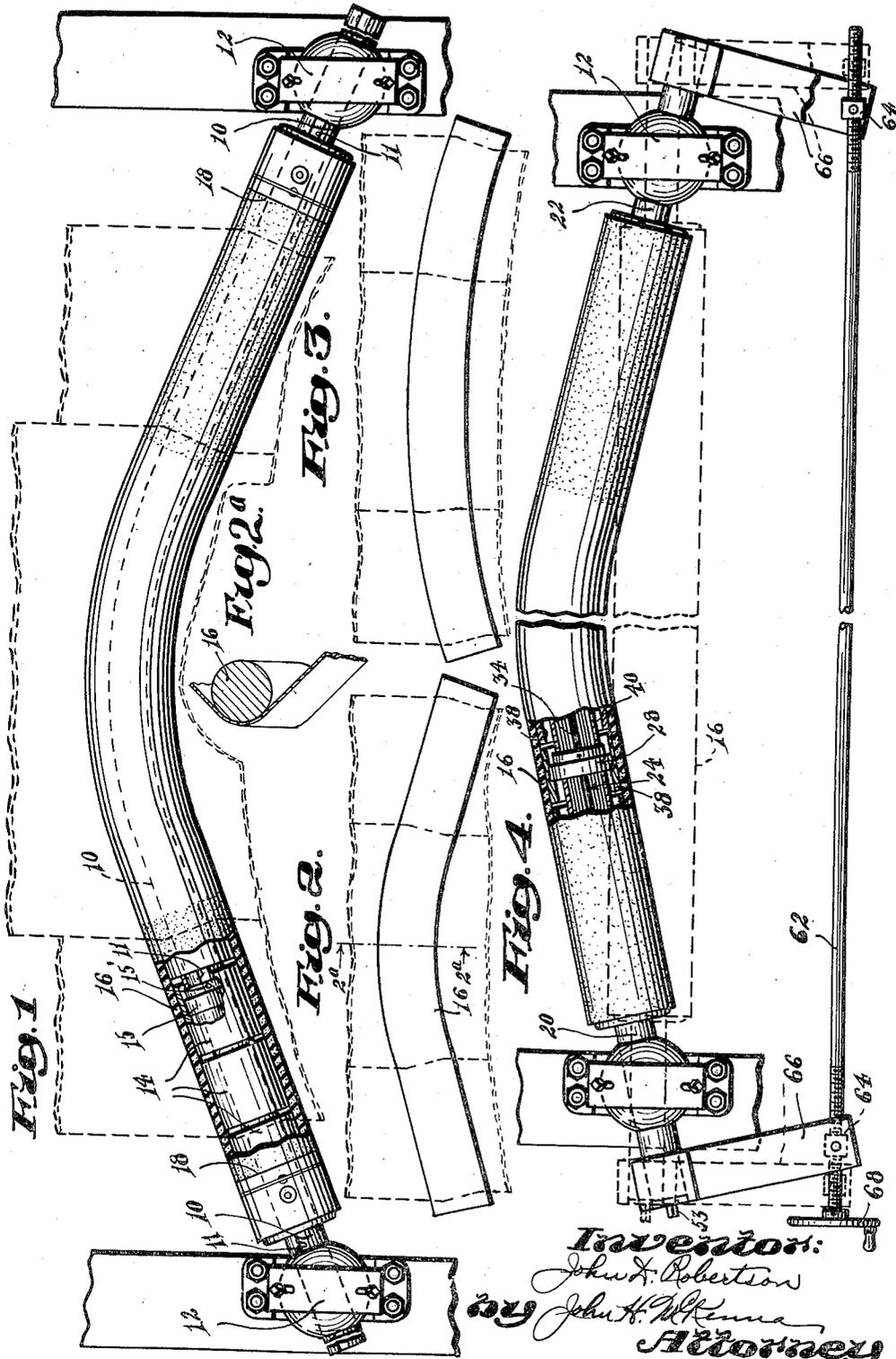
J. D. ROBERTSON

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EXPANDER AND CONTRACTOR ROLL

Filed Aug. 13, 1949

2 Sheets-Sheet 1



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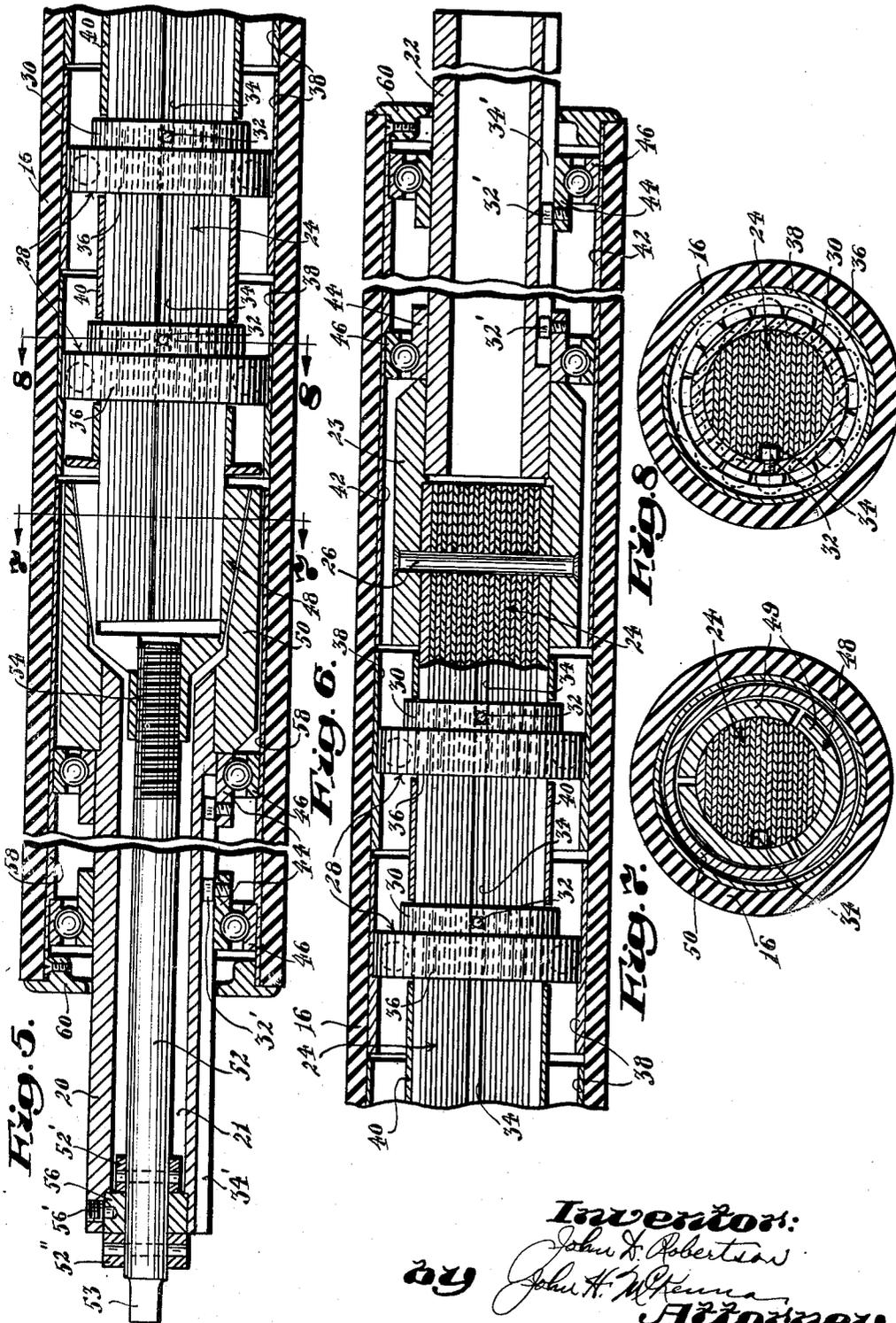
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# UNITED STATES PATENT OFFICE

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## EXPANDER AND CONTRACTOR ROLL

John D. Robertson, Taunton, Mass.

Application August 13, 1949, Serial No. 110,163

9 Claims. (Cl. 26-63)

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This invention relates to improvements in expander and contractor rolls for flexible sheet materials. More particularly it relates to rolls of the general type which have curved extent between end portions which are adapted to be adjustably clamped with the curved axis of the roll in any of various planes. Such rolls have utility for spreading travelling sheets of fabric, paper, foils, films, and the like, and for eliminating wrinkles therein as the sheet comes to the roll at its concave side and leaves the roll at its convex side on a course leading to or from any of various processing devices. However, while the rolls are commonly referred to as expander rolls, they have utility also for contracting the width of travelling sheets, as in the manufacture of creped sheet materials, for example, in which case the sheet is led to the roll at its convex side and leaves the roll at its concave side.

Curved rolls of the general type to which the invention relates ordinarily have a sheet-engaging surface of resiliently flexible material, such as rubber, engaged elastically in tubular form over a series of roll sections or sleeves which are rotatably mounted on a curved shaft whose opposite end portions project into supporting clamps which conveniently may be mounted on the frame of any particular machine or device with which the roll is to be associated. Considering only the utility of such rolls as expanders, the travelling sheet comes to the expander roll at the inner side of its curved extent and leaves the roll at the outer side of its curved extent, the resilient surface portion of the roll expanding and contracting as the sheet or web rotates the roll about its curved axis, whereby the engaged sheet or web is spread or stretched laterally in passing around the roll.

Heretofore, such curved rolls have had gradual curvature throughout the extent of their working faces or, in some cases where expansion only at selvage regions has been effected, the central portion of the roll has been made straight and the curvature has been provided only at the opposite end regions of the rolls. Both of the mentioned prior types of rolls have been unsuitable for handling narrow sheets and also relatively wide sheets. In other words, a roll designed with curvature for effectively expanding sheets having width of from sixty to seventy inches, is inadequate for effectively expanding sheets having thirty to forty inch widths, for example. This has been due to the inherent character of a roll whose gradual curvature extends throughout its working face, or throughout such portions

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thereof as may be engaged by the marginal portions of a travelling sheet, whereby its spreading character is substantially greater near its ends than at regions relatively close to the center of the roll. Hence, when a prior roll has been designed to produce a proper expansion of a sheet whose width is only a little less than the working face of the roll, it could not produce a desired amount of expansion of a sheet having width only half as much as the length of the working face of the roll. In consequence, separate rolls have been necessary for adequately expanding relatively narrow sheets and relatively wide sheets.

It is among the objects of the present invention to provide an expander and contractor roll for travelling sheet material capable of exerting a substantially equal stretching force on narrow sheets and on wide sheets. The invention provides a roll having gradual curvature only at its central region and having straight extent from the curved region to the opposite ends of the working face of the roll. It has been discovered that, by providing central curvature suitable for proper expansion of the narrowest sheets which may be handled by the roll, the portions outward from this curved central region may be made straight, and that such a roll will exert a substantially equal stretching force on the said narrowest sheets and on wider sheets up to the full length of the working face of any particular roll.

Another object is to provide an expander and contractor roll having straight end portions of substantial extent with a substantial curved or bowed central section, and having a resilient and elastic tubular surface portion at the curved or bowed extent of the roll, and tubular surface portions at the straight end portions of the roll which may be substantially more resistant to wear than the surface portion at the central region of the roll. It has long been recognized in the art that the surface portions of such expander and contractor rolls which are engaged by the marginal portions of sheets are subjected to greater wear than the central portions of the roll surface, and relatively frequent replacement of the surface tube has been necessary heretofore due to wear at end regions although the central portion of the surface tube usually is in condition for a longer useful life. According to the invention, the surface tube at the straight end portions of the roll is required to undergo no appreciable elastic distortion during rotation of the roll and these end regions of the surface

tube may be made of harder and less resilient rubber which can withstand wear much longer than the necessarily required softer end portions of the surface tubes of the prior rolls.

A further object of the invention is to provide an expander and contractor roll for travelling sheet material having straight end portions of substantial extent and having a substantial curved or bowed central section the degree of whose curvature may be adjusted to suit particular requirements or conditions. The invention makes it practicably possible to provide a single expander and contractor roll of any desired total length of working surface whose bowed central portion may be varied as to the amount of its bow, whereby any particular roll readily and quickly may be adjusted to vary the expanding effect of the roll on a sheet of any particular width.

Yet another object is to provide an expander and contractor roll having a curved or bowed portion which is adjustable to vary its curvature or bow, and means for effectively adjusting said curvature or bow, which means may be removed or not, as may be desired, after the adjustment has been effected.

It is, moreover, my purpose and object generally to improve the structure, effectiveness and general utility of expander and contractor rolls and more especially such rolls which have a substantial curved portion intervening between the opposite ends thereof.

In the accompanying drawings:

Fig. 1 is an elevational view of a mounted expander and contractor roll embodying features of the invention, a fragment of the resiliently flexible surface tube or sleeve being broken away;

Fig. 2 is a diagrammatic view illustrating the expanding effect of my improved roll on both narrow and wide sheet material, and showing the substantially equal stretching force for both the narrow and the wide sheets;

Fig. 2a is a cross-section on line 2a—2a of Fig. 2;

Fig. 3 is a diagrammatic view illustrating the comparable expanding effect of a prior roll having uniform curvature from end to end, and showing the substantially different expanding effect on a wide sheet as compared with a narrow sheet;

Fig. 4 is an elevational view of a modified form of my improved roll which is adjustable to vary the curvature of its central curved region, and which includes means for effecting such adjustments;

Fig. 5 is a cross-sectional view of the left-hand straight end portion of the roll of Fig. 4, with certain interior elements shown in elevation;

Fig. 6 is a view similar to Fig. 5 but showing the right hand straight end portion of the roll of Fig. 4;

Fig. 7 is a cross-sectional view on line 7—7 of Fig. 5; and

Fig. 8 is a cross-sectional view on line 8—8 of Fig. 5.

Referring to the drawings, the embodiment of the invention shown in Fig. 1 has a rigid curved shaft 10 whose opposite ends are securely clamped in the end clamps 12. By loosening the clamps, the axis of the shaft may be set in any desired plane about a straight axis common to both end clamps 12.

According to the invention, shaft 10 has a substantial central region of bowed extent, and has straight extent from the bowed central region to

each end of the shaft, so that the shaft has substantial straight portions on opposite sides of its bowed region.

A series of sleeves 14 are rotatably mounted on shaft 10, in slightly spaced relation therealong, and an elastic surface sleeve 16, of rubber, or the like, is engaged over the sleeves 14 and rotates therewith when a travelling sheet or web engages the surface sleeve, the elastic surface sleeve resiliently flexing and stretching as it rotates about the axis of the bowed region of shaft 10.

The rotatable sleeves 14 may have ball bearing support on a non-round shaft 10, as disclosed in my Patent No. 2,393,191, of January 15, 1946, or they may be mounted on a non-round shaft 10 with cylindrical bearing surfaces, as disclosed in my co-pending application for patent Serial No: 84,449, filed March 30, 1949. Preferably, however, a cross-sectionally round shaft 10 is employed, and the inner bearing element for each of the sleeves 14, such as the inner race of the ball-bearing unit 15 in Fig. 1, is non-rotatably secured on the round shaft 10 by a square-headed screw 15' screwed into the inner race and having its head engaged in a groove or spline 11 extending throughout the length of the shaft. In every case, however, an abutment shoulder is provided at 18 for engaging the opposite ends of the elastic surface sleeve 16 for maintaining the sleeve 16 against any appreciable longitudinal travel.

My improved roll, of Fig. 1, has important advantages over the prior comparable rolls in that it is adapted to effectively and efficiently handle sheets of widely varying widths, whereas a prior roll uniformly bowed from end to end, if designed to provide adequate spreading of a sheet having seventy inch width, for example, could provide only a wholly inadequate spreading of a sheet from thirty to forty inches wide, for example. This is illustrated in Fig. 3 where it will be apparent that the amount of spreading effected by the illustrated roll diminishes as the width of sheets being processed diminishes.

However, by reference to Fig. 2, it will be apparent that both narrow and wide sheets are subjected to substantially equal stretching force by my improved roll which may have its central region bowed an amount to provide needed spreading of the narrowest sheet to be handled, with the edges of this narrowest sheet extending a little on the straight portions of the roll. Then, as wider sheets are processed by the roll, each such wider sheet, up to the maximum width that the roll can accommodate, will be subjected to substantially the same amount of stretching force as the narrowest sheet.

Also, an important practical advantage resides in the fact that the surface sleeve 16 is not required to stretch and contract at the straight portions of the roll as it necessarily must do when rotating about a curved axis. As a result, the straight portions of the surface roll can be of harder rubber to be more resistant to wear than the curved portions which necessarily must be of relatively soft and highly elastic rubber. Heretofore, the surface sleeve of such rolls has been subjected to maximum wear at the end regions of the rolls. According to the invention, these end regions are made straight, and the surface sleeve at the straight end regions may be more resistant to wear which greatly prolongs the useful life of a surface sleeve. In Fig. 1, the stippled end regions of the roll indicate a harder rubber than at the central un-stippled region, or the stippling

may represent merely a surface treatment of the sleeve to make it more wear-resistant.

Actually, in Fig. 1, it is not necessary to have multiple bearing sleeves 14 at the straight portions of the roll, and a single long sleeve may be employed at each straight portion of the roll, if desired.

Figs. 4-8 illustrate a modification having the advantages of the Fig. 1 roll but having the additional important feature of being adjustable to vary the radius of the arc of the central region of the roll. In this embodiment of the invention, two straight and rigid shaft sections 20, 22 are connected together by a flexible and resilient leaf spring section indicated generally at 24, and the relatively long surface sleeve 16, of rubber or the like, is rotatably mounted thereon with substantial extent around the straight sections 20, 22 as well as around the entire extent of the leaf spring section 24. The straight end sections may be hexagonal in cross-section comparable to the curved shafts in my prior patents earlier identified herein or, and preferably, they may be round in cross-section as herein shown. However, the straight sections 20, 22 are adapted to extend a substantial distance beyond the clamps 12 for a purpose which later will appear.

The leaf spring section 24 is made up of a multiplicity of leaves of varying widths which are associated together in stacked relation to provide a leaf spring having circular cross-section as illustrated in Figs. 7 and 8. The straight shaft section 22 has a sleeve member 23 fixed on its inner end, as in Fig. 6, and member 23 has an axial hole or socket therein for reception of one end of the leaf spring section 24. A pin 26 secures the end portions of all of the spring leaves and the sleeve member 23 against relative movement. Actually, the sleeve member 23 and shaft section 22 are in effect integral, and may be formed in one piece, if desired.

A series of ball bearing units, indicated generally at 28 are distributed in spaced relation along the leaf spring section 24, the inner race 30 of each unit being non-rotatably secured to the leaf spring, and the outer race 36 of each unit being fixed each within a different one of a series of cylindrical roll sections 38 which are distributed along the leaf spring in slightly spaced end to end relation. A feature of commercial importance is that the inner race 30 of each ball bearing unit simply and effectively may be secured against rotation on the leaf spring by a square headed screw 32 which may be screwed into the inner race prior to mounting of the unit on the leaf spring. A longitudinal slot 34 is formed in the leaf spring, and the head of the screw is loosely engaged in the slot when the unit is mounted. The screw head prevents relative rotation of the inner race and leaf spring, and the screw is prevented from coming out even though it may not be screwed tight in the inner race. Preferably, loose spacing sleeves 40 on the leaf spring limit the relative longitudinal movements of the ball bearing units.

A single relatively long cylindrical roll section 42 is rotatably mounted on the straight shaft section 22 by means of two or more ball bearing units whose inner races 44 are secured against rotation on shaft section 22 by square-headed screws 32' screwed into the inner races and having their heads engaged in a groove or spline 34' in the straight shaft section 22. The outer races 48 are fixed within the roll section 42.

Referring now to Fig. 5, the opposite or left

hand end of the leaf spring section 24 extends into a split clamp member 48 whose clamping jaws 49 are best illustrated in Fig. 7. Clamp member 48 has exterior tapering walls for fitting within the interiorly tapering walls of a co-acting clamp member 50 which is fixed on the inner end of the straight shaft section 20. Or, if desired, the shaft section 20 and clamp member 50 may be formed in one piece. Shaft section 20 has an axial hole 21 therethrough, and a long screw 52 extends through hole 21 with its inner end threaded into a non-split neck of clamp member 48, as at 54 in Fig. 5, and with its outer end projecting out of shaft section 20 and provided at its extreme end, with the squared portion 53, for reception of a wrench or the like. Screw 52 is rotatable in shaft section 20 but is anchored against longitudinal movement relative to shaft 20 by the pinned collars 52', 52'' on opposite sides of the bushing 56 which latter is secured against rotation in the end of shaft section 20 as by the screw 56'.

A single relatively long cylindrical roll section 58, comparable to the roll section 42 at the other end, surrounds a substantial extent of shaft section 20 and the clamp members, being rotatably mounted on shaft section 20 by means of two or more ball bearing units whose inner races 44 are secured against rotation on shaft section 20 by screws 32' whose square heads engage in a groove or spline 34 the same as at the other end. The outer races 46 are fixed within the roll section 58. The long surface sleeve 16, of rubber, or the like, is engaged over all of the roll sections 38, 42 and 58, so that the surface sleeve 16 and all of the roll sections can rotate as a unit. An abutment member 60 is secured to the outer end of each of the roll sections 42 and 58, engaging the opposite ends of the surface sleeve 16 and preventing any appreciable relative longitudinal movement of the surface sleeve and roll sections.

My improved roll of Figs. 4-8 may be mounted loosely in the end clamps 12, with the roll straight from end to end, as represented by the dotted lines in Fig. 4, and with the clamp members 48, 50 loosened, as in Fig. 5, as a result of counterclockwise rotation of the end 53 of screw 52 in Fig. 5, which forces clamp member 48 out of engagement with the co-acting member 50. In this condition of the clamp the leaves of the leaf spring 24 are released for longitudinal slip relative to each other when the spring is bowed. However, the right hand ends of the leaves are fixed by the pin 26. While end clamps 12 are loose, and while clamp members 48, 50 are disengaged, a bowing mechanism may be applied to the ends of shaft sections 20, 22 to effect bowing of the roll, as in Fig. 4. The bowing mechanism may comprise a long screw 62 having right and left screw threads at its opposite end portions. A nut 64 is screwed on each of the threaded ends of screw 62, each nut having pivotally connected thereto a member 66 which is formed at its outer end for engaging over the respective ends of the shaft sections 20, 22. Each member 66 has two spaced arms between which the nut 64 is pivoted, one of these arms of the right hand member 66, in Fig. 4, being broken away to show the nut in full lines. A hand wheel 68 is fixed to one end of the screw 62.

When the roll is straight, as dotted in Fig. 4, the members 66 will hang loosely downward in their dotted positions of Fig. 4. By rotating screw 62 clockwise in Fig. 4, the lower pivoted ends of members 66 move with the nuts 64 toward each

other along the screw causing the roll to become bowed at its central portion, with the leaves of the leaf spring 24 slipping relatively as needed during the bowing. When a desired degree of bow has been imparted to the roll, the clamp screw 52 may be rotated, at its end 53, clockwise in Fig. 5, thereby to draw the clamp member 48 into clamp member 50 enough to securely clamp the left hand ends of the leaves against relative slippage, whereby the roll is set with its central portion bowed a predetermined amount. The end clamps 12 then may be tightened after first positioning the axis of the roll in a desired plane. After the setting of the bow, the bowing mechanism may be removed from the ends of the shaft sections, or may be left thereon.

The surface sleeve 16 of the Figs. 4-8 roll may have its straight end portions made of harder and more durable rubber than the central bowed portion thereof, as described in connection with the Fig. 1 roll.

It is intended that the patent shall cover, by suitable expression in the appended claims, whatever features of patentable novelty exist in the invention disclosed.

I claim as my invention:

1. An expander and contractor roll for flexible sheet material, comprising an axial shaft having a bowed portion of substantial extent and having a straight portion of substantial extent extending from the bowed portion to each end of the shaft, a series of generally cylindrical roll sections rotatably mounted on the shaft and distributed along the shaft with some of the roll sections on the bowed portion of the shaft and some on the straight portions of the shaft, and a surface sleeve of resiliently flexible material engaged over all of the roll sections and adapted to rotate therewith, whereby a substantial central portion of the surface sleeve rotates about a curved axis at said bowed portion of the shaft and straight end portions of the surface sleeve, having substantial straight extent, rotate about straight axes at said straight portions of the shaft.

2. An expander and contractor roll for flexible sheet material, comprising an axial shaft having a bowed portion of substantial extent and having a straight portion of substantial extent extending from the bowed portion to each end of the shaft, a series of generally cylindrical roll sections rotatably mounted on the shaft and distributed along the shaft with some of the roll sections on the bowed portion of the shaft and some of the straight portions of the shaft, a surface sleeve engaged over all of the roll sections and adapted to rotate therewith, said surface sleeve having its portion which engages over the roll sections on the bowed portion of the shaft made of relatively soft elastic material whereby it can rotate about the curved axis of the bowed portion of the shaft, and the portions of said surface sleeve which engage over the roll sections on the straight portions of the shaft being of material whose surface is substantially more resistant to wear than the surface of said relatively soft elastic material at the bowed portion of the roll.

3. An expander and contractor roll for flexible sheet material, comprising an axial shaft having rigid and straight end portions of substantial extent and having a resiliently flexible central portion of substantial extent, a series of roll sections rotatably mounted on the shaft and distributed in slightly spaced end to end relation

therealong, with some of the roll sections on the resiliently flexible portion of the shaft and some on the rigid and straight end portions of the shaft, a flexible surface sleeve engaged over all of said roll sections and adapted to rotate therewith, said shaft being adapted to be selectively bowed varying amounts at its central region by flexing said resiliently flexible portion thereof, thereby to provide a predetermined amount of bow at the central portion of the roll, and means at a juncture region of said resiliently flexible portion of the shaft with a said rigid and straight end portion of the shaft for securing the shaft with a said predetermined bow at its said resiliently flexible portion.

4. An expander and contractor roll for flexible sheet material, comprising an axial shaft having rigid and straight end portions of substantial extent and having a resiliently flexible central portion of substantial extent, a series of roll sections rotatably mounted on the shaft and distributed in slightly spaced end to end relation therealong, with some of the roll sections on the resiliently flexible portion of the shaft and some on the rigid and straight end portions of the shaft, a flexible surface sleeve engaged over all of said roll sections and adapted to rotate therewith, said resiliently flexible portion of the shaft comprising a leaf spring whose leaves are relatively movable longitudinally, whereby the resiliently flexible portion of the shaft may be bowed predetermined amounts thereby to introduce a predetermined amount of bow at the central portion of the roll between straight end portions thereof, and means for clamping the leaves of the spring against relative longitudinal movement to secure the spring and the roll with a predetermined amount of bow therein.

5. An expander and contractor roll for flexible sheet material, comprising an axial shaft having rigid and straight end portions of substantial extent and having a resiliently flexible central portion of substantial extent, a series of roll sections rotatably mounted on the shaft and distributed in slightly spaced end to end relation therealong, with some of the roll sections on the resiliently flexible portion of the shaft and some on the rigid and straight end portions of the shaft, a flexible surface sleeve engaged over all of said roll sections and adapted to rotate therewith, said resiliently flexible portion of the shaft comprising a leaf spring whose leaves, at one end, are anchored against longitudinal movement relative to each other and relative to the adjacent rigid and straight portion of the shaft, the other ends of the leaves being free to move relatively in longitudinal directions whereby the spring may be flexed varying amounts to introduce any predetermined amount of bow in the spring and in the central portion of the roll, a clamp engaging around said free ends of the leaves of the spring, and means extending to one end of the shaft for operating said clamp while the spring is bowed a predetermined amount, thereby to clamp the leaves in their bowed condition and to set the roll with the predetermined amount of bow at its central portion.

6. An expander and contractor roll for flexible sheet material, comprising an axial shaft having rigid and straight end portions of substantial extent and having a resiliently flexible central portion of substantial extent, a series of roll sections rotatably mounted on the shaft and distributed in slightly spaced end to end relation therealong, with some of the roll sections on the

resiliently flexible portion of the shaft and some on the rigid and straight end portions of the shaft, a flexible surface sleeve engaged over all of said roll sections and adapted to rotate therewith, said flexible surface sleeve being of relatively soft elastic material at its portion which is engaged over the roll sections on the said resiliently flexible central portion of the shaft, and its portions which are engaged over the roll sections on the rigid and straight portions of the shaft being substantially more resistant to surface wear, said shaft being adapted to be flexed at its said resiliently flexible portion for introducing bow at the central portion of the roll, and means for setting the resiliently flexible portion of the shaft in any of various flexed conditions, thereby to provide a predetermined amount of bow at the central portion of the roll between substantial straight end portions of the roll.

7. An expander and contractor roll for flexible sheet material, comprising an axial shaft having rigid and straight end portions of substantial extent and having a resiliently flexible central portion of substantial extent, a series of roll sections rotatably mounted on the shaft and distributed in slightly spaced end to end relation therealong, with some of the roll sections on the resiliently flexible portion of the shaft and some on the rigid and straight end portions of the shaft, a flexible surface sleeve engaged over all of said roll sections and adapted to rotate therewith, said shaft being adapted to be selectively bowed varying amounts at its central region by flexing said resiliently flexible portion thereof, thereby to provide a predetermined amount of bow at the central portion of the roll, means for forcibly drawing the opposite ends of the shaft in directions generally toward each other, thereby to flex the resiliently flexible central portion of the shaft, and means, operable while the resiliently flexible portion of the shaft is held flexed a predetermined amount by said means, for setting the flexed portion of the shaft in its flexed condition, thereby to provide a predetermined amount of bow at the central portion of the roll between substantial straight end portions thereof.

8. An expander and contractor roll for flexible sheet material, comprising an axial shaft having

rigid and straight end portions and having a cross-sectionally round flexible central portion which connects the rigid end portions, ball-bearing units mounted at spaced locations along said flexible portion of the shaft, each bearing unit having an inner and an outer ball race, with each inner race closely surrounding the flexible portion of the shaft, a screw screwed into each said inner race and having a non-round head projecting radially from the race toward the axis of the unit, there being a longitudinal groove in the flexible portion of the shaft in which the said projecting non-round head of the screw is non-rotatably engaged, ball-bearing units on the end portions of the shaft, cylindrical roll sections mounted on and rotatable with the outer ball races of the ball-bearing units, a flexible surface sleeve engaged over all of the roll sections, and means for setting the flexible portion of the shaft in a rigid condition having a predetermined amount of bow therein.

9. An expander and contractor roll for flexible sheet material, comprising an axial shaft having at least a substantial central portion of its extent curved and having round cross-section throughout its extent, ball-bearing units mounted at spaced locations along the shaft, each bearing unit having an inner and an outer ball race, with each inner race loosely surrounding the shaft, a screw screwed into each inner race and having a non-round head projecting radially from the race toward the axis of the unit, there being a longitudinal groove in the shaft, extending at least from one end thereof throughout the portions thereof having the bearing units distributed thereon, and the said projecting non-round heads of the screws being slidably but non-rotatably engaged in said groove, cylindrical roll sections mounted on and rotatable with the outer ball races of the bearing units, and a flexible surface sleeve engaged over all of the roll sections.

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