ADJUSTABLE CURVATURE AXLE ASSEMBLY FOR EXPANDER ROLLS AND THE LIKE

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ABSTRACT
An axle or roll assembly has an axle which is split along part of its length to form two elements. Curvature is introduced into the axle by tensioning one axle element and applying a reaction in compression to another. The axle is supported adjustably in end supports so that the orientation of its plane of curvature may be altered. An adjusting means is threaded axially on a free end of one of the axle elements, and bears axially against a free end of the other. Releasable clamping means restrain the axle against rotation, so that rotation of the adjusting means changes the degree of curvature of the roll. Upon release of the clamping means, rotation of the adjusting means rotates the axle bodily to change the orientation of its plane of curvature, without changing the amount of curvature.

14 Claims, 6 Drawing Figures
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BACKGROUND AND BRIEF DESCRIPTION OF THE INVENTION

Longitudinally curved rolls of a type whose degree of curvature is adjustable have found wide use for the lateral spreading and expansion of sheet materials such as cloth, paper, foil, plastic film, and the like, both to control the width of the material and to remove wrinkles. Such rolls are also used for correcting bow distortions of the weft threads of woven goods or the courses of knit goods. While in many applications curved rolls having a fixed degree of curvature or bow are satisfactory, it is often necessary or desirable to provide means for changing the curvature of the roll in order to obtain better control of the processing under varying conditions.

U.S. Pat. Nos. 2,689,392 issued Sept. 21, 1954, and 2,898,662 issued Aug. 11, 1959, both to John Douglas Robertson, and assigned to the assignee of this application, describe and claim adjustable-curve rolls of types which have found wide acceptance. Both of these patents employ mechanical screw devices, which protrude axially from a longitudinally split end of the axle, for the purpose of adjusting the curvature of the roll. This increases the total length of the roll substantially over that of a conventional curved roll of the type having a fixed amount of curvature. The same is true of those types of adjustable-bow rolls which employ an hydraulic ram in place of a screw device. The increased length imposes difficulties and limitations where such rolls are required to be mounted between the frames of an existing machine. Further, in these known types of adjustable-bow rolls, the adjustment of both the degree of curvature, and the angular orientation of the plane of curvature, require access to both ends of the roll to release and then re-secure clamping devices. This is time-consuming, and also requires clearance space at each end of the roll.

The general objects of the present invention are to shorten the overall axial lengths of adjustable-curve axle or roll assemblies, to permit both the degree of curvature and the orientation of the plane of curvature of such assemblies to be adjusted from only one end of the axle or roll. It is a further object to provide an improved mechanism for adjusting the curvature of such an axle or roll assembly, and for changing the angular position of its plane of curvature. Other objects and advantages of the invention will become apparent as the following description proceeds.

DESCRIPTION OF THE DRAWINGS

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 a preferred embodiment thereof, referring to the accompanying drawings, in which:

FIG. 1 is a cross-sectional view in front elevation of an adjustable-bow roll embodying my invention;

FIG. 2 is a view in side elevation showing clamping means which comprise a portion of the improved adjusting mechanism;

FIG. 3 is a fragmentary view in side elevation of another portion of the adjusting mechanism;

FIG. 4A is a schematic sectional view taken along line 4—4 in FIG. 1, looking in the direction of the arrows, and illustrating an angular adjustment of the plane of curvature of the roll;

FIG. 4B is a view similar to FIG. 4A, but illustrating an adjustment in the degree of curvature of the roll; and

FIG. 5 is a fragmentary cross-sectional view taken along line 5—5 in FIG. 3, looking in the direction of the arrows.

Referring first to FIG. 1, the improved axle assembly is shown incorporated in a roll which has a flexible hollow cylindrical surface sleeve 54 of rubber or other suitable material. This sleeve is received over an axially spaced array of annular cylindrical spools 52, which are in turn rotatably mounted on an axle 10 by means of a series of axially spaced bearings 26. The sleeve 54 is located with respect to one of the end spools 52 by a disc 56 attached by rivets 57, and is located at the opposite end by a drive sheave 58 mounted by screws 60 on a flanged ring 62, which fits inside the end spool.

The bearings 26 are axially located by annular cylindrical spacers 32, 34, 36, 38, 40, 42, etc., held between a ring 24 attached to an axle element 16 near one end of the roll, and a ring 48 attached by a pin 50 to the axle near the opposite end. A ring 44 and a plurality of Belleville washers 46, which act as compression springs, are interposed in the stack of spacers. This applies sufficient axial preloading to the assembly to insure accurate positioning of the parts, and yet allows spacers 36 and 38, and others not shown of the same type near the center of the roll, to realign themselves as required by changes in the degree of curvature of the roll. The realignment is permitted by chamfering the mating ends of the spacers 36 and 38, as shown at 37.

The axle 10, initially a cylindrical bar of circular cross-section, is longitudinally slit on axial planes from one end through a substantial part of its length, but the opposite end is left integral. In the form shown, the slits are formed by parallel planar saw-cuts at 12 and 14, leaving a filler strip 18 which serves as a spacer. These cut form elements 16 and 20. An additional filler block 22 is attached to the free end of the element 16, and serves with the strip 18 to hold the elements 16 and 18 in properly-spaced relation when the axle is curved.

The free end of the element 20 extends into a cylindrical threaded portion 80, and thence into a stud 100. An adjusting means comprising a spheroidal element 82 is threadedly engaged on the axle portion 80. The threads of the axle portion 80 and element 82 can be regarded as mutually engaged inclined planes which act as cam surfaces for the purpose of producing relative axial motion between them upon rotation of the element 82 while the axle is restrained against rotation. For this reason, this relationship is expressed in the appended claims as an inclined-plane engagement between the axle portion 80 and the adjusting means or spheroidal element 82, this is intended generically to describe helical threads and other forms of equivalent inclined-plane or cam surfaces.

The spheroidal form of the adjusting element 82 permits it to cant about an axis transverse to the axle and parallel to the planes of the slits 12 and 14, to allow the axle to bend freely as its curvature is adjusted. The canting axis is defined by pins 84 received in the ele-
ment 82, as shown in Figs. 3 and 5. The opposite end of the axle 10 is supported for free canting movement by a spheroidal element 66 received conformably in a mounting bracket 64. This bracket is provided with a tapped bore 65 for supplying grease, which is normally closed by a screw 67, and with mounting screws 68 for attachment to a machine frame (not shown).

The pins 84 extend outwardly from the adjusting element 82 into slots 86 cut axially through a tapered portion 85 of a worm wheel 90, which is rotatably received in a mounting bracket 92. Clearance for the teeth of the worm wheel is provided by an annular chamfer 93 in the bracket 92. The worm wheel and the element 82 are rotatable about the roll axis by turning a worm screw 94 by means of its shaft 96 and adjusting handle 98. It should be noted that this arrangement places the adjusting means within and to one side of the mounting bracket, instead of requiring it to project axially beyond. This contributes to the shortening of the roll.

A clamping bracket 106 abuts axially against the bracket 92, and is mounted with the bracket to the machine frame (not shown) by screws 108. The bracket 106 rotatably receives a ring 104, and is split at 107 (see Fig. 21). A stud 110 is threaded into a portion of the bracket 106 below this split, and is locked in adjusted position by a nut 112 bearing against a surface 107. The stud 110 extends with clearance through the upper portion of the bracket 106, and has an eye 114 which is pivotally connected at 116 to a clamping handle 118. In the illustrated position, a cam surface 115 of the handle presses downwardly against a surface 117 of the bracket 106, deforming the bracket and locking the ring 104 against rotation. A tang 102 is welded within the ring 104, and fits into a slot 101 (see Figs. 2 and 3) in the axle stud 100.

It will be seen that in the locking position of the clamping handle 118 as shown in Fig. 2, the axle 10 is thus restrained against bodily rotation. Rotation of the adjusting handle 98 therefore produces a threading motion of the adjusting element 82 along the threaded portion 80 of the axle. The element 82 bears axially against the axle element 16 through a ring 81, a collar 30, and the ring 24. Threading movement of the element 82 along the axle portion 80 thus produces a changing amount of longitudinal tension in the axial element 20, and a corresponding amount of longitudinal compression in the axle element 16. These forces cause the axle and roll to curve as at 54', parallel to the plane of Fig. 1, which may be referred to as the plane of curvature, and is shown at P in Fig. 4B. Motion of the element 82 along the portion 80 to the right as viewed in Fig. 1 increases these forces to produce an increasing degree of curvature of the roll. This is illustrated by a progressive change in the exterior shape of the roll from a cylindrical sleeve form shown at 54 in Fig. 4B, to those shown at 54' and 54''. The principle on which this effect rests is more fully described by the aforementioned U.S. Pat. Nos. 2,689,392 and 2,898,662, is now well understood in the art, and need not be further elaborated.

Assume now that the clamping handle 118 is rotated about 90° in a clockwise direction, as viewed in Fig. 2. The cam surface 115 presents a smaller radius, and releases the ring 104 from clamping engagement, so that the axle 10 is free to turn about a straight longitudinal axis determined by the mounting brackets 92 and 64. Rotation of the adjusting handle 98 now turns the element 82 as before; but the axial loading between the threads of the element 82 and the axle portion 80, applied by the tension and compression forces in the axle elements 16 and 20, prevents the element 82 from threading along the axle portion 80. Rather, the portion 80 and the now-free axle 10 rotate bodily with the element 82. This action is illustrated in Fig. 4A by a displacement of the roll's plane of curvature P from a vertical position to a horizontal position at P'. The position of the plane of curvature of the roll can thus be turned to any desired angular orientation.

As will be understood by those skilled in the art, the surface presented by the roll to a length of material partially wrapped around its surface can be adjusted by my improved mechanism both as to the degree of curvature and the form of the surface presented. Expansion, contraction, and control of material width is subject to ready adjustment, as is the correction of bow deformations in woven or knit goods.

It should be noted that the specifically-illustrated form of the axle 10 is not critical; alternatives are numerous, and include those shown by the aforementioned U.S. Pat. Nos. 2,689,392 and 2,898,662, as well as other known equivalent forms, including groups of rods or bars of round, square, or other cross-section, whether laterally spaced apart or not.

What I claim is:

1. An adjustable-curvature axle assembly, comprising: an axially elongated axle member separated along an axially-extending plane from one end of said axle member along a substantial part of its length into at least two axle elements lying on opposite sides of said plane, said elements being joined together at a second end of said axle member;

means supporting the opposite ends of said axle member for free rotation of said axle about a straight longitudinal axis thereof;

a single adjusting device for selectively adjusting the curvature of said axle member and for adjusting the angular orientation of said axle member about said longitudinal axis thereof, said adjusting device comprising: an adjusting element having inclined-plane engagement with one of said axle elements, and bearing axially against a second of said axle elements, to apply axial tension and compression forces to said axle elements, respectively; means for selectively rotating said adjusting element; and a releasable clamping element fixed with respect to said supporting means and selectively operable for restraining said axle member against rotation relative to said supporting means about said straight longitudinal axis thereof;

said supporting means locating said adjusting element axially with respect to said axle member and rotatably supporting said adjusting element;

said adjusting element and said clamping element cooperating, upon rotation of the former and clamping of the latter, to displace said one axle element axially with respect to said second axle member element to adjustably bend said axle;

said adjusting element and said clamping element further cooperating, upon rotation of the former and release of the latter, to rotate said axle member about said straight axis as the reaction between said forces produces sufficient friction between said adjusting element and said one axle element to re-
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1. An axle assembly as recited in claim 10, said stationary bracket means comprising a split clamp, said gripping means comprising a movable cam member bearing on said split clamp for adjusting the engagement thereof with said ring means.

2. An axle assembly as recited in claim 1, said adjusting element and said one of said axle elements having mutually engaging inclined-plane surfaces forming said inclined-plane engagement.

3. An axle assembly as recited in claim 1, said adjusting element being threaded axially on said one of said axle elements to form said inclined-plane engagement.

4. An axle assembly as recited in claim 1, said adjusting element comprising a spheroidal element having said inclined-plane engagement with said one of said axle elements adjacent to said one end of said axle member, said supporting means including mounting bracket means conformably receiving said spheroidal element to accommodate relative canting motion thereof accompanying adjustment of the curvature of said axle member, said means for selectively rotating said adjusting element including said bracket means as a component thereof.

5. An axle assembly as recited in claim 4, said mounting bracket means including adjusting wheel means rotatable about said straight longitudinal axis, together with means drivingly and pivotally connecting said wheel means with said spheroidal element for joint rotation and accommodation of said relative canting motion.

6. An axle assembly as recited in claim 5, said pivotal connection providing a pivotal axis extending transverse to said axle and parallel to said axially extending plane.

7. An axle assembly as recited in claim 1, said adjusting element and said clamping element being circumferentially spaced about said axle member adjacent to said one end thereof.

8. An axle assembly as recited in claim 7, said means for selectively rotating said adjusting element including a driven annular externally toothed gear wheel drivingly connected with said adjusting element for joint rotation therewith, a driving gear engaging an outer circumference of said gear wheel, and means drivingly connected with said driving gear for adjusting said axle assembly; said driven gear wheel, said driving gear, and said means drivingly connected therewith being circumferentially spaced about said adjusting element.

9. An axle assembly as recited in claim 8, said driving gear comprising a worm screw extending transversely of said axle member into engagement with said gear wheel.

10. An axle assembly as recited in claim 7, said clamping element comprising ring means havingrotational driving connection with said axle member, stationary bracket means rotatably receiving said ring means, and gripping means constructed and arranged for releasably engaging said bracket means with said ring means to restrain said ring means against rotation therein.

11. An axle assembly as recited in claim 10, said stationary bracket means comprising a split clamp, said gripping means comprising a movable cam member bearing on said split clamp for adjusting the engagement thereof with said ring means.

12. An axle assembly as recited in claim 1, together with:

a series of bearings mounted in axially spaced relation along said axle;
and a series of annular spool members mounted on said bearings in an axially-spaced array.

13. An axle assembly as recited in claim 12, together with a flexible surface sleeve received circumferentially about said array of spool members for rotation in unison therewith.

14. An adjustable-curvature axle assembly, comprising: an axle member comprising at least two axially elongated axle elements lying on opposite sides of an axially extending plane, said elements being free of one another from one end of said axle member along a substantial part of its length, and being joined together at a second end of said axle member; means supporting the opposite ends of said axle member for free rotation of said axle about a straight longitudinal axis thereof; a single adjusting device for selectively adjusting the curvature of said axle member and for adjusting the angular orientation of said axle member about said longitudinal axis thereof, said adjusting device comprising: an adjusting element having axially threaded engagement with a free end of one of said axle elements, and bearing axially against a free end of a second of said axle elements, to apply axial tension and compression forces to said elements, respectively; means for selectively rotating said adjusting element; and a releasable clamping element fixed with respect to said supporting means and selectively operable for restraining said axle member against rotation relative to said supporting means about said straight longitudinal axis thereof; said supporting means locating said adjusting element axially with respect to said axle member and rotatably supporting said adjusting element; said adjusting element and said clamping element cooperating, upon rotation of the former and clamping of the latter, to thread said adjusting element along said one axle member element to adjustably bend said axle; said adjusting element and said clamping element further cooperating, upon rotation of the former and release of the latter, to rotate said axle member about said straight axis as the reaction between said forces produces sufficient friction between said adjusting element and said one axle element to restrain said axle elements against rotation relative to said adjusting element.

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