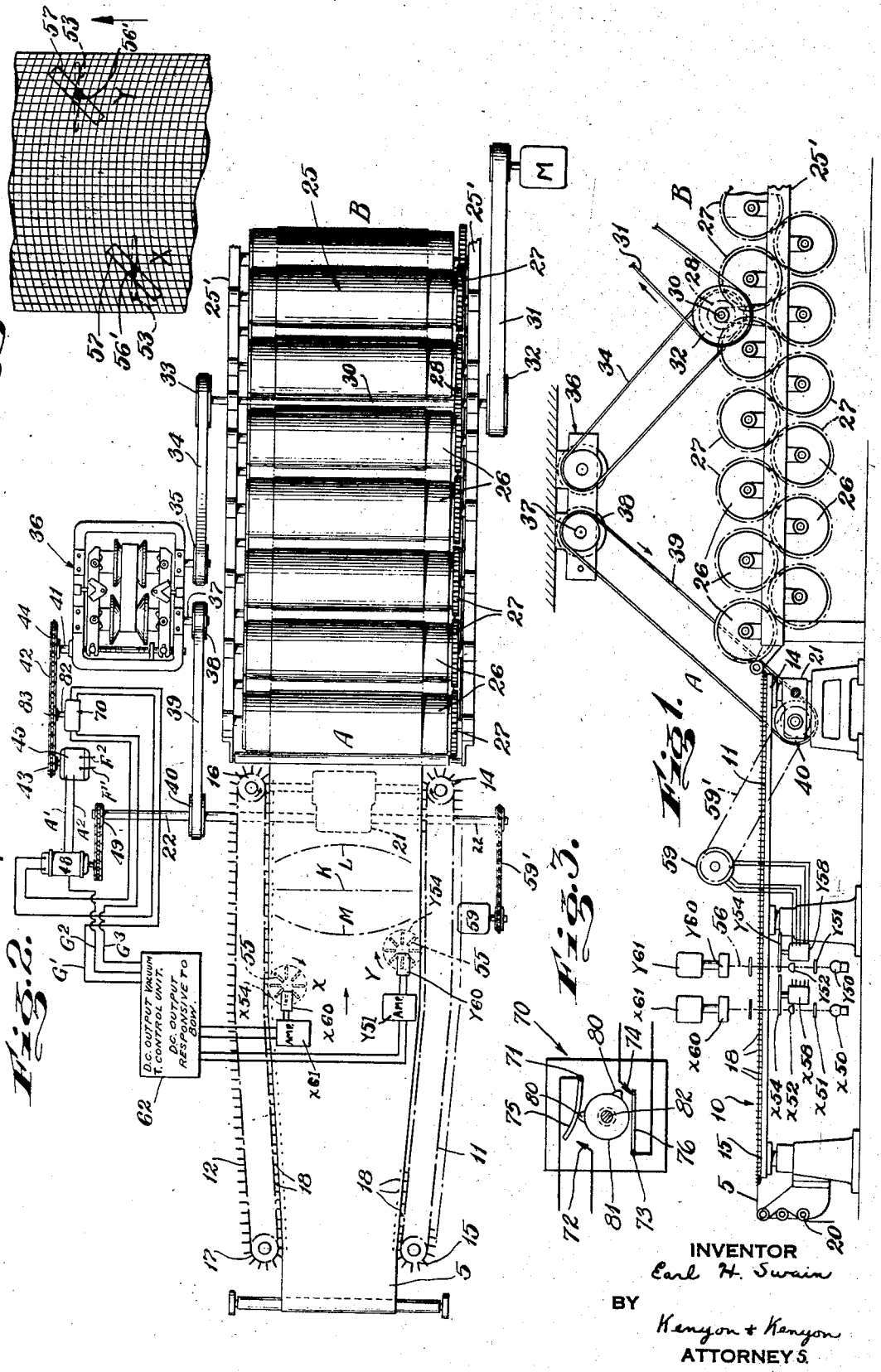
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METHOD AND APPARATUS FOR CORRECTING BOW IN WOVEN MATERIAL

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METHOD AND APPARATUS FOR CORRECTING BOW IN WOVEN MATERIAL

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This invention relates to apparatus employed in the finishing of woven material, and more particularly to apparatus and a method for correcting bow in the fabric.

In the finishing of woven fabric, the weft elements may become bowed for example in the passage of the woven fabric from the tenter to a cylinder dryer. This bow whether leading or lagging is objectionable and must be eliminated.

An object of this invention, therefore, is to provide improved means for detecting either a leading or a lagging bowed condition of the weft threads.

A further object is to provide means responsive to the detecting means which will automatically correct a leading or a lagging bow when either occurs.

Heretofore apparatus has been described, for example, that in U. S. Letters Patent No. 2,106,611 of January 25, 1938, to C. W. La Pierre, for detecting and correcting a bowed condition. In that patent, photo-electric cells are utilized to detect the bowed condition. This detecting means serves to control the position of a movable idler roller located at the exit end of a tenter above a driven roller which latter is normally out of contact with the fabric passing to the tenter. The drive connection of the latter roller is such that its surface moves at a somewhat greater speed than that of the tenter chains. When a bowed condition is detected, the material is pressed against the driven roller with a variable pressure by the idler roller which is somewhat larger in diameter at its middle portion than at its ends whereby there is a variable amount of slip between the material and the driven roll. Variation in pressure varies the amount of slip between the material and the driven roll to correct the bowed condition in the latter. The idler roll is moved toward or away from the driven roll by a reversible motor controlled by the detecting means.

This device, which requires the special driven roller at the exit end of the tenter and the specially shaped idler roller is objectionable among other reasons because of the additional structure required which adds to the expense of finishing and because of the likelihood of damage to the fabric.

The bow control structure embodying the present invention eliminates objections noted, and permits the use of standard equipment in conjunction with standard tenter frames and standard cylinder driers without requiring reconstruction of any of the equipment. An object, therefore, of the present invention is the structural simplification of apparatus for correcting bow.

The simplification is effected in one aspect by the provision of a standard form of variable speed transmission between the drive for the cylinder driers and the drive for the tenter frame chains. The variable speed transmission gear is responsive through detecting means to leading or lagging bow in fabric as it moves over the tenter frame toward the drying drums or cylinders. It serves to vary the relative speed of the tenter frame chains with respect to the peripheral speed of the drying can drums so that a leading bow, for example, will be eliminated by a speeding up of the tender frame chains relative to the peripheral speed of the drying drums, whereas a lagging bow will be eliminated by a slowing up of the tenter frame chains relative to the peripheral speed of the drying drums.

This relative speeding up or slowing down of the tenter chains with respect to the peripheral speed of the drying drums must be controlled within limits to prevent overspeeding which would result in the delivery of fabric in a slack condition to the drying cylinders, and to prevent underspeeding which would result in a tearing of the fabric out of the tenter chain clips.

It is another object of this invention, therefore, to provide limit means for accomplishing this control.

To the accomplishment of the foregoing and such other objects as may hereinafter appear, this invention consists in the novel method, construction and arrangement of parts herein described and then sought to be defined in the appended claims, reference being had to the accompanying drawing forming a part hereof and which shows, merely for the purpose of illustrative disclosure, a preferred embodiment of the invention, it being expressly understood that various changes may be made in practice within the scope of the claims without digressing from the inventive idea.

In the drawing, in which similar reference characters denote corresponding parts:

Fig. 1 is a diagrammatic side elevational view of an arrangement embodying my invention;

Fig. 2 is a top plan view of the structure illustrated in Fig. 1 and including diagrammatically electric circuits employed to illustrate the variable speed regulation and the overspeed and underspeed control; and

Fig. 3 is an enlarged detail view of the overspeed and underspeed limit mechanism.

Fig. 4 is a diagrammatic view illustrating the scanning system for detecting bow.

In the drawing, the strip 5 of woven material is shown as having its opposite edges engaged by a tenter 10 of well known form. This tenter comprises the endless chains 11 and 12 which are supported respectively by the pairs of sprockets 14, 15, 16 and 17. One sprocket of each pair, as sprockets 14 and 16, is driven in a manner to be presently described. Each chain has a series of grippers or clips 18. The direction of drive of the sprockets 14 and 16 is such as to move the grippers of both chains in the same direction and towards a dryer 25 to be presently described. The grippers 18 in well known manner, are so constructed that as they leave the sprockets 15 and 17 each automatically grips an edge of the woven material moving it forwardly and stretching it laterally in the wider portion of the tenter 10. The grippers 18 as they arrive at said sprockets 14 and 16 in well known manner, release the woven material to permit its transfer to the dryer 25. Suitable tension bars 20 of well known construction are provided at the entry end of the tenter to properly tension the material prior to its entry to said tenter 10.

The sprockets 14 and 16 are driven in opposite directions from a gear-box 21 whose input shaft 22 is driven as will be presently described.

The dryer 25 in the embodiment shown comprises a series of horizontally arranged drying cylinders 26 supported on a frame 25' and each having a gear 27 meshing with the gears of adjacent cylinders in such manner that a single driving gear 28 applied to one of said gears 27 serves to rotate all the drying cylinders. The woven material is delivered to the first of the cylinders 26 at the entry end A of the dryer and moves in a tortious path around the various cylinders to the exit end B of the dryer. Driving gear 28 is keyedly supported on a shaft 30 suitably carried by the dryer frame 25', and is driven from a motor M or the like through belting 31 passing around a pulley 32 also keyed to shaft 30. A second pulley 33 also keyed to shaft 30 and driven by said shaft is connected by belting 34 to the input pulley 35 of a variable speed transmission 36 shown in the present embodiment as a "Reeves" variable speed transmission. Any other type of variable speed transmitter may be substituted. The output shaft 37 of this variable speed transmission has a pulley 38 which is connected by belting 39 to a pulley 40 keyed to the input shaft 22 which operates the gear trains (not shown) in the gear box 21 to drive the sprockets 14 and 16 of the tenter 10 in opposite directions. Thus the driving speed of the tenter chains 11 and 12 relative to the surface speed of the cylinders 26 is adjustable and dependent upon the variable speed transmission 36.

Normally if the relative speed of the tenter chains with respect to the drying cylinders is properly adjusted, the weft threads are straight as indicated by the dot-dash line K in Fig. 2. If the surface speed of the drying cylinders is in excess of that of the tenter chains, the weft threads will take a leading bow position indicated by the dot-dash line L in Fig. 2. If, on the other hand, the surface speed of the drying cylinders is less than that of the tenter chains, the weft threads will take a lagging bow position indicated by the dot-dash line M in Fig. 2.

The automatic regulation of the speed of the tenter chains serves to correct either a leading or a lagging bow. This speed regulation is accomplished by the automatic readjustment of the variable speed transmission 36 to cause a speeding up or slowing down of the tenter chains as is necessary. The automatic readjustment of the variable speed transmission is accomplished through photo-electric detecting mechanism which in turn controls the operation of a pilot motor 45 serving to actuate the variable speed transmission 36. This pilot motor has a built-in reducing gear (not shown), is rotatable in either direction, and is coupled to the control shaft 41 of the variable speed transmission by the chain drive 42 operating over the driving sprocket gear 43 on the output shaft of the motor and sprocket gear 44 on the control shaft 41.

The pilot motor 45 is of the D. C. type and has a fixed field current supply led to it through the leads F_1 and F_2. The armature (not shown) is directly connected by the leads A_1 and A_2 to the armature (not shown) of a D. C. generator 48. This generator has a pair of opposing field windings (not shown) and the differential field produced by current in both field windings of the generator determines the direction of induced current generated and consequently the direction of rotation of the pilot motor 45. The generator armature (not shown) is driven in suitable manner from the tenter drive shaft 22. As shown, this drive comprises sprocket chain 49 coupling the sprockets on the shaft 22 and on the armature shaft.

The detecting mechanism is made up of well known units available upon the open market. Two such units X and Y are herein employed. These units are arranged beneath the woven strip on the tenter frame. They include the similar light sources X50 and Y50, the light from which is concentrated, by way of example, by the condensing lenses X51 and Y51 and by the cylindrical lenses X52 and Y52 to form a light line on the strip of material 5 extending transversely thereof, such a light line being represented by the dotted line 53 in Fig. 4. Close beneath the strip are the rotatable slotted disks X54 and Y54, the slots 55 of which extend radially and are spaced apart a distance approximately equal to the length of the light line 53. As shown in the drawings, disks X54 and Y54 rotate in the same direction, the speeds of these disks being exactly the same. As the successive slots of each disk sweep through each line of light 56, each narrow light beam shown by the black rectangle 56' in Fig. 4 passes through the material and by reason of the forward movement of the material, these beams sweep across the material in a direction which is inclined to the warp members and to the edge of the material as represented by the lines 57. As so arranged, it will be seen that, if no bow is present in the strip, the light beams of units X and Y will be intercepted by the same number of weft elements. However, if a leading bow is present in the strip, the number of interceptions of the beam of unit X by the weft members will be less than the number of interceptions of the beam of unit Y as is clearly evident from an inspection of Fig. 4. Likewise, if there is a lagging bow in the strips, the number of interceptions of the beam of unit X will be greater than the number of interceptions of unit Y.

The two disks which rotate at equal speeds may be driven by any suitable means. For example, separate polyphase synchronous motors shown at X58 and Y58, which motors are parallelly connected to the polyphase synchronous generator 59, which in turn is chain driven as

at 59' from the shaft 22 or an extension thereof, may be used. With this arrangement, the speed of the disks bears a fixed relation to the speed of the moving material.

Two photo-electric tubes X60 and Y60 are arranged in the path of the light beams. Each photo-electric tube is connected to a suitable amplifier X61 and Y61 and the output of the amplifiers is connected to a control unit 62. The control unit is an electronic tube circuit of a standard type available in the open market whose output D. C. voltages are proportional to the ratio of two frequencies applied to the input circuit. The voltages generated in the phototube amplifiers as described in the La Pierre patent aforementioned are used to supply these frequencies and hence the output of the control unit are D. C. voltages which are proportional to the direction and magnitude of bow in the cloth.

The D. C. voltages proportional to the bow in the cloth supplied by the control units are used to regulate the D. C. generator field current and are fed to said field from the control unit by the leads G_1, G_2 and G_3. The generator field current is proportional to the bow and hence its generated voltage is also proportional to bow. The correcting of pilot motor is a D. C. motor 45 with constant field excitation. The generator armature (not shown) is connected directly across the pilot motor armature (not shown) by leads A_1 and A_2 and hence the direction of rotation and speed of the pilot motor are dependent upon the direction and magnitude of the bow in the cloth.

Thus a leading bow will upon detection cause a corrective movement of the variable speed transmission to increase the speed of the tenter chains and eliminate the bow. A lagging bow will upon detection cause a correcting movement of the variable speed transmission to decrease the speed of the tenter chains and eliminate the lagging bow.

Since either an excessive increase or decrease of speed of the tenter chains is undesirable a suitable limit switch 70 is employed to cut out the power supply to the pilot motor when overspeeding or underspeeding occurs. This limit switch 70 is of a standard type having two pairs of contacts 71, 72, and 73, 74 and spring actuated blades 75, 76 normally serving to bridge the respective contacts. Each pair of contacts is connected in series in one of the field lines G_1 and G_3 to the generator so that, when the blades 75 or 76 are moved to break the circuit in the limit switch, the field circuits to the generator through lines G_1 and G_3 are opened. Consequently, the pilot motor remains inoperative for further rotation in a given direction until the opened circuit is again closed by the blades 75 or 76. The opening of the circuits by the blades is controlled by cam members 80 on a gear 81 mounted on a shaft 82 which is driven through suitable sprocket gearing 83 from the sprocket chain 42 coupling the motor to the variable speed transmission.

Increase and decrease of relative speed of the tenter frame with respect to the cylinder drums depends upon the relative adjustment of the pulley ratios in the variable speed transmission. These pulley ratios in well-known manner are controlled by the control shaft 41 of the variable transmission. Any given speed change ratio in the variable speed transmission is accomplished by a specific number of rotations of the control shaft 41 in one direction or the other from a given starting position. In actual practice, the gear reduction accomplished in pilot motor 45 and the sprocket sizes are such that the control shaft 41 actually makes less than one revolution in operating the variable speed device. Thus, if the limit switch is set to cause separation of the blades when the control shaft under action of the pilot motor has rotated a certain given angular amount, in either direction from the starting position (ideal unbowed condition), a limit to underspeeding and overspeeding is effected because the opening of the generator field circuits G_1 or G_3 at these two limits prevents further operation of the pilot motor in the given directions.

Between the limits of overspeed and underspeed set by the limit switch, the variable speed transmission is responsive to the action of the pilot motor 45. The latter in turn is responsive to excitation induced by the detecting mechanism and moves in a direction to eliminate a leading or lagging bow in the fabric passing from the tenter to the drier.

While I have described a particular form of generator operated pilot motor control for the variable speed transmission, it should be understood that the particular means intermediate the phototube detectors and the form of pilot motor employed is not material. For example, the bow control motor described in the aforementioned La Pierre Patent No. 2,106,611 controlled by the circuits of that patent could be coupled to the control shaft 41 of the variable speed transmission. Other pilot motors and circuit controls could be used.

It is to be understood that modifications in structural detail and in electrical circuit arrangements are contemplated within the scope of the appended claims. There is no intention of limitation to the exact details shown and described.

What is claimed is:

1. Apparatus for correcting bow in fabrics moving from the tenter chains of a tenter to the drying drums of a dryer, comprising means for driving said drying drums, a variable speed transmission coupling said driving means to said tenter chains to drive the latter and permit a relative speed variation between the speed of said chains and the speed of said drums, means for detecting any bow in the fabric on said tenter chains and means operatively controlled by said detecting means for regulating said variable speed transmission to effect a corrective speed change of said tenter chains and consequently the edges of said material with respect to the speed of the drums and the body of said material in the dryer to eliminate the bow in said fabric.

2. Apparatus for correcting bow in fabrics moving from the tenter chains of a tenter to the drying drums of a dryer, comprising means for driving said drying drums, a variable speed transmission coupling said driving means to said tenter chains to drive the latter and permit a relative speed variation between the speed of said chains and the speed of said drums, photoelectric means for automatically detecting any bow in the fabric on said tenter chains and means operatively and automatically controlled by said detecting means for regulating said variable speed transmission to effect a corrective relative speed change of said tenter chains with respect to the speed of the drums to eliminate the bow in said fabric.

3. Apparatus for correcting bow in fabrics moving from the tenter chains of a tenter to the drying drums of a dryer, comprising means for

driving said drying drums, a variable speed transmission coupling said driving means to said tenter chains to drive the latter and permit a relative speed variation between the speed of said chains and the speed of said drums, means to limit the amount of said relative speed variation, means for detecting any bow in the fabric on said tenter chains, and means operatively controlled by said detecting means for regulating said variable speed transmission to effect a corrective relative speed change of said tenter chains with respect to the speed of said drums within the limits imposed by said limiting means to eliminate the detected bow in said fabric.

4. Apparatus for correcting bow in fabrics moving from the tenter chains of a tenter to the drying drums of a dryer, comprising means for driving said drying drums, a variable speed transmission coupling said driving means to said tenter chains to drive the latter and permit a relative speed variation between the speed of said chains and the speed of said drums, means to limit the amount of said relative speed variation, photo-electric means for automatically detecting any bow in the fabric on said tenter chains, and means operatively and automatically controlled by said detecting means for regulating said variable speed transmission to effect a corrective relative speed change of said tenter chains with respect to the speed of said drums within the limits imposed by said limiting means to eliminate the detected bow in said fabric.

5. Apparatus for correcting bow in fabrics comprising a tenter having drivable tenter chains serving to advance said fabric along the tenter, a dryer having cylindrical drivable drums for receiving the fabric delivered from said tenter, means for driving the drums of said dryer, a variable speed transmission coupled to said driving means and to said tenter chains to drive the latter and permit a relative speed variation between the speed of said chains and the speed of said drums, photo-electric mechanism serving to detect automatically any bow in the fabric on said tenter, and means operative through said detecting mechanism for motivating said variable speed transmission for effecting a corrective relative speed change of said tenter chains to eliminate the bow in said fabric.

6. Apparatus for correcting bow in woven fabric comprising a tenter having drivable tenter chains serving to advance said fabric along the tenter, a dryer having cylindrical drivable drying drums for receiving and drying the fabric delivered from said tenter chains, means for driving said drums, a variable speed transmission coupled to said driving means and to said tenter chains to drive the latter and permit a relative speed variation between the speed of said drums and that of said chains, means to limit the amount of over or under speeding of said chains relative to the speed of said drums, detecting mechanism serving to detect automatically any bow in the fabric on said tenter chains and means operative through said detecting mechanism for motivating said variable speed transmission for effecting a corrective relative speed change of said tenter chains with respect to said drums within the limits imposed by said limiting means to eliminate the bow in said fabric.

7. Apparatus for correcting bow in fabrics comprising a tenter, a cylinder dryer, means for driving said dryer, a variable speed transmission coupled to said driving means and to said tenter to permit relative speed variation of said tenter with respect to said dryer, photo-electric detecting mechanism serving to detect bow in fabric on said tenter and means operative through said detecting mechanism for motivating said variable speed transmission for effecting a corrective relative speed regulation of said tenter with respect to said dryer to eliminate the bow.

8. Apparatus for correcting bow in fabrics comprising a tenter, a cylinder dryer, means for driving said dryer, a variable speed transmission coupled to said driving means and to said tenter to permit relative speed variation of said tenter with respect to said dryer, automatic means to limit the amount of said relative speed variation, photo-electric detecting mechanism serving to detect bow in fabric on said tenter and means operative through said detecting mechanism for motivating said variable speed transmission for effecting a corrective relative speed regulation of said tenter with respect to said dryer to eliminate the bow.

9. A method for correcting bow in a moving piece of woven material capable of being moved independently in a tentering zone and a drying zone during the finishing of said material comprising moving said material independently in said two zones, photo-electrically detecting bow in said tentering zone and changing the relative speed of the edges of said material in the said tentering zone with respect to the speed of said material in said drying zone in response to the photoelectrically detected bowed condition to eliminate the latter.

10. Apparatus for correcting bow in fabrics moving from a tentering device having moving members engaging opposite edges of said material to a dryer having driven parts engaging the body of the material comprising means for driving said parts of said dryer, a variable speed transmission coupling said driving means to said moving members to drive the latter and permit a relative speed variation between the speed of said members and the speed of said parts, means for detecting any bow in the fabric on said moving members, and means operatively controlled by said detecting means for regulating said variable speed transmission to effect a corrective speed change of said moving members and consequently the edges of said material with respect to the speed of said driven parts and the body of the material in the dryer to eliminate the bow in said fabric.

11. Apparatus for correcting bow in fabrics comprising a tenter having drivable members serving to engage the edges of said fabric and advance the said fabric along the tenter, a dryer having drivable means for receiving the fabric delivered from said tenter, means for driving said drivable means, a variable speed transmission coupled to said driving means and to said drivable members to drive the latter and permit a relative speed variation between the speed of said members and the speed of said drivable means, photoelectric mechanism serving to detect automatically any bow in the fabric on said tenter, and means operative through said detecting mechanism for motivating said variable speed transmission for effecting a corrective relative speed change of said members to eliminate the bow in said fabric.

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