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APPARATUS FOR AND METHOD OF DETECTING AND CORRECTING FOR SKEW IN WOVEN MATERIAL

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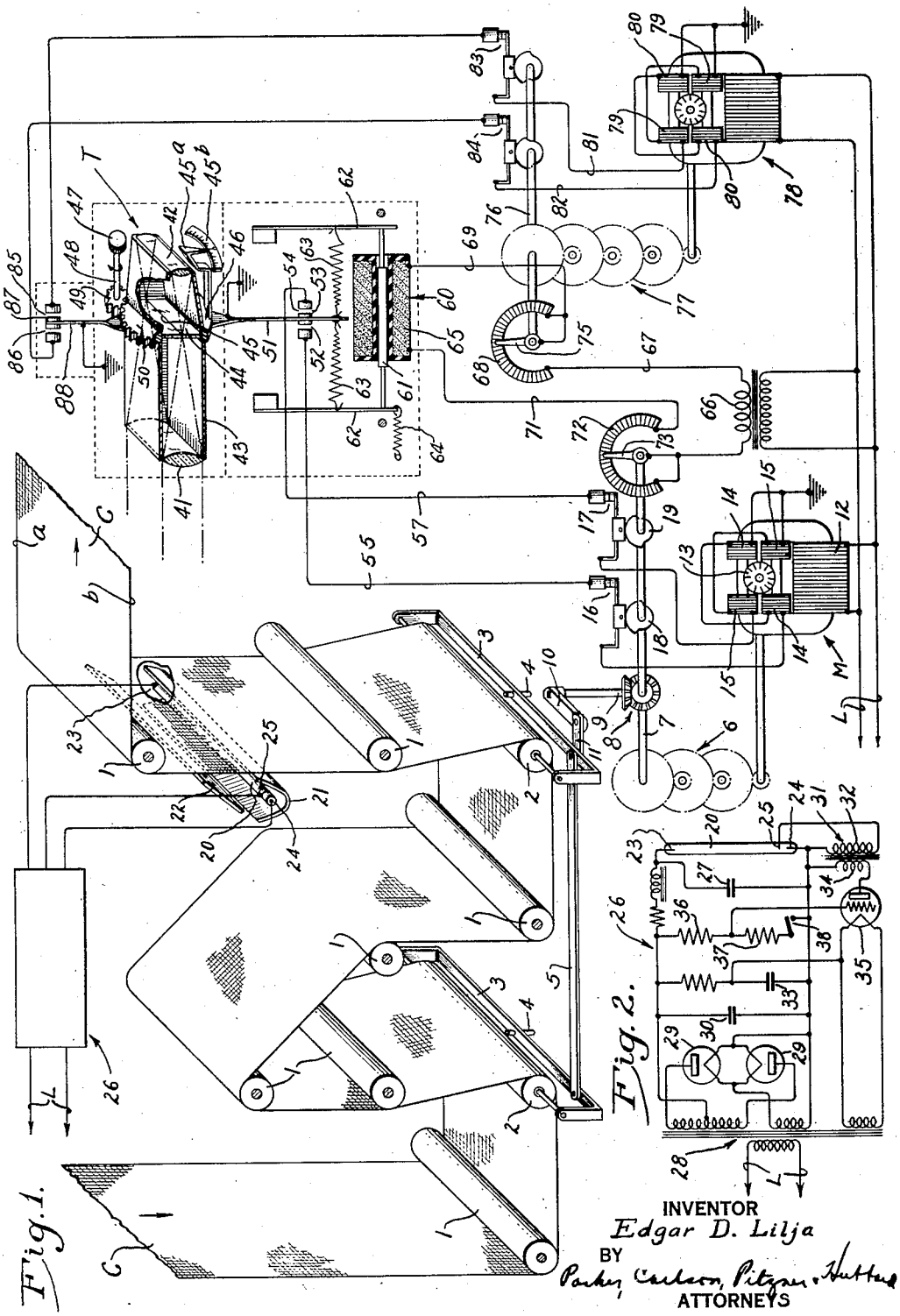


Fig. 1.

Fig. 2.

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APPARATUS FOR AND METHOD OF DETECTING AND CORRECTING FOR SKEW IN WOVEN MATERIAL

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The weft and warp threads of woven cloth are generally perpendicular to each other as the cloth comes from the loom. This relationship is disturbed in subsequent processing such as dyeing, shrinking, etc., thus necessitating what is commonly called a weft straightening operation to correct for the so-called skew of the weft threads. Such straightening is ordinarily performed in conjunction with the drying of the cloth by an attendant who observes the weft threads as the cloth passes through the tenter and manually adjusts a canting roll to correct for skew. With a drier speed of 180 yards per minute such as is commonly attained in practice, over 12,000 weft threads per second will pass a fixed point with cloth of 120 square. At such frequency, the weft threads are not readily distinguishable to the human eye; consequently it is difficult to detect skew with any degree of accuracy and properly gauge the correction thereof. As a result, the production capacity of cloth driers has been curtailed and only the most skillful observers may be employed.

One object of the present invention is to overcome the above difficulties and provide a novel method of and means for visually detecting skew in a cloth web while the latter is traveling at a substantially higher speed than has heretofore been practicable.

Another object is to enable skew to be observed and corrected for with a minimum of skill on the part of the observer.

The carrying out of the foregoing objects is based in part on my discovery that a substantial reduction in the apparent speed of the weft threads may be obtained by intermittent illumination of the observed area of the traveling web at a frequency well within the range of practicability and only a small fraction of the frequency at which the threads pass a fixed point.

A further object is to increase the sharpness of definition of the weft threads that are observed while at the same time decreasing the distinctness of the warp threads.

The invention also resides in the novel and simple construction of the means employed in carrying out the foregoing objects.

Another object is to provide a novel means for adjusting a weft straightener under manual control and in response to observed skew.

Other objects and advantages of the invention will become apparent from the following detailed description of the preferred embodiment illustrated in the accompanying drawing in which:

Figure 1 is a schematic view and wiring diagram of a skew detecting and correcting apparatus embodying the novel features of the invention.

Fig. 2 is a circuit diagram of the current supply circuit for the scanning lamp.

For purposes of illustration, the invention has been shown and will herein be described in conjunction with a canting roll type of weft-straightening mechanism. I do not intend to limit the invention by this disclosure but aim to cover all modifications and alternative constructions, methods and uses falling within the spirit and scope of the invention as expressed in the appended claims.

Generally stated, the improved method involves directing a beam of light onto an area of a traveling cloth web, interrupting or flashing the illumination periodically at a suitable frequency to reduce the apparent speed of the threads as viewed by the human eye, observing the illuminated weft threads, and correcting for a skewed condition of the threads. Preferably, the observation is made through an optical system which improves the visibility of the threads and increases their apparent skew while at the same time decreasing the distinctness of the warp threads. Also, the observation is made from the side of the web opposite the light source so that the effective light is that transmitted through the interstices between adjacent weft threads the latter thereby appearing more readily distinguished.

Referring now to the drawing, the strip or web of woven material or cloth C to be straightened is run over a series of rollers, one or more of which may be power driven. Certain of the rollers indicated at 1 are rotatably supported in fixed parallel relation while others 2 are adjustably supported so as to vary the tension in opposite edges of the cloth strip for the purpose of shifting skewed weft elements into the desired perpendicular relation to the warp elements. Such adjustment is ordinarily made by oscillating the rollers about axes perpendicular to their rotational axes and in a plane substantially parallel to the path of travel of the cloth.

As herein shown, each of the rollers 2 is journaled in a bracket 3 pivotally supported intermediate its ends on pivot pin 4 located substantially at the center of the bracket. A rigid link 5 connects the brackets so that they swing together as a unit. When the brackets and their rollers 2 are swung out of parallel relation to the rollers 1 in a clockwise direction (as viewed in Fig. 1) the outer edge of the strip C is placed

under greater tension than the inner edge. The reverse effect is obtained by swinging the rollers in the opposite direction. The difference in the tension in the edges of the strip, and therefore the degree of correction provided by any setting of the rollers 2, is determined by the extent to which these rollers are displaced from parallelism with respect to the rollers 1.

While any suitable means may be employed for swinging the brackets 3 and their respective rollers 2 to adjust the machine, it is preferred to employ power driven means which is quickly responsive to control and subject to accurate regulation. The reversible operator herein shown comprises an electric motor M operating through speed reduction gearing indicated generally at 6 to drive a main operating shaft 7. Through beveled gears 8, the shaft drives a secondary shaft 9 which has a rigid crank arm 10 connected by a link 11 with one of the brackets 3 adjacent its connection with the link 5.

The motor M is preferably of the shaded pole induction type having a winding 12 constantly energized from a suitable alternating current source, herein shown as a power line L. A rotor 13 is arranged to turn in either a clockwise direction or a counter-clockwise direction depending on which of two sets of shading coils 15 and 14 is short circuited, the rotor remaining stationary when both sets of shading coils are open circuited. One terminal of each coil set is grounded, while the other terminal is connected to a suitable control device through limit switches 16 and 17 arranged to be opened by cams 18 and 19 when the rollers 2 reach opposite limit positions.

The control device for controlling the shading coil circuits may be of any suitable character. As the control is utilized to adjust the machine for correcting a skewed condition of the cloth passing therethrough, it necessarily follows that the device should be operable in accordance with the condition of the cloth, that is by the presence or absence of skewed weft elements. This condition is most conveniently determined by visual inspection of the cloth as it leaves the machine.

To overcome the limitations in speed and accuracy inherent in visual inspection of the cloth as heretofore carried out, the present invention contemplates illumination of a portion of the traveling web C by a light source which is flashed periodically at a controllable frequency which I have discovered may be substantially less and only a small fraction of the frequency at which the weft threads pass a fixed point. This frequency of flashing is adjusted to reduce the apparent speed of the weft appreciably, that is, produce the effect on the observer's eye of slowing down the web. For example, a frequency as low as 60 per second has been found suitable for observing, in accordance with the present invention, cloth of various weaves traveling at a speed of 180 yards per minute. With cloth of 80 square, 8640 weft threads would, at this speed, pass a given point per second. With a frequency of 60 flashes per second, the light source would be illuminated for .00001 of a second and dark for .01666 of a second in each cycle. As a result, the weft threads may be compared easily with a reference line and any deviation from the desired perpendicular relation to the warp may easily be detected.

Preferably, the periodically operative light source is disposed on the side of the cloth opposite the observer who sees only the light transmitted through the spaces between the adjacent weft threads. By thus observing the transmitted light, the weft threads are more prominent so that any skew is more easily detected thereby permitting a greater rate of travel of the cloth.

In the present instance, the light source comprises an elongated lamp 20 arranged transversely of the cloth and closely adjacent one side thereof as shown in Fig. 1. The lamp is preferably located at or near the end of the straightener from which the finished cloth emerges, the cloth being held taut and always in the same plane by the last two rollers 1. Cooperating reflectors, including a parabolic reflector 21 and an angularly disposed diffusing reflector 22 focus the light from the lamp 20 into a relatively thin beam of approximately the same length as the width of the strip of cloth. This beam is directed substantially perpendicular to the plane of the strip so as to provide a relatively narrow illuminated zone extending transversely across the strip parallel to the desired position of the warp elements.

While the lamp 20 may be of any suitable type, it is herein shown as a lamp of the well known gaseous conductor type comprising an elongated glass tube containing mercury vapor, argon or the like and having electrodes 23 and 24 sealed in opposite ends. A starting electrode 25 is located closely adjacent the electrode 24. Current may be supplied to the lamp from any suitable source 26 through an energizing circuit which includes timing means for periodically ionizing the gas in the tube to cause the lamp to flash at a suitable rate.

A typical energizing circuit for the lamp 20 is shown diagrammatically in Fig. 2. This includes a condenser 27 bridged across the terminals 23 and 24 of the lamp and charged from a suitable source of direct current. The condenser is periodically discharged through the lamp to produce a momentary bright flash of light. The direct current source, as herein shown, comprises a power transformer 28 connected to the line L, a pair of conventional rectifier tubes 29 receiving current from the transformer, and a filter condenser 30 bridged across the direct current output leads. The voltage of the source is not sufficient to cause a discharge between the lamp terminals 23 and 24 until the gas in the tube is ionized as by a preliminary discharge between the terminals 24 and 25.

In the particular circuit illustrated, the ionizing voltage is supplied to the lamp terminals 24 and 25 at predetermined intervals by means of a trigger circuit including a step-up transformer 31 having its secondary winding 32 connected across the terminals 24 and 25. A condenser 33 charged from the direct current source above described, is arranged to be discharged into the primary winding 34 of the transformer 31 at the desired periodic intervals under control of a Thyraton tube 35. As is well known, a tube of this character remains non-conducting until a predetermined voltage is applied to the grid whereupon the tube becomes conducting.

In the present instance, a positive grid tripping voltage is derived from a voltage divider consisting of a pair of resistors 36 and 37 bridged across the output leads of the direct current source in series with a suitable timing switch 38. When the timing switch is closed, the voltage at the junction of the resistors is applied to the grid of the Thyraton tube 35, this voltage being positive with respect to the cathode so that the tube becomes conducting and condenser 33 discharges

into the transformer primary 34. This discharge induces a sufficiently high potential in the secondary 32 to cause an ionizing discharge between the lamp terminals 24 and 25 and thus initiate the discharge of the condenser 27 between the terminals 23 and 24. The latter discharge produces a brilliant flash of light which is of very short duration since the resistance of the lamp drops to a low point once ionization has taken place.

The timing switch 38 above referred to may be actuated in any preferred manner as by a suitable motor (not shown) whose speed can be regulated as desired. Alternatively, 60 cycle alternating current might be employed to trip the tube 35. The correlation of the flashing frequency with the speed of the cloth is not critical and, as above mentioned, this frequency may be a surprisingly small fraction of the frequency at which the weft elements pass a reference point. Presumably, this is due to the fact that the observer does not actually view or follow each weft thread but rather only those which are the more pronounced. By such concentration, skew of these threads may be detected even though their apparent speed is relatively high.

While the moving cloth strip illuminated in the above manner may be observed with the unaided eye if desired, it is preferred to magnify the weft threads because of the greater accuracy obtainable and the reduction in strain on the observer's eyes. Preferably the magnification is in one direction only, that is, transversely of the weft threads so as to increase the apparent skew of the weft threads while decreasing the definition of the warp. Accordingly, the observation is made through a telescope T comprising an elongated flattened casing disposed on the side of the cloth opposite the light source and supporting at opposite ends cylindrical lenses including an objective lens 41 and an eye piece lens 42. The longitudinal axes of the lenses thus extend parallel to the unskewed weft threads and, as a result, the images of these threads, as viewed through the telescope, are enlarged in the direction of their diameters and, with the telescope properly focused, are plainly distinguishable. At the same time, the definition of the warp threads is greatly reduced if not substantially eliminated because they are not magnified and are not in focus.

To provide an index or reference line for checking the angular position of the weft threads, a transparent screen 44 is mounted within a stationary housing 43 for free movement relative thereto and is disposed in the image plane of the objective lens. The screen carries a fine straight line 45 extending parallel to the longitudinal axes of the lenses. The arrangement is such that the line 45 is superimposed on the image of the cloth as viewed through the eye piece. Thus, any change in the angular position of the weft threads can be detected instantly by comparison of the thread image with the index line image. When the threads are skewed, their images, as viewed through the telescope, will be out of parallelism with respect to the reference line 45 when the latter is disposed in zero position as indicated by the position of a pointer 45a rigid with the screen 44 and coacting with a stationary scale 45b.

While the screen may be stationarily mounted if desired, it is preferably mounted for limited rotational movement about an axis perpendicular to the plane of the cloth strip C at the viewing point so that the image of the index line may be alined with the image of the weft threads as they vary in angle from perpendicular relationship to the warp threads in the skewed portions of the strip. This movement is utilized to control the operator motor M and thus automatically adjust the direction and extent of shifting of the rollers 2 to correct for the skew.

As herein shown, the screen 44 is mounted on a suitable frame 46 rotatably supported in suitable guides (not shown) on a stationary part of the machine framework. Suitable manually operable means is provided for rotating the screen. This means, as herein shown, comprises a knob 47 mounted at one end of a rotatably supported rod 48 which has a rigid pinion 49 meshing with the teeth of a segmental gear element 50 fixed to the top of the screen. Thus, by simply turning the knob 47 the screen may be swung into position to aline the images of the index line and the weft threads regardless of the angular position of the threads.

Movement of the screen in either direction from its normal horizontal position acts through a suitable control device to initiate the operation of the motor M in a direction effective to swing the rollers 2 into position to shift the weft threads back to the desired perpendicular relation to the warp threads and thus correct the skewed condition of the cloth. The control device, as herein shown, comprises a flexible blade 51 secured at one end to the screen 44 and carrying at its other end a contact 53 cooperating with a pair of stationary contacts to form two switches 52 and 54. The switch 52 is connected by a conductor 55 to the limit switch 16 which, in turn, is connected to one terminal of the shading coils 14, while the switch 54 is connected by a conductor 57 with the limit switch 17 associated with the corresponding terminal of the shading coils 15. The other terminals of the shading coils are grounded, as before explained, and since the blade 51 is also grounded, closure of either switch will short-circuit its associated shading coils and thus initiate the operation of the motor. The stationary contacts are spaced apart so that when the blade 51 is in its mid-position both switches are open and the motor is idle.

Preferably the stationary contacts forming the switches 52 and 54 are located so that the switches are open when the line 45 is in a horizontal position. Then, the weft thread image will lie parallel as long as the weft threads retain their desired perpendicular relationship to the warp threads. Any deviation from this relationship is indicated immediately by a misalinement of the weft threads and index line images, whereupon the observer will rotate the screen until alinement is again attained. As a result of this rotation, one or the other of the switches 52 or 54 is closed, thereby starting the motor M which swings the rollers 2 into position to shift the weft threads back to their desired position. As the skewed condition is corrected, the operator turns the screen backwardly following the corrective movement and maintaining the weft thread image and reference line parallel. This procedure is continued until the reference line 45 has been restored to zero position which may be gauged, if desired, by the pointer 45a. If desired, the screen 44 can also be stationary and the switches 52 and 54 manually manipulated to aline the weft threads with the horizontal index line.

To stabilize the action of the skew correct-

ing mechanism and enable the operator to follow the skew changes more accurately, it is sometimes desirable to provide means, operable independently of the manual control, for proportioning the initial correcting movements to correspond to the change of skew and for producing a further corrective movement at a slower rate to fully restore the weft to the straightened condition. The proportioning action is attained in the present instance through the use of a solenoid 60 having an armature 61 suspended by flexible arms 62 and connected to the tongue 51 through the medium of light contractile springs 63. The constant pull of the solenoid is opposed by a spring 64. The solenoid winding 65 is constantly energized through a circuit including a voltage source 66, a conductor 67, a resistance 68, a conductor 69, the winding 65, a conductor 71, and a resistance 72 varied by movement of a wiper arm 73. The latter is fast on the main controller shaft 7 and its direction of movement is always such as to vary the energization of the solenoid in a direction to return the tongue 51 to neutral position. As a result, the rollers are shifted initially by an amount proportional to the amount of skew which is measured by the angle through which the screen is turned to match the weft and the reference line 45.

The resetting or supplemental corrective movement is effected as an incident to the proportioning movement by varying the value of the resistance 68 at a slow rate and in a direction opposite to that caused by the balancing resistance 72. To this end, an arm 75 contacting the resistance element is carried by a shaft 76 which is driven through gearing 77 and a reversing motor 78 at a speed approximately one tenth that of the main controller shaft 7. The control windings 79 and 80 of this motor are short-circuited respectively through conductors 81 and 82 respectively including cam operated limit switches 83 and 84 and switches 85 and 86. The latter have stationary contacts and a common contact 87 on an arm 88 carried by the screen so that one switch or the other will be closed whenever the screen is moved out of neutral position.

Summarizing the operation briefly, let it be assumed that the cloth leaving the straightener is skewed so that the ends of the weft threads along the margin *b* lead the ends along the margin *a*. The operator, looking into the eye piece, turns the knob 47 to make the reference line 45 appear parallel to the weft threads. Since the image of the threads as viewed by the operator is inverted, it is necessary to turn the knob in the direction indicated by the arrow. The arm 51 is thus moved to close the switch 54 causing the motor M to run clockwise and turn the shaft 7 counterclockwise and the arm 10 to the right. This causes retardation of the cloth margin *b* tending to restore the weft to normal perpendicular position. This corrective action continues until the solenoid current and pull have been reduced to a value at which the switch 54 is permitted to open. Operation of the motor M is thus interrupted after this initial corrective movement, which is proportional to the amount of the skew.

While the screen remains out of neutral position, the switch 86 is closed and the motor 78 runs in a direction to turn the slider 75 counterclockwise. This slowly increases the solenoid pull causing the switch 54 to be reclosed. The motor M again operates in the same direction producing a further corrective movement until the switch is again reopened by action of the balancing resistance 72. This resetting action is repeated intermittently until the screen has been turned by the operator back to its normal position and the weft thus fully straightened.

I claim as my invention:

1. Apparatus for correcting skew in a traveling web of cloth having, in combination, apparatus supporting said traveling web and selectively adjustable to straighten the cloth, a light source arranged to illuminate an area of said web extending across the latter, means operable to flash the illumination periodically at a suitable frequency to reduce the apparent speed of travel of the threads as observed by the human eye, a member mounted to turn on an axis approximately normal to said web and having a reference line adapted to be brought into parallelism with skewed weft threads, and mechanism automatically responsive to turning of said member in opposite directions from a neutral position to adjust said straightening apparatus in opposite senses and correct for observed skew.

2. Apparatus for correcting skew in a traveling web of cloth having, in combination, apparatus supporting said traveling web and selectively adjustable to straighten the cloth, a light source arranged to illuminate an area of said web extending across the latter, means operable to flash the illumination periodically at a frequency such as to reduce the apparent speed of travel of the threads as observed by the human eye, means providing a reference line rotatable about an axis extending approximately normal to the web in said illuminated area whereby to permit measuring of the amount of skew in either direction by turning said line into parallelism with the skewed weft threads, and mechanism controlled automatically in response to movement of said line in either direction out of normal neutral position to correspondingly adjust said straightening apparatus and condition the same for correcting for the detected skew.

3. Apparatus for correcting for skew in a traveling web of cloth having, in combination, a light source arranged to illuminate an area of said web extending across the latter, means operable to interrupt the illumination periodically at a frequency such as to reduce the apparent speed of travel of the threads as observed by the human eye, means providing a reference line rotatable into parallelism with skewed threads in said illuminated area, mechanism selectively operable on said traveling web to correct for skew of the weft threads in either direction, and means controlled automatically by movements of said reference line to govern said mechanism and correct for detected skew.

4. Apparatus for detecting skew in a traveling web of cloth having, in combination, means arranged to direct a light beam toward and against one side of said web and illuminate an area thereof extending across the web, means operable to flash the illumination periodically at a suitable frequency to reduce the apparent speed of travel of the threads as observed by the human eye, and viewing means disposed on the side of said web opposite said light beam and arranged to facilitate observation of the light transmitted through the interstices between the adjacent weft threads within said area.

5. In an apparatus for detecting skew in woven material having warp and weft elements normally perpendicular to each other, the combination of means for supporting a strip of the material,

means for illuminating an area of the material extending transversely across the strip substantially parallel to the normal position of the weft elements, means for visually observing the illuminated area of the strip including a pair of elongated magnifying members arranged in spaced relation with their longitudinal axes generally parallel to the illuminated area of the strip, a transparent screen interposed between said members having an index line thereon, said screen being positioned so that the image of the index line is superimposed on the image of the weft elements observed through said magnifying members.

6. In an apparatus for detecting skew in woven material having warp and weft elements normally perpendicular to each other, the combination of means for illuminating an area extending transversely across the strip substantially parallel to the normal position of the weft elements, means for visually observing the illuminated area including a pair of elongated cylindrical lenses, a housing supporting said lenses with their longitudinal axes generally parallel to the illuminated area, and a member rotatable about an axis substantially perpendicular to the plane of the observed area so as to maintain the member parallel to the weft elements as these elements deviate from their normal perpendicular relationship to the warp elements.

7. Apparatus for detecting skew in a traveling web of cloth having, in combination, a light source arranged to illuminate an area of said web extending across the latter, means operable to flash the illumination periodically at a suitable frequency whereby to reduce the apparent speed of travel of the threads as observed by the human eye, and means for observing and detecting skew of said threads including a lens system adapted to magnify said weft threads only in the direction of their widths.

8. In an apparatus of the character described, the combination of means for supporting a traveling web of woven material having warp and weft elements normally perpendicular to each other, a source of light disposed on one side of the web to illuminate an area thereof extending transversely across the web substantially parallel to the normal position of the weft elements, and a lens located on the opposite side of the strip for viewing said illuminated area and operable to magnify the weft elements only in the direction of their width.

9. Apparatus for detecting skew in a traveling web of cloth having, in combination, a source of light, reflecting means operable to direct a light from said source toward and against one side of said web to illuminate an area extending across the web, means operable to flash the illumination periodically at a frequency such as to reduce the apparent speed of travel of the weft threads, and means on the opposite side of the web facilitating observation of the light transmitted through the spaces between the adjacent weft threads.

10. Apparatus for correcting for skew in a traveling web of cloth having, in combination, means for straightening the cloth in its travel including a member movable in opposite directions from a neutral position to correct for skew in opposite direction, a reversible power operator for actuating said member, means for detecting skew including a reference line disposed adjacent said web in a path of visual observation of the latter and mounted to turn in opposite directions about an axis approximately normal to said web, means responsive to movements of said line to control said operator and cause movement of said member in a direction to correct for the detected skew, and supplemental control means operable to proportion the corrective movements of said member in accordance with the extent of deviation of said line from said neutral position.

11. Apparatus for correcting for skew in a traveling web of cloth having, in combination, means for straightening the cloth in its travel including a member movable in opposite directions from a neutral position to correct for skew in opposite directions, a reversible power operator for actuating said member, means for detecting skew including a reference line disposed adjacent said web in a path of visual observation of the latter and mounted to turn in opposite directions about an axis approximately normal to said web, means responsive to movements of said line to control said operator and cause movement of said member in a direction to correct for the detected skew, and supplemental control means operable to proportion the initial corrective movements of said member in accordance with the deviation of said line from said neutral position and then to cause further corrective movement at a reduced rate so long as said line is out of neutral position.

12. In an apparatus of the character described, the combination of means for supporting a traveling web of woven material having warp and weft elements normally perpendicular to each other, a source of light arranged to illuminate an area of the web extending transversely across the latter, and an optical system for observing the weft threads in said area and operable to magnify the diameters of said weft threads while impairing the definition of the warp threads.

13. The method of correcting for skew in a traveling web of cloth which includes the steps of directing a light beam toward and against one side of said cloth whereby to transmit light through the interstices between adjacent weft threads, interrupting such transmission periodically at a frequency correlated with the speed of the web whereby to reduce the apparent speed of the weft threads and render them readily distinguishable to the human eye, viewing the illuminated portion of the web from a position on the side of the web opposite from said light beam, and correcting for deviations of the weft threads out of parallelism relative to a perpendicular to the direction of travel of the web.

14. The method of correcting for skew in a traveling web of cloth which includes the steps of directing light against one side of said web, flashing the light periodically at a suitable frequency to reduce the apparent speed of such threads, viewing the illuminated area of said web from the side thereof opposite the light source, comparing the positions of the weft threads with a reference mark extending perpendicular to the path of travel of the cloth, and correcting for deviations of the weft threads out of parallelism with respect to said mark.

15. Apparatus for detecting skew in a traveling web of cloth having, in combination, means providing a source of light periodically illuminating an area of said web extending across the latter whereby to reduce the apparent speed of travel of the weft threads as observed by

the human eye, and a cylindrical lens by which said illuminated area may be observed.

16. Apparatus for detecting skew in a traveling web of cloth having, in combination, means providing a source of light periodically illuminating a band of said web extending across substantially the entire width of the web, and a lens extending throughout the full length of said illuminated band and operable to produce a pattern visible to the human eye and having the warp threads obscured and the weft threads emphasized.

17. The method of correcting for skew in a traveling web of cloth which includes the steps of periodically illuminating the web to reduce the apparent speed of its weft threads, and observing the illuminated area through an optical system capable of magnifying the weft threads only.

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