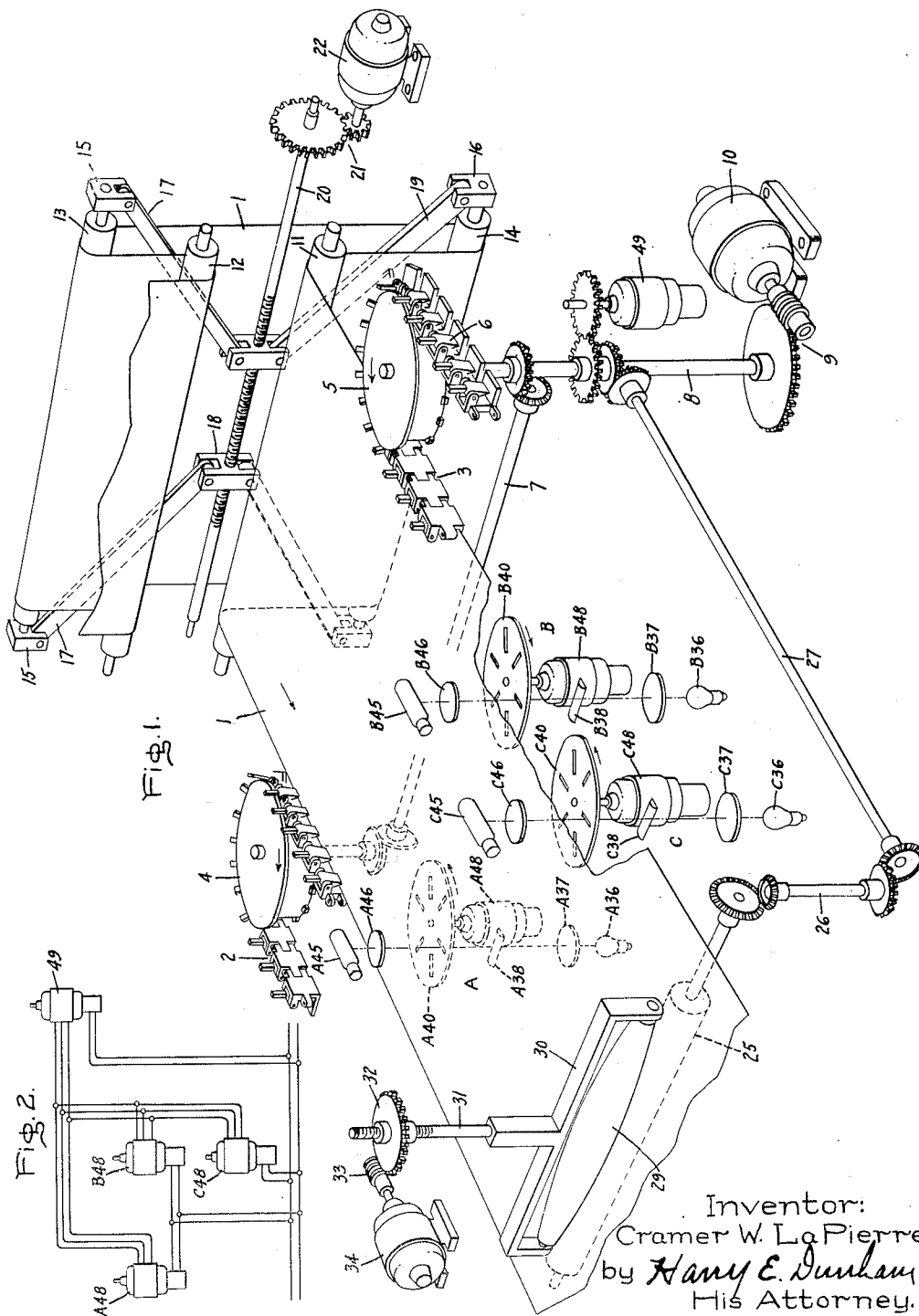


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Jan. 25, 1938.

C. W. LA PIERRE

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Fig. 3.

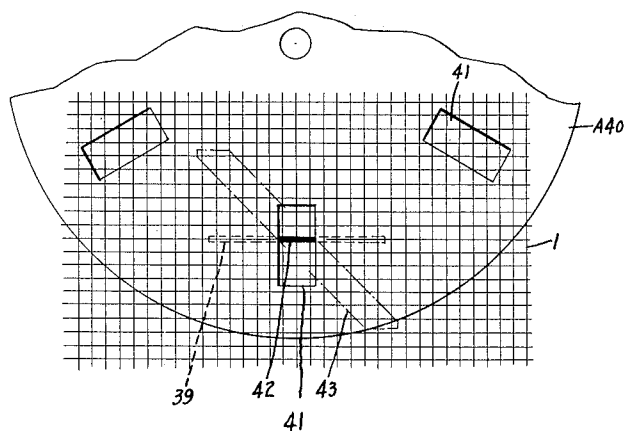


Fig. 4.

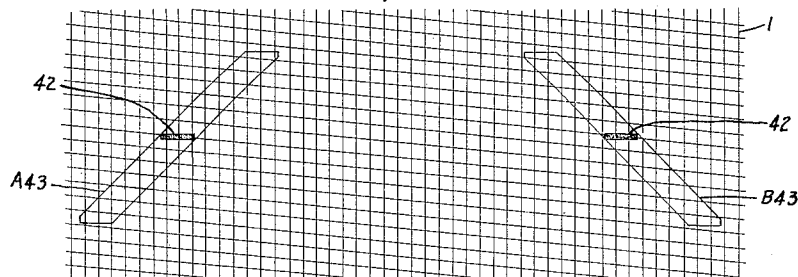
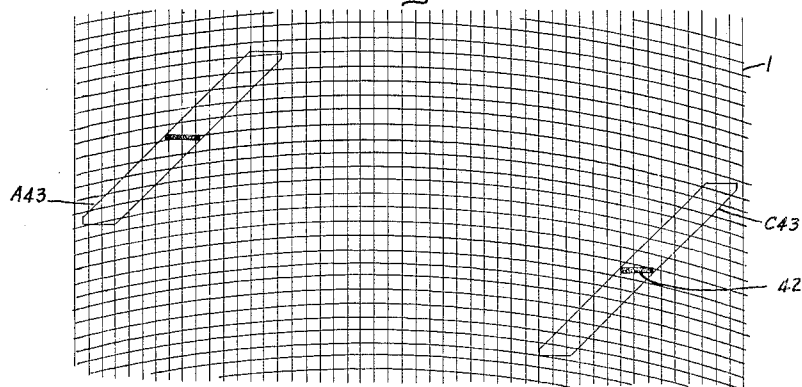


Fig. 5.



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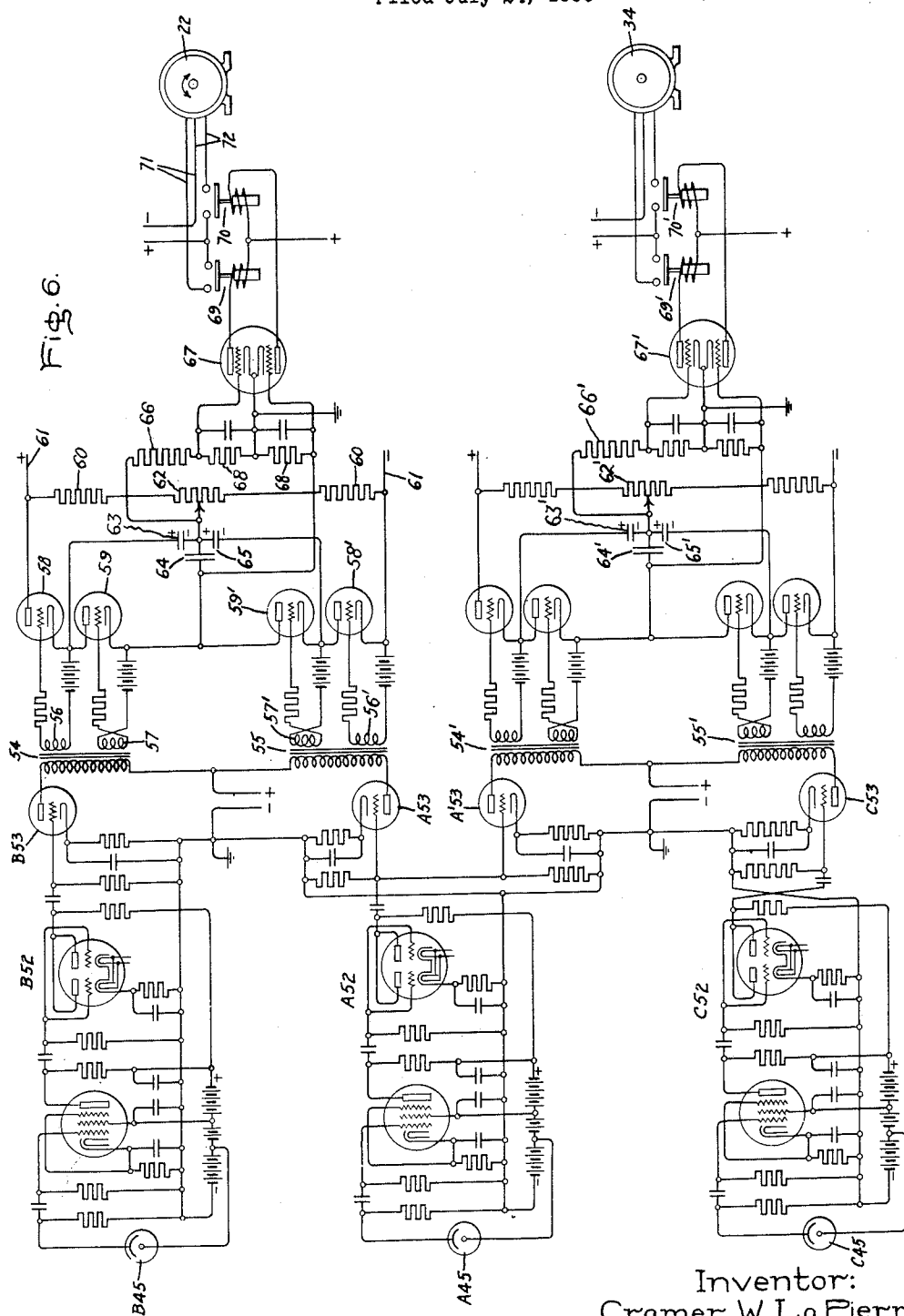
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APPARATUS FOR CORRECTING SKEW AND BOW IN WOVEN MATERIAL

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Fig. 6.



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UNITED STATES PATENT OFFICE

2,106,611

APPARATUS FOR CORRECTING SKEW AND
BOW IN WOVEN MATERIALCramer W. La Pierre, Schenectady, N. Y., assign-
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Application July 24, 1936, Serial No. 92,416

9 Claims. (Cl. 26—51)

My invention relates to apparatus employed in the manufacture of woven material. In the copending application of Francis B. Menger and myself, Serial No. 34,932, filed August 6, 1935, there is disclosed and claimed apparatus for detecting and automatically correcting any skew that may occur in woven material such as cloth during its manufacture. It is well known to those skilled in the art that due to the process employed in the manufacture of the material there is sometimes a further objection, namely, the weft elements of the material become bowed which condition may be due, for example, to the material being drawn along by the edges over a drying plate or through an oven. The material may show both bow and skew or either one separately.

One object of my invention is to provide improved means for detecting a bowed condition of woven material. Another object is to provide improved means which in response to a bowed condition of the material will automatically correct that condition. A further object is the provision of improved apparatus which serves to correct both a condition of skew and a condition of bow if either or both exist.

My invention will be better understood from the following description taken in connection with the accompanying drawings and its scope will be pointed out in the appended claims.

Referring to the drawings, Fig. 1 is a perspective view of one form of apparatus embodying my invention; Fig. 2 illustrates a detail of the electrical equipment forming a part thereof; Fig. 3 is a detail of the light beam controlling apparatus shown in Fig. 1; Fig. 4 is a detail illustrating the paths of the light beams for detecting skew in the woven material; Fig. 5 is a detail illustrating the paths of the light beams for detecting bow in the woven material; and Fig. 6 is a circuit diagram.

In the drawing, Fig. 1, the strip 1 of woven material is shown having its opposite edges engaged by a tenter of well known form comprising the endless chains 2 and 3 which are driven by the sprockets 4 and 5 respectively and which each comprise a series of grippers 6, sometimes called clips, which upon leaving a sprocket automatically grip the edge of the woven material to draw it forward and also to stretch it laterally. The tenter may be employed in the well known manner to move the woven material such as fabric over a hot plate or through an oven to effect the drying thereof. In certain cases, however, I may prefer that the above described tenter shall com-

prise an auxiliary or additional tenter employed ahead of the main tenter in order that the woven material may be delivered without skew or bow to the main tenter.

For the correction of any skew that may be present in the material as it reaches the tenter I may provide means such, for example, as that shown in the above-mentioned copending application for appropriately varying the speed of one of the two tenter chains relative to the other. In the present case, however, I have shown the driving sprockets 4 and 5 of the two tenter chains connected by the shaft 7 to be driven at the same speed, suitable connections being made through the main drive shaft 8 on which the sprocket 5 is mounted and the worm gearing 9 with the main driving motor 10. For the correction of skew in this case I have provided a different mechanism which I shall now describe. This mechanism includes the two fixedly mounted idler rolls 11 and 12 and the two adjustably mounted idler rolls 13 and 14 over which the material passes in two successive loops. Roll 13 is mounted in the bearing blocks 15 and the roll 14 is likewise mounted in the bearing blocks 16. The blocks 15 connect through the links 17 with the nuts 18 and the blocks 16 likewise connect through the links 19 with the same nuts 18. The nuts 18 are threaded on the screw shaft 20 which through the gearing 21 is driven in one direction or the other by the motor 22. With this apparatus it will be seen that if the material approaching the tenter is skewed, that is, if the weft members are not perpendicular to the warp members or to the edge of the strip, the skew can be readily corrected by the rotation of the motor 22 in the proper direction to cause corresponding ends of the rolls 13 and 14 to approach each other or to separate from each other. Correction for skew is thus made in the material before it reaches the tenter, the control of the motor 22 which effects this correction being governed by the skew detecting apparatus which will be described later.

The material 1 in being drawn along by the tenter sometimes becomes bowed, that is, the central portion of the strip of material lags behind the edge portions. To remove any bow that may be present in the material, there is provided the driven roll 25 mounted directly beneath the strip, the roll being driven through the shafts 26 and 27 and suitable gearing from the main shaft 8. The drive connection of the roll 25 is such that the surface of the roll moves at a somewhat greater speed than that of the tenter chains. The material is pressed against

the roll 25 with a variable pressure by means of the idler roll 29 which preferably 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, the amount of slip and accordingly the amount of bow correction produced by the apparatus depending upon the amount of downward pressure exerted by the roll 29. This roll is mounted in the frame 30 which by suitable means, not shown, is supported for vertical movement and fixed to the frame is the screw-threaded rod 31 upon which is threaded the wormwheel 32. The latter is rotated in one direction or the other by the worm 33 driven by the motor 34 to raise or lower the roll 29. If the presence of a rearward bow is detected in the material the motor 34 is energized to cause it to rotate in a manner to depress the roll 29, thereby increasing the pressure with which the material is pressed against the driven roll 25 and decreasing the slip. The central portion of the strip thereupon is drawn forward with a somewhat greater speed than the edge portions thereof and the rearward bow decreases. If as a result of the above a forward bow in the strip begins to appear, the detecting apparatus operates to cause the motor 34 to rotate in the reverse direction to relieve the pressure exerted by the roll 29.

I shall now describe the apparatus by which the presence of skew or bow is detected and by which the motors 22 and 34 are operated. Shown arranged beneath the strip of woven material are three similar units designated A, B, and C. These units include the similar light sources A36, B36, and C36, the light from which is shown concentrated, by way of example, by the condensing lenses A37, B37, and C37 and by the cylindrical lenses A38, B38, and C38 to form a light line on the strip of material extending transversely thereof, such a light line being represented by the dotted line 39 in Fig. 3. Close beneath the strip are the rotatable slotted disks A40, B40, and C40, the slots 41 (see Fig. 3) of which extend radially and are spaced apart a distance approximately equal to the length of the light line 39. As shown on the drawings, disks A40 and B40 rotate in opposite directions while disks A40 and C40 rotate in the same direction, the speeds of all of these disks being preferably the same. As the successive slots of each disk sweep through the line of light 39 a narrow light beam shown by the black rectangle 42 in Fig. 3 passes through to the material and by reason of the forward movement of the material this beam sweeps across the material in a direction which is inclined to the warp members and to the edge of the material as represented by the dot and dash line 43. The inclination of the path of movement of the light beam will of course depend upon the direction of rotation of the disk and the speed thereof with respect to the speed of the moving material. Since disks A and B rotate in opposite directions the paths A43 and B43 will be inclined in opposite directions and if the disks rotate at the same speed the inclination of the two paths will be equal.

If no skew exists in the material, that is, if the weft members are perpendicular to the warp members and to the edge of the strip, the light beams of units A and B will be intercepted by the same number of weft members during passage from one end of the path to the other. However, if the material is skewed in a

manner represented, for example, by Fig. 4 the beam of unit A will be intercepted a greater number of times than the unit B. Hence the frequency of interception of the beam of unit A will be greater than the frequency of interception of the beam of unit B. In this connection it should be noted that no attempt has been made in Figs. 3, 4, and 5 to show the warp and weft members of the material in their proper proportion relative to the spacing thereof or to the size of the light beam, it being understood that in actual use the width of the weft members is so related to the width of the light beam that a substantial reduction in the amount of light is effected each time a weft member passes through a beam and the length of the beam is such that the change in the number of warp members which intercept it does not produce an appreciable change in the beam. For the purpose of making an electrical response to the interception of the light beams I have provided the photoelectric devices A45, B45, and C45 which, for example, may be photoelectric tubes and which are arranged above the strip to receive the light beams which pass therethrough and on which the light is focussed by suitable lenses A46, B46, and C46.

As described above, units A and B are employed in the detection of skew in the material. For the detection of bow in the material I employ units A and C. The disks of these two latter units rotate in the same direction; hence the paths of the light beams therefrom on the material are similarly inclined, that is, they incline in the same direction and make substantially the same angle with the warp elements and the edge of the strip as shown, for example, at A43 and C43 in Fig. 5. It is essential for the detection of bow that units A and C shall be spaced apart laterally of the strip. As so arranged it will be seen that if no bow is present in the strip the light beams of units A and C will be intercepted by the same number of weft elements. However, if a rearward bow is present in the strip the number of interceptions of the beam of unit A by the weft members will be less than the number of interceptions of the beam of unit C as will be clearly evident from an inspection of Fig. 5. Likewise if there is a forward bow in the strip the number of interceptions of the beam of unit A will be greater than that of unit C.

The three light disks which preferably rotate at equal speeds may be driven by any suitable means. I prefer to drive these disks by separate polyphase synchronous motors shown at A48, B48, and C48 which motors are connected as shown in Fig. 2 with the polyphase generator 49 which in turn is geared to the main drive shaft 8 as shown in Fig. 1. With this arrangement the speed of the disks bears a fixed relation to the speed of the moving material.

I shall now describe the apparatus which I have provided for controlling the operation of the motor 22 which operates the skew correcting mechanism in response to a difference in the frequency of output of photoelectric devices A45 and B45 and also the apparatus for controlling the direction of rotation of the motor 34 which operates the bow correcting mechanism in response to a difference in the output frequency of the photoelectric devices A45 and C45. In Fig. 6 I have shown the three photoelectric devices A45, B45, and C45 connected to have their output amplified by the similar three stage resistance coupled amplifiers A52, B52, and C52 respectively.

Inasmuch as these amplifiers are of common and well known form it is not thought necessary to give a detailed description thereof. It will be noted that amplifiers B52 and C52 are shown each having a single amplifier tube B53 and C53 respectively in the final stage while amplifier A52 is shown having two similar final stage amplifier tubes A53 and A'53, the purpose of which will be apparent as the description proceeds.

The output circuit of the amplifier tube B53 includes the primary of the transformer 54 and the output circuit of the amplifier tube A53 includes the primary of the transformer 55. The transformer 54 is provided with the two secondary windings 56 and 57 of which the former controls the grid circuit of the valve 58 and the latter controls the grid circuit of the valve 59. The two windings 56 and 57, however, are reversely connected to the grid circuits of valves 58 and 59 whereby at the same half cycle, which for convenience will be termed the positive half cycle, of the transformer voltage, the grid of the valve 58 is made less negative with respect to its cathode and the grid of the valve 59 is made more negative with respect to its cathode. The grid circuit of each of the valves 58 and 59 is provided with a suitable negative biasing means, such as a battery, by which the valves are biased to cut off; hence the current in the output circuit of each of said valves is negligible when no voltage is received from the windings 56 and 57.

The output circuit of the valve 58 is supplied by one half of the voltage across the voltage divider comprising the two fixed resistors 60 and the adjustable resistor or potentiometer 62 connected across the source 61 of direct current supply. The output circuit of the valve 58 includes the capacitor 63 which receives a charge whenever valve 58 is rendered conductive. The output circuit of the valve 59 includes the capacitor 64 and the capacitor 64 in series whereby when this valve is rendered conductive the former capacitor may discharge into the latter capacitor. The capacitance of the capacitor 64 is much greater than that of the capacitor 63 being preferably of the order of ten times greater. At each positive half cycle, therefore, the valve 58 becomes conductive and the capacitor 63 receives a charge. At each following (negative) half cycle the valve 59 becomes conductive and allows the capacitor 63 to discharge into capacitor 64.

The magnitude and duration of each half cycle or impulse by which the valves 58 and 59 are rendered conducting need be only sufficient to permit the capacitor 63 to become substantially charged to the voltage supplied thereto and to discharge into the capacitor 64 until the voltage across each capacitor is substantially the same. Any half cycles or impulses of greater magnitude or duration, hence, will not materially affect the total charge received by the capacitor 64.

The transformer 55 like the transformer 54 is provided with the two secondary windings 56' and 57' which control the operation of the valves 58' and 59' respectively in the same manner as the corresponding parts described above. In the output circuit of the valve 58' is the capacitor 65 which is like the capacitor 63 and which receives a charge during each half cycle of one polarity of the voltage supplied by the transformer secondary 56'. The valve 59' like the valve 59 permits the capacitor 65 to discharge into the larger capacitor 64 during each half cycle of the opposite polarity. The charges supplied to the capacitor 64 by each of the smaller

capacitors 63 and 65 are of opposite polarity, hence, they produce charges on the capacitor 64 of opposite polarity. If therefore the frequency of the output of the photoelectric devices A45 and B45 are equal, equal and opposite charges will be supplied from the capacitors 63 and 65 to the capacitor 64 and at the same rate and the net charge on the latter capacitor therefore will be zero. However, if the frequency of the output of the photo device B45 is greater than that of device A45, then capacitor 64 will acquire a net charge of one polarity; likewise, if the frequency of the output of the photo device A45 is greater than that of the device B45 the capacitor 64 will acquire a charge of the opposite polarity.

The polarity of the resulting charge on the capacitor 64 controls the direction of rotation of the motor 22. The apparatus which I have devised for effecting this control of motor 22 may comprise a plurality of similar valves but preferably comprises the single valve 67 shown as having duplicate cathode, grid and anode elements. It has two input circuits each connected across one of the two equal resistors 68 which resistors connect through the resistor 66 with the opposite sides of the capacitor 64. The two anodes of the valve 67 connect through the windings of the relays 69 and 70 with a suitable source of current which may be direct or alternating and the controlled circuits of these relays serve to close the motor circuits 71 or 72 respectively. The motor 22 may be of any well known and suitable form which is adapted to rotate in one direction or the other in accordance with whether the circuit 71 or the circuit 72 is energized. If, therefore, the resultant charge on the main capacitor 64 is zero the valve 67 will not pass sufficient current through either of its anode circuits to operate the relay connected therewith. If, however, the main capacitor 64 has a resultant charge in one polarity the valve 67 will pass current through one of its anodes, energizing one of the relays to cause the motor 22 to turn in one direction. If the main capacitor has a resultant charge in the opposite sense the valve 67 will pass current through the other anode circuit energizing the other relay to cause the motor to turn in the opposite direction.

The output circuits of the amplifier tubes A'53 and C53 include the primaries of the transformers 54' and 55'. Each of these transformers is provided with two secondary windings like the corresponding windings of the transformers 54 and 55 which windings control valves like the corresponding valves already described above. These valves control the charges received by the capacitors 63' and 65' and also control the discharge of those capacitors into the main capacitor 64' in the same manner as has been described above in connection with the corresponding capacitors 63, 65 and 64. The net charge on capacitor 64' whether in one sense or the other controls the direction of rotation of the motor 34, which may be like the motor 22, in the same manner as has been described above for the control of the motor 22 through the instrumentality of the valve 67', and the relays 69' and 70'. Thus if the output frequencies of the photoelectric devices A45 and C45 are equal, the resultant charge on the capacitor 64' will be zero and neither of the two relays 69' and 70' will be energized. However, if the frequency of output of the photo device C45 is greater than that of the photo device A45 in response to the presence of a rearward bow in the strip of material, then the main capacitor 64' will

receive a charge in a sense that will cause the valve 67' to energize the relay 69' to cause the motor 34 to turn in a direction that will increase the pressure between the rolls 29 and 25 thereby removing the bow condition. If after the rearward bow has been removed from the material the slippage of the material over the roll 25 does not prevent an overcorrection of that bow but results in the appearance of some forward bow, the apparatus obviously will respond thereto and operate in the reverse manner whereby the pressure between the rolls 29 and 25 will be decreased thereby to allow a somewhat greater amount of slippage.

By means of the potentiometer 62 suitable correction may be made for circuit variations and for capacitance variations in the capacitors 63 and 65. Also by the adjustment of this potentiometer the motor 22 may be controlled to respond only when the difference in the output frequencies of the photoelectric devices departs from a predetermined amount. For example, if it is desired that the output frequency of the device B45 normally shall be 30% higher than that of the device A45, the potentiometer 62 would be adjusted so that motor 22 would operate in the proper direction only in response to a certain small deviation from that difference in the output frequencies of the devices.

It will be seen that by the above-described apparatus both a condition of skew and a condition of bow in the material is corrected, the two functions being carried out simultaneously and independently. If desired the unit A may be duplicated whereby one may cooperate with the B unit to detect skew and the other cooperate with the C unit to detect bow. However, I prefer to employ a single A unit and combine it with both the B and C units in a manner such as I have disclosed.

I have chosen the particular embodiment described above as illustrative of my invention and it will be apparent that other modifications may be made without departing from the spirit and scope of my invention which modifications I aim to cover by the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. Apparatus for detecting a bowed condition of the weft members of a strip of woven material comprising means for producing a plurality of light beams directed on said strip and spaced apart laterally thereof, means for causing relative movement between the beams and the strip, the lines of said movement on said material being similarly inclined to the edges of the strip whereby the beams are intercepted by said weft members and means responsive to the difference in frequency of interception of said beams for indicating a bowed condition of said members.

2. Apparatus for detecting a bowed condition of the weft members of a strip of woven material comprising a plurality of photoelectric devices, means for directing a narrow light beam through said material on each of said devices, means for causing relative movement between each beam and said material whereby the beams are intercepted by said weft members, the lines of said movement being spaced apart laterally of and similarly inclined to the edge of said strip and apparatus responsive to the difference in frequency of output of said devices adapted to indicate a bowed condition of said members.

3. Apparatus for detecting a bowed condition of the weft members of a strip of woven material

comprising a plurality of photoelectric devices, means for directing a narrow light beam through said material on each of said devices, means for moving said material longitudinally of the strip, means for moving each of said light beams transversely of the strip whereby the beams are intercepted by the weft members of the material, the lines of movement of the beams on the material being spaced apart laterally and similarly inclined to the edge of the strip and apparatus responsive to the difference in frequency of output of said devices constructed to indicate a bowed condition of said members.

4. Apparatus for detecting a bowed condition of the weft members of a strip of woven material comprising a plurality of photoelectric devices, means for directing a narrow light beam through said material on each of said devices, means for causing relative movement between each beam and said material whereby the beams are intercepted by said weft members, the lines of said movement being spaced apart laterally and similarly inclined to the edge of said strip, means for moving the central part of the strip forward and means responsive to the difference in frequency of output of said devices for controlling said last mentioned means.

5. Apparatus for detecting a bowed condition of the weft members of a strip of woven material comprising a plurality of photoelectric devices, means for directing a narrow light beam through said material on each of said devices, means engaging the edges of said strip for moving the same longitudinally, means for moving each of the light beams transversely of the strip whereby the beams are intercepted by the weft members of the material, the lines of movement of the beams on the material being spaced apart laterally of and similarly inclined to the edge of the strip and apparatus responsive to the difference in frequency of output of said devices for moving forward the central portion of the strip faster than the edges thereof.

6. Apparatus for correcting a bowed condition of the weft members of a strip of woven material comprising means for directing a plurality of narrow light beams on said material at points spaced apart laterally of the strip, means for producing relative movement of the beams and the strip, the lines of said movement being similarly inclined to the edge of the strip whereby the beams are intercepted by said weft members, a photoelectric device arranged to receive the unintercepted portion of each beam and a driven member responsive to the difference in frequency of output of said devices for moving forward the central portion of said strip.

7. Apparatus for correcting a bowed condition of the weft members of a strip of woven material comprising means adjacent the opposite edges of said strip for directing a plurality of light beams thereon, means for moving said beams laterally of the strip, means engaging the edges of the strip for advancing it whereby said beams are intercepted by said weft members, the lines of movement of the beams on the strip being inclined in the same direction and making approximately equal angles with the edge of the strip, photoelectric devices arranged to receive the light of said beams not intercepted by said weft members, a driven roller adjacent the central portion of said strip and means responsive to the difference in frequency of output of said devices for pressing the strip against the roller.

8. Apparatus for separately detecting a bowed condition and a skewed condition of the weft members of a strip of woven material comprising means for producing a plurality of light beams directed upon said strip, two of said beams being spaced apart laterally of said strip, means for causing relative movement between said strip and each of said two beams, the lines of said movement on said material being similarly inclined to the edges of the strip and the line of movement of another beam being oppositely inclined to said edges and a plurality of devices, one responsive to the difference in frequency of interception of said two first mentioned beams by said weft members for indicating a bowed condition thereof and another responsive to the difference in frequency of interception of said other beam and one of the first mentioned beams by said weft members for indicating a skewed condition thereof.

9. Apparatus for separately correcting a bowed condition and a skewed condition of the weft members of a strip of woven material comprising

two photoelectric devices, means for directing a narrow light beam through said material on each of said devices at points spaced apart laterally of the strip, means for moving the edge portions of said strip longitudinally, means for moving said beams laterally of the strip, the lines of movement of the beams on the strip being similarly inclined to the edges of the strip, a third photoelectric device, means for directing a third narrow light beam through said material thereon, means for moving said third beam laterally of the strip, the line of movement of the third beam on the strip being oppositely inclined to that of the other beams, means responsive to the difference in frequency of output of said two devices for advancing the central portion of said strip faster than the edge portion thereof and means responsive to the difference in frequency of one of said two devices and said third device for changing the relative position of the two edges of said strip.

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