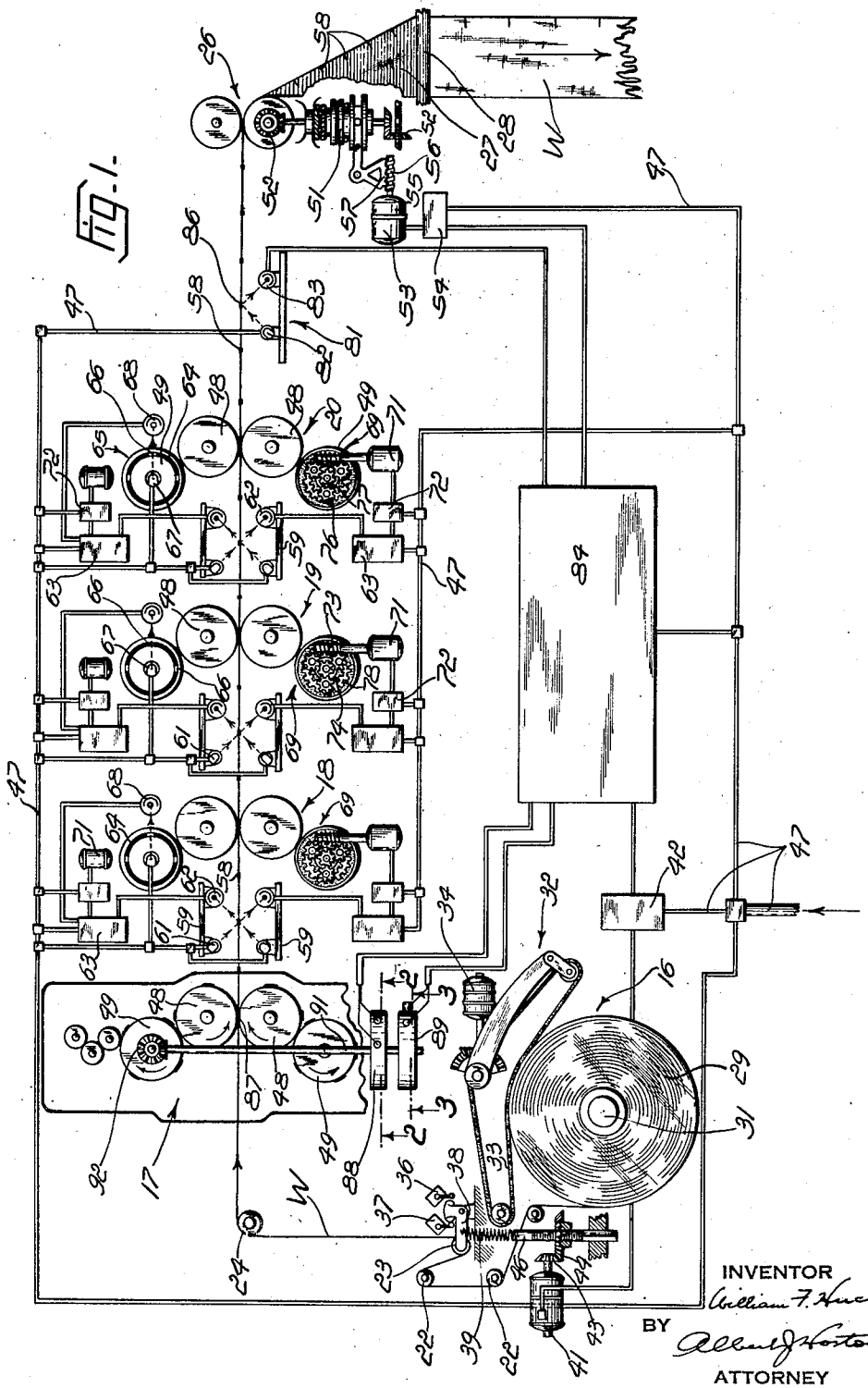
April 17, 1951 W. F. HUCK 2,549,605

REGISTER CONTROL DEVICE FOR WEB PRINTING MACHINES

Filed April 16, 1945 8 Sheets-Sheet 1

Fig. 1.



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REGISTER CONTROL DEVICE FOR WEB PRINTING MACHINES

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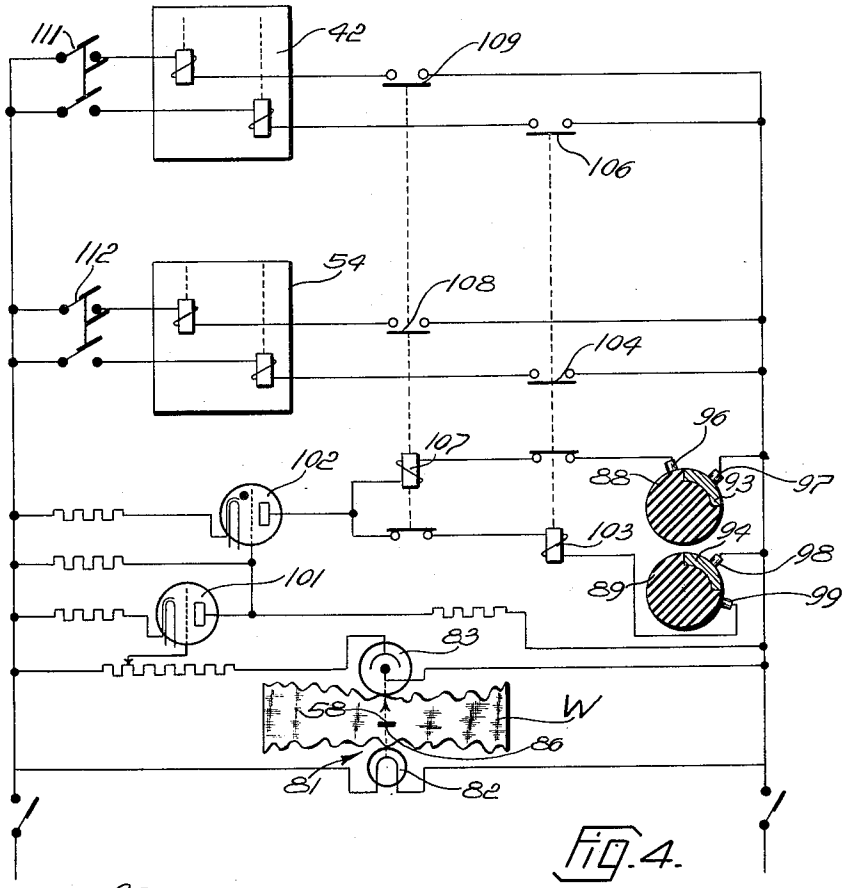


Fig. 4.

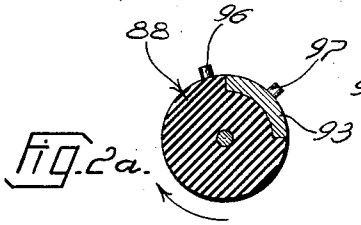


Fig. 2a.

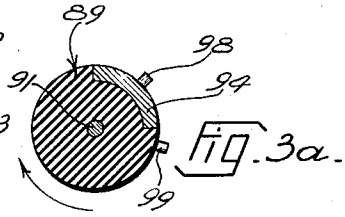


Fig. 3a.

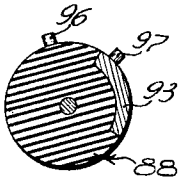


Fig. 2b.

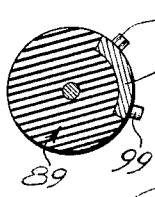


Fig. 3b.

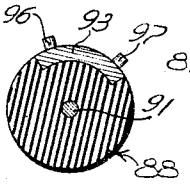


Fig. 2c.

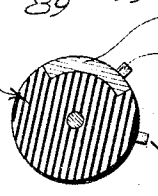


Fig. 3c.

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REGISTER CONTROL DEVICE FOR WEB PRINTING MACHINES

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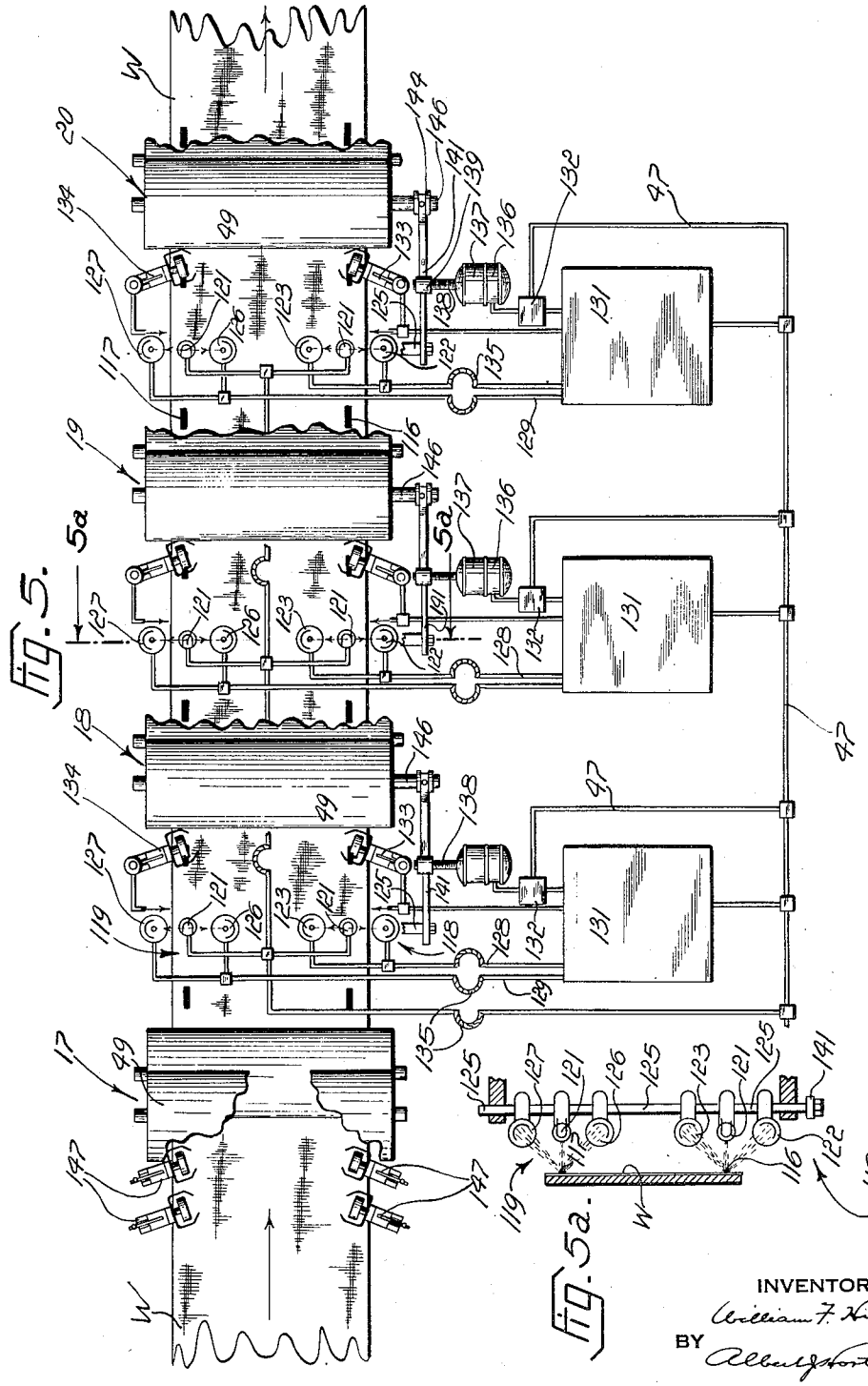


Fig. 5.

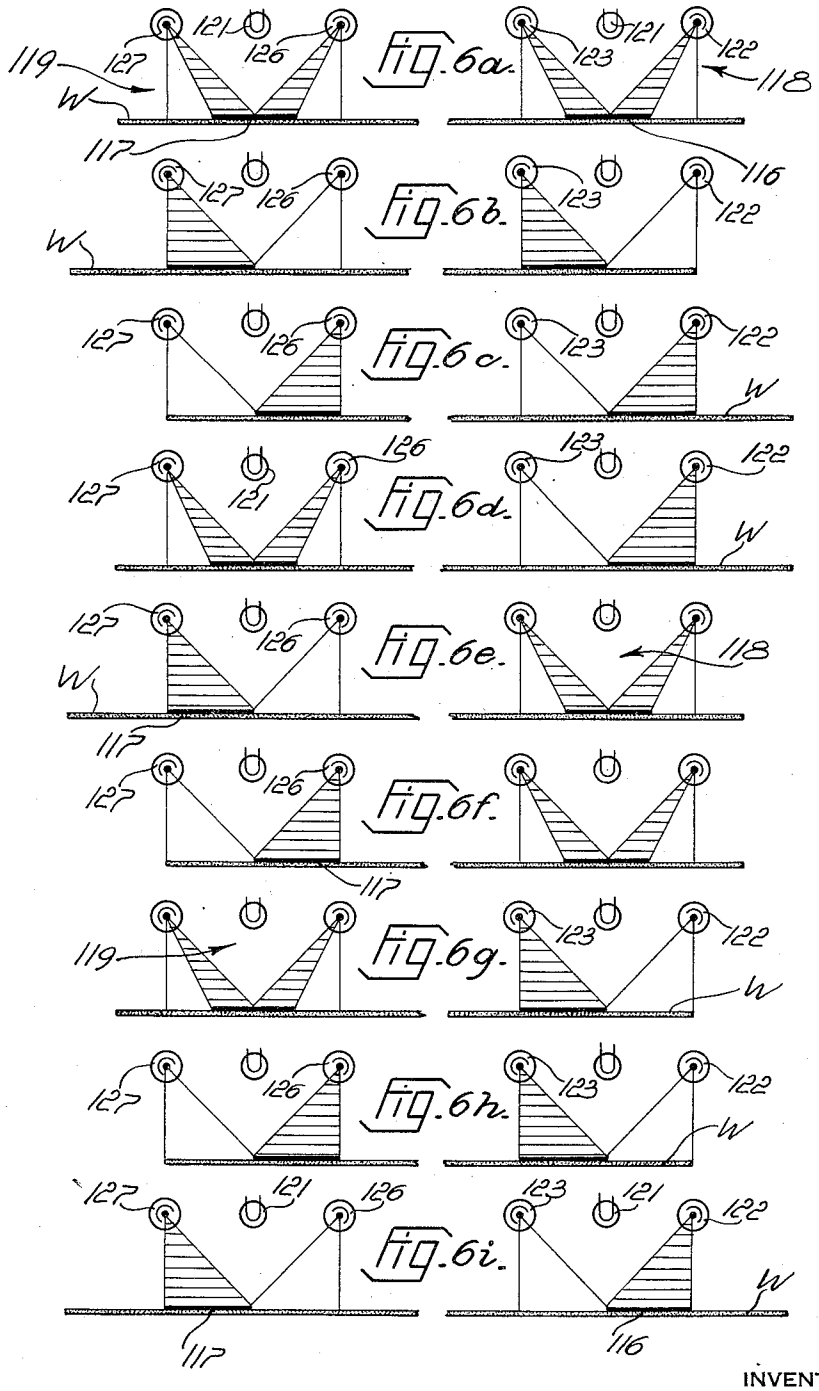
Fig. 5a.

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REGISTER CONTROL DEVICE FOR WEB PRINTING MACHINES

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REGISTER CONTROL DEVICE FOR WEB PRINTING MACHINES

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Fig. 7.

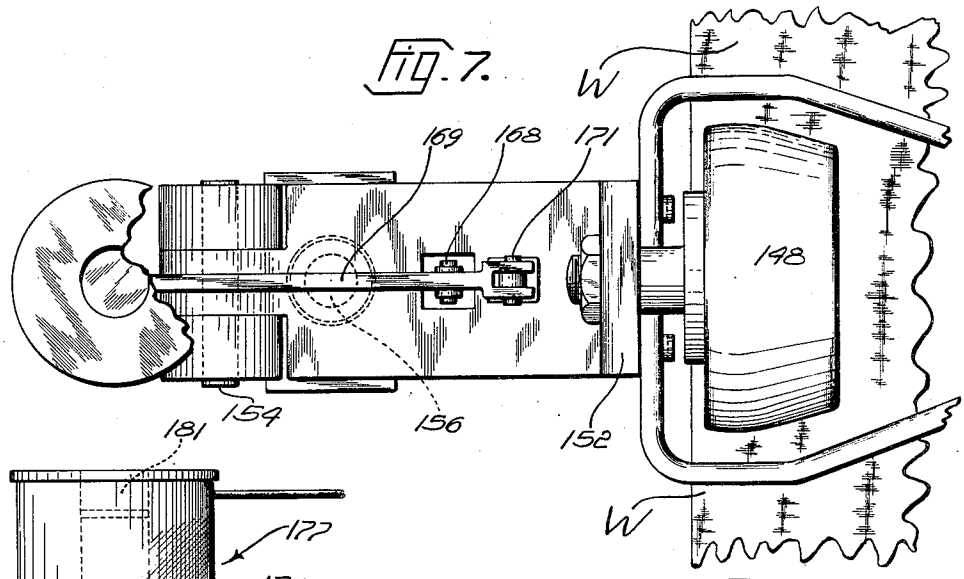


Fig. 8.

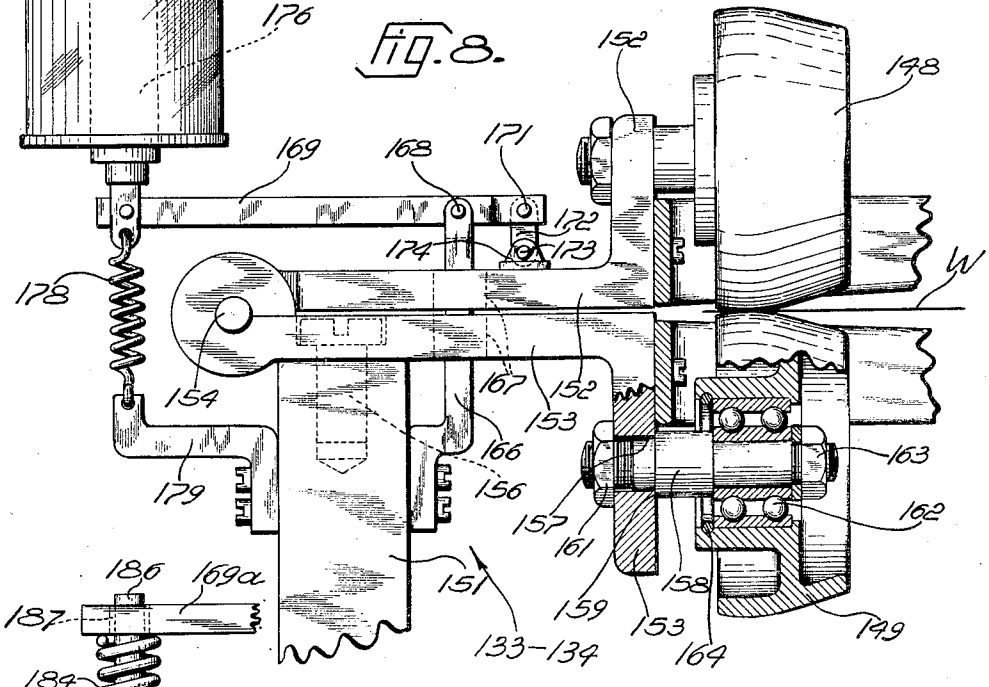
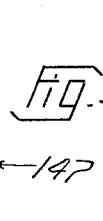


Fig. 9.



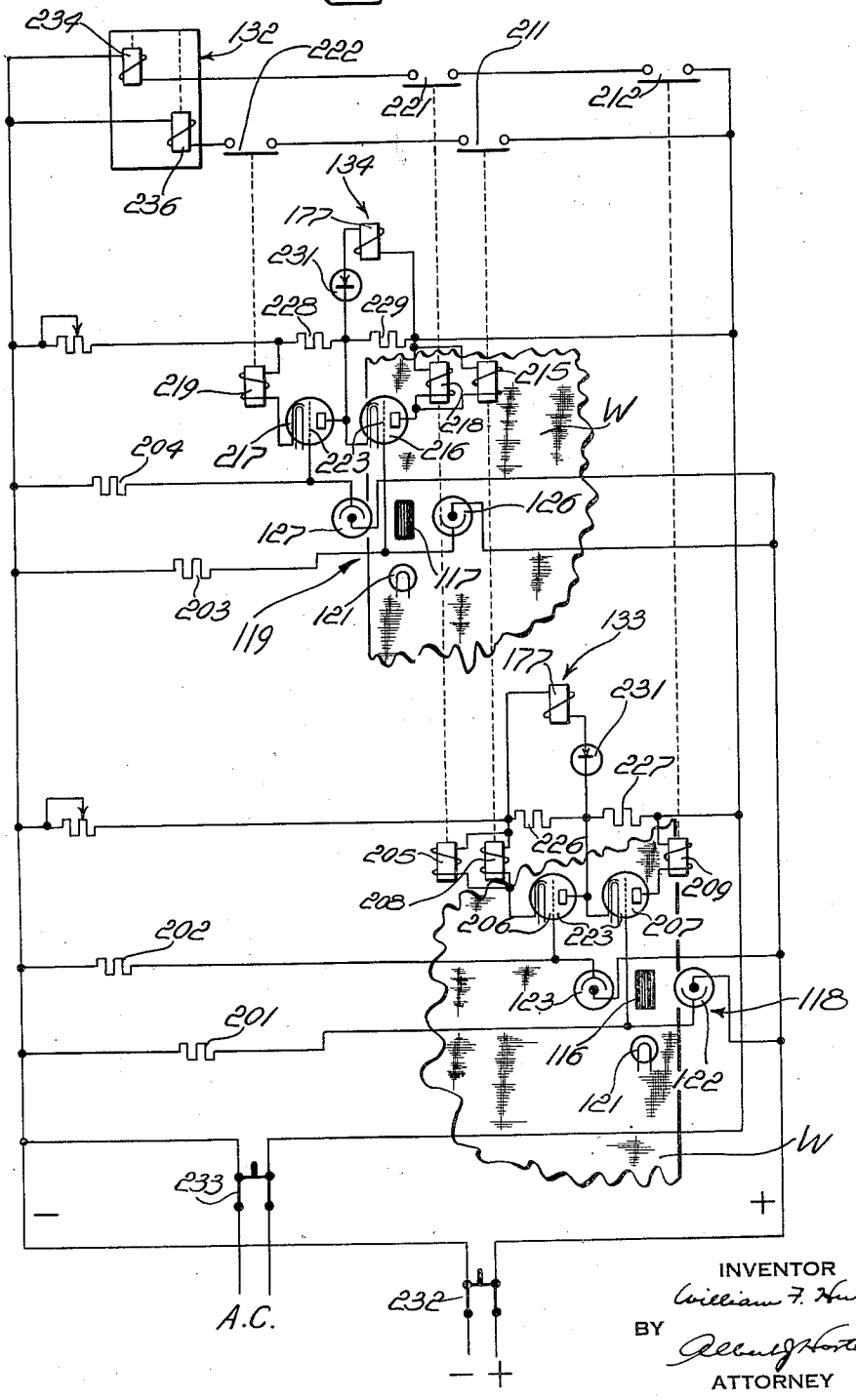
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REGISTER CONTROL DEVICE FOR WEB PRINTING MACHINES

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Fig. 10



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REGISTER CONTROL DEVICE FOR WEB PRINTING MACHINES

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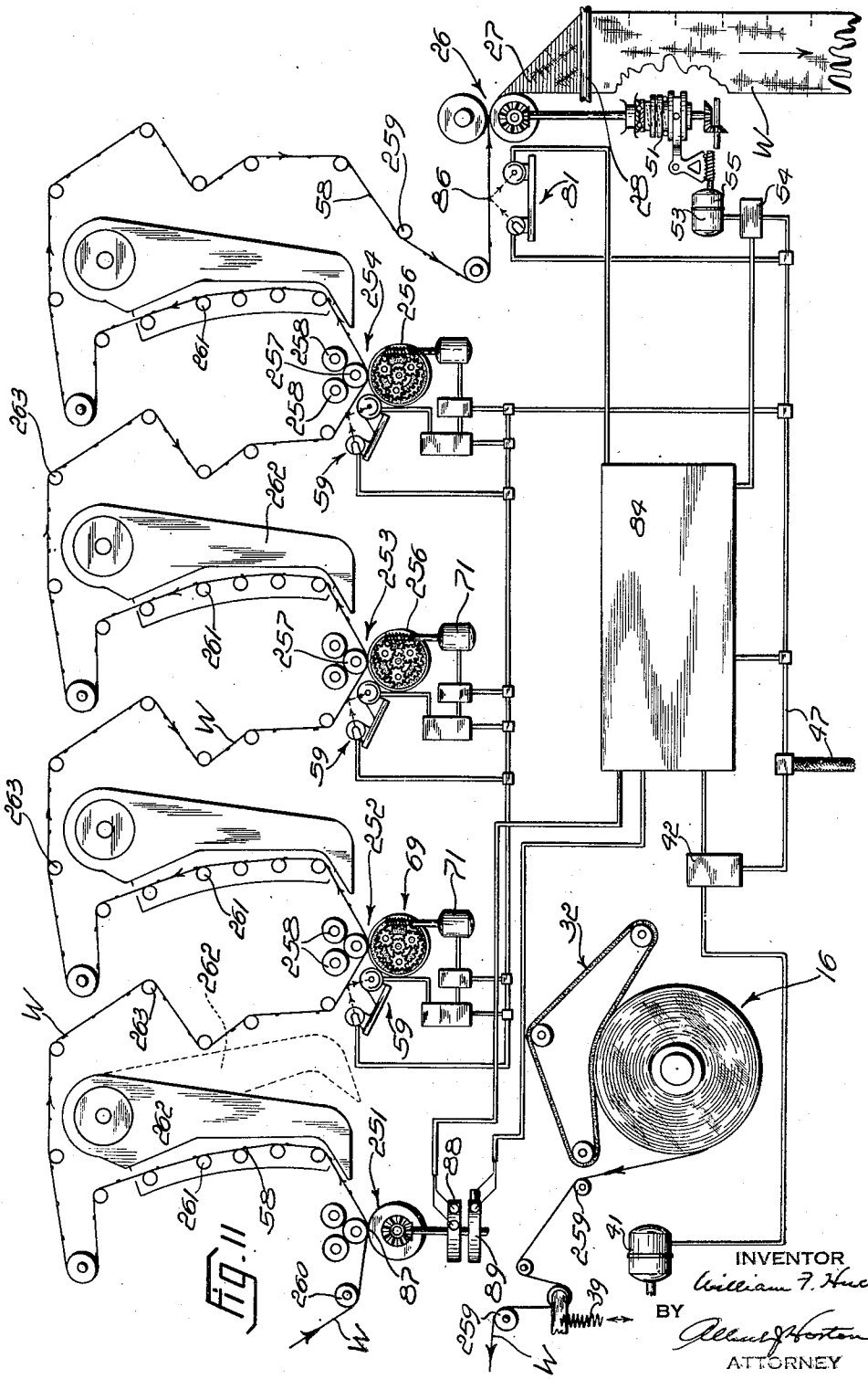


Fig. 11

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REGISTER CONTROL DEVICE FOR WEB PRINTING MACHINES

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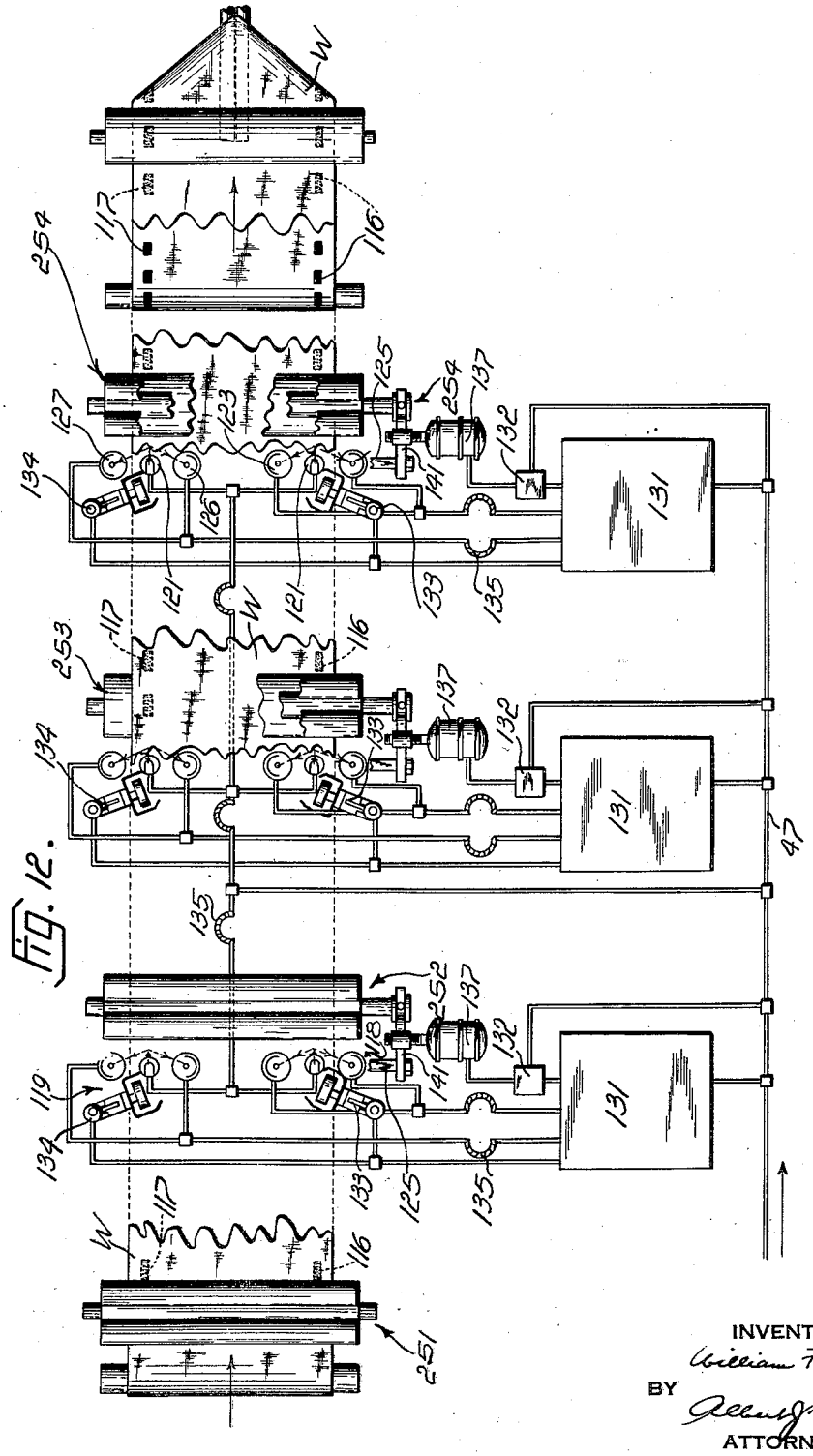


FIG. 12.

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Patented Apr. 17, 1951 2,549,605

UNITED STATES PATENT OFFICE

2,549,605

REGISTER CONTROL DEVICE FOR WEB PRINTING MACHINES

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Application April 16, 1945, Serial No. 588,438

9 Claims. (Cl. 101—181)

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This invention relates to web and register control mechanism for multi-color web printing machines and more specifically, to a method and means for varying tension on a web both longitudinally and transversely in order to improve register.

Multi-color web printing machines, especially those arranged for either lithographic or intaglio printing usually comprise a plurality of printing units positioned in a line with each printing unit arranged to successively print a different color. In a lithographic offset machine operating on newsprint or similar paper, each printing unit adds moisture to the web, and the accumulation of moisture causes the web to expand longitudinally and transversely as it passes through the machine. In the case of an intaglio printing machine, a heater is provided to dry the web after each color is printed, and thus as the web passes through the machine it becomes dryer and shrinks longitudinally and transversely as each color is printed.

Heretofore lateral register control for multi-color web printing machines has usually been accomplished by mechanism which shifts each printing cylinder axially, and mechanism for shifting compensating rollers, or mechanism for advancing or retarding each printing cylinder with respect to other cylinders, usually employed to control longitudinal register. Since the dimensions of a web change in passing through a printing machine, due to either loss or acquisition of moisture, it is apparent that accurate register control can not be obtained by simply changing the position of the printing cylinder. Therefore, it is an object of the invention to provide a new and improved method and means of web control whereby the spacing between like points in impressions printed on the web are maintained constant by variably stretching the paper or other material as it passes through a printing machine.

Another object of the invention is to provide, in the case of an offset press, a means for progressively decreasing the transverse tension applied to a web.

Another object of the invention is to provide, in the case of a press having heaters, of a means for progressively increasing the transverse tension applied to a web.

Another object of the invention is to provide a new and improved web stretching mechanism, that may operate simultaneously with a means for register control.

A preferred embodiment of the invention

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is illustrated in the accompanying drawings wherein:

Figure 1 is a diagrammatic elevational view, showing a conventional form of longitudinal register control in combination with one form of longitudinal web tensioning control as applied to a web offset press;

Figures 2*a*, 2*b* and 2*c* are sections taken along the line 2—2 of Figure 1, and showing various positions assumed by the mechanism;

Figures 3*a* 3*b* and 3*c* are sections taken along the line 3—3 of Figure 1, also showing various positions assumed by the mechanism;

Figure 4 is a schematic electrical wiring diagram showing a means for controlling the longitudinal web control mechanism shown in Figure 1;

Figure 5 is a diagrammatic plan view, partly broken away, showing a transverse register control in combination with a transverse web tensioning control as applied to the web offset press shown in Figure 1;

Figure 5*a* is a section, taken on the line 5*a*—5*a* of Figure 5 and showing means for supporting scanning heads shown in that figure;

Figures 6*a* to 6*i* diagrammatically show different transverse positions assumed by a web as it passes through the printing machine of Figure 5;

Figure 7 is a plan view of a web spreader device;

Figure 8 is an elevational view of the mechanism shown in Figure 7;

Figure 9 shows a modification of a portion of the device shown in Figure 8;

Figure 10 is a schematic electrical wiring diagram showing a means for controlling the transverse register and web control mechanism shown in Figure 5;

Figure 11 is a view similar to Figure 1, showing the longitudinal register and web control mechanism, as applied to an intaglio web printing machine;

Figure 12 is a view similar to Figure 5, showing the transverse register and web control mechanism as applied to the intaglio printing machine shown in Figure 11.

Referring to the drawings, Figures 1 to 10 show the applicant's invention, as applied to a multi-color offset lithographic web printing machine having a web supply mechanism 16 for supplying a web W to a plurality of printing units 17, 18, 19, and 20. The web W from the web supply mechanism is led over a plurality of guide rollers 22, a floating roller 23, a driven guide roller 24 and thence successively through the four

printing units where it is perfected in four colors. From the last printing unit, the web W is led to a pair of cooperating web propelling rollers 26 and thence to a former 27 and a folder 28. The printing machine herein shown is of conventional construction and is well known in the art, therefore, it is thought that the brief disclosure herein made will be sufficient.

The web supply mechanism 16 (Figure 1) comprises a web roll 29 rotatably supported on an axis 31, a web tensioning mechanism 32 having endless belts 33 under control of a motor 34 and a pair of "more tension" and "less tension" switches 36 and 37 respectively, that are controlled by the floating roller 23 positioned in a loop in the web W. An L-shaped lever 38, that carries the floating roller on one of its arms and which operates the switches 36 and 37 with the other arm, is biased by a tensioning spring 39. A motor 41 operated by a reversing contactor 42 has a bevel gear 43 arranged to drive a cooperating bevel gear 44, the hub of which is internally threaded to fit a longitudinally movable screw 46, secured to an end of the spring 39. Operating the motor 41 in one direction, increases the tension on the spring, while operating the motor in the other direction decreases the tension. The reversing starter 42, and thus the motor 41 are fed from an electric service conduit 47 which has branches to supply electric power to all of the electrically operated mechanism.

The individual printing units 17, 18, 19 and 20 are arranged to perfect the web W in a plurality of colors, by sequentially printing it in yellow, blue, red, and black on both sides. Each printing unit 17, 18, 19, and 20 includes two sets of cylinders, one set for operating on each side of the web and each pair of cylinders includes a printing or blanket cylinder 48 and a plate cylinder 49. It will be understood that all of the cylinders are driven from the main printing machine drive in a manner well known in the art.

As shown, the propelling roller 26 is driven from the main printing machine drive through an adjustable slip clutch 51 and a pair of cooperating bevel gears 52. The slip clutch device is adjusted by a reversible motor 53, connected to the electric service conduit 47 through a reversing contactor 54, and the motor is provided with a gear reduction 55. Rotating the motor 53 in one direction rotates a worm 56 carried on the shaft of the motor and adjusts a segmental gear 57 in one direction to increase the effect of the clutch and thus to increase the pull on the webs produced by the propelling roller 26, while operating the motor in the other direction decreases the pull thereof.

In accordance with known practice the first, or yellow printing unit 17, prints a succession of register marks 58 on both sides of the web. Preferably these marks, used for longitudinal registration of the web, will be printed in the center margin thereof, and may be about one-half an inch (½") long in a direction transverse to the direction of web travel and about two one-hundredths of an inch (0.02") in the direction of web travel. For convenience of illustration, the four printing units are shown spaced equi-distantly, however it will be understood that any conventional spacing may be used. Also the number of register marks printed by each revolution of the cylinder may vary, but for convenience, the herein illustrated machine shows four register marks printed per cylinder revolution. A viewing or scanning head 59, having an illuminating device, or lamp 61 connected to the electric conduit 47, and having a light sensitive cell 62 connected to an impulse compensator or mixer panel 63 is associated with each upper and lower blue, red, and black printing cylinder 48. One of the scanning heads views each side of the web just before it contacts the printing cylinders.

Although shown associated with only the upper plate cylinder 49, it will be understood that each plate cylinder of the blue, red and black printing units 18, 19, and 20 respectively is equipped with a scanning device 65, having a slotted scanning ring 64 with a plurality of slits 66 equal in number to the number of register marks printed on the web. As the ring 64 rotates, an illuminating device or lamp 67, located inside thereof intermittently illuminates a light sensitive cell 68 located outside of the ring. Each lamp 67 is connected to the electric service conduit 47 whereas each light sensitive device 68 is connected to the mixer panel 63.

A means for adjusting longitudinal register is provided and as herein embodied includes a means for circumferentially adjusting the plate cylinders, but it will be understood that compensating rollers may be used in place of the cylinder adjustment herein shown. Although shown associated with only the lower plate cylinders 49 (Figure 1), it will be understood that each plate cylinder of the blue, red and black printing units 18, 19, and 20 respectively is provided with an adjustable drive gear 69 operated by a reversing motor 71 and a reversing contactor 72, for circumferentially adjusting the plate cylinders in order to correct longitudinal register in a known manner. A shaft of the motor 71 carries a worm 73 which engages and drives a worm wheel 74 that carries three planetary pinions 76. The pinions 76 are in mesh with a sun gear 77 mounted on the shaft of the plate cylinder 49, and are also in mesh with an internally toothed rotatably mounted ring gear 78. During normal operation, the plate cylinder 49 will be driven at printing speed by a means not shown. This will cause the sun gear 77 to rotate the planetary pinions 76 and the ring gear 78 will be driven by the planetary gears. The worm wheel 74, which carries the three pinions 76 will be stationary under normal conditions, being held by the worm 73. If the scanning head 59 and the scanning device 65 indicate to the mixer panel 63 that the web will be out of register when printed by the next printing cylinders, the mixer panel will operate the contactor 72 and the motor 71 to circumferentially adjust the plate cylinder the required amount to effect proper longitudinal register.

The foregoing description is primarily concerned with a known register control means for shifting the printing cylinders circumferentially to improve longitudinal register. The following description of other mechanism associated with the offset press shown in Figure 1 will deal with mechanism for further improving longitudinal register by holding the web under such tension longitudinally and transversely as may be required to maintain the dimensions of the web constant while passing through the machine, regardless of the amount of moisture it may absorb while being printed.

A viewing or scanning head 81 located between the printing unit 20 and the folder 28 (Figure 1), has a lamp 82 connected to the power con-

duit 47, and a light sensitive cell 83 connected to a master control panel 84. The scanning head 81 views register marks 58 printed on the under side of the web as they pass a point 86 between the last printing unit 20 and the rollers 26. This mechanism, in cooperation with the previously described web tensioning mechanism 32, web propelling rollers 26, the master control panel 84, and a mechanism hereinafter described, maintains a constant spacing between like points in impressions printed on the web between a point 87 where the yellow printing cylinder prints the register marks 58 and the point 86 where the scanning head 81 views the marks.

It will be understood that the register marks 58, printed by the first or yellow printing unit 17, are spaced at equal distances apart and in order to obtain this arrangement, an equal number of register marks are printed by each revolution of the printing cylinders. A mechanism timed with the register marks printed by the unit 17 is provided, and as herein embodied comprises a pair of timing discs 88 and 89, secured to a shaft 91, that is driven through a pair of bevel gears 92, from the plate cylinder, preferably at a speed equal to the number of register marks printed per cylinder revolution. As previously stated, four register marks are printed per revolution of the plate cylinder, and hence the discs 88 and 89 are driven four times as fast as the plate cylinder 49. The insulated discs 88 and 89 as shown in Figure 4 each carry electrical conducting segments 93 and 94 respectively covering approximately 90 degrees of the circumference of the disc. The segment 93 connects a brush 96 with a brush 97, and the segment 94 connects a brush 98 with a brush 99, once during each revolution of the discs. It will be noted that the brush 96 is positioned somewhat more than 45 degrees from the brushes 97 and 98, and that brush 99 is spaced from the brushes 97 and 98 by an angle somewhat greater than 45 degrees. The timing discs are adjustably mounted and are initially set so they are both in open circuit position as shown in Figures 2*a* and 3*a* when no longitudinal correction of the web is necessary.

Figure 4 shows an elementary electrical diagram for controlling the two reversing controllers 42 and 54 and thus the two motors 41 and 53. Light from the illuminating device 82 is reflected from the web W to the light sensitive cell 83 and as each of the register marks 58 passes, the amount of light reaching the light sensitive cell 83 is momentarily decreased. The impulse thus created is amplified by a vacum tube 101, which in turn fires a thyratron or other gas filled tube 102 when either pair of brushes 96—97 or 98—99 is bridged by the segments 93 or 94 respectively, at the instant that the register mark passes by the light sensitive cell 83. When the length of web between the point 87, printed by the yellow printing unit, and the point 86 viewed by the scanning devices 81 is normal, the gas-filled tube 102 cannot fire because the circuits through both timer discs 88 and 89 are open, as shown in Figures 2*a* and 3*a*.

In the event that the web shrinks longitudinally, the register mark 58 will not be viewed by the scanning device 81 at the instant that both the circuits are open, but will be viewed after the timing discs 88 and 89 have advanced to the position shown in Figures 2*b* and 3*b*. In this position the segment 94 connects brush 98 to the brush 99 establishing a circuit through the thyratron 102 and a solenoid 103 of a first time delay

relay having switches 104 and 106. The reversing contactors 42 and 54 would then operate the motors 41 and 53 respectively, to apply more tension to stretch the web to its normal length.

In the event that the web stretches, the register mark 58 will be viewed by the scanning device 81 when the discs are in the positions shown in Figures 2*c* and 3*c*, before the instant at which both the discs 88 and 89 are open circuited. The segment 93 then connects the brush 96 to the brush 97 and establishes a circuit through a solenoid 107 of a second time delay relay having switches 108 and 109. The closing of switches 108 and 109 would operate the reversing contactors 42 and 54, and the motors 41 and 53, to apply less tension to the web so that it will assume the desired normal length.

It will be understood that any suitable mechanism time dwith the register marks at the first printing unit can be used in place of the pair of discs 88 and 89. For example a scanning head similar to the scanning head 81 can be arranged to view the register marks immediately following their printing by the first printing unit 17.

Manually operated switches 111 and 112 are provided in the circuits of the solenoids of the reversing contactor 42 and 54 respectively. Opening either the switch 111 or 112 prevents the contactors 42 or 54 and thus motors 41 or 53 from operating. This makes it possible to regulate either or both of the web tensioning means 26 and 32 as desired. It will be noted that the mechanism herein described is not arranged to maintain a constant tension on the web, but acts to maintain a constant dimension in the length of the printed web between like points in spaced impressions, as for example at points 86 and 87.

In addition to the register marks 58, previously described, the yellow unit 17 prints a row of register marks 116 (Figure 5) in the right hand margin of the web and a second row of register marks 117 in the left hand margin of one side of the web W. These marks 116 and 117, are used for transverse or side register web control and may be about two inches (2″) long in the direction of the web travel and about one-half an inch (½″) wide in a direction transverse to the direction of web travel.

Each of the blue, red, and black printing units 18, 19 and 20 has associated therewith right and left viewing or scanning heads 118 and 119 respectively for viewing the two rows of marks 116 and 117 just before the web enters each printing unit. Each of the right and the left scanning heads has an illuminating device or lamp 121 and a pair of light sensitive cells 122 and 123, and 126 and 127 respectively. The light sensitive cells 122 and 123 are focused on opposite sides of the register marks 116 and the light sensitive cells 126 and 127 are focused on opposite sides of the register marks 117, so the same amount of light is reflected to each light sensitive cell when the viewed register marks are centered in proper location. As the various register marks pass the scanning heads, impulses or indications, that are more fully described hereinafter are received by each set of light sensitive cells 122, 123, and 126 and 127. The scanning heads 118 and 119 are both carried on a support 125 that may be moved transversely of the web by means of a yoke 141.

The various indications received by each set of light sensitive cells are transmitted by means of circuits 128 and 129, having flexible portions 135, to a mixer control panel 131 that receives a

source of electric power from the conduit 47. Each panel 131 operates a reversing contactor 132 and a pair of electrically controlled angularly disposed web-spreading devices 133 and 134 located at the right and left of the web respectively.

The contactor 132, which is connected to the source of power by the circuit 47, controls a motor 136, having a gear reduction 137 and a threaded output shaft 138. A nut 139, carried by the yoke 141, is adjustably screw threaded to the shaft 138. The heaviest end of the yoke 141 engages a double-flange collar 144 secured to a shaft 146 of the plate cylinder 49, whereas the lighter end of the yoke 141 is secured to the support 125. Operating the motor 136 in a forward or reverse direction shifts the yoke 141 and moves the cylinder axially to adjust side register. This also causes the scanning heads 118 and 119 to move transversely of the web to follow the movement of the cylinder.

In addition to the web spreading devices 133 and 134, a double pair of manually adjusted web spreading devices 147 are arranged to transversely spread the web just before it enters the first or yellow printing unit 17. By properly adjusting these four spreaders manually the web will be stretched to a width equal to the width it will assume due to the acquisition of moisture from the printing cylinders.

As the web expands due to the acquisition of moisture the web spreading devices 133 and 134 before each of the blue, red and black printing cylinders will automatically apply less and less transverse pull to the web. Thus the web after it leaves the black printing unit 20 will, without the aid of any spreader rollers, be the same width as the unprinted web was when it entered the yellow printing unit 17.

The web spreading devices 133 and 134 (Figures 7 and 8) each have paired cooperating rollers 148 and 149 of approximately frustro-conical form, one located above and one below the web W. The plane in which the rollers rotate as seen in Figure 5, is at an angle to the edge of the web with the result that each pair of rollers applies a side pull to the running web.

Each web spreading device has a bracket 151 (Figures 7 and 8) which may be secured to convenient portion of the printing machine frame (not shown). An upper L-shaped arm 152, carrying the upper roller 148 is hinged to a lower arm 153 at 154. The lower L-shaped arm 153 is secured to the bracket 151 by a bolt 156. Each arm is provided with a hole 157 through which extends one end of an axle 158 having a shoulder 159 abutting the arm. A nut 161 screw threaded to the axle secures it to the arm. Each axle carries an anti-friction device or ball bearing 162, the inner race of which is secured thereto by a nut 163. The outer race of each bearing carries one of the rollers 148 or 149 which is secured thereto by a snap ring 164. A bracket 166 secured to the bracket 151 extends through a hole 167 in each of the arms 152 and 153, and by means of a pin 168 provides a fulcrum for a lever 169, one end of which is secured to the upper arm 152 through a pin 171, a link 172, a pin 173 and a bracket 174. The other end of the lever 169 is pivoted to the lower end of a plunger 176 of a solenoid 177. Attached to the extreme lower end of the plunger 176 is a tension spring 178, the other end of which is secured to a bracket 179 that in turn is secured to the bracket 151. The upper end of the plunger 176 is positioned close to a pole piece 181 located internally of the solenoid, thus permitting the plunger a limited vertical movement. When the solenoid 177, is energized the plunger moves upward against the spring 178 and raises the end of the lever 169 causing increased pressure of the upper roller against the web W and the lower roller 149. When the current passing through the solenoid 177 is decreased, the pressure of the roller 148 against the web is decreased.

The web spreaders 147 (Figure 5) may be duplicates of the spreader 133 and 134 except that the solenoid 177, the tension spring 178, the bracket 179, and plunger 176 are replaced by a threaded adjusting stem 182 (Figure 9) having a knurled handle 183 screwed into a bracket 185 for increasing or decreasing the pressure of a compression spring 184 against the lower side of a lever 169*a*, analogous to the levers 169, for manually adjusting the pressure applied to the web W by the rollers 148 and 149. The stem 182 has an unthreaded end 186 that passes through the spring 184 and a hole 187 in the arm 169*a*, the arrangement being such that spring pressure and the bite of the roller on the web can be completely released.

Figures 6*a* to 6*i* diagrammatically show the instantaneous positions taken by the web W and the register marks 116 and 117, and also show the illumination reflected to the four light sensitive devices 122, 123, 126 and 127 at the instant after the web has shifted, expanded or shrunk sidewise. These indications as hereinbefore described are transmitted to the mixer control panel 131 and there open and close a plurality of solenoid operated switches hereinafter described, which in turn control the contactor 132, the motor 136, and the web spreading devices 133 and 134.

Specifically Figure 6*a* shows the web W properly registered. The cells 122 and 123, and the cells 126 and 127, receive equal amounts of reflected light, and thus the motor 136 and the web spreading devices 133 and 134 will remain unadjusted.

Figure 6*b* shows the whole web W shifted to the left, the cells 127 and 123 being darkened while the cells 126 and 122 receive increased illumination. This causes the motor 136 to shift the plate cylinder 49 and the scanning heads 118 and 119 to the left to follow the shifted web.

Figure 6*c* shows the whole web W shifted to the right with the cells 126 and 122 darkened while the cells 127 and 123 receive increased illumination. This causes the motor 136 to shift the plate cylinder and the scanning heads 118 and 119 to the right to follow the shifted web.

Figure 6*d* shows the web stretched toward the right with the cell 123 receiving increased illumination while the cell 122 is darkened and the illumination received by the cells 127 and 126 is not changed. This causes the pull of the right web spreader 133 to be decreased.

Figure 6*e* shows the web stretched toward the left with the cell 126 receiving increased illumination and the cell 127 darkened. This causes the pull of the left web spreader 134 to be decreased.

Figure 6*f* shows the web shrunk at the left with the cell 127 receiving increased illumination and the cell 126 darkened. This causes the pull of the left spreader 134 to be increased.

Figure 6*g* shows the web shrunk at the right with the cell 122 receiving increased illumination and the cell 123 darkened. This causes the pull of the right spreader roller 133 to be increased.

Figure 6*h* shows the web shrunk at both sides

with the cells 122 and 127 receiving increased illumination and the cells 123 and 126 darkened. This causes the pull of both spreaders 133 and 134 to be increased.

Figure 6*i* shows the web to be stretched at both sides with the cells 122 and 127 darkened and the cells 123 and 126 receiving increased illumination. This causes the pull on both spreaders 133 and 134 to be decreased.

Figure 10 illustrates, by means of a schematic electrical wiring diagram, a means by which the light sensitive cells 122, 123, 126 and 127, control the web spreaders 133, 134 and the reversing contactor 132. In addition to devices hereinbefore mentioned, this equipment includes resistors 201 and 202 associated with the cells 122 and 123 respectively, and resistors 203 and 204 associated with the cells 126 and 127 respectively. A vacuum tube 206 is connected in series with a parallel circuit containing solenoids 205 and 208, the latter being arranged for closing a normally open switch 211. A vacuum tube 207 is connected in series with a solenoid 209 for closing a normally open switch 212. A vacuum tube 216 is connected in series with a parallel circuit containing solenoids 215 and 218 the latter being arranged for closing a switch 221. A vacuum tube 217 is connected in series with a solenoid 219 for closing a normally open switch 222. The grids 223 of the four tubes 206, 207, 216 and 217 are controlled by the four cells 123, 122, 126 and 127 respectively, whereas the hereinbefore mentioned four series circuits are short circuited by resistors 226, 227, 229 and 228 respectively. The solenoids 177 of the web spreaders 133 and 134 are each connected in series with a rectifier 231 and the series circuit thus created is connected in parallel with resistors 226 and 229 respectively.

The four light sensitive cells are energized from a direct current source 232 whereas the four vacuum tubes, the web spreader solenoids, and the reversing contactor 132 are energized from an alternating current source 233. The switches 211 and 222 are connected in series with an operating solenoid 236, whereas the switches 212 and 221 are connected in series with an operating solenoid 234 of the reversing contactor 132.

It will be apparent that the tube-resistor combinations 207—227 and 217—228 are in series relationship with the solenoids 177 of the spreaders 133 and 134 respectively, whereas the tube-resistor combinations 206—226 and 216—229 are in parallel relationship therewith. When the current through the vacuum tubes 207 or 217 is increased or decreased the current through the solenoids 133 or 134 will be correspondingly increased or decreased, and if the current through the tubes 206 and 216 is increased or decreased, the circuit through the solenoids of the devices 133 or 134 decreases or increases respectively.

In operation of the mechanism shown in Figure 10, if the register marks 117 shift to the left (Figure 6*e*), the light received by the cell 127 is decreased and the light received by the cell 126 is increased and the grids 223 of the tubes 217 and 216 become more negative and less negative respectively. This double effect decreases the current through the solenoid 177 of the spreader roller 134 and thus decreases the pull on the left side of the web. If the register mark 117 shifts to the right, the light received by the cell 127 is increased and the light received by the cell 126 is decreased (Figure 6*f*), and the grids of the tubes 217 and 216 become less negative and more negative respectively. This increases the current through the solenoid of the spreader roller 134 and thus increases the side pull on the side of the web. In like manner the cells 122 and 123 control the solenoid of the spreader roller 133.

If the whole web W shifts to the left (see Figure 6*b*), the currents in the solenoids 209 and 218 are increased to such an extent that the switches 212 and 221 will close to energize the solenoid 234 of the reversing contactor 132. This causes the form cylinder and the scanning heads 118 and 119 to be shifted to the left as hereinbefore described. In like manner a shifting of the whole web W to the right (Figure 6*c*) causes a closing of the switches 211 and 222 energizing the solenoid 236 and moving the form cylinder and the scanning heads to the right. As soon as the cylinders and scanning heads have moved sufficiently to compensate for the change in the web, the light reflected to the scanning heads will be equalized and the contactor 132 will stop the motor 136.

The solenoids 205 and 215, as hereinbefore described, are in parallel with the solenoids 208 and 218 respectively, and act as interlocks to insure that all four switches 211, 212, 221 and 222 are not closed at the same time when the four light sensitive cells 122, 123, 126 and 127 view the unprinted web between marks. It will be understood that energizing the solenoids 205 and 215 will prevent the closing of switches 221 and 211 respectively, even though the solenoids 218 and 208 are energized sufficiently to close them. If the whole web shifts to the left, the current flowing in solenoid 205 will decrease during the period when the register marks are being viewed by the light sensitive cells, and the solenoid 218 will be able to close the switch 221 as hereinbefore described, and if the web W shifts to the right, the current flowing in the solenoid 215 will be decreased and thus will not interfere with the closing of the switch 211 by the solenoid 208.

When the whole web W shifts to the right or left (Figure 6*b* or 6*c*) the web spreader rollers 133 and 134 will also be affected. Consideration of Figure 10 will show that a shift of the whole web to the left will slightly decrease the pull of the left spreader roller 134 and slightly increase the pull of the right roller 133. In like manner a shift of the whole web to the right will decrease the pull of the right roller 133 and increase the pull of the roller 134. Thus the register and web control mechanisms operate together to maintain proper register.

From the foregoing it is apparent that if the web W while passing through the printing machine shrinks or stretches longitudinally or transversely the web control mechanism disclosed will function to so shift or stretch the web that the printing of the several cylinders will be in accurate register.

Figures 11 and 12 show the invention as applied to a multi-color intaglio web printing machine, the arrangement being similar to that shown in Figures 1 and 5 respectively. Printing units 251, 252, 253, and 254, located in a line, are arranged to print the web W by consecutively printing a plurality of colors as for example yellow, blue, red and black, on one side of the web. In addition to the printing units shown, the machine preferably will include one or more printing units for printing on the opposite side of the web. Each printing unit includes an intaglio form cylinder 256 and a cooperating im-

pression cylinder 257. The impression cylinder is engaged by speed rollers 258 which reinforce it against movement away from the form cylinder during the printing operation.

A plurality of web guide rollers 259 are provided to guide the web W from the web supply mechanism 16 to the printing units not shown, and rollers 260 guide the web from these units to the unit 251. After the web W is printed by the unit 251 it is guided from printing unit to printing unit by a plurality of rollers 261, operably supported in a web drying device 262 of conventional construction. After the web leaves the web drying device it is guided by rollers 263 to the next printing unit or to the propelling rollers 26 and folder 28.

Figures 11 and 12 disclose a heater equipped multicolor intaglio printing machine, the arrangement being very similar to that shown in Figures 1 and 5 respectively. The web supply mechanism 16, although not fully illustrated in Figure 11, has a web tensioning mechanism 32 that may be the same as that shown in Figure 1. The yellow printing unit 251 prints a succession of register marks 58 on one side of the web W and a scanning head 59 views the register marks as the web enters each of the blue, red and black printing units 252, 253 and 254. Each blue, red and black printing cylinder 256, although not shown, is understood to be equipped with a slotted scanning ring, a lamp and a light sensitive cell of construction similar to that shown for rings 64, lamp 67 and light sensitive cell 68 shown in Figure 1. Each of the blue, red and black printing cylinders is preferably equipped with a registering mechanism which, as shown includes an adjustable drive gear 69 with an operating motor 71. As an alternative to such drive mechanism, a compensating roller of well known type and a motor for operating it may be used. The scanning device 81 is focused to view the register marks 58 at the point 86 and cooperates with the propelling roller 26, panel 89 and discs 88 and 89 to maintain a constant length of web between the points 86 and 87 in the manner hereinbefore described.

The yellow printing unit 251 also prints the series of register marks 116 and 117 in the right and left hand margins of the web W (Figure 12), and the blue, red, and black printing unit each have the right and left scanning head 118 and 119 and the right and left spreader roller 133 and 134 cooperating with the control panel 131 for adjusting the printing cylinder circumferentially, or axially, or stretching or allowing the web to contract in order to provide register and web control for the web as it changes size due to absorption or expulsion of moisture.

The transverse web control mechanism for the intaglio printing machine shown in Figure 12 differs from that shown in Figure 5 in that manually operated spreader rollers are not used to stretch the web W before it is printed by the yellow printing unit 251. The web W, as it passes through the intaglio printing machine shown in Figures 11 and 12, is heated, becomes drier, and shrinks with each printing. For this reason the web spreader rollers 133 and 134 before the printing units 252, 253 and 254 will successively exert more and more force in order that the dried web when it enters the last or black printing unit will be the same width as it was when it entered the yellow unit. Aside from the differences mentioned, the operation of the mechanism disclosed in Figures 11 and 12 is substantially the same as the operation of the devices hereinbefore described.

Many variations in the above described mechanism can be made without departing from the spirit of the invention as defined by the appended claims. For example, instead of shifting the printing cylinder transversely to follow variations in the printed web, the web can be shifted by means of well known tilting rollers. Also, instead of operating the web spreaders 133 and 134 as hereinafter described, wherein either spreader may pull or relax its side of the web, or wherein both may operate together to pull or relax both sides of the web; both web spreaders can be made to increase or decrease the side pull simultaneously, so that if either or both sides of the web move inwardly, the pull of both spreaders will increase, and if either or both sides of the web move outwardly, the pull of both spreaders will be relaxed. This operation may cause the printing to be slightly out of register. However, any mis-register will immediately be corrected by shifting of the printing cylinders or by shifting of the web.

It will also be understood that the register marks can be variously printed. For example, instead of controlling the transverse movement of the cylinder from the double register marks 116 and 117, a single register mark printed in the center of the web may be used. Thus the invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof, and it is therefore desired that the present embodiments be considered in all respects as illustrative and not restrictive, reference being made to the claims rather than to the foregoing description for an indication of the scope of the invention.

What I claim is:

1. In a multi-color web fed printing machine comprising a web feeding mechanism having a web tensioning mechanism, a plurality of individual printing units for successively printing a plurality of colors on the web, the first printing unit being arranged to print a succession of register marks, and a web propelling roller arranged to receive and forward the web after it has been printed by the other printing units; mechanism timed with the register marks at the first printing unit, a light sensitive cell for viewing the register marks on the web at a point between the last printing unit and the web propelling roller, and means actuated by the light sensitive cell for controlling the web tensioning mechanism and the web propelling roller the said means being arranged to increase the tension exerted on the web by the tensioning mechanism and web propelling roller when the register marks are delayed in reaching the point viewed by the light sensitive cell and decreasing the tension when the register marks reach this point prematurely, whereby a constant length of web will be maintained between each register mark passing the timed mechanism and a register mark then passing the said light sensitive cell.

2. In a multi-color web fed printing machine comprising a web feeding mechanism having a web tensioning mechanism, a plurality of individual printing units for successively printing a plurality of colors on the web, the first printing unit being arranged to print a succession of register marks, and a web propelling roller arranged to receive and forward the web after it has been printed by the other printing units; mechanism timed with the register marks at the first print-

ing unit, a light sensitive cell for viewing the register marks on the web at a point between the last printing unit and the web propelling roller, and a means for controlling the web tensioning mechanism the said means being arranged to increase the tension exerted on the web by the tensioning mechanism and web propelling roller when the register marks are delayed in reaching the point viewed by the light sensitive cell and decreasing the tension when the register marks reach this point prematurely, whereby a constant length of web will be maintained between each register mark passing the timed mechanism and a register mark then passing the said light sensitive cell.

3. In a multi-color web fed printing machine comprising a web feeding mechanism having a web tensioning mechanism, a plurality of individual printing units for successively printing a plurality of colors on a web, the first printing unit being arranged to print a succession of register marks, and web propelling rollers arranged to receive and forward the web after it has been printed by the other printing units; mechanism timed with the register marks at the first printing unit, a light sensitive cell for viewing the register marks on the web at a point between the last printing unit and the web propelling rollers, and means for controlling the web propelling rollers the said means being arranged to increase the tension exerted on the web by the tensioning mechanism and web propelling roller when the register marks are delayed in reaching the point viewed by the light sensitive cell and decreasing the tension when the register marks reach this point prematurely, whereby a constant length of web will be maintained between each register mark passing the timed mechanism and a register mark then passing the said light sensitive cell.

4. In a multi-color web fed printing machine comprising a web feeding mechanism having a web tensioning means, a plurality of individual printing units having form cylinders and printing cylinders for successively printing impressions in a plurality of colors on both sides of a web, the first printing unit being arranged to print a succession of register marks on both lateral edges of the web, and web propelling rollers arranged to forward the web after it has received the last impression; a timing mechanism timed with the printing of the register marks, first light sensitive cells located on each lateral edge of the web for viewing the register marks printed thereon and a mechanism controlled by each of the said cells and arranged to circumferentially adjust one of the cylinders to correct register, and a second light sensitive cell located at a point between the last printing unit and the web propelling roller and arranged for controlling the web tensioning mechanism and the web forwarding rollers, whereby a constant length of web will be maintained between each register mark passing the first impression cylinder and a register mark then passing the point viewed by the second light sensitive cell, and the printing cylinders will be adjusted so as to maintain correct register.

5. In a multi-color web fed printing machine comprising a plurality of individual printing units for successively printing a plurality of colors on a web, a first printing unit arranged to print a succession of paired register marks, one being located near each edge of the running web, a first pair of light sensitive devices for simultaneously viewing the paired register marks, a first pair of web spreader rollers under the control of the light sensitive devices, a second pair of light sensitive devices, and a second pair of web spreader rollers under the control of the second light sensitive devices, another printing unit between the first and second pairs of light sensitive devices and web spreader rollers, the second pair of web spreading devices being arranged to produce a different degree of tension on the web than is produced by the first pair of spreader rollers, and each pair of light sensitive devices being arranged to operate the web spreading devices controlled by it to maintain a constant widthwise spacing between the pair of register marks.

6. In a multi-color web fed lithographic printing machine comprising a plurality of individual printing units having form and printing cylinders for successively printing a plurality of colors on the web, a plurality of manually operated web spreading devices arranged to spread the web before it is printed by the first printing unit, a plurality of electrically operated web spreading devices arranged between the printing units to control the web before it is printed by each of the successive printing units, and photocell control mechanism for the electrically operated web spreading devices including means between the printing units for scanning register marks near the edges of the web.

7. In a multi-color web fed printing machine having a plurality of printing units each equipped with a printing cylinder for printing a plurality of colors on a web, a light sensitive device for viewing one side of a first register mark printed on the web, a second light sensitive device for viewing the other side of the first register mark, a third light sensitive device for viewing one side of a second register mark printed on the web, a fourth light sensitive device for viewing the other side of the second register mark, a web spreader device under control of the first and second light sensitive devices, a second web spreader device under control of the third and fourth light sensitive devices, and means under control of the four light sensitive devices for adjusting the printing cylinder axially.

8. In a multi-color web fed printing machine comprising a plurality of individual printing units having cylinders for successively printing a plurality of colors on the web, a plurality of web spreading devices for controlling the transverse dimensions of the web, a means for correcting longitudinal misregister and including means for varying the longitudinal tension on the web between the printing units, a light sensitive scanning device positioned for reading register marks on the web, and a control mechanism responsive to the light sensitive device and operating the web spreading devices to maintain a constant width of the web between the register marks.

9. In a multi-color web fed printing machine comprising a plurality of individual printing units arranged to successively print a plurality of colors on a web, in combination, first means automatically to control the longitudinal and transverse register of the printing, the longitudinal register controlling means comprising means for varying the longitudinal tension on the web, second means operating simultaneously with the first means to automatically control the longitudinal and transverse dimensions of the web, a control mechanism for the last said means in-

cluding light sensitive devices positioned for reading register marks on the web and operating the said means to maintain a constant width of web between the register marks.

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