

Sept. 8, 1964

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3,147,898

TRANSVERSE WEB CONTROL DEVICES

Filed July 10, 1962

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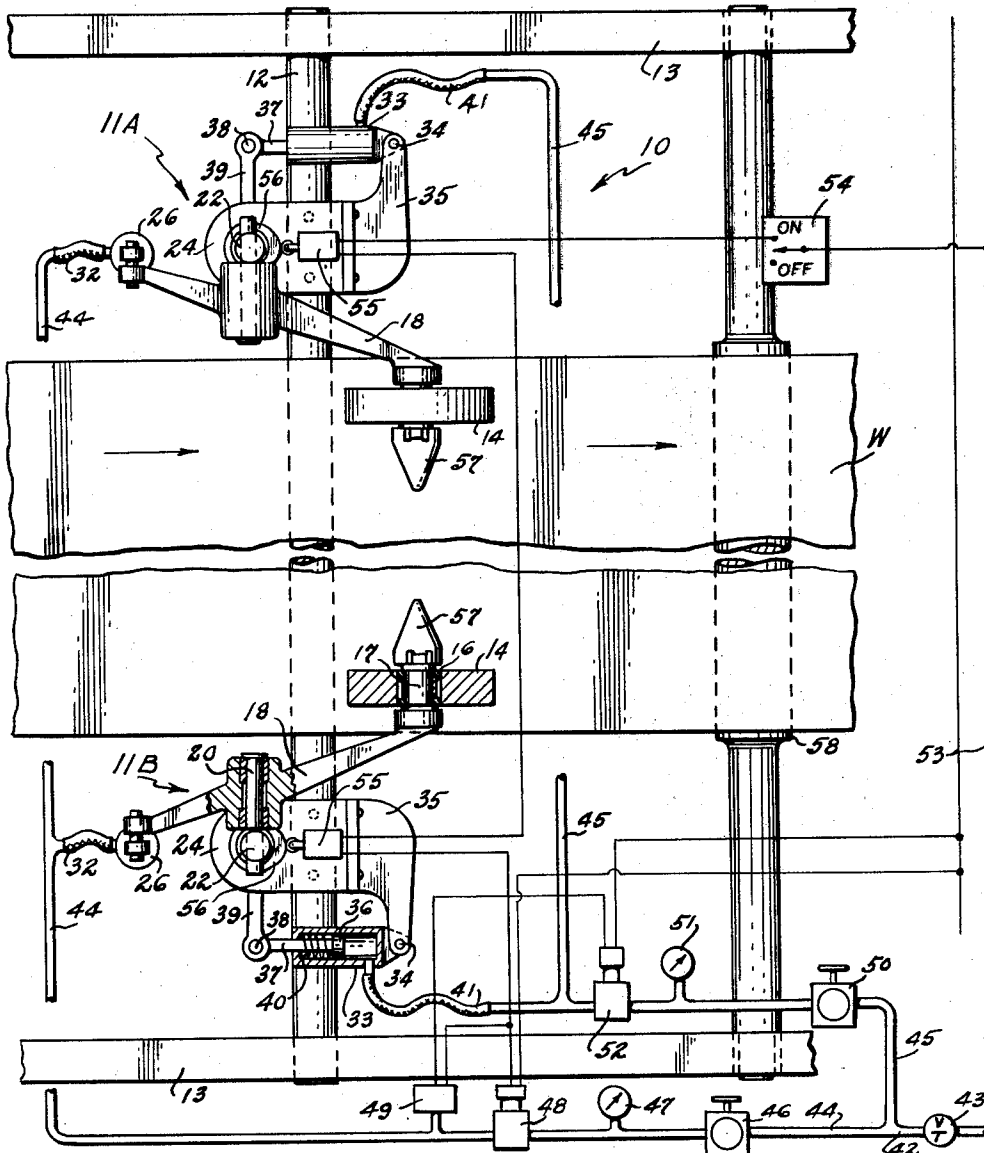


Fig. 1.

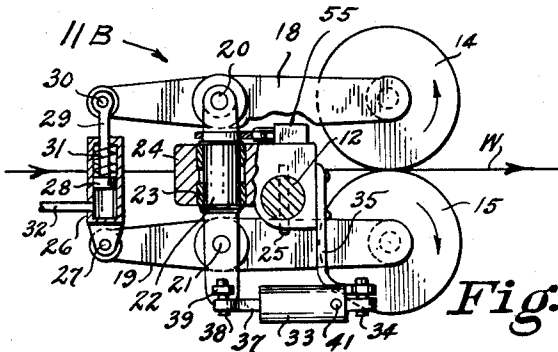


Fig. 2.

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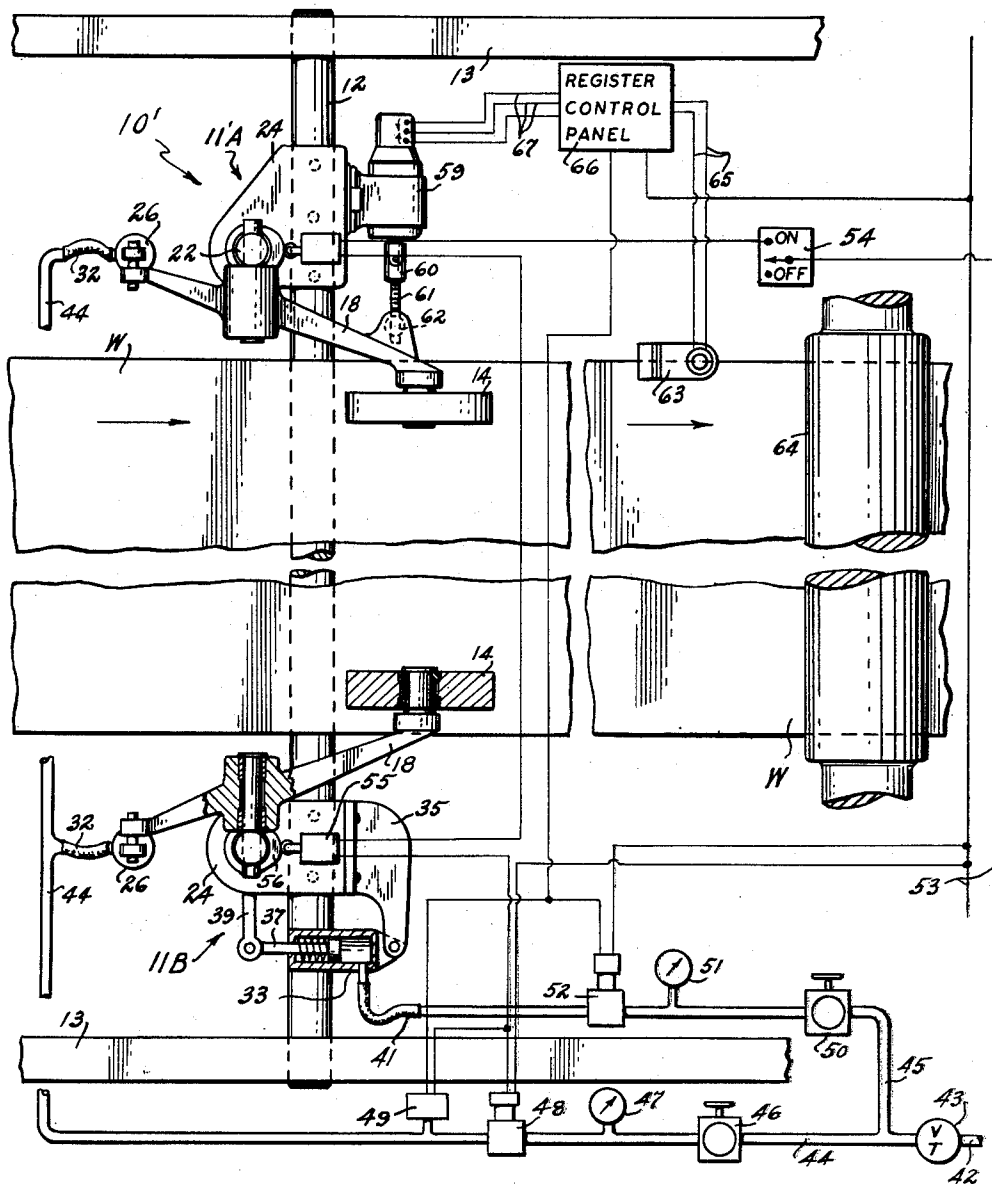


Fig. 3.

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4 Sheets-Sheet 3

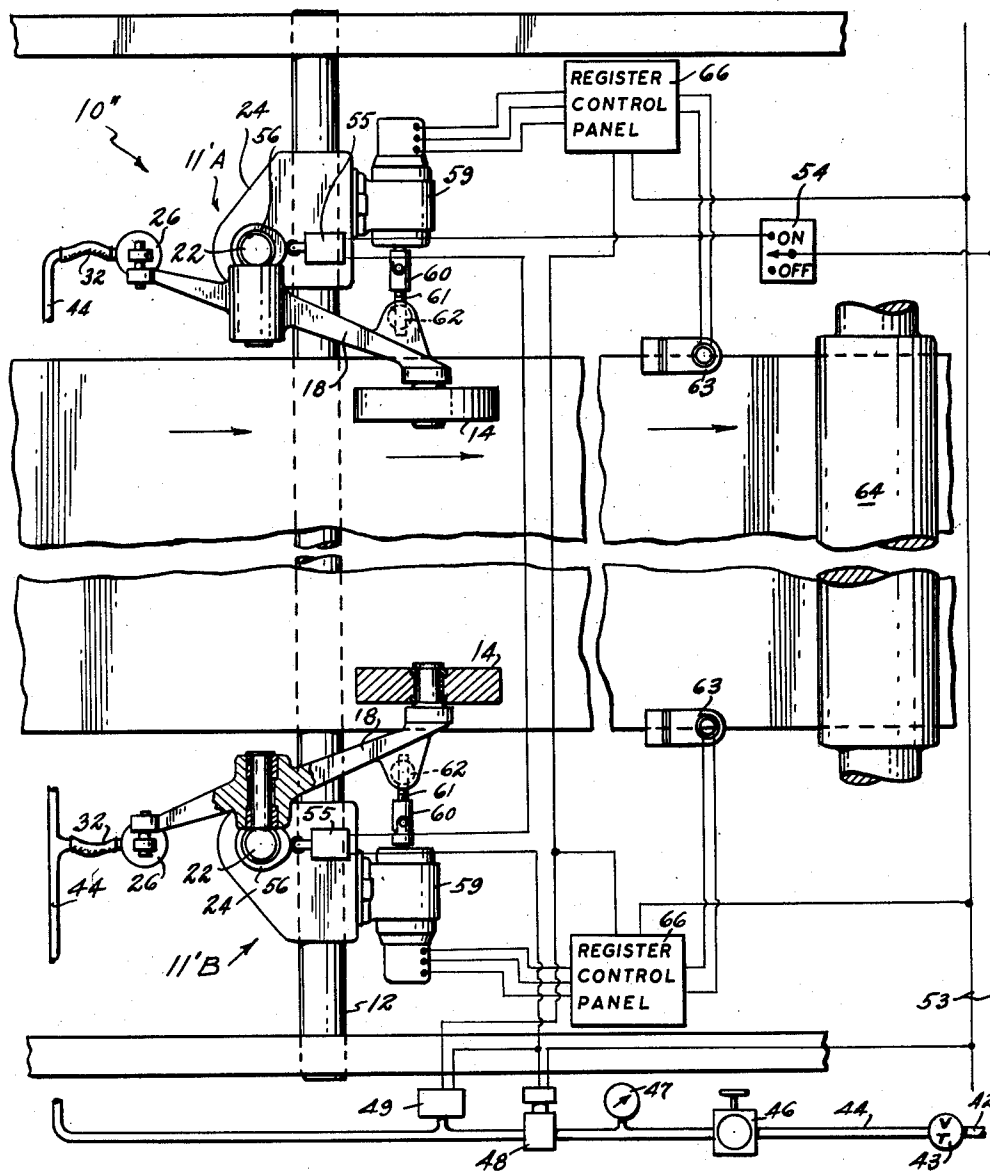


Fig. 4.

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4 Sheets-Sheet 4

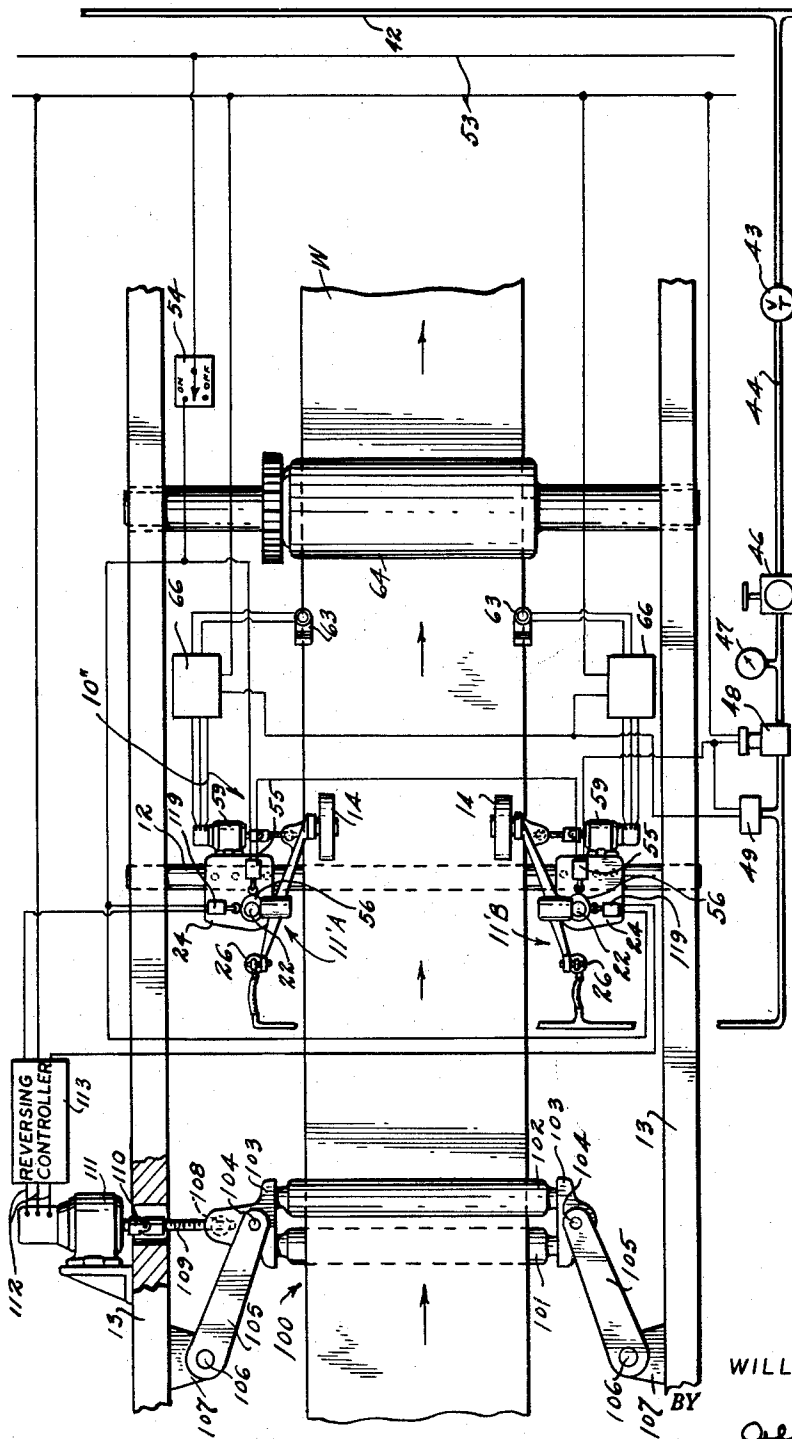


Fig. 5.

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TRANSVERSE WEB CONTROL DEVICES

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Filed July 10, 1962, Ser. No. 208,966

34 Claims. (Cl. 226—17)

This invention relates generally to devices for transversely controlling a continuous web in a printing press or the like, and more particularly for maintaining a desired transverse tension or registration of the web, or for maintaining both a desired transverse tension and registration of the web.

In web-fed printing presses having pairs of printing or other processing cylinders operating successively on both surfaces of the web so as to obtain multi-color impressions, the runs of the web between pairs of printing cylinders acting successively on the web are usually unsupported, as any surface contact with the web immediately after the application of impressions to both surfaces thereof would cause the freshly applied ink to blur or smear. In such presses, the successive pairs of cylinders have their nips arranged in a straight line so that the web passing through the press does not have any wrap around the cylinders to resist transverse shrinking or wrinkling of the relatively long unsupported runs of the web between the successively acting cylinders.

Further, certain types of web material have a tendency to change the width of the web a limited amount when moisture is applied thereto, as during printing, tinting or water marking, when heat is applied to the web material for drying the latter, or when the web is subjected to a variable longitudinal tension or unsupported along a variable length thereof. Thus, such webs undergo non-uniform variations in the width thereof as they are subjected to a succession of different processes so that it is difficult to obtain accurate transverse register of the several processes successively applied to the web. Attempts have been made, for example, in multi-color printing presses, to obtain accurate transverse registration of the successively applied impressions by successively changing the widths of the applied impressions. However, this solution to the problem has not been satisfactory because of the high cost that is inherent therein, and further by reason of its inflexibility in that the corrective transverse dimensional variations between the successively applied impressions cannot be altered to accommodate variations in the change of width occurring during operation.

The problem of maintaining transverse web tension and register is further complicated by those variations in the webs which result in unsupported runs or lengths thereof having longitudinal tensions that vary across the width of the web, which condition particularly causes wrinkles in the web as the successive contacts of the latter with the pairs of printing or other processing cylinders do not result in a force tending to urge apart the longitudinal edges of the web.

Rollers presently exist for removing wrinkles from the web. Such rollers include a series of short axial sections rotatable on a curved stationary shaft and covered by a common rubber sleeve or envelope forming a continuous surface for contact with the web. However, such rollers have contact with the entire width of the web and thus cannot be used when the web has processing applied thereto that is susceptible to damage by contact with the roller. Further, the described wrinkle-removing rollers have considerable resistance to rotation by contact with the web even though the sections of the roller are provided with anti-friction bearings. Such considerable resistance to rotation results from the large number of bearings and also from the hysteresis effect of the flexing of

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the rubber sleeve. Thus, considerable power is required for effecting rotation of the described wrinkle-removing rollers, and this power must be transmitted to the rollers through the web so that longitudinal web tension is affected in that the tensions are different in the portions of the web respectively extending to and from contact with the roller.

It has also been proposed to provide suction boxes having a surface that supports the web and is formed with angularly disposed narrow slots so that a suction or vacuum acting on the web at such slots tends to stretch the web laterally from its center towards its longitudinal edges for removing wrinkles from the web. However, this arrangement has the disadvantage of imposing a relatively high frictional resistance to the movement of the web, and also fails to provide any means by which the transverse tensioning of the web can be adequately controlled.

Accordingly, it is an object of this invention to provide devices for accurately maintaining a desired transverse web tension or register, or both a desired web tension and register, while avoiding the above mentioned disadvantages of the devices previously proposed for such purposes.

Another object is to provide devices for accurately maintaining transverse web tension or register, or both transverse web tension and register, which devices can be employed for supporting a web between locations at which the web is subjected to printing or other processes without disturbing the processing of the web, for example, the wet ink of imprints applied thereto.

A further object is to provide devices of the described character for maintaining transverse web tension or register, or both transverse web tension and register, without unduly influencing the longitudinal tension in the web.

In accordance with an aspect of this invention, pairs of rollers or wheels are urged into firm, non-slippable rolling engagement with both surfaces of the web adjacent the opposite longitudinal edges of the latter and exert suitable, transversely directed forces on the related edge portions of the web while the latter is in motion so as to maintain a desired transverse tension in the web or to transversely register the web, for example, with respect to a printing or other processing apparatus through which the web travels. Since the pairs of rollers or wheels are held in firm, non-slippable engagement with the surfaces of the web, transversely directed forces or movements applied to the rollers or wheels are accurately transmitted to the web for precisely maintaining the desired transverse web tension or register, as distinguished from those existing web tensioning or registering devices which rely on frictional or slipping contact with the web and therefore have inaccurate operating characteristics by reason of changes in the frictional coefficient therebetween resulting from variations in the thickness of the web, the smoothness of the latter or of the supporting surface in contact therewith.

Further, since the pairs of rollers or wheels only engage the surfaces of the web adjacent the opposite longitudinal edges of the latter, transverse web tensioning or registering devices embodying this invention can act on runs of a web between successive processing stations, for example, between successively acting printing cylinders, without affecting the processing, such as, printed impressions, applied to the web.

In accordance with another aspect of this invention, each of the pairs of wheels or rollers held in firm, non-slippable engagement with the surfaces of the web is mounted for pivotal movement about an axis perpendicular to the plane of the web and disposed adjacent the related longitudinal edge of the latter, with the axes of rotation of the pair of rollers or wheels being offset or spaced away from the pivoting axis thereof in the direction of movement of the web and normally being posi-

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tioned transverse to that direction by means independent of the pull or other power of the web. Thus, the rollers or wheels track on the moving web and normally are held in positions at which the planes of rotation of the rollers are parallel to the direction of movement of the web, and movements of each pair of rollers or wheels about the pivoting axis thereof result in both a transverse displacement of the rollers and a proportional small angular displacement of the latter about the pivoting axis.

When devices embodying the invention are employed for maintaining a predetermined transverse tension in the moving web, a suitable force is yieldably applied, for example, through a pressure fluid operated cylinder, to at least one of the pairs of rollers so as to urge the latter to move about its pivoting axis in the direction away from the other pair of rollers or wheels, thereby applying a transverse tension to the web corresponding to the magnitude of the yieldably applied force. If the yieldably applied force causes transverse and angular displacement of the rollers in maintaining the desired transverse tension in the moving web, the angular displacement of the rollers from their normal tracking positions, at which the rollers rotate in planes parallel to the direction of movement of the web, gives rise to additional restoring forces which tend to gradually return the rollers to their tracking positions.

When devices embodying the invention are employed for maintaining transverse registration of the moving web, at least one of the pairs of rollers or wheels is positively displaced about its pivoting axis upon a deviation of the adjacent longitudinal edge of the web, or of a line pre-printed therealong, from a predetermined transverse position. Such displacement of the pair of rollers about its pivoting axis effects a transverse displacement of the rollers, and of the adjacent edge portion of the web, in the direction for restoring the web to the desired transverse registered position, and the corresponding angular displacement of the pair of rollers causes the web to gradually return to the desired direction of web travel while maintaining the transverse displacement of the web resulting from the transverse displacement of the rollers.

In accordance with still another aspect of the invention, a device for accurately maintaining transverse registration of the moving web by displacement of pairs of rollers or wheels held firmly in non-slippable engagement with the opposite longitudinal edge portions of the moving web, as generally described above, is combined with a device for effecting coarse transverse register corrections at a location along the web in advance of the device for effecting fine or accurate transverse register corrections, and the fine or accurate transverse register correction device operates to correct for deviations of transverse registration within predetermined small limits, while any deviation of the web beyond such limits results in actuation of the coarse transverse register correction device so that the latter returns the web to a position within the limits of operation of the fine or accurate transverse register correction device.

In accordance with a further aspect of this invention, movement of either one of the pairs of rollers or wheels about its pivoting axis beyond predetermined limits causes release of the rollers from their firm, non-slippable engagement with the web whereupon the associated printing press or other web processing apparatus may be halted to permit correction of the causes of the large deviation from the desired transverse web tension or register which results in the excessive movement of the rollers.

The above, and other objects, features and advantages of the invention, will be apparent in the following detailed description of illustrative embodiments thereof which is to be read in connection with the accompanying drawings forming a part hereof, and wherein:

FIG. 1 is a top plan view, which is partly schematic and in section, of a device for maintaining a predetermined transverse web tension in accordance with the present invention;

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FIG. 2 is a side elevational view, partly broken away and in section, of one of the roller units included in the device of FIG. 1;

FIG. 3 is a view similar to that of FIG. 1, but showing a device embodying the invention for maintaining a desired transverse web tension and transverse registration of one of the longitudinal edges of the moving web;

FIG. 4 is another view similar to that of FIG. 1, but showing a device embodying the invention for maintaining transverse registration of both longitudinal edges of the moving web; and

FIG. 5 is a top plan view, which is partly schematic, of an arrangement embodying the invention which includes a device for accurately maintaining transverse registration of the opposite longitudinal edges of a moving web within a predetermined range of deviations in combination with a coarse transverse register correction device which operates to maintain the web within the range of operation of the fine or accurate transverse register correction device.

Referring to the drawings in detail, and initially to FIG. 1 thereof, it will be seen that a device 10 embodying the invention, as there illustrated, is intended to maintain a predetermined transverse tension in a moving web W. The portion of web W appearing in FIG. 1 may be a run thereof moving horizontally, as shown, or vertically or along an inclined path, between stations at which the web is successively processed, for example, by pairs of printing cylinders applying inked impressions to one or both surfaces of the web, as in a multi-color printing press.

The device 10 for maintaining a predetermined transverse tension in moving web W generally includes two units 11A and 11B mounted adjacent the opposite longitudinal edges of the web on a support bar 12 extending transversely across the web and having its opposite ends rigidly secured in side frame members 13 of the associated printing press or other web processing apparatus.

Each of the units 11A and 11B includes a pair of rollers or wheels 14 and 15 mounted for rolling engagement with the opposite surfaces, for example, the upper and lower surfaces of a horizontally moving web, as shown in FIG. 2, near the adjacent longitudinal edges of the web. The rollers 14 and 15 are freely rotatable on antifriction bearings 16 carried by axles 17 projecting laterally inward from one end of upper and lower levers 18 and 19, respectively. The levers 18 and 19 are pivotally mounted, intermediate their opposite ends, on pivot pins 20 and 21, respectively, projecting radially from the upper and lower end portions of a support shaft 22 having its axis perpendicular to the plane of web W, that is, extending vertically in the illustrated arrangement. Intermediate pins 20 and 21 the support shaft 22 is turnably mounted in bearings 23 within a housing 24 which is rigidly secured, as by bolts 25, on support bar 12. Thus, rollers 14 and 15 of each of the units 11A and 11B are movable toward and away from each other by swinging of levers 18 and 19 about pivot pins 20 and 21, and further are movable together about their pivoting axis defined by support shaft 22. It will also be noted that the axes of rotation of each pair of rollers 14 and 15 are offset or spaced from the pivoting axis defined by support shaft 22 in the direction of web W. Thus, movement of rollers 14 and 15 about the axis of shaft 22 results in a transverse displacement of the rollers and a proportional small angular displacement of the rollers.

In order to firmly hold each pair of rollers 14 and 15 in firm, non-slippable rolling engagement with the opposite surfaces of web W, each of the units 11A and 11B includes a cylinder 26 pivotally connected, as at 27, to the end of lever 19 remote from roller 15 and containing a reciprocable piston 28 with a piston rod 29 extending from the latter out of cylinder 26 and being pivotally connected, as at 30, to the end of lever 18 remote from roller 14. A helical compression spring 31 is also dis-

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posed in cylinder 26 and acts against piston 28 in the direction for retracting piston rod 29 and thereby rocking levers 18 and 19 in the directions moving rollers 14 and 15 away from each other, that is, out of contact with the surfaces of web W. A conduit 32 opens into cylinder 26 below piston 28 for supplying fluid under pressure, for example, compressed air, which acts against piston 28 and overcomes the force of spring 31 for rocking levers 18 and 19 in the directions moving rollers 14 and 15 toward each other, that is, into contact with the opposite surfaces of web W.

When rollers 14 and 15 of each of units 11A and 11B are thus firmly held in non-slippable rolling contact with the surfaces of web W, the rollers normally tend to track on the web with their planes of rotation extending parallel to the direction of movement of the web so as to present the minimal resistance to movement of the web. If the rollers 14 and 15 are displaced transversely, and thus angularly moved from their normal tracking positions by reason of the mounting on support shaft 22, so that the planes of rotation of the rollers are no longer parallel to the direction of movement of web W, there is an increased resistance to movement of the web. This increased resistance to movement of the web causes a corresponding force to be exerted on the rollers having a transversely directed component which, by reason of the previously described spacing of the axes of rotation of rollers 14 and 15 from the support shaft 22 in the direction of movement of the web, tends to restore the rollers to their normal tracking positions illustrated on FIG. 1.

Since rollers 14 and 15 of units 11A and 11B are normally firmly held in non-slippable rolling engagement with both surfaces of moving web W adjacent the opposite longitudinal edges of the latter, it will be apparent that forces applied to the rollers of both units for urging them transversely away from each other are directly transmitted to the web for transversely tensioning the latter. In order to thus transversely tension the web, each of units 11A and 11B further includes a cylinder 33 pivotally mounted at one end, as at 34, on a bracket 35 depending from the related housing 24 and containing a reciprocable piston 36 having a piston rod 37 projecting from the cylinder and pivotally connected, as at 38, to a radial arm 39 extending rigidly from the lower end of support shaft 22. A helical compression spring 40 is disposed in cylinder 33 and acts against piston 36 to urge the latter to move in the direction retracting piston rod 37 for turning the related support shaft 22 in the direction moving rollers 14 and 15 or each unit transversely toward the center of web W, that is, toward the rollers of the other unit. A conduit 41 opens into cylinder 33 for supplying fluid under pressure, for example, compressed air, which acts within the cylinder against piston 36 so as to overcome the force of spring 40 and thereby tend to turn support shaft 22 in the direction moving rollers 14 and 15 of each unit transversely outward, that is, in the direction away from the corresponding rollers of the other unit thereby to impose the desired transverse tension on the web.

As shown in FIG. 1, a system for controlling the operation of cylinders 26 and 33 of both units 11A and 11B may include a main conduit 42 extending from a suitable source of compressed air and having the usual flow control valve 43 interposed therein. The main conduit 42 branches into conduits 44 and 45 which, in turn, branch into the conduits 32 extending to cylinders 26 and the conduits 41 extending to cylinders 33, respectively. Interposed in the conduit 44 are a pressure regulator 46, a pressure gauge 47, a solenoid controlled valve 48 and a pressure sensitive switch 49. Similarly, a pressure regulator 50, a pressure gauge 51 and a solenoid operated valve 52 are interposed in conduit 45. The pressure regulators 46 and 50 and the associated pressure gauges 47 and 51 provide convenient means for in-

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dependently adjusting the pressure of air supplied to cylinders 26, and hence the nip pressure between the pairs of rollers 14 and 15, and the pressure of air supplied to cylinders 33, and hence the magnitude of the transversely directed forces exerted by the rollers on the moving web for transversely tensioning the latter.

The system for controlling the operation of cylinders 26 and 33 further includes an electric circuit extending from power supply lines 53 and having a shut-off switch 54 and two limit switches 55 all connected in series with the solenoid of valve 48 so that the latter is energized and thereby permits the supply of compressed air to the related cylinders 26 only when switches 54 and 55 are all simultaneously closed. Further, the electrical circuit connects the solenoid of valve 52 in series with switches 54 and 55, and also with pressure sensitive switch 49 which closes only in response to a predetermined pressure in conduit 44.

Limit switches 55 are mounted on housings 24 of units 11A and 11B, respectively, and engage cams 56 secured on the related support shaft 22. Cams 56 are shaped so as to maintain the related limit switches 55 in their closed condition only so long as the rollers 14 and 15 are within an allowable range of movement from their illustrated normal tracking positions. Thus, if either one of the pairs of rollers 14 and 15 moves about the axis of its related support shaft 22 beyond the allowable range of movement, for example, upon longitudinal splitting of the web, cam 56 permits the associated limit switch 55 to open and thereby interrupt the electrical circuit for energizing the solenoids of valves 48 and 52 so that the latter close and relieve the pressure in cylinders 26 and 33. In the absence of pressure in cylinders 26 and 33, the associated springs 31 and 40 act on pistons 28 and 36 to both move each pair of rollers 14 and 15 away from the web and to move the pairs of rollers laterally toward each other, thereby quickly releasing the transverse web tension.

Although an electro-pneumatic system has been illustrated and described above for the purpose of controlling the operation of units 11A and 11B, it is to be understood that other electrically actuated fluid-pressure control systems functioning in substantially the same manner may be substituted therefor.

The above described device for maintaining a desired transverse tension in the moving web W operates as follows:

The operation of device 10 is initiated by closing switch 54, thereby energizing solenoid valve 48 through limit switches 55. Until the pressure in conduit 44 builds up to a suitable pressure for firmly holding rollers 14 and 15 in non-slipping engagement with web W, switch 49 remains open. Thus, solenoid valve 52 is energized to permit compressed air to flow to cylinders 33 for laterally tensioning the web, only after switch 49 closes upon firm engagement of the rollers with the web.

Pressure regulator 46 is initially adjusted so that the pressure of air acting in cylinders 26 is sufficient to firmly hold the pairs of rollers 14 and 15 in non-slippable rolling contact with both surfaces of the web. Further, pressure regulator 50 is initially adjusted so that the pressure of compressed air acting in cylinders 33 to urge the pairs of rollers laterally apart produces transverse forces at the lines of rolling contact of the rollers with the moving web equal to, and opposed by the transverse tension to be maintained in the latter.

If the transverse tension in the web becomes either greater or less than the tension to be maintained in the latter, the non-slippable rolling contact of the rollers 14 and 15 with the web ensures that the rollers are displaced by the differential forces either inwardly or outwardly from their normal tracking positions until the transverse tension in the web again balances the transverse forces resulting from the adjusted pressure of compressed air in cylinders 33. However, as previously

noted herein, transverse displacement of the rollers is accompanied by an angular displacement thereof about the axis of the related support shaft 22 and such angular displacement of the rollers out of their normal tracking positions gives rise to transverse restoring forces which gradually return the rollers to their normal tracking positions.

Since rollers 14 and 15 engage the surfaces of moving web W only adjacent the opposite longitudinal edges thereof, it is apparent that the device 10 can be employed for maintaining a predetermined transverse tension in the web and for supporting the latter intermediate stations at which printed impressions or other processing is applied to the web without blurring or smearing the printed impressions or otherwise interfering with the processing of the web. Further, the rollers 14 and 15, being freely rotatable by rolling contact with the web and normally assuming tracking positions in which their planes of rotation are arranged parallel to the direction of movement of the web, offer insignificant resistance to movement of the web and therefore do not substantially influence the longitudinal tension of the web. Since rollers 14 and 15 are firmly held in non-slippable rolling contact with the web, the transversely applied forces for establishing the desired transverse web tension are directly transmitted to the moving web so that the transverse tension can be accurately maintained and controlled, as distinguished from those previously proposed devices in which there is frictional contact between the web and the rollers slipping relative thereto, in which case the frictional contact forces are very difficult to control and the transverse web tension thereby produced varies with frictional changes resulting from variations in the web thickness or changes in the surface conditions of the web and rollers.

In order to avoid buckling of the web against the edges of rollers 14 and 15 during the restoration of the latter to their normal tracking positions following transverse displacement of the rollers, a guide shoe 57 (FIG. 1) may be suspended from the free end of each axle 17 to project inwardly from the related roller 14 or 15 in close proximity to the web adjacent the line of rolling contact of the roller with the moving web.

Further, when the web W is formed of a relatively delicate material having little or no inherent resiliency, for example, light fabrics, tissue paper or the like, it is desirable to provide an idler roller 58 having its ends rotatably mounted in side frame members 13 and engaging the moving web W over an extended angle of wrap after passage of the web between rollers 14 and 15. The idler roller 58 prevents the redevelopment of wrinkles in webs of the described character shortly after such wrinkles have been removed by the transverse web tension applied to the web through rollers 14 and 15.

Referring now to FIG. 3, it will be seen that the device 10' there illustrated for maintaining transverse web tension and register in accordance with the invention is generally similar to the previously described device 10 and includes two units 11'A and 11'B acting on the opposite longitudinal edge portions of the moving web W. The unit 11'B of device 10' may be identical to the unit 11B of the previously described device 10, while the unit 11'A of the latter is replaced by a similar unit 11'A in which a reversible electric correction motor 59 mounted on housing 24 takes the place of the fluid pressure operated cylinder 33. Motor 59 has its shaft connected through a universal coupling 60 with an adjusting screw 61 threaded through a nut member 62 carried by one of the roller supporting levers, for example, the lever 18, so that rotation of the shaft of motor 59 positively effects displacement of the related pair of rollers 14 and 15 about the axis of support shaft 22.

Since the pair of rollers 14 and 15 of unit 11'A is held firmly in non-slippable rolling contact with the opposite surfaces of moving web W, it is apparent that any

transverse displacement imparted to such rollers through operation of the reversible correction motor 59 effects corresponding transverse displacement of the adjacent longitudinal edge portion of the moving web, while the other unit 11B of device 10' continuously applies a yieldable transverse force to the opposite longitudinal edge portion of the web in the direction away from unit 11'A, and thereby maintains a desired transverse tension in the moving web.

The reversible correction motor 59 is preferably energized by means of a photoelectric control system including a photoelectric scanning head 63 that may be of the type commercially available from the Specialty Control Department of General Electric Company, Waynesboro, Virginia, as Item No. 3S7515PS102. The scanning head 63 is suitably mounted so that a light source therein will direct a beam of light against either the longitudinal edge of the moving web adjacent unit 11'A or against a register line preprinted along such edge at a location along the web that is intermediate unit 11'A and printing cylinders 64 or any other web processing device with which an edge of the moving web is to be transversely registered.

The scanning head 63 is laterally located so that, when there is correct transverse registration between the related longitudinal edge of the web or the register line preprinted thereon and the cylinder 64, which may be one of two coating printing cylinders, the area or region of the web surface illuminated by the beam of light from the scanning head is exactly bisected by the longitudinal edge of the web or by one longitudinal edge of the preprinted register line thereon, and thereby establishes the normal intensity of light reflected from the web to a photoelectric cell included in scanning head 63 during correct transverse register. It will be apparent that any deviation of the transverse position of the longitudinal edge of the web, toward one side or the other from the position for correct transverse register causes a change in the intensity of light reflected by the web from the light source of head 63 into the photoelectric cell of the latter, and thereby alters the voltage generated by the cell.

The voltage generated by the photoelectric cell of head 63 is fed through conductors 65 to a register control panel 66 which may be of the type that is commercially available from the Specialty Control Department of General Electric Company, Waynesboro, Virginia, as item No. 3S7515SR100 and which, as shown in the wiring diagram thereof appearing between pages 18 and 19 of the instruction bulletin published by General Electric Company under the designation GEH-2121A, generally includes a Wheatstone bridge network that is balanced when the strength of the electrical signal from scanning head 63 corresponds to correct transverse register of the web. Any deviation in the strength of electrical signals received from scanning head 63 serves to unbalance the Wheatstone bridge which thereby generates an error signal which is sufficiently amplified by a conventional amplifier included in panel 66 and which is led from the latter to transverse register correction motor 59 by way of conductors 67 for energizing the motor. The resulting rotation of motor 59 is converted through screw 61 and nut member 62 into a proportional transverse displacement of the related rollers 14 and 15 which is transmitted to the web and thereby restores the desired accurate transverse registration of the adjacent longitudinal edge of the web.

Since the rollers 14 and 15 of unit 11'A are mounted for pivoting about the axis of the related support shaft 22, any transverse displacement of such rollers by operation of the correction motor 59 is accompanied by a corresponding small angular displacement of the rollers. Such angular displacement of the rollers is maintained by the irreversible effect of nut member 62 and screw 61 which avoids turning of the motor shaft by forces exerted on rollers 14 and 15. Thus, the angular displacement of

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the rollers which causes the planes of rotation of the latter to deviate from the parallel to the direction of movement of the web gives rise to forces acting on the web to alter the direction of movement of the web towards parallelism with the planes of rotation of the rollers of unit 11'A. Thus, the angular displacement of the rollers also acts on the moving web to alter the direction of movement thereof in the direction for eliminating the error of transverse registration resulting in the operation of correction motor 59.

In the device 10' described above, accurate transverse register of one of the longitudinal edges of the moving web is thus maintained by the unit 11'A, while the other unit 11'B of the device acts on the opposite longitudinal edge portion to maintain a desired transverse tension in the moving web even though the latter is transversely displaced from time to time in order to correct for errors in the transverse registration of one edge thereof.

If it is desired to transversely register the longitudinal medial line of the web W, rather than an edge thereof, the device 10' may be provided with a second scanning head similar to head 63, the second head being also connected through conductors to register control panel 66 and being disposed adjacent the edge of web W remote from head 63 so that correct register corresponds to the condition when both heads receive equal light intensities. Any deviation of the longitudinal medial line of the web from the correct transverse registration thereof, unbalances the signals from the two heads and panel 66 causes corresponding actuation of correction motor 59.

Further, as shown in FIG. 4 of the drawings, a device 10'' may be provided in accordance with the invention to accurately maintain transverse registration of both longitudinal edges of a moving web W with respect to printing cylinders 64 or any other web processing device through which the web passes.

The device 10'' includes two units 11'A and 11'B which are both the same as the unit 11'A described above in connection with the device 10' and which act upon the opposite longitudinal edge portions of the moving web. Thus, each of units 11'A and 11'B includes a reversible transverse register correction motor 59 operative to displace the related rollers 14 and 15 about the support shaft 22 and being under the control of a photoelectric control system including an associated scanning head 63 sensing any deviation of the related longitudinal edge of the web from accurate transverse register.

In the arrangement of FIG. 4, it will be seen that register control panels 66 of the photoelectric control systems associated with units 11'A and 11'B draw power from the electric supply lines 53 through the circuit having the pressure sensitive switch 49 and limit switches 55 included therein so that, upon an excessive displacement of either one of the pairs of rollers 14 and 15, the resulting interruption of the circuit relieves the pressure in cylinders 26 of both units by deenergizing the solenoid of valve 48 and simultaneously deenergizes the photoelectric control systems of both correction motors 59. The device 10'' maintains the transverse register of both longitudinal edges of the moving web within close tolerances at all times so that, in effect, the transverse width of the web fed to printing cylinders 64 or any other web processing device is maintained constant. However, the width of the web may vary somewhat during web processing because of variations in the response of the web to printing, moisture application, heating and cooling. Thus, with the device 10'', the accurate transverse registration of both longitudinal edges of a web having a varying width is accompanied by corresponding variations in the transverse web tension. As a relatively wide portion of the web passes the scanning head 63, the correction motor 59 may displace the related pairs of rollers 14 and 15 so as to laterally compress the web slightly, or at least to remove transverse tension therefrom, and thereby provide the continued accurate transverse registration of both

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longitudinal edges. A web controlled in this fashion may be printed or otherwise processed successfully, provided that the transverse looseness or lack of transverse tension is not excessive so as to cause wrinkling of the web.

Referring now to FIG. 5, it will be seen that a device 10'', as previously described herein for accurately maintaining transverse registration of both longitudinal edges of a moving web W, may be combined with another side register control mechanism 100 which engages the web prior to the pairs of rollers 14 and 15 of device 10''. The mechanism 100 is intended to effect coarse transverse register correction and generally includes parallel web contacting rollers 101 and 102 having their opposite ends rotatably journaled in bearing blocks 103 which are centrally pivoted on pins 104 carried by the free ends of arms 105. The arms 105 are pivotally mounted on shaft 106 carried by brackets 107 extending from side frame members 13, and the various parts are dimensioned so that, when rollers 101 and 102 are in their illustrated central position, arms 105 converge in the direction of movement of the web. One of bearing blocks 103 carries a nut member 108 in threaded engagement with an adjustment screw 109 which is connected by a universal coupling 110 with the shaft of a reversible correction motor 111 mounted on the adjacent side frame member 13.

It will be apparent that rotation of the shaft of motor 111, in one direction or the other, causes corresponding lateral displacement of rollers 101 and 102 which, by reason of the previously mentioned convergence of arms 105 in the neutral or central position of the roller, are also tilted or inclined from the lateral. As shown in FIG. 5, the web W passes over roller 101 and then under roller 102 so that the tilting action of the rollers that accompanies the lateral displacement thereof is effective to urge the web laterally in the same direction as the lateral displacement of rollers 101 and 102.

The motor 111 is connected through conductors 112 with a reversing controller 113 of conventional design which is, in turn, connected through two limit switches 119 with the power supply lines 53. Limit switches 119 are mounted on the housings 24 of units 11'A and 11'B and are engageable by the cams 56 provided on support shafts 22 for actuating the previously described limit switches 55 of the transverse register control device 10''. Switches 119 are arranged so as to be normally open, and hence render inoperative the coarse register control device 100, so long as the pairs of rollers 14 and 15 of device 10'' are within a predetermined range of movement about the support shafts 22. Thus, so long as the deviation of the moving web from transverse register with respect to the printing cylinders 64 or other web processing device is within a predetermined small range, the device 10'' operates to effect fine or accurate transverse register corrections in the manner previously described herein. However, if the deviation of the web from transverse register with respect to printing cylinder 64 is beyond the predetermined small range so that, in seeking to correct for such deviation, the pairs of rollers 14 and 15 are displaced by correction motors 59 to a relatively large extent about the related support shafts 22, one or the other of cams 56 then closes the related limit switch 119 to initiate the operation of reversing controller 113 by which motor 111 is made to rotate the screw 109 in the sense to sufficiently displace the moving web for returning the latter to within the normal operating range of the fine transverse register control device 10'', whereupon the latter again becomes operative to accurately maintain the desired transverse register of the web relative to printing cylinders 64. However, if the rollers 14 and 15 are displaced beyond the point at which one or the other of the cams 56 closes the related switch 119, the cam permits opening of switch 55, thereby deenergizing solenoid valve 48 to release the rollers from the web and also deenergizing control panels 66, so that the register control device 10'' is rendered inoperative.

From the above, it will be apparent that, in the arrangement illustrated on FIG. 5, the mechanism 100 provides relatively coarse transverse register corrections, while the device 10" provides fine or accurate transverse register corrections. Transverse register control mechanisms employing angularly tilting rollers, as in the illustrated mechanism 100, tend, during their lateral displacement of the web, to increase the longitudinal tension at one side of the longitudinal medial line of the web and to decrease the longitudinal tension at the opposite side of the longitudinal medial line. Such variations in the longitudinal tension across the web cause wrinkling of the latter. However, when the transverse register control mechanism 100 having the tilting rollers 101 and 102 is combined with the transverse register control device 10" having pairs of rollers acting on the opposite longitudinal edge portions of the moving web and being laterally displaced so as to maintain accurate transverse registration of both longitudinal edges of the web, such pairs of rollers operate to remove any wrinkles from the web that might otherwise be produced as a result of the varying longitudinal tensions across the web resulting from the tilting action of rollers 101 and 102.

When devices embodying the invention are employed as transverse register controls, for example, as in FIGS. 3, 4 and 5, it is desirable that a substantial length of the web be free or unsupported between such transverse register control device and the printing cylinders or other processing device with respect to which the web is being transversely registered so as to allow sufficient space along the web for effecting the necessary transverse register corrections. However, when devices embodying the invention are employed only for maintaining a desired transverse web tension, as in FIG. 1 hereof, the pairs of rollers 14 and 15 of such device may engage the moving web at any locations along the latter, even close to printing cylinders or other devices for processing the web.

Although several embodiments of the invention have been described in detail herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various changes and modifications may be effected therein without departing from the scope or spirit of the invention which is intended to be defined in the appended claims.

What is claimed is:

1. A transverse web control device comprising pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter, first force applying means urging the rollers of each of said pairs toward each other for non-slippable rolling contact of said rollers with the moving web, means mounting each pair of rollers for movement substantially transversely relative to the direction of movement of the web, and second force applying means independent of power of the web for normally disposing said pairs of rollers in tracking positions in which they rotate in planes substantially parallel to said direction and for exerting forces substantially transversely on said pairs of rollers for direct transmission by the latter to the related edge portions of the moving web so as to transversely control the latter.
2. A transverse web control device comprising pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter; means urging the rollers of each of said pairs towards each other for non-slippable rolling contact of said rollers with the moving web; means mounting each pair of rollers for movement about a pivoting axis perpendicular to the plane of the moving web near the adjacent longitudinal edge

of the latter, and with the axes of rotation of each pair of rollers being spaced away from the pivoting axis thereof in a direction parallel to the direction of movement of the web,

means independent of power of the web for normally holding said rollers disposed in tracking position with the planes of rotation thereof parallel to the direction of movement of the web so that pivotal movement of either pair of rollers from its said tracking position involves both a transverse displacement of the entire rollers toward one side of said position and a proportional angular displacement of the rollers about the pivoting axis giving rise to forces tending to restore the parallel relationship of said planes of rotation and direction of movement of the web, and

said positioning means including means for urging said pairs of rollers to pivot about the related pivoting axes and thereby exert substantially transversely directed forces on the related edge portions of the web for transversely controlling the latter.

3. A transverse web control device comprising pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter, means urging the rollers of each of said pairs toward each other for non-slippable rolling contact of said rollers with the moving web, means mounting each pair of rollers for movement substantially transversely relative to the direction of movement of the web, and means applying a predetermined yieldable force to at least one of said pairs of rollers for urging said one pair of rollers transversely away from the other pair of rollers so that said rollers directly transmit proportional transverse forces to the moving web for maintaining a corresponding transverse tension in the latter.

4. A transverse web control device comprising pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter, means urging the rollers of each of said pairs toward each other for non-slippable rolling contact of said rollers with the moving web, means mounting each pair of rollers for movement substantially transversely relative to the direction of movement of the web, and means applying predetermined yieldable forces to both of said pairs of rollers urging the latter transversely away from each other so that said rollers directly transmit proportional transverse forces to the moving web for maintaining a corresponding transverse tension in the latter.

5. A transverse web control device comprising pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter, means urging the rollers of each of said pairs toward each other for non-slippable rolling contact of said rollers with the moving web, means mounting each pair of rollers for movement substantially transversely relative to the direction of movement of the web, means detecting errors in the transverse registration of the web along at least one of the longitudinal edges thereof, and

means independent of power of the web for normally disposing said pairs of rollers in tracking positions in which they rotate in planes substantially parallel to said direction, including power operated means responding to any detected error in transverse registration of said one edge to transversely displace the pair of rollers engaging the web adjacent said one

edge in the sense for eliminating the detected error in registration.

6. A transverse web control device comprising pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter, 5
 means urging the rollers of each of said pairs toward each other for non-slippable rolling contact of said rollers with the moving web,
 means mounting each pair of rollers for movement substantially transversely relative to the direction of movement of the web, 10
 means detecting errors in the transverse registration of the web along one of the longitudinal edges thereof, power operated means responding to said detecting means upon the detection of an error in the transverse registration along said one edge of the web to transversely displace the pair of rollers engaging the web adjacent said one edge in the sense for eliminating the detected error, and 15
 means applying a predetermined yieldable force to the other of said pairs of rollers for urging the latter transversely away from the first mentioned pair of rollers so that said other pair of rollers directly transmits proportional transverse forces to the moving web for maintaining a corresponding transverse tension in the latter. 20

7. A transverse web control device comprising pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter, 30
 means urging the rollers of each of said pairs toward each other for non-slippable rolling contact of said rollers with the moving web,
 means mounting each pair of rollers for movement substantially transversely relative to the direction of movement of the web, 35
 means detecting errors in the transverse registration of the web along each of the longitudinal edges thereof, and 40
 means independent of power of the web for normally disposing said pairs of rollers in tracking positions in which they rotate in planes substantially parallel to said direction, including power operated means for each of said pairs of rollers responding to said detecting means upon the detection of an error in transverse registration along a longitudinal edge of the web to transversely displace the pair of rollers engaging the web adjacent that edge in the sense for eliminating the detected error in registration. 45

8. A transverse web control device comprising first and second pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter; 50
 means urging the rollers of each of said pairs towards each other for non-slippable rolling contact of said rollers with the moving web; 55
 means mounting each pair of rollers for movement about a pivoting axis perpendicular to the plane of the moving web near the adjacent longitudinal edge of the latter, and with the axes of rotation of each pair of rollers being spaced away from the pivoting axis thereof in the direction of movement of the web, 60
 means independent of power of the web for normally holding said rollers disposed in tracking positions where the planes of rotation thereof are parallel to the direction of movement of the web so that pivotal movement of either pair of rollers from its said tracking position involves both a transverse displacement of the entire rollers toward one side of said position and a proportional angular displacement of the rollers about the pivoting axis; and 65
 said positioning means including means yieldably ap- 70 75

plying predetermined forces to both of said pairs of rollers in directions tending to move the pairs of rollers transversely away from each other about the related pivoting axes so that corresponding transversely opposed forces are directly transmitted from said rollers to the moving web for maintaining a transverse tension in the web adequate to balance the transmitted transversely opposed forces when said rollers are in said tracking positions thereof, and any angular displacement of the rollers from said tracking positions gives rise to restoring forces disturbing the balance of the web tension and transmitted forces and tending to return said rollers to said tracking positions thereof.

9. A transverse web control device comprising first and second pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter; 5
 means urging the rollers of each of said pairs towards each other for non-slippable rolling contact of said rollers with the moving web; 10
 means mounting each pair of rollers for movement about a pivoting axis perpendicular to the plane of the moving web near the adjacent longitudinal edge of the latter, and with the axes of rotation of each pair of rollers being spaced away from the pivoting axis thereof in the direction of movement of the web, means independent of power of the web for normally holding said rollers disposed in tracking positions where the planes of rotation thereof are parallel to the direction of movement of the web so that pivotal movement of either pair of rollers from its said tracking position involves both a transverse displacement of the entire rollers toward one side of said position and a proportional angular displacement of the rollers about the pivoting axis; 15
 means detecting errors in the transverse registration of the web along at least one of the longitudinal edges thereof; and 20
 said positioning means including power operated means responding to said detecting means upon the detection of an error in transverse registration along said one edge to move the pair of rollers adjacent said one edge about the related pivoting axis in the direction causing transverse displacement of the rollers, and hence of the web, in the sense for eliminating the detected error in registration, while the proportional angular displacement of the moved pair of rollers gives rise to restoring forces tending to alter the direction of movement of the web toward a condition of parallelism with the planes of rotation of the moved pair of rollers. 25

10. A transverse web control device comprising first and second pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter; 30
 means urging the rollers of each of said pairs towards each other for non-slippable rolling contact of said rollers with the moving web; 35
 means mounting each pair of rollers for movement about a pivoting axis perpendicular to the plane of the moving web near the adjacent longitudinal edge of the latter, and with the axes of rotation of each pair of rollers being spaced away from the pivoting axis thereof in the direction of movement of the web, 40
 means independent of power of the web for normally holding said rollers disposed in tracking positions where the planes of rotation thereof are parallel to the direction of movement of the web so that pivotal movement of either pair of rollers from its said tracking position involves both a transverse displacement of the entire rollers toward one side of said position and a proportional angular displacement of the rollers about the pivoting axis; 45
 means detecting errors in the transverse registration

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of the web along the longitudinal edge thereof adjacent said first pair of rollers;
 said positioning means including power operated means responding to said detecting means upon the detection of an error in transverse registration along said edge to move said first pair of rollers about the related pivoting axis in the direction causing transverse displacement of said first pair of rollers in the sense for eliminating the detected error of registration, while the proportional angular displacement of said first pair of rollers gives rise to restoring forces tending to alter the direction of movement of the web toward a condition of parallelism with the planes of rotation of said first pair of rollers; and
 means yieldably applying a predetermined force to said second pair of rollers tending to move the latter about the related pivoting axis transversely away from said first pair of rollers so that said second pair of rollers directly transmit transverse forces to the engaged edge portion of the web for maintaining a transverse tension in the web adequate to balance the transmitted transverse forces when said second pair of rollers are in the tracking positions thereof, and any angular displacement of the second pair of rollers from said tracking positions gives rise to restoring forces disturbing the balance of the web tension and transmitted transverse forces and tending to return said second pair of rollers to said tracking positions thereof.

11. A transverse web control device comprising first and second pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter; means urging the rollers of each of said pairs towards each other for non-slippable rolling contact of said rollers with the moving web;
 means mounting each pair of rollers for movement about a pivoting axis perpendicular to the plane of the moving web near the adjacent longitudinal edge of the latter, and with the axes of rotation of each pair of rollers being spaced away from the pivoting axis thereof in the direction of movement of the web,
 means independent of power of the web for normally holding said rollers disposed in tracking positions where the planes of rotation thereof are parallel to the direction of movement of the web so that pivotal movement of either pair of rollers from its said tracking position involves both a transverse displacement of the entire rollers toward one side of said position and a proportional angular displacement of the rollers about the pivoting axis;
 first and second sensing means detecting errors in the transverse registration of the moving web along the opposite longitudinal edges thereof; and
 said positioning means including first and second power operated means responding to said first and second sensing means, respectively, to move said first and second pairs of rollers about the related pivoting axes in directions causing transverse displacement of the rollers, and hence of the adjacent edges of the web, in the sense for eliminating the detected error in registration, while the proportional angular displacement of the rollers gives rise to restoring forces tending to alter the direction of movement of the web toward a condition of parallelism with the planes of rotation of the rollers.

12. A transverse web control device comprising pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter;
 mounting means supporting each pair of rollers for movement toward and away from each other and for movement substantially transversely relative to the direction of movement of the web;

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first force applying means acting on each of said pairs of rollers through said mounting means and operative to firmly urge the related rollers toward each other for non-slippable rolling contact of the rollers with the moving web;
 second force applying means acting on said pairs of rollers through said mounting means and operative to urge the related rollers to move substantially transversely and thereby directly transmit substantially transverse forces to the related edge portions of the moving web for transversely controlling the latter; and
 means responsive to substantially transverse movements of said pairs of rollers beyond predetermined limits to render inoperative at least said first force applying means and thereby release said rollers from the moving web.

13. A transverse web control device as in claim 1; wherein said mounting means for each pair of rollers includes
 a turnable support shaft extending perpendicular to the plane of the moving web adjacent the edge portion of the latter engaged by the related pair of rollers and being spaced substantially from the axes of rotation of the latter in a direction parallel to the direction of movement of the web, and
 a pair of levers mounted on said support shaft for rocking about axes parallel to said axes of rotation and each carrying a roller at an end of the lever so that the rollers impose a minimum resistance to movement of the web when disposed in tracking positions where the planes of rotation thereof are parallel to the direction of movement of the web and said substantially transverse movements of said rollers occur about the axes of the related support shafts and are accompanied by proportional angular displacements of said planes of rotation which give rise to forces tending to restore the parallel relationship of said planes of rotation of the rollers and direction of movement of the web.

14. A transverse web control device as in claim 13; wherein said first force applying means includes fluid pressure operated means connected to said pair of levers of each of said mounting means to rock said levers relative to each other in the direction urging the related pair of rollers toward each other in response to the supplying of fluid under pressure thereto, and
 means for supplying fluid under pressure to each of said fluid pressure operated means and having adjustable pressure controlling means therein for varying the force with which the related rollers are urged toward each other.

15. A transverse web control device as in claim 14; and means responsive to substantially transverse movement of either of said pairs of rollers beyond a predetermined limit to render inoperative at least said first force applying means, including
 solenoid operated valve means interposed in said means for supplying fluid under pressure and interrupting the supplying of fluid under pressure to each of said fluid pressure operated means when the solenoid of said valve means is deenergized,
 electric circuit means for energizing said solenoid, switch means associated with each of said pairs of rollers and interposed in series in said electric circuit means so that the latter is completed only when both of the switch means are simultaneously closed, and
 switch actuating means movable with each of said pairs of rollers and operative to maintain the associated switch means in closed condition only so long as the related rollers are within said predetermined limits of movement.

16. A transverse web control device as in claim 14;

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further comprising means operative to cause relative rocking of said pair of levers of each mounting means in the direction for moving apart the related pair of rollers upon interruption of the supplying of fluid under pressure to said fluid pressure operated means.

17. A transverse web control device as in claim 1; wherein said second force applying means includes fluid pressure operated means connected to each of said mounting means for urging the related pair of rollers transversely away from the other pair of rollers in response to the supplying of fluid under pressure thereto so that opposed transversely directed forces are transmitted by the rollers directly to opposite edge portions of the moving web for maintaining a corresponding transverse tension in the latter, and means for supplying fluid under pressure to each of said fluid pressure operated means and having adjustable pressure controlling means therein for varying the transverse tension to be maintained in the moving web.

18. A transverse web control device as in claim 17; and means responsive to substantially transverse movement of either of the pairs of rollers beyond a predetermined limit for interrupting the supplying of fluid under pressure to said fluid pressure operated means of said second force applying means, thereby to release the transverse tension on the moving web.

19. A transverse web control device as in claim 1; wherein said second force applying means includes fluid pressure operated means connected to each of said mounting means for urging the related pair of rollers transversely away from the other pair of rollers in response to the supplying of fluid under pressure thereto so that transversely directed forces are transmitted by the first mentioned pair of rollers to the edge portion of the moving web engaged thereby for maintaining a corresponding transverse tension in the web, means for supplying fluid under pressure to said fluid pressure operated means and having adjustable pressure controlling means therein for varying the transverse tension to be maintained in the moving web, power operated means connected to the other of said mounting means for positively displacing said other pair of rollers in substantially transverse directions, thereby to correspondingly displace the edge portion of the moving web engaged by said other pair of rollers, and

sensing means detecting errors in the transverse registration of the web along the longitudinal edge thereof adjacent said other pair of rollers and actuating said power operated means for displacing said other pair of rollers in the sense eliminating the detected error in transverse registration.

20. A transverse web control device as in claim 19; wherein said power operated means for positively displacing said other pair of rollers includes a reversible electric motor, and mechanical means converting rotating of said motor into substantially transverse displacements of said other pair of rollers; and wherein said sensing means includes photoelectric means scanning the related edge of the moving web and generating characteristic electric signals upon deviation of the scanned edge from a predetermined transverse position relative thereto, and electrical means for operating said motor in response to said signals.

21. A transverse web control device as in claim 1; wherein said second force applying means includes power operated means connected to each of said mounting means for positively displacing the related pairs of rollers in substantially transverse directions, thereby to correspondingly displace the edge portions of the moving web, and

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sensing means detecting errors in the transverse registration of the moving web along each longitudinal edge thereof and actuating the related power operated means for displacing the corresponding pair of rollers in the sense eliminating the detected error in transverse registration, thereby maintaining accurate transverse registration of both edges of the moving web.

22. A transverse web control device as in claim 21; wherein each of said power operated means includes a reversible electric motor, and mechanical means converting rotation of the motor into substantially transverse displacements of the related pair of rollers; and wherein said sensing means includes a photoelectric head scanning each longitudinal edge of the moving web and generating characteristic electrical signals upon deviation of the scanned edge from a predetermined transverse position relative to the head, and electrical means for driving each motor in response to said signals from the related scanning head.

23. A transverse web control device as in claim 21; in combination with

a mechanism for effecting coarse transverse register corrections at a location along the moving web in advance of said device; and

means rendering said mechanism operative to effect coarse transverse register corrections of the moving web only upon transverse movements of at least one pair of said rollers beyond predetermined operating limits of said transverse web control device, whereby said mechanism restores the web to the operating limits of said transverse web control device.

24. The combination as in claim 23; wherein said mechanism for effecting coarse transverse register corrections includes

a pair of parallel rolls extending across the moving web and engaging the latter,

means mounting said rolls for transverse displacements and corresponding tilting movements to effect said coarse transverse register corrections, and

power operated means for effecting said transverse displacements of the rolls in the sense for eliminating gross errors in transverse registration resulting in movements of said rollers beyond said predetermined operating limits of the transverse web control device.

25. A transverse web control device comprising pairs of freely rotatably rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter;

mounting means supporting each pair of rollers for movement toward and away from each other and for movement substantially transversely relative to the direction of movement of the web;

first force applying means acting on each of said pairs of rollers through said mounting means and operative to firmly urge the related rollers toward each other for non-slippable rolling contact of the rollers with the moving web;

second force applying means acting on said pairs of rollers through said mounting means and operative to urge the related rollers to move substantially transversely and thereby directly transmit substantially transverse forces to the related edge portions of the moving web for transversely controlling the latter; and

means for permitting operation of said second force applying means only when said first force applying means firmly urges the related rollers into non-slippable rolling contact with the web.

26. A transverse web control device as in claim 25; wherein said first force applying means is operated by fluid under pressure supplied thereto, and said means for permitting operation of the second force applying means is responsive to the pressure of fluid operating said first force applying means.

27. In a transverse web control device; the combination of
 mounting means adapted to be disposed adjacent an edge of a moving web,
 a support shaft turnable in said mounting means with its axis perpendicular to the plane of the web,
 a pair of levers mounted on said support shaft for rocking about parallel axes at right angles to said axis of the support shaft and substantially transverse to the direction of movement of the web, each of said levers having an arm extending away from said shaft largely in said direction,
 a roller rotatably mounted on said arm of each of said levers with the axis of rotation of the roller extending parallel to the rocking axis of the related lever,
 first force applying means acting on said levers to urge the latter to rock relative to each other in the direction for moving said rollers toward each other, and hence into non-slippable rolling engagement with the opposite surfaces of the web near the adjacent edge of the latter, and
 second force applying means acting on the assembly of said shaft and said levers to urge the rollers to move substantially transversely about the axis of said support shaft and thereby directly transmit substantially transverse forces to the edge portion of a moving web engaged by the rollers.
28. In a transverse web control device; the combination as in claim 27:
 wherein said first force applying means includes fluid pressure operated means connected between said levers, and conduit means for supplying fluid under pressure to said fluid pressure operated means;
 and further comprising fluid pressure responsive means sensing the pressure in said conduit means to permit operation of said second force applying means only upon a predetermined build-up of pressure in said conduit means when said rollers are urged together.
29. In a transverse web control device; the combination as in claim 27:
 wherein said second force applying means includes fluid pressure operated means connected with said support shaft for turning it about its said axis, and conduit means for supplying fluid under pressure to said fluid pressure operated means and having adjustable pressure regulating means interposed therein for varying the yieldable force exerted on said rollers.
30. In a transverse web control device; the combination as in claim 27:
 wherein said second force applying means includes a reversible electric motor, and control means for said motor causing operation of the latter for displacing said roller about said axis of the support shaft upon deviation of the web from correct transverse registration.
31. A transverse web control device comprising pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter,
 means urging the rollers of each of said pairs toward each other for non-slippable rolling contact of said rollers with the moving web,
 means mounting each pair of rollers for movement substantially transversely relative to the direction of movement of the web, and
 means independent of power of the web for normally

- disposing said pairs of rollers in tracking positions in which they rotate in planes substantially parallel to said direction, including power operated means for detecting and responding to error in transverse registration of the longitudinal medial line of the web to transversely displace at least one of said pairs of rollers in the sense for eliminating the error in registration.
32. A transverse web control device comprising pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter,
 first force applying means urging the rollers of each of said pairs toward each other for non-slippable rolling contact of said rollers with the moving web, means mounting each pair of rollers for movement substantially transversely relative to the direction of movement of the web,
 second force applying means independent of power of the web for normally disposing said pairs of rollers in tracking positions in which they rotate in planes substantially parallel to said direction and for exerting forces substantially transversely on said pairs of rollers for direct transmission by the latter to the related edge portions of the moving web so as to transversely control the latter,
 and web confining members located close to the path of the web and to rollers of said opposite pairs at the sides of said rollers away from said edges of the web, to inhibit buckling of the web out of its path by movement of said rollers transversely thereof.
33. A device according to claim 32, said confining members comprising shoes supported in positions fixed relative to axes of said rollers.
34. A transverse web control device comprising pairs of freely rotatable rollers engageable with both surfaces of a moving web adjacent the opposite longitudinal edges of the latter,
 first force applying means urging the rollers of each of said pairs toward each other for non-slippable rolling contact of said rollers with the moving web, means mounting each pair of rollers for movement substantially transversely relative to the direction of movement of the web,
 second force applying means independent of power of the web for normally disposing said pairs of rollers in tracking positions in which they rotate in planes substantially parallel to said direction and for exerting forces substantially transversely on said pairs of rollers for direct transmission by the latter to the related edge portions of the moving web so as to transversely control the latter,
 and a freely rotatable roller extending across the web path and having the web wrapped upon a part of its surface at a location spaced ahead of said pairs of rollers, to inhibit wrinkling of the web under forces applied to it by said pairs of rollers.

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