Nov. 8, 1966 W. F. HUCK 3,283,629

WEB PROCESSING MACHINES WITH COORDINATED WEB REGISTER AND TENSION CONTROLS

Filed Dec. 14, 1964 2 Sheets-Sheet 1

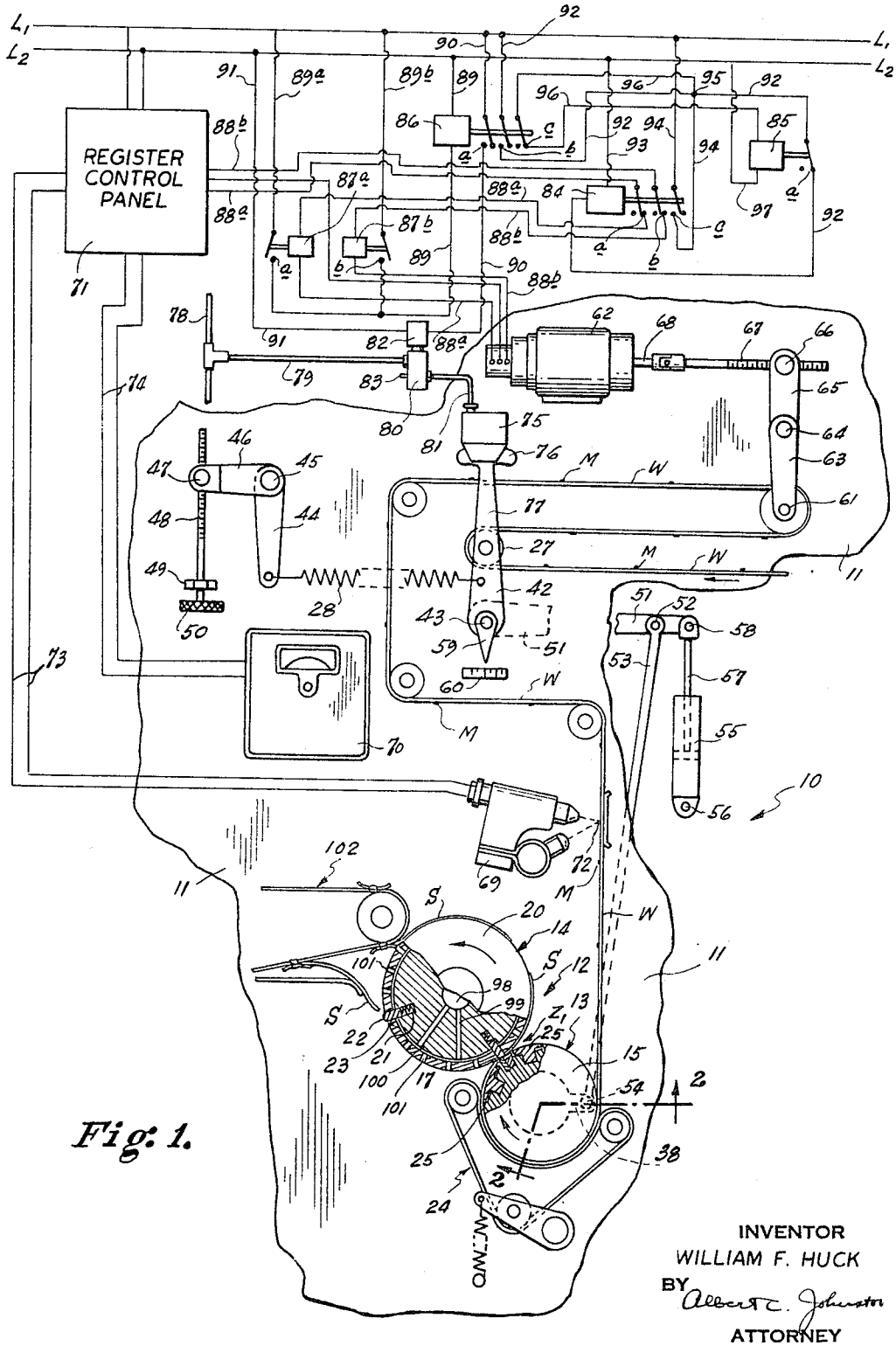


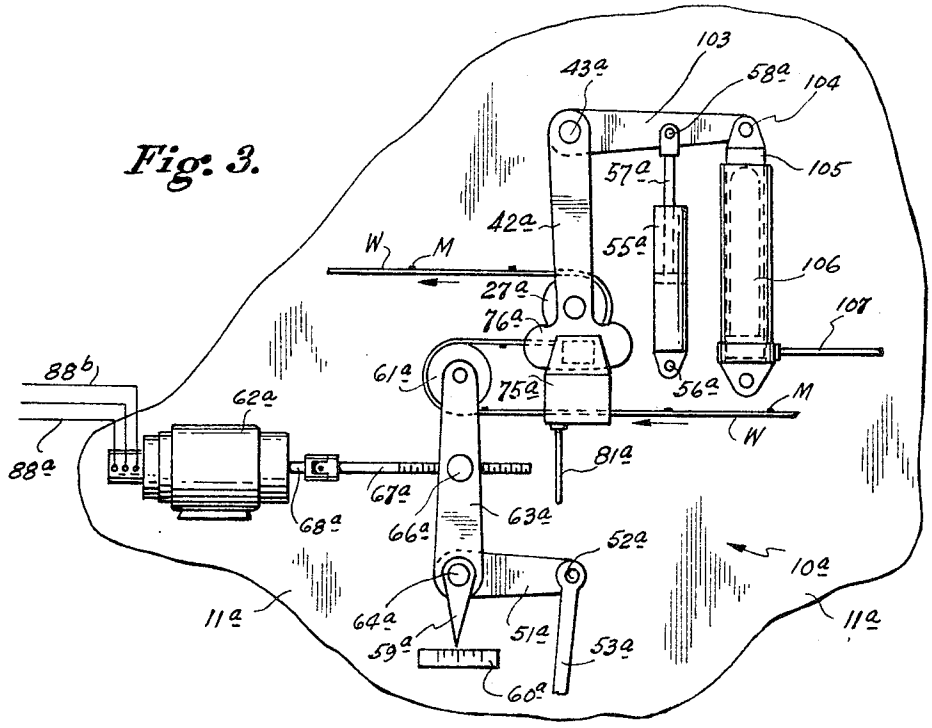
Fig. 1.

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Fig. 3.



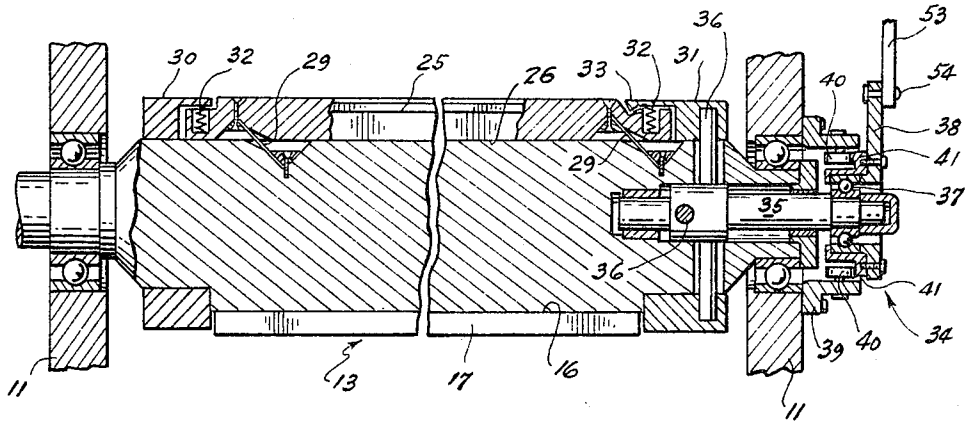


Fig. 2.

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WEB PROCESSING MACHINES WITH COORDINATED WEB REGISTER AND TENSION CONTROLS

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13 Claims. (Cl. 83—75)

This invention relates generally to machines for subjecting flexible webs, such as webs of paper, cardboard, cloth, plastic, metal foil or the like, while traveling continuously at high speeds, to processing operations, for example, printing, perforating, embossing or transverse cutting or sheet-forming operations. The invention is directed more particularly to machines of the described character for processing webs having printed or other repetitive patterns previously applied thereto, and wherein the processing operations are to be performed at predetermined positions relative to the repetitive patterns on the webs.

In machines for processing webs while the latter travel continuously at high speeds, the printing, perforating, embossing, or transverse cutting or sheet-forming operations are performed by at least one rotary cylinder peripherally engaging the web to propel the latter and carrying web processing elements to act periodically upon the web. For accurate maintenance of a desired repeat length of the processing along the web, for example, of the size of sheets cut from the web in the case of transverse cutting operations, it is important that the web be drawn or propelled by the rotary cylinder under a substantially uniform, predetermined tension, notwithstanding the tension varying effects of changes in environmental conditions or of variations of physical qualities of the web. Further, where the web has printed or other repetitive patterns previously applied thereto, it is necessary to provide register control means by which proper register or positional relationship is maintained between the repetitive patterns on the web and the processing elements carried by the cylinder to act periodically on the web. However, all register controls are normally operative, upon sensing of deviations from a registered condition of the repetitive patterns on the web with respect to the processing elements on the cylinder, to effect variation of web tension in a run of the web leading to the cylinder in the sense for restoring the registered condition. Thus, the operation of the register control means is normally inconsistent with the requirement for maintenance of a uniform predetermined tension in the web run leading to the cylinder.

Accordingly, it is an object of this invention to provide a machine for processing a web having repetitive patterns thereon by means of web processing elements carried by a rotary cylinder which peripherally engages the web to continuously propel the web, and wherein web register and tension controls, which may be of known types, are coordinated to afford both accurate register of the repetitive patterns with respect to the web processing elements and maintenance of a predetermined uniform tension in the web run leading to the cylinder.

In web processing machines according to this invention, means are provided for interrupting or preventing displacement of the web run leading to the processing cylinder by the tension control upon operation of the register control until the web tension variation introduced by operation of the register control has been effective to compensate substantially for the deviation from the registered condition which gave rise to operation of the register control.

In preferred embodiments of the invention, the tension control is rendered inoperative for a limited period upon operation of the register control and, thereafter, the register control is rendered inoperative for a limited period during which the tension control is free to operate and thereby correct for any departure from the uniform web tension to be maintained. Thus, the register and tension controls of the web processing machine act alternately and incrementally to achieve both accurate register and a generally constant or uniform web tension during the processing of the web.

In some embodiments of the invention, a register control roller engages a run of the web leading to the cylinder which propels the web and carries the web processing elements and such roller is positively displaced for adjusting the length of the web path in said run upon deviation from the registered condition of the repetitive patterns on the web with respect to the web processing elements; a tension control roller is yieldably biased against the web run under a predetermined force so as to be displaced upon variations of the tension in the web run from a predetermined value; and the tension control roller is held against displacement for a predetermined period upon displacement of the register control roller effective to compensate substantially for deviations from the registered condition, whereupon, displacement of the register control roller is prevented for a predetermined period during which the tension control roller is free to be displaced for restoring said predetermined value of tension in the web run.

The above arrangement is particularly adapted to make use of a web propelling and processing cylinder of a construction having radially displaceable members forming part of its peripheral surface, and positioning means which displace such members radially upon and in proportion to displacements of either the register control roller or the tension control roller so as to vary compensatingly the web engaging circumference of the cylinder, and thus the speed of its propulsion of the web, in the sense for correcting either a deviation from the registered condition or a variation of web tension from the constant value to be maintained.

The above, and other important objects, features and advantages of the invention, will be apparent from the following detailed description of illustrative embodiments thereof, which is to be read in connection with the accompanying drawings.

In the drawings:

FIG. 1 is a schematic side elevational view, partly broken away and partly in section, of a high-speed web sheeting machine embodying the invention;

FIG. 2 is a transverse sectional view taken along the line 2—2 on FIG. 1, but on an enlarged scale; and

FIG. 3 is a fragmentary schematic view showing an alternative arrangement of the register and tension control rollers.

Referring in detail to FIG. 1 of the drawings, the invention is there shown embodied in a high speed web sheeting machine **10** which is of a type disclosed in detail in U.S. patent application Serial No.180,585, filed March 19, 1962, by William F. Huck, and embodies features disclosed in U.S. patent application Serial No. 28,609, filed May 12, 1960, also by William F. Huck. Such web sheeting machine is intended to receive a continuous flexible web W of relatively thin material, such as paper, cardboard, cloth, plastic or metal foil, or the like, delivered continuously to the machine at a high speed, to cut the web into successive sections or sheets of uniform size, and to deliver the sections or sheets individually away from the cutting zone as rapidly as they are formed.

The web W may be received by machine **10** directly from a rotary web printing press or other machine by

which it has been previously printed or otherwise processed, or it may be drawn continuously from an unwinding roll stand or other suitable supply source. It will be understood that the web sheeting machine **10** is driven in synchronism with the printing press, roll stand or other source of the web. The web may be composed of a single layer or ply of paper or other flexible material, or it may be a multi-ply web such as may be formed, for example, by slitting a web or webs into ribbons and assembling the ribbons so that they are superposed in a continuous flexible strip. Further, a plurality of separate webs or ribbons, such as may be formed by slitting a wide printed web into narrower strips or ribbons each having the width of a printed book or magazine page, may be processed simultaneously in side-by-side relation in the web sheeting machine.

The web sheeting machine **10** generally comprises a cutting mechanism **12** composed of first and second cylinders **13** and **14**, respectively, which are journalled at their ends in suitable bearings carried by side frame members **11**. The two cylinders are rotated in continuous relation about parallel axes, so as to provide between them a zone of tangency Z_1, in which cross cutting operations are performed periodically upon the web W to convert the web continuously into a succession of separate sheets.

The first cylinder **13**, which constitutes a web propelling cylinder, includes a generally cylindrical body **15** having one or more axially extending recesses **16** in the periphery thereof at locations spaced apart equally about its circumference, with each recess receiving a cutting blade or knife **17** which is suitably secured therein. The number of knives **17** carried by cylinder **13** depends upon the circumference of the cylindrical body **15** and the length of the successive sections or sheets to be cut from web W, which length is equal to the circumference of the cylinder divided by the number of knives **17** thereon.

The second or transfer cylinder **14** of the cutting mechanism includes a cylindrical body **20** having a plurality of axially extending recesses or slots **21** in its periphery, which are equal in number to the knives **17** carried by cylinder **13** and are also equally spaced apart in the circumferential direction. The recesses or slots **21** accommodate elongated anvil members **22** which are urged radially outward, as by springs **23**, to an adjustably determined extent.

The first cylinder **13** is suitably rotated in the clockwise direction, as viewed on FIG. 1, and the second or transfer cylinder **14** is rotated at the same angular speed as cylinder **13**, but in the counter-clockwise direction. Although cylinders **13** and **14** are counter-rotated at the same angular speed, cylinder **14** is made to have a diameter substantially greater than that of cylinder **13**, so that the peripheral or circumferential speed of cylinder **14** is considerably greater than that of cylinder **13**. However, since the two cylinders have the same numbers of coacting knives **17** and anvil members **22** and are rotated at the same angular speed, the gears or other means by which the two cylinders are rotated can be arranged to ensure that each knife **17** moves through the zone of tangency Z_1 between the cylinders simultaneously with a related one of the anvil members. **22**.

It will be seen that the web W passes downwardly to and travels around the lower peripheral portion of the first cylinder **13** in wrapped relation thereto before reaching the zone of tangency Z_1 between the two cylinders, so that the web can be kept in non-slipping relation to cylinder **13** and will be advanced to the zone of tangency at the circumferential speed of that cylinder. The part of the web wrapped upon the cylinder **13** is held tightly against the same in a fixed position with respect to a knife or knives **17** thereon by suitable web guiding means **24**.

For accurate maintenance of the desired size of the sheets cut from the web, which size is determined by the circumferential distance at the periphery of cylinder **13** between the successive knives **17**, it is important that the web be drawn continuously to the rotary cutting mechanism **12** under a substantially uniform predetermined tension, notwithstanding the tension varying effects of changes in environmental conditions or of variations of physical qualities of the web. Furthermore, in order to keep the cutting elements acting upon a printed or otherwise repetitively patterned web at the proper locations relative to the printed areas or other patterns on the web, it is important that the machine be provided with suitable register control means and that the required web tension be maintained notwithstanding register correcting actions of the register control means.

In the machine shown on FIG. 1, the web tension control system is of the type employing a variable diameter web propelling cylinder to vary the speed at which the web is propelled for maintaining a desired constant tension in the web. In order to perform the foregoing function, the web propelling cylinder **13** is provided with radially displaceable members **25** slidably received in axially extending slots **26** (FIG. 2) opening radially in the cylindrical body **15** at locations spaced apart about the periphery of such body between the knives **17**. Each member **25** is of T-shaped cross-section so as to provide a relatively wide head having a suitably arcuate outer surface that forms a considerable segment of the peripheral surface of cylinder **13** engaging the web W. The web travelling to cylinder **13** is passed about a floating or displaceable roller **27** which is yieldably biased against the web under a predetermined force, such as, that of a spring **28**, so as to tension the web to the desired extent. Positioning means are provided, such as the system of levers and links seen between the roller **27** and cylinder **13** and hereinafter described in detail, to displace members **25** radially relative to the axis of cylinder **13** upon and in proportion to displacements of roller **27**. Thus, the effective diameter and web engaging circumference of cylinder **13**, and hence the speed of its propulsion of the web, are varied automatically in compensation for variations of the tension of the web approaching the cylinder so long as roller **27** is free to be displaced by such tension variations.

More specifically, the arrangement is such that an incremental reduction of the tension in the run or lead of the web leading to cylinder **13** is attended by a displacement of roller **27** that causes a compensating increase of the web propelling circumference of cylinder **13** for correspondingly increasing the speed of propulsion of the web by the cylinder, while an incremental increase of the web tension is attended by a reverse displacement of roller **27** causing a compensating decrease of the speed of propulsion of the web.

As shown particularly on FIG. 2, each member **25** is mounted within its slot **26** by a pair of inclined leaf springs **29** which have their outer ends secured to the displaceable member **25** and their inner ends secured to the cylindrical body **15**, and which constantly urge the member **25** toward the left and radially inward as viewed on FIG. 2. The opposite ends of each member **25** extend loosely into undercut rings **30** and **31** provided on the opposite ends of body **15**, and helical compression springs **32** act between these rings and the ends of each member **25** to further urge the latter radially inward. The ring **30** is fixed in place, while the ring **31** is movable axially relative to the body **15** and is provided with an inturned flange **33** which engages in a notch at the adjacent end of each member **25**. The displaceable members **25** thus are positioned by and constrained to follow any axial displacement of the axially movable ring **31**.

The position of ring **31** and members **25** is determined by a mechanism **34** that includes a shaft **35** slidable axially within a bore at one end of body **15** and carrying radial rods **36** that pass loosely through radial passages in body **15** and have their outer ends engaged in suitable sockets in ring **31**. The outer end of shaft **35** carries an antifriction bearing **37** on which there is mounted the hub of a radially extending arm **38** so that shaft **35** can rotate with

cylinder 13 independently of radial arm 38. A housing 39 is fixed around bearing 37 and has follower rollers 40 mounted therein in engagement with a cam ring 41 suitably secured at the inside of arm 38 around the hub of the latter.

The springs 29 and 32 constantly urge the members 25, ring 31, rods 36 and shaft 35, as a unit, axially toward the left, that is, in the direction tending to retract shaft 35 within body 15. Therefore, the cam ring 41 is constantly urged against the follower rollers 40, and any angular displacement of arm 38 on bearing 37 is effective either to displace shaft 35 and members 25 towards the right, as viewed on FIG. 2, or to permit the members 25 to be displaced toward the left by the force of springs 29 and 32. When members 25 are displaced toward the right, they move radially outward on the inclined mounting springs 29, thus increasing the effective circumference of cylinder 13 and, when members 25 are displaced toward the left, they move radially inward to decrease that circumference.

As further seen on FIG. 1, the displaceable roller 27 is journalled in arms 42 which extend generally upward from a rockable shaft 43. The tension spring 28 biasing roller 27 against the web is connected at one end to one of the arms 42 and at its other end to a rockable arm 44 secured on a shaft 45. Another arm 46 secured to shaft 45 carries a pivotal nut 47 having an adjusting screw 48 threaded through it. The screw 48 is rotatable in a bearing bracket 49 and may be turned by a knob 50 so as to change the position of arm 44 and thereby vary the force exerted by spring 28 upon arm 42, and hence the force exerted by roller 27 against the web W for determining the tension to be maintained in the web.

The shaft 43 which carries arms 42 has another radial lever arm 51 secured to it for angular displacement upon displacement of roller 27. The arm 51 is pivotally connected at 52 to a link or rod 53 that extends downwardly to a pivotal connection at 54 with the radial arm 38 of the above described mechanism 34, so that any displacement of the roller 27 is attended by a proportionate angular displacement of the arm 38 and cam ring 41, and thus by a proportionate variation of the radial position of the displaceable members 25 of cylinder 13. A dash pot 55 pivotally mounted at 56 on the frame of the machine has its piston rod 57 pivotally connected at 58 to the end of the lever arm 51, and serves both to reduce any tendency of the floating roller 27 to hunt during operation and to prevent shocks in the mechanism 34 in the event of a break in the web W.

It will be evident that if the tension of web W falls below the desired value determined by the adjustment of spring 28, the spring displaces roller 27 toward the left as viewed in FIG. 1 and causes axial displacement of shaft 35 in the direction for effecting radially outward displacement of the members 25, thereby increasing the effective diameter and peripheral speed of the cylinder 13 and correspondingly increasing the tension in the web until the tension variation is corrected and the roller 27 is restored to its normal operating position. Conversely, if the web tension increases beyond the desired value, the roller 27 is displaced toward the right as viewed on FIG. 1, and the corresponding angular displacement of arm 38 causes a corresponding inward movement of the members 25 which decreases the effective diameter and web propelling speed of cylinder 13 so as to decrease the tension in the web until the tension variation is corrected and the roller 27 is returned to its normal operating position. A pointer 59 may be secured on shaft 43 to cooperate with a scale 60 for constantly indicating the position of the displaceable roller 27.

In order maintain repetitive printed or otherwise formed patterns on the web in the required registered relation to the cutting elements 17 on cylinder 13, the web travelling to the cylinder 13 is further passed about a roller 61 which is positioned adjustably by a reversible register correction motor 62. The roller 61 is journaled in arms 63 secured to a shaft 64 which is turnable in suitable bearings carried by side frame members 11, and another arm 65 is secured on the shaft 64 and carries a pivotal nut 66 which receives and is positioned by a screw 67 coupled to the rotary shaft 68 of the motor 62.

The motor 62 consitutes one element of a register control system, of a character known per se, which is operative to continually compare the angular position of cylinder 13, hence the position of the knives 17 thereon, with the position of register marks M located in the web W and which normally acts, upon sensing a deviation from the required registered condition of the register marks with the knives, to displace the roller 61 in the direction and to the extent required for correction of the sensed register error. This known register control system also comprises a photoelectric scanning head 69, which may be of the type commercially available from the Specialty Control Department of General Electric Company, Waynesboro, Virginia, under Item No. CR7515–P202–G4; a photoelectric selector or pulsing switch 70 which may be of the type commercially available from the above source as Item No. CR7515–P145–G4; and a register control panel 71 which may be of the type commercially available from the above source as Item No. 3S7515–CT100–A1.

The scanning head 69 detects the register marks M on the web and emits control signals as these marks pass by a fixed scanning station 72. The selector or pulsing switch 70 is driven continuously in timed relation to the cylinder 13 and generates signals which are emitted from the switch 70 at intervals which give a precise measure of the angular position and speed of the knives on cylinder 13.

At the outset of the operation of the machine 10, the web W is so positioned relative to scanning head 69 and the register control system is so regulated that, when the web wrapped on cylinder 13 is correctly registered with one or more of the knives 17 thereon, that is, when it overlies a knife so as to be severed at the correct location between two of the successive printed areas or other patterns on the web, the signals generated by the movement of the register marks past the scanning head 69 will coincide with the signals generated by the selector or pulsing switch 70.

In the course of the cutting operations, whenever the register marks M passing the scanning station 72 run ahead of, or lag behind their position that corresponds to correct registration of the web with the knives 17, the signals emitted by scanning head 69 and transmitted to register control panel 71 by way of conductors 73 no longer coincide with the signals emitted by selector switch 70 and fed from the latter to the control panel by way of conductors 74, and such lack of coincidence of the respective signals resulting from deviation from the registered condition is detected by register control panel 71 which, in turn, emits an error signal proportional to the deviation and intended to energize the motor 62 in the direction for correction of the register error.

Thus, if the register marks and patterns on the web are running ahead of the correct position, control panel 71 emits error signals for energizing motor 62 so as to displace roller 61 toward the right, as viewed on FIG. 1. Such displacement of roller 61 causes an incremental increase of the tension in the web run leading to cylinder 13 and tends to increase the length of the path of travel of the web in such run so that the desired locations for the cuts of the web are brought back to the correct positions over the knives on the cutting cylinder 13. Conversely, if the register marks and patterns on the web are lagging behind the correct position, control panel 71 emits error signals for energizing motor 62 so as to displace roller 61 toward the left, and thereby incrementally reduce the tension in the web run leading to cylinder 13. Such decrease in the web tension and in the length of the path of the web in the run leading

to cylinder 13 tends to advance the desired locations for the cuts of the web to the correct positions over the knives.

If tension control roller 27 is free to be displaced immediately upon an increase or decrease in the web tension resulting from displacement of the register control roller 61, the effect is to return the tension in the web run to the value corresponding to the force with which roller 27 is biased against the web by spring 28. Thus, the operation of the tension control system in immediate response to a variation in web tension resulting from displacement of the register control roller 61 tends to defeat the effectiveness of such displacement in restoring the registered condition.

In accordance with the present invention, the operation of the tension control system is delayed, upon operation of the register control system, until the web tension variation introduced by displacement of the register control roller 61 has been effective to compensate substantially for the deviation from the registered condition which gave rise to operation of the register control system. More specifically, in the machine illustrated on FIG. 1, the tension control system is rendered inoperative for a limited period of time upon displacement of the register control roller 61, particularly by holding the roller 27 against displacement in response to the variation in web tension resulting from displacement of the register control roller, and, thereafter, the register control system is rendered inoperative, as by interrupting the transmission of error signals from panel 71 to motor 62, for a limited period during which the tension control system is free to operate and thereby correct for any departure from the uniform web tension to be maintained. Thus, in accordance with this invention, the register and tension control systems of the web sheeting or other processing machine act alternately and incrementally to achieve both accurate register and generally constant or uniform web tension during the processing of the web.

In order to operate in the above manner, the illustrated web sheeting machine 10 further includes a brake device 75 actuated by fluid under pressure, for example, compressed air, and carried by one of the side frame members 11 so as to be engageable with a flange 76 formed on an extension 77 of one of the arms 42 supporting roller 27. A supply conduit 78 carrying compressed air or other fluid under pressure from a compressor or other source is connected through a branch conduit 79 to a control valve 80 which is, in turn, connected through a pipe 81 with the brake 75. The valve 80 is actuated by a solenoid 82 so that, when the solenoid is energized, valve 80 establishes communication between conduit 79 and pipe 81 and fluid under pressure thus supplied to the brake 75 causes engagement of the latter with flange 76 to hold roller 27 against displacement. On the other hand, when solenoid 82 is deenergized, valve 80 places pipe 81 in communication with a vent or exhaust port 83 of the valve to release the fluid pressure from brake 75 and thereby disengage the latter from flange 76 so that roller 27 is then free to be displaced in response to variations in the tension of the web.

Interconnected electric circuits are provided for the energization of solenoid 82 controlling valve 80 and for the transmission of error signals from control panel 71 to the reversible register correction motor 62. As shown on FIG. 1, these electric circuits have, as the main components thereof, a first adjustable time delay relay 84 determining the length of the time period during which the register control system operates and the brake 75 is engaged with the flange 76 to prevent displacement of roller 27, and hence to prevent operation of the tension control system; a second adjustable time delay relay 85 determining the length of the time period during which the brake 75 is disengaged to permit the web tension control system to operate, while the transmission of any error signals from control panel 71 to motor 62 of the register control system is interrupted; a control relay 86 which controls the energization of time delay relays 84 and 85 and of solenoid 82; and relays 87*a* and 87*b* which initiate the operation of the electric timing circuit when an error signal is emitted by control panel 71 for operation of motor 62.

Conductors 88*a* and 88*b* extend from control panel 71 to motor 62 for carrying error signals intended to effect rotation of motor shaft 68 in one direction or the other. Normally closed contacts *a* and *b* of time delay relay 84 and the coils of relays 87*a* and 87*b* are interposed, in series, in the conductors 88*a* and 88*b*, respectively. Thus, so long as relay 84 is in its illustrated untripped condition, closed circuits for error signals are provided between control panel 71 and motor 62 through closed contacts *a* and *b* of time delay relay 84 and through the coils of relays 87*a* and 87*b*. Relays 87*a* and 87*b* have normally open contacts *a* and *b*, respectively, interposed in conductors 89*a* and 89*b* extending in parallel from one power supply line L_1 to a conductor 89 connected to the other power supply line L_2 and having the coil of control relay 86 interposed therein. Thus, one or the other of the relays 87*a* and 87*b* is energized when an error signal is transmitted from control panel 71 to motor 62, and the energization of the relays 87*a* and 87*b* closes the circuit for energizing the control relay 86.

The control relay 86 has a normally open contact *a* interposed in a conductor 90 extending from supply line L_1 to solenoid 82, and the circuit for energizing the solenoid is completed by a conductor 91 extending from the solenoid to the supply line L_2. Thus, solenoid 82 is energized to cause engagement of the brake 75 whenever control relay 86 is energized to close its normally open contact *a*.

The circuit for energizing the first time delay relay 84 includes a conductor 92 extending from supply line L_1 to the coil of relay 84 and having a normally open contact *b* of control relay 86 and a normally closed contact *a* of the second time delay relay 85 interposed therein, in series, and a conductor 93 extending from the coil of relay 84 to the power supply line L_2. The relay 84 further has a normally open hold contact *c* interposed in a conductor 94 extending from supply line L_1 to a junction 95 with conductor 92 at a location along the latter between contact *b* of relay 86 and contact *a* of relay 85.

In order to provide for energization of the second time delay relay 85, a conductor 96 extends from the junction 95 to the coil of relay 85 and has a normally closed contact *c* of the control relay 86 interposed therein, and a conductor 97 extends from the coil of relay 85 to supply line L_2.

The above described electric circuits operate as follows: An electric error signal flowing from control panel 71 through either of conductors 88*a* or 88*b* for energizing reversible register correction motor 62 first passes through one or the other of the normally closed contacts *a* and *b* of time delay relay 84, and then energizes one or the other of the relays 87*a* or 87*b*. Closing of the contacts *a* or *b* of the energized relay 87*a* or 87*b* causes energization of control relay 86 for immediately tripping or actuating the latter. Actuation of relay 86 closes the contact *a* thereof for energizing the solenoid 82 of valve 80 so that the latter permits fluid under pressure to enter brake 75 which thereby engages flange 76 to hold roller 27 against displacement and prevent operation of the web tension control system. Actuation of relay 86 further closes its contact *b* and thereby causes energizing of the first time delay relay 84 through the closed contact *a* of the second time delay relay 85. Actuation of control relay 86 further causes opening of its contact *c*, thereby interrupting the conductor 96 so that the second time delay relay 85 will not be energized during energization of the first time delay relay 84.

The time delay relay **84** is tripped or actuated at an adjustably predetermined time interval after initial energization thereof. Actuation of relay **84** causes opening of its contacts *a* and *b* which opens or interrupts the conductors **88***a* and **88***b* so that error signals can no longer be transmitted from control panel **71** to register correction motor **62**, thereby rendering inoperative the register control system. Opening of the contacts *a* and *b* of relay **84** further deenergizes the relays **87***a* and **87***b*, thereby opening the contacts *a* and *b* of such relays and deenergizing the control relay **86**. Upon deenergization of control relay **86**, the contact *a* thereof opens to effect deenergization of solenoid **82**, whereby valve **80** vents or discharges fluid under pressure from brake **75** to disengage the latter from flange **76** and free roller **27** for displacement upon variation of the web tension from the predetermined value to be maintained. Accordingly, the web tension control system then becomes operative. The actuation or tripping of the first time delay relay **84** also causes closing of its contact *c* to complete the circuit for energizing the second time delay relay **85** through conductor **94** to junction **95**, through conductor **96** having the closed contact *c* of deenergized relay **86** interposed therein, and through conductor **97**.

The first time delay relay **84** is held in its tripped condition through conductor **94** having the closed hold contact *c* of relay **84** interposed therein, conductor **92** having the closed contact *a* of relay **85** interposed therein, and conductor **93**.

The second time delay relay **85** is tripped or actuated at a predetermined time interval after initial energization thereof, thereby opening its contact *a* and deenergizing the relay **84** so that the contact *c* of the latter is returned to its normal open condition for deenergizing the relay **85**. Accordingly, the circuit is returned to its original condition, and remains thus until an error signal is again emitted by control panel **71** for operating the register correction motor **62**.

So long as there are no deviations from correct registration of the repetitive patterns on the web with respect to the knives or other processing elements on cylinder **13**, tension control roller **27** is free to be displaced upon variations of the tension in the web so as to maintain the desired constant web tension. However, it will be apparent that, when deviation from correct registration are detected, the register control system and the tension control system are made to act alternately and incrementally, thereby to have the combined effect of restoring correct registration and of maintaining the desired constant web tension. The time delays provided by the adjustable time delay relays **84** and **85** may be suitably varied so as to select the most desirable proportional relationship of the periods in each cycle during which the register control system and the tension control system are respectively operative to achieve both correct registration of the transverse cutting of the web with respect to the printed patterns thereon and also a uniform repeat length or distance between the successive transverse cuts.

After the web is transversely cut by the cooperative action of knives **17** and anvil members **22** at the zone of tangency Z_1, the resulting individual sheets S are carried away on the surface of cylinder **14**. For example, as described in detail in U.S. patent application Serial No. 180,585, which is further identified above, the body **20** of cylinder **14** may have an axial bore **98** suitably connected to a source of vacuum and communicating through radial passages **99** and annular cavities **100** with air ports **101** opening at the peripheral surface of cylinder **14** between the anvils **22**. Thus, each sheet S cut from the web W by the coaction of the knives **17** and anvils **22** at the zone of tangency Z_1 is made to adhere to the surface of cylinder **14** by the suction acting on the sheet at ports **101** and the sheet is carried away at the relatively high peripheral speed or cylinder **14**. Each sheet S cut from the web is spaced from the new web end travelling behind it at the relatively slower peripheral speed of the cylinder **13**. Finally, the successive, spaced apart sheets S may be removed from the surface of cylinder **14** by means of a delivery conveyor **102**.

In the web sheeting machine **10** described above with reference to FIG. 1, the expansible cylinder **13** is part of the tension control system in that its effective diameter is varied in response to displacement of the tension control roller **27** and thereby varies the speed at which the web is propelled by cylinder **13** so as to maintain a predetermined constant web tension. Further, in machine **10**, register control is effected by positively displacing the register control roller **61** in response to a detected deviation from correct register so as to vary the length of the web path and web tension in the run leading to cylinder **13** in the sense for restoring correct registration. However, as shown particularly on FIG. 3, the present invention may be also applied to a modified web processing machine **10***a* in which the mechanism **34** (FIG. 2) for altering the effective diameter of web propelling cylinder **13** is actuated in response to displacement of the register control roller rather than of the tension control roller. In such modification, the mechanism **34** has its actuating arm **38** connected to the lower end of a link or rod **53***a* which, at its upper end, is pivotally connected at **52***a* to an arm **51***a* secured to a shaft **64***a* which also carries the arms **63***a* rotatably supporting the displaceable register control roller **61***a*. One of the arms **63***a* carries a pivotal nut **66***a* which receives and is positioned by a screw **67***a* coupled to the rotary shaft **68***a* of the reversible register correction motor **62***a*. Thus, when motor **62***a* is operated by error signals received through conductors **88***a* and **88***b* to displace the roller **61***a* in the direction required for correction of a sensed register error, the corresponding angular displacement of shaft **64***a* and arm **51***a* is transmitted through rod or link **53***a* to the arm **38** of the mechanism **34** to cause a corresponding increase or decrease in the effective circumference of cylinder **13**, and hence in the speed with which the latter propels the web.

In the operation of the modification of the machine illustrated on FIG. 3, if the register marks M on the web are running ahead of the correct position, the error signals transmitted to motor **62***a* cause operation of the motor so as to displace roller **61***a* toward the left, as viewed on the drawing, and such displacement of the register control roller causes the radially movable members **25** of cylinder **13** to be displaced inwardly for proportionately reducing the circumference of cylinder **13** and hence the length of web entrained on this cylinder between successive knives and the speed at which the web is propelled. The desired locations of the cross-cutting operations performed on the web thus are restored to their correct positions over the knives on the cutting cylinder by a combination of a backward displacement of the web and a proportional decrease of the web speed.

Conversely, if the register marks are lagging behind their correct position, motor **62***a* displaces roller **61***a* toward the right, and the circumference of cylinder **13** is increased proportionally so as to take up an increased length of the web between knives **17**, and thus advance the desired locations of the cross cutting operations on the web to their correct positions over the knives by a combination of a forward displacement of the web and a proportional increase of the web speed.

In the arrangement of FIG. 3, the web tension control system includes a displaceable roller **27***a* biased yieldably against the web at a location between the roller **61***a* and cylinder **13**, as shown on the drawing, or at a location preceding roller **61***a*. The tension control roller **27***a* is carried by arms **42***a* extending from a turnable shaft **43***a*. Another radial arm **103** is secured to shaft **43***a* for angular displacement with the latter and is pivotally connected at **58***a* to a plunger or piston rod **57***a* movable

in a dash pot cylinder **55***a* which is pivotally supported at **56***a*. The arm **103** is further pivotally connected at **104** to a piston **105** movable in a cylinder **106** to which air or other fluid under pressure is supplied through a conduit **107**. The pressure of fluid supplied through conduit **107** is suitably controlled so that the force exerted by the fluid within cylinder **106** on piston **105**, and hence the yieldable force biasing roller **27***a* against the web will correspond to the value of the constant tension to be maintained in the web. It will be apparent that, so long as roller **27***a* is free to be displaced, such roller will move upon a deviation of the web tension from the value to be maintained and thereby restore the web tension to such value.

In accordance with the present invention, the arrangement shown on FIG. 3 also has the operation of its tension control system delayed, upon operation of the register control system, until the web tension variation introduced by displacement of the register control roller **61***a* has been effective to compensate substantially for the deviation from the registered condition which gave rise to operation of the register control system. Thus, as in the arrangement described with reference to FIG. 1, the machine **10***a* shown on FIG. 3 also has a fluid pressure operated brake **75***a* engageable, upon the supplying of fluid under pressure thereto through a conduit **81***a*, with a flange **76***a* formed on an extension of one of the arms **42***a* supporting the tension control roller **27***a* so that, when brake **75***a* is engaged with flange **76***a*, displacement of roller **27***a* will be prevented. The supplying of fluid under pressure through conduit **81***a* to brake **75***a* for operating or engaging the latter may be controlled by a solenoid operated valve (not shown). Interconnected electric circuits (not shown), as described in detail with reference to FIG. 1, may also be provided to actuate the solenoid operated valve and thereby cause engagement of the brake **75***a*, and hence inoperativeness of the tension control system, for a limited period of time upon displacement of roller **61***a* for correcting a register error, and, thereafter, to render the register control system inoperative by interrupting the transmission of error signals to motor **62***a* for a limited period during which the brake **75***a* is disengaged and thereby permits operation of the tension control system for maintaining the desired web tension.

The preferred embodiments of this invention, as described above, have the tension control system rendered inoperative for a limited time period upon operation of the register control system and, thereafter, cause the register control system to be inoperative for a limited time period during which the tension control system is free to operate, so that the tension control system will not reduce the effectiveness of the register control system in correcting for a register error by controlled web tension variation. However, substantially the same result may be achieved, particularly when the requirements are not overly critical, merely by delaying or slowing the response of the tension control system to a variation of web tension resulting from operation of the register control system, and without interrupting the operation of the latter system. For example, in the embodiments of FIGS. 1 and 3, the register correction motor **62** or **62***a* may be connected directly to the output of register control panel **71** and the brake **75** or **75***a* and the attendant electric circuits for controlling the same may be eliminated. In that case, the response of the tension control system to a variation in web tension resulting from displacement of the register control roller **61** or **61***a* is delayed by providing either extra heavy damping fluid in the dash pot **55** or **55***a*, or by providing a restricted metering orifice for slowing the flow of fluid in the dash pot from one side to the other of the piston movable therein. When the dash pot is provided with an extra heavy damping fluid or with a restricted metering orifice therein, the tension control system has a much slower operating rate than that of the register control system. Thus, when deviation from correct register is detected, thereby resulting in an error signal causing operation of the correction motor **62** or **62***a* and corresponding displacement of the register control roller **62** or **62***a*, such displacement of the roller is effective to restore the correct register by suitably varying the tension in the web before appreciable displacement of the tension control roller **27** or **27***a* can occur in response to such web tension variation. After accurate register has been restored, the relatively slow acting tension control system is then effective to eliminate abnormal variations in web tension resulting from changes in environmental conditions or variations of the physical qualities of the web.

Although the present invention has been described in detail and illustrated herein with reference to web sheeting machines having particular types of web tension and register control systems, it is to be understood that the invention may also be applied to other web processing machines provided with other forms of tension and register control systems.

Further, it will be apparent that the invention is not limited to the particular embodiments thereof which have been described in detail herein with reference to the accompanying drawings, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit of the invention as defined in the appended claims.

What is claimed is:

1. In a machine for processing a web having repetitive patterns thereon;

a rotary cylinder peripherally engaging the web to continuously propel the web and carrying web processing elements to act periodically upon the web,

register control means operative upon sensing of deviations from a registered condition of said repetitive patterns with respect to said processing elements to effect variation of web tension in a run of the web leading to said cylinder in the sense for restoring said registered condition,

tension control means operative to maintain a predetermined constant tension in said web, and

means for preventing displacement of said web run by said tension control means upon operation of said register control means until the web tension variation introduced by such operation has been effective to compensate substantially for the sensed deviation from the registered condition.

2. In a machine for processing a web having repetitive patterns thereon;

a rotary cylinder peripherally engaging the web to continuously propel the web and carrying web processing elements to act periodically upon the web,

register control means operative upon sensing of deviations from a registered condition of said repetitive patterns with respect to said processing elements to effect variation of web tension in a run of the web leading to said cylinder in the same sense for restoring said registered condition,

tension control means for maintaining a predetermined value of tension in said web run, said tension control means including a floating roller yieldably biased against said web run under a predetermined force so as to be displaced upon variations of the tension in said web run from said predetermined value, and

means for preventing displacement of said web run by said roller upon operation of said register control means until the web tension variation introduced by such operation has been effective to compensate substantially for the sensed deviation from the registered condition.

3. In a machine for processing a web having repetitive patterns thereon;

a rotary cylinder peripherally engaging the web to

continuously propel the web and carrying web processing elements to act periodically upon the web,

register control means operative upon sensing of deviations from a registered condition of said repetitive patterns with respect to said processing elements to effect variation of web tension in a run of the web leading to said cylinder in the sense for restoring said registered condition,

tension control means for maintaining a predetermined value of tension in said web run, said tension control means including a floating roller yieldably biased against said web run under a predetermined force so as to be displaced upon variations of the tension in said web run from said predetermined value,

restraining means operative to hold said roller against displacement, and

means responsive to operation of said register control means to cause operation of said restraining means for a limited period during which the web tension variation introduced by the register control means is effective to compensate substantially for the sensed deviation from the registered condition, whereupon said roller is freed for displacement required to restore said predetermined value of web tension in said run.

4. In a machine for processing a web having repetitive patterns thereon;

a rotary cylinder peripherally engaging the web to continuously propel the web and carrying web processing elements to act periodically upon the web,

register control means operative upon sensing of deviations from a registered condition of said repetitive patterns with respect to said processing elements to effect variation of web tension in a run of the web leading to said cylinder in the sense for restoring said registered condition,

tension control means operative to maintain a predetermined constant tension in said web run, and

means rendering said tension control means and said register control means alternately inoperative to affect the tension in said web run for predetermined periods.

5. In a machine for processing a web having repetitive patterns thereon;

a rotary cylinder peripherally engaging the web to continuously propel the web and carrying web processing elements to act periodically upon the web,

register control means operative upon sensing of deviations from a registered condition of said repetitive patterns with respect to said processing elements to effect variation of web tension in a run of the web leading to said cylinder in the sense for restoring said registered condition,

tension control means for maintaining a predetermined value of tension in said web run, said tension control means including a floating roller yieldably biased against said web run under a predetermined force so as to be displaced upon variations of the tension in said web run from said predetermined value,

restraining means operative to hold said roller against displacement, and

timing means actuated upon operation of said register control means to cause operation of said restraining means for a limited period during which the web tension variation introduced by the register control means is effective to compensate substantially for the sensed deviation from the registered condition and, thereafter, to render said register control means inoperative for a limited period during which said roller is free to be displaced for restoring said predetermined value of tension in said web run.

6. In a machine for processing a web having repetitive patterns thereon;

a rotary cylinder peripherally engaging the web to continuously propel the web and carrying web processing elements to act periodically upon the web,

register control means including a roller engaging a run of the web leading to said cylinder and being displaceable for adjusting the length of the web path in said run, reversible motor-actuated means for displacing said roller, and sensing means detecting deviations from a registered condition of said repetitive pattern with respect to said processing elements and issuing correction signals for operating said motor-actuated means to displace said roller in the sense for restoring said registered condition,

tension control means operative to maintain a predetermined constant tension in said web run, and

means for preventing said tension control means from affecting the tension of said web run upon displacement of said roller until such displacement has been effective to compensate substantially for the detected deviations from the registered condition.

7. In a machine for processing a web having repetitive patterns thereon;

a rotary cylinder peripherally engaging the web to continuously propel the web and carrying web processing elements to act periodically upon the web,

register control means including a roller engaging a run of the web leading to said cylinder and being displaceable for adjusting the length of the web path in said run, reversible motor-actuated means for displacing said roller, and sensing means detecting deviation from a registered condition of said repetitive paterns with respect to said processing elements and issuing correction signals for operating said motor-actuated means to displace said roller in the sense for restoring said registered condition,

tension control means for maintaining a predetermined value of tension in said web run, said tension control means including a floating roller yieldably biased against said web run under a predetermined force so as to be displaced upon variations of the tension in said web run from said predetermined value,

restraining means operative to hold said floating roller against displacement, and

timing means actuated upon the issuing of correction signals to said motor-actuated means to cause operation of said restraining means for a limited period during which the displacement of the register control roller is effective to compensate substantially for the detected deviations from the registered condition and, thereafter, to interrupt the transmission of correction signals to said motor-actuated means for a limited period during which the tension control roller is free to be displaced for restoring said predetermined value of tension in said web run.

8. In a machine for processing a web having repetitive patterns thereon and which is of the type including a rotary cylinder peripherally engaging the web in a non-slip manner to continuously propel the web, web processing elements carried by the cylinder to act periodically upon the web, and means to vary the web engaging circumference of the cylinder and the speed of its propulsion of the web; the combination of

two rollers successively engaging the web at a run thereof leading to said cylinder and being individually displaceable to vary the length of the path of the web in said run,

reversible motor-actuated means operative to positively displace one of said rollers,

sensing means detecting deviations from a registered condition of said repetitive patterns with respect to said processing elements and issuing corrective signals for operating said motor-actuated means to displace said one roller in the sense for restoring said registered condition,

means yieldably biasing the other of said two rollers against the web under a predetermined force so that said other roller is displaced upon variations of the tension in said web run from a predetermined value

and thereby tends to maintain said value of web tension,

means connecting one of said rollers with said means to vary the web engaging circumference of said cylinder for changing the speed at which the web is propelled in response to displacement of the related roller, and

means delaying displacement of the yieldably biased roller upon operation of the motor-actuated means until the movement of the roller positively displaced by the latter has been effective to compensate substantially for the detected deviations from the registered condition.

9. A machine for processing a web as in claim **8**; wherein said means for delaying displacement of the yieldably biased roller includes

restraining means operative to hold the yieldably biased roller against displacement, and

timing means actuated upon the issuing of corrective signals to said motor-actuated means to cause operation of said restraining means for a limited period and, thereafter, to interrupt the transmission of corrective signals to said motor-actuated means for a limited period during which the yieldably biased roller is free to be displaced for restoring said predetermined value of tension in said web run.

10. A machine for processing a web as in claim **8**; wherein said one roller connected to the means for varying the web engaging circumference of the cylinder is said yieldably biased roller so that changes in the speed at which the web is propelled by the cylinder contribute to the maintenance of said predetermined value of tension in said web run.

11. A machine for processing a web as in claim **8**; wherein said one roller connected to the means for varying the web engaging circumference of the cylinder is the roller positively displaced by operation of said motor-actuated means so that changes in the speed at which the web is propelled by the cylinder also serve to compensate for detected deviations from the registered condition.

12. In a machine for processing a web having repetitive patterns thereon;

a rotary cylinder peripherally engaging the web to continuously propel the web and carrying web processing elements to act periodically upon the web,

register control means including a first roller engaging a run of the web leading to said cylinder and being displaceable for adjusting the length of the web path in said run, reversible electric motor-actuated means for displacing said roller, and sensing means detecting deviations from a registered condition of said repetitive patterns with respect to said processing elements and issuing corrective electrical signals for operating said motor-actuated means to displace said roller in the sense for restoring said registered condition,

tension control means for maintaining a predetermined value of tension in said web run, said tension control means including a floating second roller yieldably biased against said web run under a predetermind force so as to be displaced upon variation of the tension in said web run from said predetermined value,

electrically controlled braking means operative to hold said second roller against displacement, and

electrical circuit means including control relay means energized upon transmission of signals from said sensing means to said motor-actuated means to effect operation of said braking means, first time delay relay means energized upon energization of said control relay means and being actuated a predetermined interval after initiation of its energization to interrupt said transmission of signals and thereby cause deenergization of said control relay means and inoperativeness of said braking means, and second time delay relay means energized upon actuation of said first time delay relay means and deenergization of said control relay means and being actuated a predetermined interval after initiation of energization of said second time delay relay means to interrupt the energization of said first time delay relay means and thereby restore the latter to its condition for transmission of said signals to said motor-actuated means.

13. In a machine for processing a web having repetitive patterns thereon;

a rotary cylinder peripherally engaging the web to continuously propel the web and carrying web processing elements to act periodically upon the web,

register control means including a first roller engaging a run of the web leading to said cylinder and being displaceable for adjusting the length of the web path in said run, reversible electric motor-actuated means for displacing said roller, and sensing means detecting deviations from a registered condition of said repetitive patterns with respect to said processing elements and issuing corrective electrical signals for operating said motor-actuated means to displace said roller in the sense for restoring said registered condition,

tension control means for maintaining a predetermined value of tension in said web run, said tension control means including a floating second roller yieldably biased against said web run under a predetermined force so as to be displaced upon variation of the tension in said web run from said predetermined value,

fluid pressure operated means for preventing displacement of said web run by said second roller, a source of fluid under pressure, electrically operated valve means for controlling the flow of fluid under pressure from said source to said displacement preventing means, and

electrical control means actuated in response to the issuing of signals from said sensing means to operate said valve means for a first predetermined period during which said second roller is prevented from displacing said web run and, thereafter, to cause said valve means to block the flow of fluid to said displacement preventing means and to interrupt the transmission of said signals to said motor-actuated means for a second predetermined period.

No references cited.

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