

July 16, 1963

W. F. HUCK

3,097,844

AUTOMATIC WEB REGISTER CONTROLS

Filed Sept. 17, 1959

8 Sheets-Sheet 1

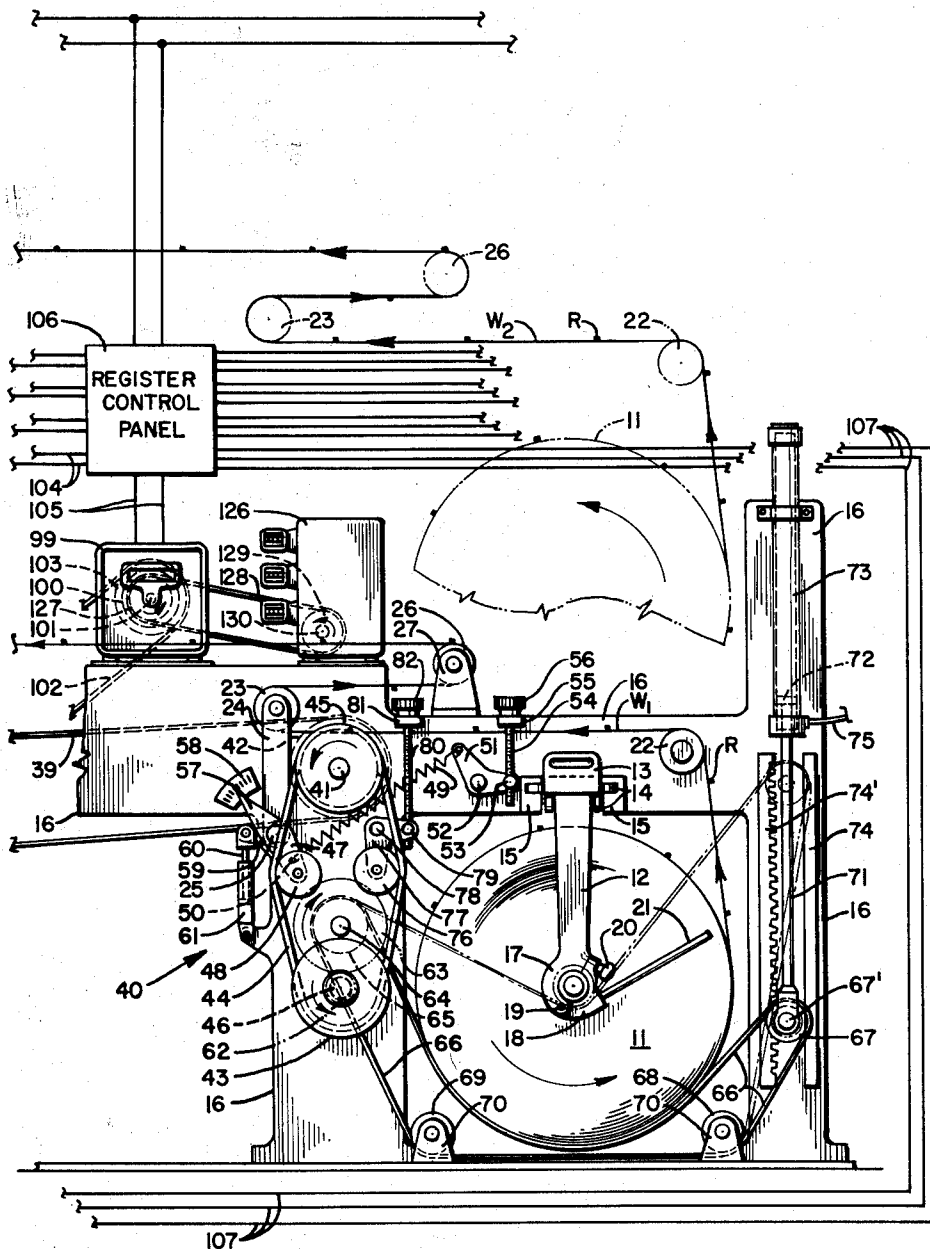


FIG. 1a

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8 Sheets-Sheet 2

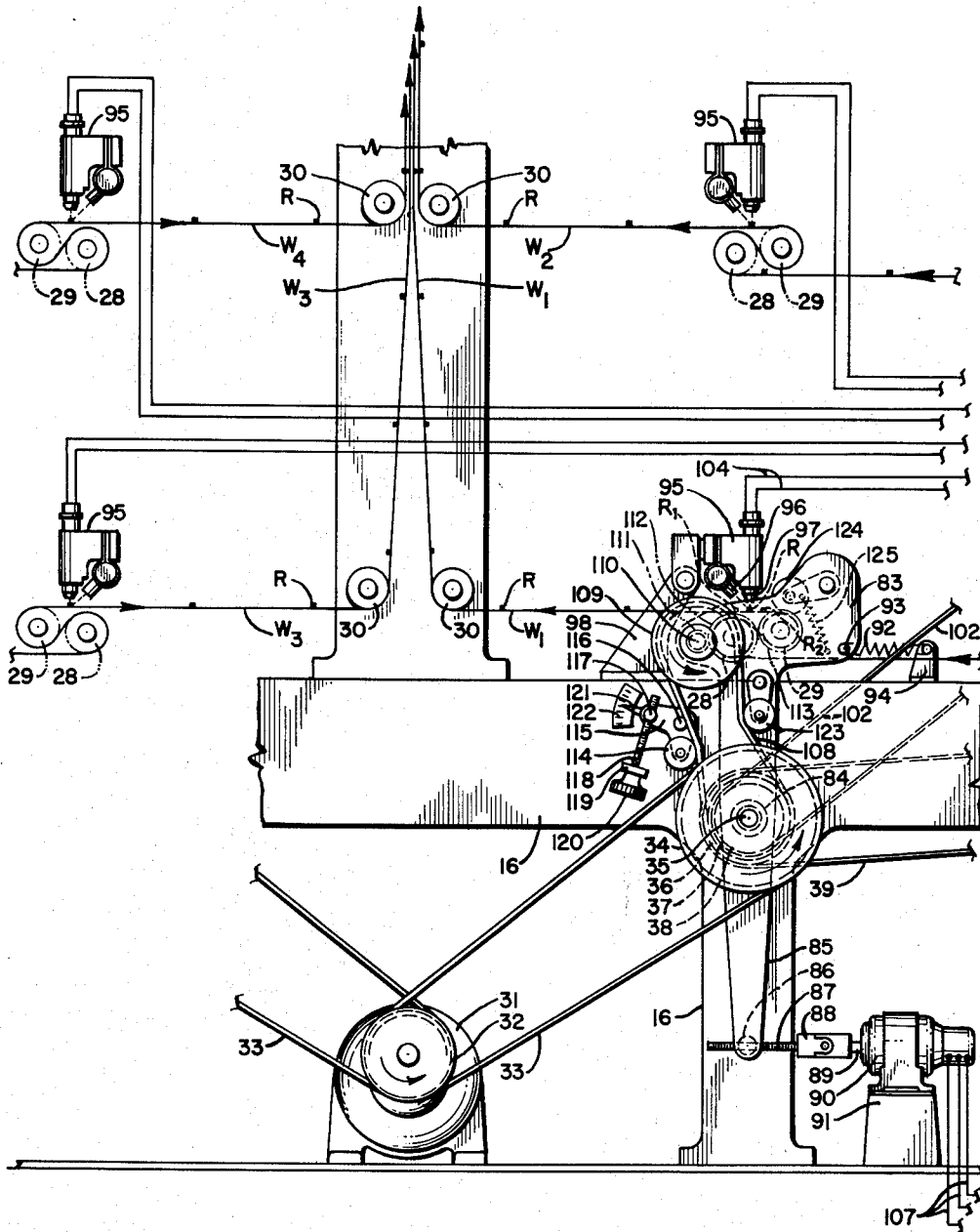


FIG. 11b

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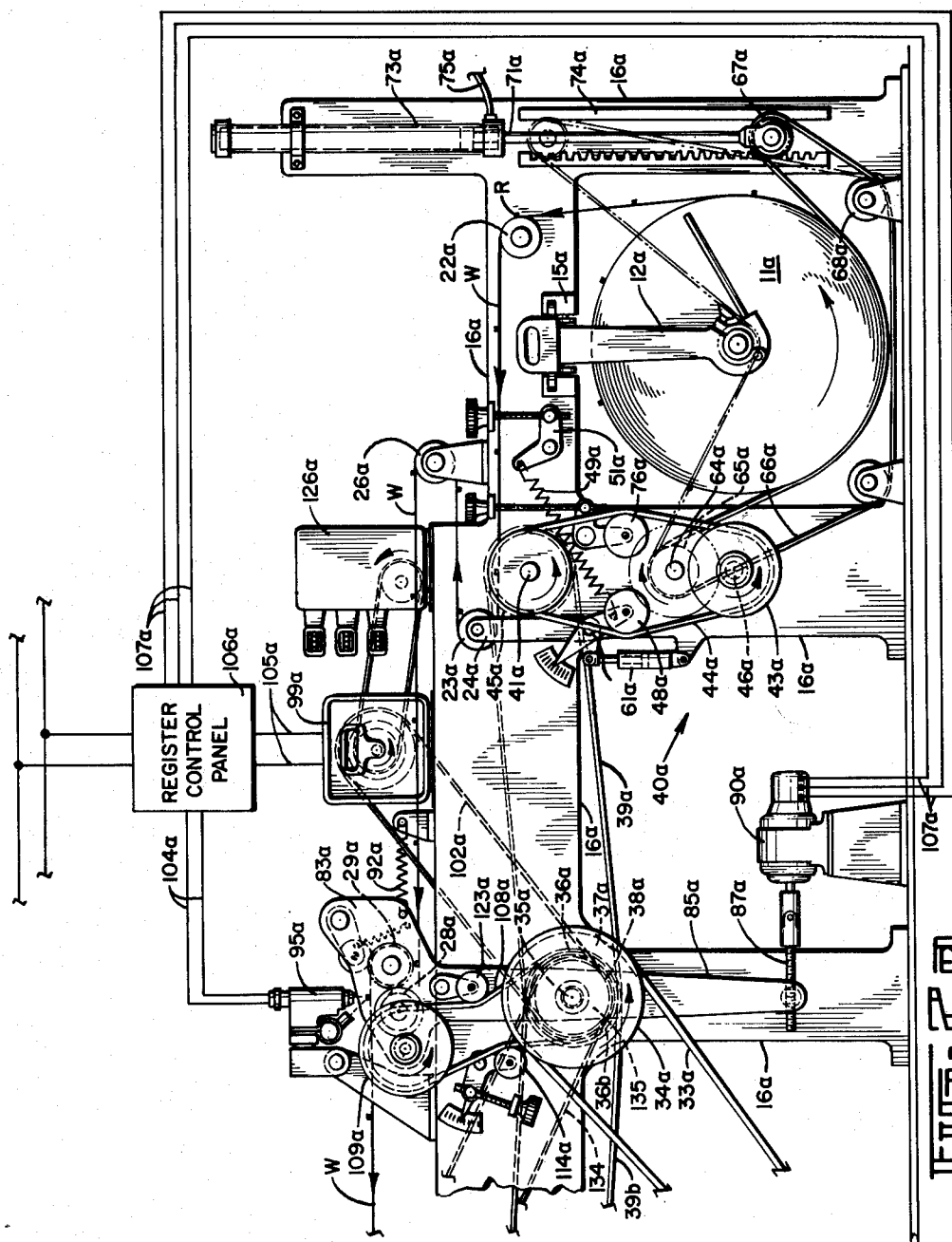
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8 Sheets-Sheet 3



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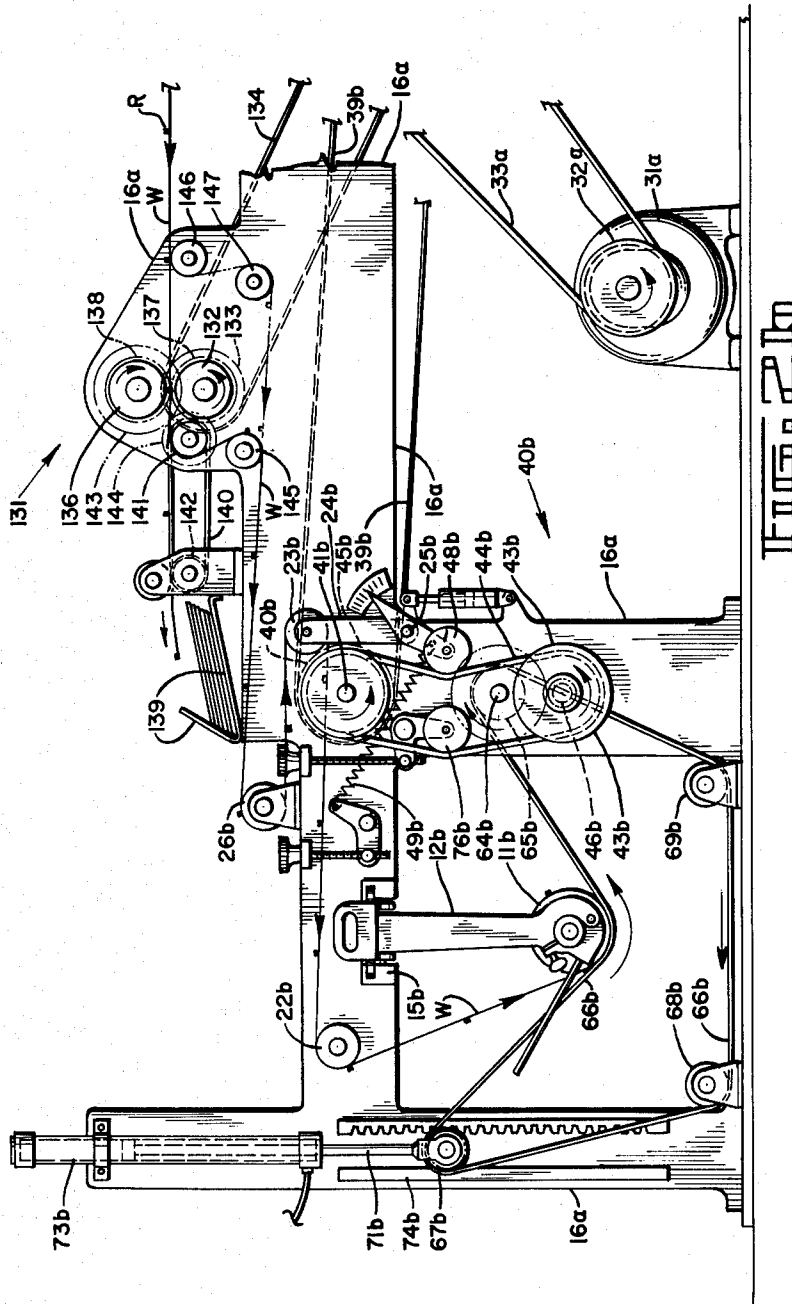
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AUTOMATIC WEB REGISTER CONTROLS

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8 Sheets-Sheet 4



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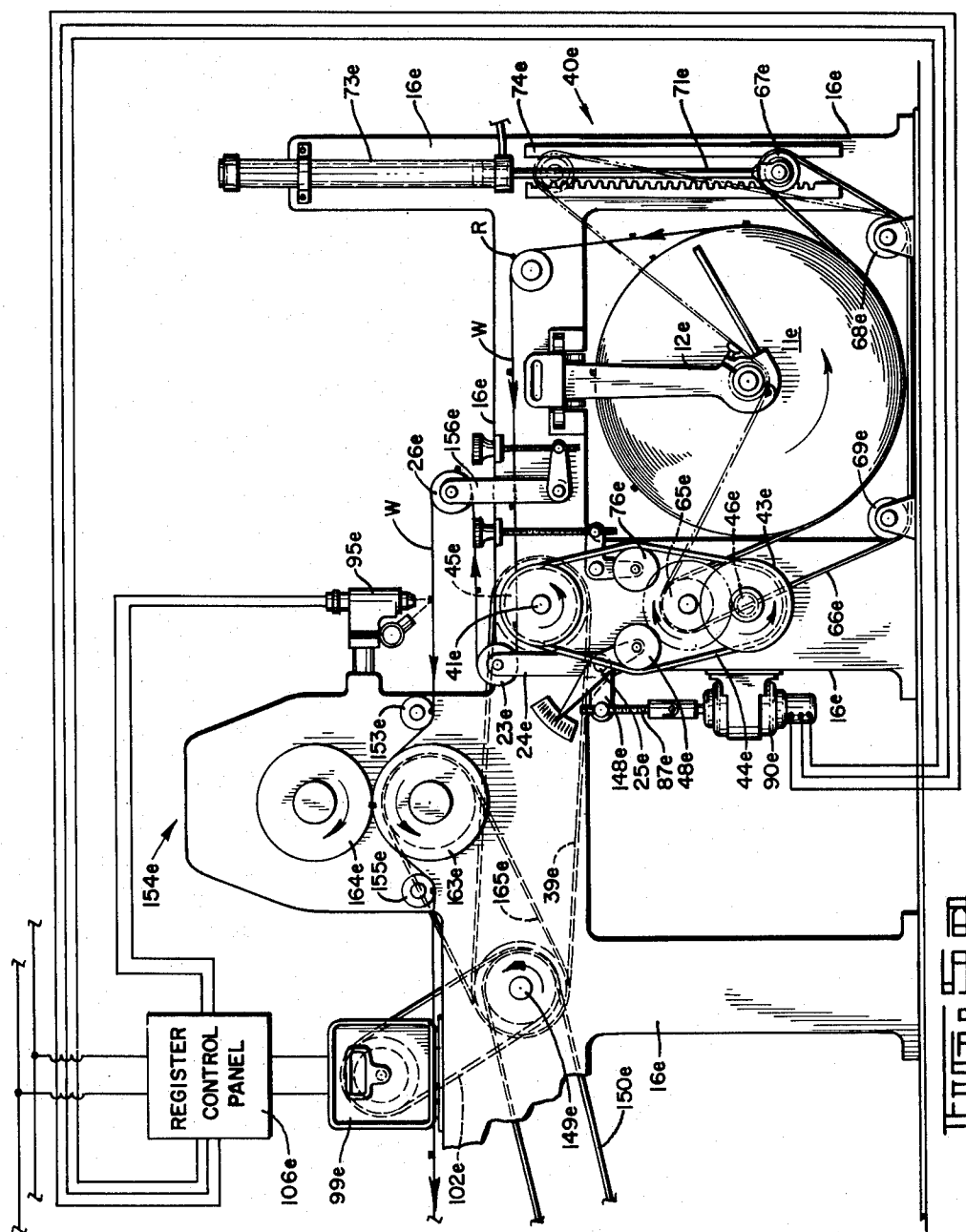
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AUTOMATIC WEB REGISTER CONTROLS

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8 Sheets-Sheet 7



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AUTOMATIC WEB REGISTER CONTROLS

Filed Sept. 17, 1959

8 Sheets-Sheet 8

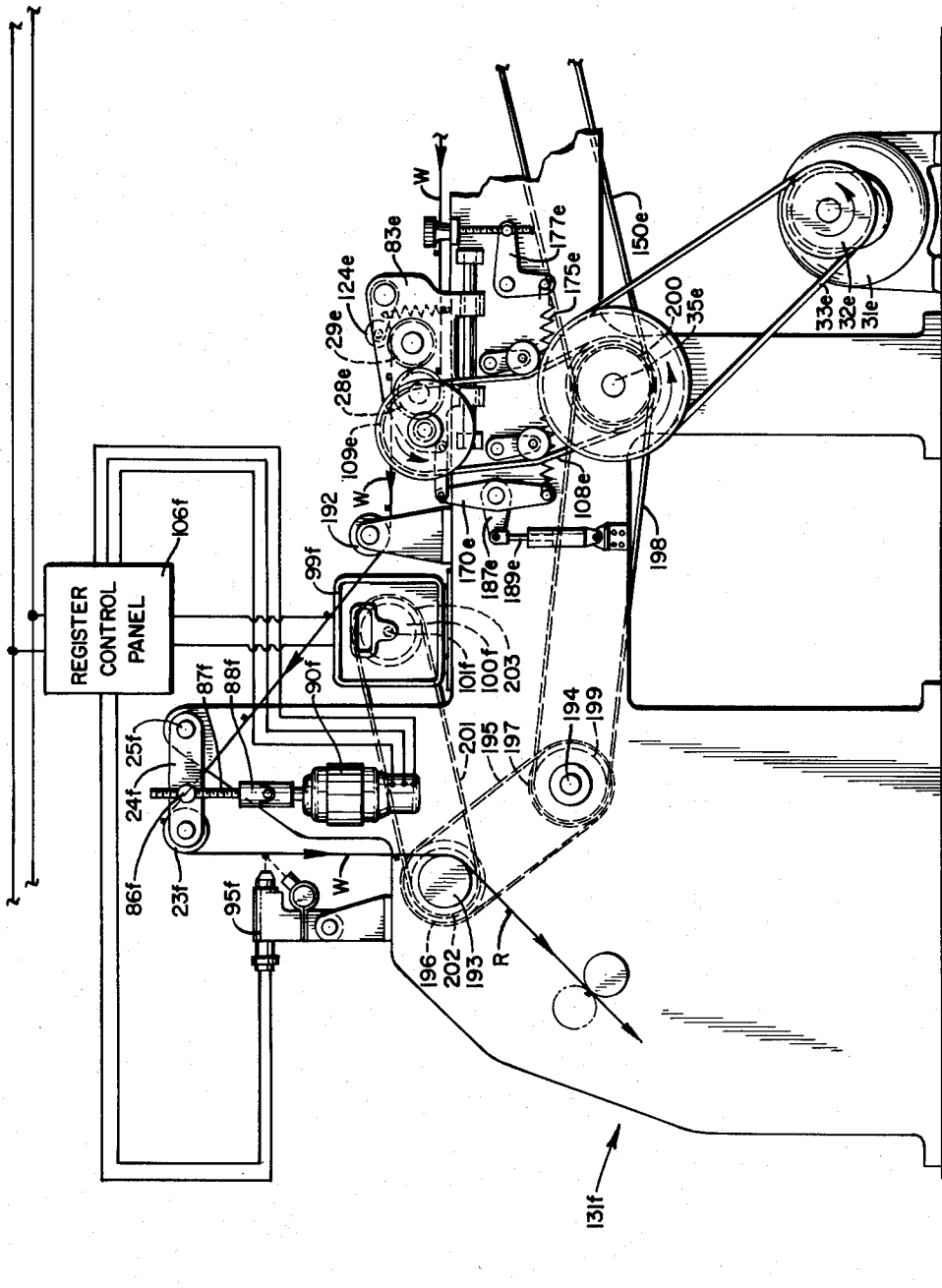


FIG. 5b

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3,097,844

AUTOMATIC WEB REGISTER CONTROLS

William F. Huck, Forest Hills, N.Y., assignor, by mesne assignments, to William F. Huck, doing business as Huck Company, New York, N.Y.

Filed Sept. 17, 1959, Ser. No. 840,744

43 Claims. (Cl. 270-52)

This invention relates generally to the registration of continuous webs of sheet materials such as paper, cloth, foil and the like, and is particularly directed to the registration of such webs which have been previously printed in a printing press and then rewound into a storage or supply roll from which the web is subsequently unwound and delivered at high speed through a station of a suitable machine in accurate register with respect to a function to be performed at the station. The function performed at the station of the machine may comprise an operation such as perforation, cutting, printing, or the like, whereby the web undergoes a physical change, or may comprise a collation process whereby a plurality of webs are brought together at the station in accurate register each with another. Also, each web may be caused to pass in accurate register through two stations of the machine at the first of which the web is subjected to one operation or process of the type mentioned and at the second of which the individually preprocessed webs are brought together in a collation process.

Registration of a pre-printed web with other similarly pre-printed webs or with a mechanism intended to otherwise process the pre-printed web is made difficult by reason of the fact that the distance or pitch between the repetitive printed matter of the web may not be exactly uniform and, therefore, may not exactly match the pitch of the mechanism into which the web is fed or the pitch of the other pre-printed webs with which the web in question is to be collated. This pitch discrepancy may be caused by the inherent very small difference existing between the pitch of the repetitive printed matter applied to the web in the printing press and the pitch of a second mechanism which receives the pre-printed web and further processes the latter. Further, changes may occur in the pitch or distance between the repetitive printed matter of the pre-printed web by reason of variations in temperature or moisture content of the web, or by reason of excessive web tension.

Previous attempts to effect registration of a pre-printed web with respect to other pre-printed webs with which it is to be collated, or with respect to a mechanism for otherwise processing the pre-printed web, frequently were unsuccessful because of the difficulty experienced in accurately controlling the speed at which the pre-printed web is supplied directly from the unwinding storage or supply roll, and the occurrence of inaccuracies in the control of the web supply speed either causes the web to become too loose and, therefore, uncontrollable, or too tight and, therefore, liable to break under the excessive tension.

It has been proposed to correct inaccuracies or variations in the length of the pitch of pre-printed webs by the application of suitably varied amounts of moisture to the web so that the repetitive printed matter of the web will be brought back into registration either with the repetitive printed matter of a similarly pre-printed web or with a mechanism for otherwise processing the pre-printed web without subjecting the web to excessive tension or causing an objectionable loss of adequate tension. However, this proposed technique has a disadvantageous slow response in that there is a substantial time lag between a variation in the moisture applied to the pre-printed web and the corresponding change effected in the length or pitch of the web. Further, many

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types of webs do not satisfactorily tolerate the application of moisture and the latter may be injurious to parts of the mechanism in which the pre-printed web is to be further processed.

When pre-printed webs are cut into separate sections in the course of being fed into a processing machine, it is a fairly simple matter to maintain accurate registration of the cut sections of the web relative to the processing machine without experiencing excessive hunting of the register correction device, and many systems now exist for successfully effecting registration under the described circumstances. However, when the pre-printed web is maintained in its original one-piece or continuous condition, the registration error either with respect to other pre-printed webs with which the web is to be collated or with respect to a mechanism for otherwise processing the web may be cumulative so that it becomes difficult to utilize the inherent resiliency or ability of the web to stretch lengthwise under tension for correction of the cumulative error in registration.

Accordingly, it is an object of the present invention to provide automatic means for effecting accurate longitudinal registration of continuous pre-printed webs, either with respect to each other when such webs are collated or with respect to mechanisms which otherwise process the pre-printed webs.

Another object of the invention is to provide automatic register control mechanisms which are effective to synchronize both the speed of movement and the relative longitudinal positions of the repetitive printed matter on several continuous pre-printed webs so that the latter may be collated with the corresponding sections or areas of printed matter in alignment.

A further object is to provide an automatic mechanism for controlling the registration of a continuous pre-printed web, either with respect to other similarly pre-printed webs with which the web is to be collated or with respect to a mechanism by which the pre-printed web is to be otherwise processed, and wherein the pre-printed web is drawn from a supply or storage roll under the influence of an automatic, variable speed unwinding drive which acts directly and positively on the supply roll in synchronism with the operation of the web register control mechanism and the web processing mechanism so that constant web register is maintained regardless of variations in the speed of operation of such web processing mechanism.

Still another object is to provide automatic mechanisms for controlling the registration of continuous pre-printed webs with respect to mechanisms in which such webs are processed, and also for maintaining accurate registration of the pre-printed webs relative to each other following this processing, so that the webs can then undergo a further process of collation.

In accordance with an aspect of the invention, a detected register error is corrected by the combined advancing or retarding effect of displacement of the web along its path and of variation of its speed of movement along such path.

In machines embodying the invention, a photoelectric device scans the web to detect a register error or relative deviation of a register mark, which is printed or embossed on the continuous pre-printed web or in the form of a slit or perforation in the web, from a predetermined timed position with respect to similar marks on other webs or with respect to the condition of a mechanism by which the pre-printed web is to be otherwise processed, and the continuous pre-printed web passes around a movable roller assembly between the supply roll from which the web is unwound and the location at which the register marks are successively scanned, with both the position of the movable roller assembly and the speed of travel of

the web being controlled in unison in response to register errors detected by the photoelectric web scanning device for effectively correcting such errors.

In one form of the invention, the movable roller assembly has drive rollers which are rotated by a variable speed transmission for driving the web, and a detected register error gives rise to bodily displacement of such drive rollers and a change in the drive ratio of the variable speed transmission, so that both the displacement of the web along its path and the variation of its speed of movement are effected by the drive rollers of the movable roller assembly. In this form of the invention, the speed at which the web is unwound from the supply roll is preferably controlled to maintain a substantially constant tension in the web between the supply roll and the drive rollers.

In another form of the invention, the movable roller assembly has a freely rotatable roller about which the web passes upon being withdrawn from the supply roll, and the position of such freely rotatable roller and the unwinding speed of the supply roll are positively controlled in response to detected register errors in order to effect the desired displacement of the web along its path and variation of its speed of movement cooperating to correct the register error.

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:

FIGS. 1A and 1B, taken together, are a side elevational view which is partly diagrammatic, and which shows an automatic web register control embodying the invention in a machine for accurately collating several continuous pre-printed webs, with the front frame of the machine being removed for the purpose of clarity;

FIGS. 2A and 2B, taken together, are a view similar to that of FIGS. 1A and 1B, but showing a machine embodying the invention wherein a continuous pre-printed web is accurately registered relative to mechanisms for further processing the web;

FIGS. 3A and 3B, taken together, are another view similar to that of FIGS. 1A and 1B, but showing a machine embodying the invention wherein several continuous pre-printed webs are registered relative to mechanisms for individually processing the same and are then accurately brought together for a collation process;

FIG. 4 is a fragmentary side elevational view showing a modification of a portion of the machine appearing in FIGS. 3A and 3B;

FIGS. 5A and 5B, taken together, are a view similar to that of FIGS. 3A and 3B, but showing an embodiment of the invention wherein a continuous pre-printed web is accurately registered with respect to several mechanisms which successively process the pre-printed web.

Referring to the drawings in detail, and initially to FIGS. 1A and 1B, which are hereinafter referred to together as FIG. 1, it will be seen that the machine there illustrated is intended for accurately registering the repetitive printed matter on four continuous pre-printed webs W_1 , W_2 , W_3 and W_4 which are to be collated after being unwound from respective supply rolls 11. In FIG. 1, only that part of the machine acting upon the web W_1 is shown in detail, but it is to be understood that the illustrated machine has identical parts for handling the several webs which are to be collated.

The supply roll 11 from which the web W_1 is unwound has the usual core or spindle which, at its opposite ends, is supported by the lower ends of vertical arms 12 depending from slides 13 slidable laterally, that is, in the direction parallel to the axis of roll 11, and guided in such movement by rollers 14 rotatably mounted in slide guides 15 extending laterally between opposite side frames 16 of the machine. In order to permit release of the core or spindle from supporting arms 12, each of the latter is preferably provided with a semi-circular seat 17 and a

generally semi-circular clamp 18 which is pivotally connected, at one end, to the seat 17, as at 19, and, at its other end, carries a screw 20 releasably engageable in a tapped bore of the seat 17 for holding the clamp in its illustrated closed position. If desired, clamp 18 may have a handle 21 extending therefrom to facilitate the opening and closing of the clamp.

The web W_1 unwound from supply roll 11 travels upwardly from the latter over an idler roller 22 journaled in suitable bearings carried by side frames 16 so that idler roller 22 is rotatable about a fixed axis. The web W_1 travels substantially horizontally from idler roller 22 and passes around a floating idler roller 23 which is rotatably mounted, at its opposite ends, in suitable bearings carried by the upper ends of generally upstanding arms 24. The lower ends of arms 24 are fixed to a shaft 25 extending laterally between, and rockably supported by side frames 16 so that arms 24 can swing in vertical planes to increase and decrease the horizontal distance between the axes of rotation of idler rollers 22 and 23. After passing around roller 23, the web W_1 travels generally parallel to the length or run of the web between rollers 22 and 23, but in opposite direction, and passes around an idler roller 26 which, at its opposite ends, is rotatably journaled in bearings mounted in brackets 27 secured to side frames 16.

After passing around idler roller 26, the web W_1 travels forwardly, that is, in the same direction as the length or run of the web between idler rollers 22 and 23, and then passes, in serpentine fashion, about two drive rollers 28 and 29 which are rotatable about parallel, laterally extending axes in fixed relationship to each other and movable as a unit, as hereinafter described in detail. The web W_1 travels horizontally from drive roller 29, and then under an idler roller 30 which is rotatably journaled, at its opposite ends, in suitable bearings fixedly carried by side frames 16, whereupon web W_1 travels upwardly and is collated with webs W_2 , W_3 and W_4 which have followed similar paths in the related parts of the machine.

All of the operative components of the several parts of the illustrated machine are driven by a single electric motor 31 rotating a pulley 32 which is engaged by a drive belt 33 for each part of the machine. Each drive belt 33 engages pulley 34 which is fixed on a main drive shaft 35 of the related part of the machine. Each main drive shaft 35 is rotatably journaled, at its opposite ends, in suitable bearings carried by side frames 16, and carries V-belt pulleys 36, 37 and 38 which are fixed to the drive shaft for rotation with the latter and are employed for simultaneously operating the various components of the related part of the machine.

The pulley 36 drives a V-belt 39 which operates an unwinding roll stand assembly generally identified by the reference numeral 40. The unwinding roll stand assembly 40 is preferably of the kind disclosed in U.S. Letters Patent No. 2,670,907, issued March 2, 1954 to W. F. Huck, and includes a driven shaft 41 which is rotatably mounted in the opposite side frames 16 and carries a V-belt pulley 42 engaged by belt 39 and a V-belt pulley 45 mounted on an extension of shaft 41 projecting through the front side frame 16. The pulley 45 is drivingly connected, by way of a V-belt 44, to a variable diameter pulley 43 which is preferably of the kind disclosed in U.S. Letters Patent No. 2,812,666, issued November 12, 1957, to W. F. Huck, and which is mounted on the front extension of a shaft 46 that extends parallel to the shaft 41 at a location below the latter and also is rotatably journaled in the opposite side frames 16.

With the above described arrangement, the radius of contact of belt 44 with variable diameter pulley 43, and hence the transmission ratio between the shafts 41 and 46, depends upon the tension in belt 44 and, in the embodiment of the invention now being described with reference to FIG. 1, the tension in belt 44 is made de-

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pendent upon the tension in web W_1 between drive roller 28 and supply roll 11. In order to obtain this correlation between the tension in web W_1 and the tension in belt 44, rockable shaft 25 carrying arms 24 supporting floating roller 23 also has a radial arm 47 fixed thereto and carrying a rotatable take-up pulley 48 engaging belt 44 at the inside of the latter along a run of the belt between pulleys 43 and 45 so that, when shaft 25 is rocked in the clockwise direction, in response to an increase in the tension in web W_1 engaging roller 23, the tension in belt 44 is correspondingly increased to decrease the radius of contact of belt 44 with variable diameter pulley 43. A tension spring 49 is connected at one end, as at 50, to arm 47 and, at its other end, to one arm of a bell crank 51 which is pivotally supported, as at 52, and which carries a nut 53, at its other end, threadably receiving an adjusting screw 54. The adjusting screw 54 is rotatably carried by a bracket 55 projecting from the adjacent side frame 16 and has a hand wheel 56 at its upper end so that rotation of the hand wheel causes rocking movement of the bell crank 51 and thereby varies the force exerted by spring 49 on arm 47 for rocking shaft 25 in the counterclockwise direction, as viewed in FIG. 1. Thus, spring 49 opposes the effect on roller 23 of the tension in web W_1 and tends to move roller 23 away from idler rollers 22 and 26, that is, toward the left as viewed in FIG. 1, so that the force exerted by spring 49 determines the tension to be maintained in web W_1 between supply roll 11 and drive roller 28. When the tension in the web decreases below the predetermined value, spring 49 causes rocking of shaft 25 in the counterclockwise direction so that pulley 48 tends to move inwardly away from belt 44 and thereby decreases the tension in the latter so as to cause a corresponding increase in the radius of contact of belt 44 with variable diameter pulley 43.

The position of the floating roller 23 may be indicated at all times by a pointer 57 extending from rockable shaft 25 and cooperating with a suitably calibrated scale 58. Further, in order to avoid hunting of floating roller 23, an arm 59 extending radially from shaft 25 is pivotally connected to the plunger 60 of a dash pot 61 which serves to damp the oscillations of rockable shaft 25.

A spur gear 62 fixed on shaft 46 meshes with a spur gear 63 fixed on a pulley shaft 64 which is rotatably journaled at its opposite ends in side frames 16. Pulley shaft 64 carries a drive pulley 65 engaged by a belt 66 having an upper run passing under supply roll 11 in positive, non-slipping contact with the surface of the latter and then passing around a vertically movable pulley 67 prior to returning to the drive pulley by way of a lower run which is guided by idler pulleys 68 and 69 rotatably supported in bearings in brackets 70. In order to maintain the desired positive, non-slipping contact between the belt 66 and the surface of the unwinding supply roll 11 as the diameter of the latter decreases, the movable pulley 67 is mounted on a rotatable shaft 67' between the ends of that shaft, and each end of the shaft 67' turns in a bearing in the lower end of a vertically extending piston rod 71 depending from a piston 72 which is vertically reciprocable within a cylinder 73. The cylinders 73 are fastened to the inner sides of the opposite machine frames 16. Fluid under pressure is admitted to each cylinder 73 at its lower end, for example, through a conduit 75, so as to urge the corresponding piston 72 upwardly for effecting upward movement of shaft 67' and pulley 67, for example, to the position shown in broken lines on FIG. 1, as the diameter of the unwinding supply roll 11 decreases.

The axis of rotation of the pulley 67 is kept parallel to the axis of roll 11 by suitable guides, such as by the guides 74 and 74' mounted at the inner sides of the frames 16 and pinions (not shown) fixed to the shaft 67' in meshing relation with the respective toothed guides or racks 74'. With this arrangement, the racks 74' and meshing pinions

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guide the vertical movement of shaft 67' and pulley 67 so that their axis will always be kept horizontal and canting or skewing and binding of the pulley shaft will be avoided even if unequal fluid pressures develop in the cylinders 73.

In order to establish the initial transmission ratio between variable diameter pulley 43 and pulley 45 and to permit compensation for wear of such pulleys or the V-belt 44 engaged thereby, the belt 44 is further engaged by a pulley 76 at a location between pulleys 43 and 45, and pulley 76 is rotatably supported at one end of a bell crank 77 which is pivotally mounted at 78, and at its other end, carries a nut 79 threadably engaged by an adjustment screw 80. Screw 80 is rotatably supported by a bracket 81 extending from an adjacent side frame 16 and has a hand wheel 82 at its upper end so that, by turning such hand wheel, bell crank 77 may be rocked to adjust the position of pulley 76 and thereby determine the initial tension in belt 44.

As previously indicated, floating roller 23 is effective to detect any deviation from a predetermined value of tension in the unwound web W_1 and is correspondingly displaced clockwise or counterclockwise about the axis of rockable shaft 25 to decrease the radius of contact of belt 44 with variable diameter pulley 43, and thereby increase the rotational speed of shaft 46, in response to an excessive tension in web W_1 , or to increase the radius of contact of belt 44 with pulley 43, and thereby decrease the rotational speed of shaft 46, in response to an insufficient tension in web W_1 . Thus, when the tension in web W_1 exceeds the predetermined value, the speed of movement of belt 66 is increased and correspondingly increases the speed at which the web is unwound from supply roll 11, thereby restoring the desired value of web tension. On the other hand, when an insufficient tension is detected by floating roller 23, the speed of movement of belt 66 is decreased and correspondingly decreases the speed at which web W_1 is unwound from roll 11 until the desired value of tension is restored in the web.

The drive rollers 28 and 29 are rotatably journaled, at their opposite ends, in a carriage 83 which is secured to a tubular shaft 84 mounted on drive shaft 35 so that carriage 83 can rock about the axis of shaft 35 to displace rollers 28 and 29, as a unit, generally horizontally parallel to the longitudinal axis of the web W_1 traveling to and from the drive rollers. A lower extension 85 projects downwardly from carriage 83 and, at its lower end, carries a nut 86 which threadably receives an adjusting screw 87 connected, by a universal joint 88, to the shaft 89 of a reversible electric motor 90 mounted on a base 91 secured to the frame of the machine. Thus, rotation of shaft 89 of motor 90 in one direction or the other causes corresponding rockable displacement of carriage 83 about the axis of shaft 35. A tension spring 92 is connected, at one end, to a pin 93 on carriage 83 and, at its other end, to a bracket 94 fixed to the adjacent side frame 16 and counterbalances the tendency of carriage 83 to pivot about the axis of shaft 35 in the counterclockwise direction, as viewed in FIG. 1, under the influence of the net tension in web W_1 , thereby to reduce the thrust load on and resulting excessive wear and/or possible binding of the adjusting screw 87.

It will be apparent that, when carriage 83 is angularly displaced about the axis of shaft 35, drive rollers 28 and 29 move bodily, as a unit, generally toward and away from idler roller 30 and, since web W_1 is in non-slipping engagement with drive rollers 28 and 29, such bodily movement of the drive rollers either increases or decreases the tension in web W_1 at the outgoing side of the drive rollers, that is, in the length of the web extending from the drive rollers in the direction toward idler roller 30 and thereby tends to longitudinally shift web W_1 in relation to the other webs W_2 , W_3 and W_4 for bringing pre-printed matter on web W_1 into registration with pre-printed matter on the other webs with which it is to be collated.

In order to provide for the control of the registration of pre-printed web W_1 with the other webs W_2 , W_3 and W_4 , each pre-printed web is formed, preferably during the printing thereof, with longitudinally spaced apart register marks R which may be either printed thereon or embossed in the web, or in the form of slits or perforations made in the web, and such register marks R are successively scanned by a photoelectric scanning head 95 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 scanning head of the identified type generally includes a light source 96 directing a beam of light against web W_1 at the location between drive roller 29 and idler roller 30, but preferably adjacent the drive roller assembly, and a photoelectric detection cell 97 disposed to scan the surface of the web at the location where the light beam from source 96 impinges thereagainst so that, when a register mark R passes through the scanned region or area, such register mark changes the intensity of light reflected from the web into the photoelectric cell 97 and causes a suitable electrical signal to be emitted from the head 95. As shown in FIG. 1, the described photoelectric scanning head 95 may be suitably mounted at the desired location on a bracket 98 carried by a side frame 16.

The register control further includes a photoelectric selector switch which is generally identified by the reference numeral 99 and which is suitably mounted on a firm support, for example, on a side frame 16. The photoelectric selector switch 99 may be of the type which is commercially available from the Specialty Control Department, General Electric Company, Waynesboro, Virginia, as Item No. CR7515-P145-G4, and generally includes a slotted disc 100 mounted on a rotatable shaft 101, a light source (not shown) directing a beam of light against one side of slotted disc 100 and a photoelectric cell (not shown) at the opposite side of the slotted disc 100 so as to be intermittently energized by light passing through the slots of the rotated disc and thereby produce an electrical pulse or signal at regularly spaced apart intervals. Slotted disc 100 is driven by a non-slip (toothed) belt 102 which runs around pulley 38 on main drive shaft 35 and a pulley 103 secured on shaft 101.

The slotted disc 100 of selector switch 99 is disposed on shaft 101 so that, when the related web W_1 is properly registered in the longitudinal direction, the electrical signal resulting from the scanning of a register mark R by the photoelectric scanning head 95 occurs simultaneously with an electrical signal emanating from selector switch 99. However, if the web W_1 is out of register in the longitudinal direction, the electrical pulse or signal issuing from the scanning head 95 occurs either before or after the electrical pulse or signal issuing from selector switch 99.

The electrical pulses or signals issuing from scanning head 95 and selector switch 99 are fed, by way of conductors 104 and 105, respectively, to a register control panel 106 which is commercially available from the Specialty Control Department, General Electric Company, Waynesboro, Virginia, as Item No. 3S7515-CT100-A1, and which may have the assembly of electrical components as illustrated in the wiring diagram appearing between pages 9 and 10 of the Instruction Bulletin published by General Electric Company under the designation GEI-46908B.

The register control panel 106 of the above identified type is operative to amplify the signals received from scanning head 95 and selector switch 99, respectively, and to compare such signals so that any timing discrepancy between a signal resulting from a detected register mark R and a related signal from selector switch 99 produces an error signal which causes energization of reversible correction motor 90, by way of conductors 107, and thereby effects rotation of adjustment screw 87 in one direction

or the other for displacing drive rollers 28 and 29 in the direction tending to overcome the detected register error. Thus, if the detected register mark is ahead of its correct position, as indicated at R_1 , so that the signal issuing from scanning head 95 occurs in advance of the related signal issuing from selector switch 99, reversible motor 90 is rotated in the direction for rocking carriage 83 in the clockwise direction, as viewed in FIG. 1, thereby to displace the register mark R_1 in the direction opposed to the travel of the web. On the other hand, if the register mark being scanned lags behind its correctly registered position, for example, as indicated at R_2 , so that the signal from scanning head 95 occurs after the related signal from selector switch 99, motor 90 is turned in the opposite direction to rock carriage 83 in the counterclockwise direction, as viewed in FIG. 1, and thereby displaces the register mark R_2 in the direction of travel of the web to tend to restore the proper registration.

The drive rollers 28 and 29 are also driven from main drive shaft 35 by way of a V-belt 108 running around pulley 37 and around a variable diameter pulley 109 which is preferably of the type disclosed in the above identified U.S. Letters Patent No. 2,812,666, and which is secured on a shaft 110 rotatably mounted on carriage 83 so that the transmission ratio between shafts 35 and 110 is determined by the variable radius of contact of belt 108 with pulley 109 which is, in turn, dependent upon the tension in belt 108. A pinion 111 is fixed on shaft 110 to rotate with the latter and meshes with a gear 112 coaxially rotatable with drive roller 28, while gear 112 meshes with gear 113 coaxially rotatable with drive roller 29 so that drive rollers 28 and 29 are rotated in opposite directions in response to rotation of shaft 110.

In accordance with the present invention, the tension in belt 108, and hence the speed of rotation of drive rollers 28 and 29, are varied in response to the rocking of carriage 83 resulting from inaccurate longitudinal registration of web W_1 in the manner described above.

In order to effect the desired variation in the tension of belt 108, the machine illustrated in FIGS. 1A and 1B further includes an idler pulley 114 engaging belt 108 at the outside of a run of the latter between pulleys 37 and 109 so that, when carriage 83 is rocked in the clockwise direction in response to an error signal fed to motor 90 indicating that a scanned register mark R_1 is ahead of its correctly registered position, the tension in belt 108 is correspondingly decreased to increase the radius of contact of belt 108 with variable diameter pulley 109, thereby to decrease the speed of rotation of drive rollers 28 and 29. On the other hand, when carriage 83 is rocked in the counter-clockwise direction, as viewed in FIG. 1, in response to the feeding of an error signal to motor 90 resulting from the scanned register mark R_2 lagging behind its correctly registered position, idler pulley 114 acts to increase the tension in belt 108 and to cause a corresponding decrease in the radius of contact of belt 108 with variable diameter pulley 109, thereby to increase the speed of rotation of drive rollers 28 and 29.

From the above, it will be apparent that, when the scanned register mark is ahead of its correctly registered position, both the rocking of carriage 83 and the change in the speed of rotation of drive rollers 28 and 29 cooperate to retard the position of the detected or scanned register mark. On the other hand, when the scanned register mark lags behind its correctly registered position, both the rocking of carriage 83 and the proportional increase in the speed of rotation of drive rollers 28 and 29 cooperate to advance the position of the scanned register mark. The total retardation or advancement of the scanned register mark resulting from the detection of a register error is preferably larger than the detected error so that the original correction action introduces a register error which is in the direction opposite to the originally detected error but has a magnitude smaller than the latter. The relatively small register error resulting from the cor-

rection action initiated by the originally detected register error is also detected by the described arrangement and gives rise to an error signal fed to correction motor 90 to either advance or retard the scanned register mark to its correctly registered position, and to return carriage 83 to its original position. Thus, web register errors tend to become progressively smaller in magnitude as they are corrected by bodily movements or displacements and rotational speed changes imparted to drive rollers 28 and 29, and the desired web register condition is achieved and subsequently maintained within very close limits. The overall effect of this corrective action is that the detected web register error is rapidly eliminated, primarily by direct displacement of the web driving rollers, and the initial, mean position of these drive rollers is thereafter restored, primarily by subsequent and progressively smaller register correction actions resulting from the speed changes simultaneously introduced into the web by displacement of these rollers. The changes in web tension accompanying these register corrections are absorbed either by the associated tension control devices comprised in the machine or by the inherent resiliency of the web (that is, the inherent ability of the web to expand and contract in small amounts during variations in web tension).

Pulley 114 which varies the tension in belt 108 in response to rocking of carriage 83 may be rotatably mounted at one end of a bell-crank 115 which is pivotally supported, as at 116, on a side frame 16. A nut 117 is carried by the opposite end of bell-crank 115 and threadably receives an adjustment screw 118 which is rotatably supported by a bracket 119 secured to the adjacent side frame 16 and which has a hand wheel 120 by which screw 118 may be conveniently rotated to rock bell-crank 115 and thereby vary the initial tension in belt 108, and consequently, the initial transmission ratio between shafts 35 and 110 determining the rotational speed of drive rollers 28 and 29. A pointer 121 may be provided on bell-crank 115 to cooperate with a suitably calibrated scale 122 for indicating the setting of the variable transmission by which the drive rollers are rotated. A second idler pulley 123 engages belt 108 at the run of the latter opposed to that engaged by pulley 114, and is preferably adjustably mounted on carriage 83 so that pulley 123 can be moved generally toward or away from the engaged run of belt 108 to compensate for wear of the pulley or belt surfaces.

In order to avoid slipping of web W_1 relative to drive rollers 28 and 29, freely rotatable rollers 124 are mounted on carriage 83 above drive roller 29 and urged downwardly, for example, by a spring 125, for holding the web in secure frictional contact with the surface of drive roller 29. In some applications of the described machine embodying the present invention, the rollers 124 may be axially interspersed with, or replaced by, rotatable slitting knives effective to cut web W_1 lengthwise into two or more ribbons.

It will be apparent that, when the above described web register control acts to advance the web in response to the detection of a register error, there is a resulting increase in the tension in the web between drive rollers 28 and 29 and supply roll 11, and that this increase in tension is detected by floating roller 23 to cause an increase in the speed at which the web is unwound from roll 11 in the manner previously described in detail. Conversely, when the web register control acts to retard the web in response to a detected register error, there is a corresponding decrease in tension in the web between the drive rollers and the supply roll, and this decreased tension is detected by floating roller 23 to cause a decrease in the speed at which the web is unwound from supply roll 11. Thus, a substantially constant web tension is maintained between the supply roll and the drive rollers.

It is to be understood that each of the webs to be

collated is maintained in precise, timed register by a part of the machine which is the same as that described above with reference to the part of the machine handling the web W_1 , and, since a single selector switch 99 may be incorporated in the several web register controls, as shown in FIG. 1, the several webs are accurately registered relative to the master web fed by the part of the machine directly connected with the selector switch 99, hence relative to each other, when they are brought together at the collation station of the machine after traveling around idler rollers 30. The same result would also be achieved if the web register control of each part of the machine had an individual selector switch 99, with the several selector switches all being driven from the same motor 31.

The maintenance of precise, timed web register in the manner previously described facilitates the inclusion of timed web processing devices at locations between the unwinding supply rolls 11 and the station where the several webs are collated, as shown in FIGS. 1A and 1B. For example, a conventional mechanical counting device 126 may be driven directly from selector switch 99 by way of a pulley 127 mounted on the rotated shaft 101 of the selector switch and driving a non-slip belt 128 which runs around a pulley 129 mounted on a drive shaft 130 of the counting device. Since the register marks R on the pre-printed web are always brought into timed register with the pulses or signals emanating from selector switch 99 at uniformly spaced apart intervals, counting device 126 provides an accurate count of the number of pre-printed repetitive patterns on the web passing scanning head 95 in any period of time regardless of the operating speed of the machine.

Although the machine described above with reference to FIGS. 1A and 1B is operative to automatically register a plurality of webs which are to be collated, it is to be understood that the automatic web register control provided in such machine for each web handled by the latter may be employed in a machine processing a single web. For example, as shown in FIGS. 2A and 2B, which are hereinafter referred to together as FIG. 2 and wherein all parts corresponding to those described with reference to FIGS. 1A and 1B are identified by the same reference numerals, but with the letter "a" appended thereto, the web W, after passing around drive roller 29a and traveling under scanning head 95a may be passed through a web processing device shown in the form of a sheeting unit generally identified by reference numeral 131. Sheeting unit 131 includes a lower cutting cylinder 132 which is rotatably journaled, at its opposite ends, in the side frames 16a of the machine, and which has a pulley 133 rotatably connected therewith and driven by a non-slip belt 134 running around a pulley 135 fixed to the main drive shaft 35a so that lower cutting cylinder 132 is rotated in synchronism with the automatic web register control. The sheeting unit 131 further includes an upper cutting cylinder 136 located above cylinder 132 and also having its opposite ends rotatably journaled in the side frames of the machine. Meshing gears 137 and 138 are rotatably connected to the cylinders 132 and 136, respectively, for rotatably driving upper cylinder 136 from lower cylinder 132. The web W passes between cylinders 132 and 136, and the latter cooperate, in the usual way, to transversely cut the web into separate sheets of the desired length. Since cutting cylinders 132 and 136 are driven from main drive shaft 35a which also drives the automatic web register control, it is apparent that cuts made across the pre-printed web W by the cutting cylinders are in accurate register with the repetitive pre-printed patterns on the web.

The sheeting unit 131 may further include a conveyor extending between cutting cylinders 132 and 136 and a stacking tray 139 for transporting the cut sheets to the stacking tray where they are collected. Such conveyor

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may include a conveyor belt 140 running around a pulley 141 rotatably mounted adjacent the cutting cylinders and around a pulley 142 rotatably mounted adjacent the stacking tray. The conveyor may be driven by meshing gears 143 and 144 which are rotatably secured to upper cutting cylinder 136 and pulley 141, respectively.

If desired, the cutting cylinders 136 and 132 may be replaced by other web processing devices, for example, by printing or perforating cylinders or by rotary cutting or slitting knives for cutting the web W along longitudinal lines, and, in each of these cases, the conveyor belt 140 for transporting the individual cut sheets and the stacking tray 139 for collecting the cut sheets are removed, and the web processed by the printing or perforating cylinders or by the rotary slitting knives which replace the cutting cylinders 132 and 136 then passes over roller 141, which acts as an idler roller, and under an idler roller 145 before being received by a rewind roll stand 40b which is substantially the same as the unwind roll stand 40a carrying the supply roll 11a from which the web W is initially unwound.

In FIG. 2, the various parts of the rewind roll stand 40b are identified by the same reference numerals employed in the description of the unwinding roll stand 40 shown in FIG. 1, but with the letter "b" appended thereto. Thus, the processed web W travels from idler roller 145 around an idler roller 26b, then around a floating roller 23b, and finally around an idler roller 22b before being rewound on a suitable core or spindle rotatably carried by arms 12b to form a storage roll 11b.

As in the unwinding roll stand 40a accommodating the supply roll 11a, the storage roll 11b in the rewinding roll stand 40b is rotated by a belt 66b maintained in positive non-slipping engagement therewith and driven at a variable speed from a shaft 64b which is, in turn, driven from a shaft 46b. A variable speed transmission connects shaft 46b to shaft 41b and is formed by a belt 44b running around a variable diameter pulley 43b on shaft 46b and a pulley 45b on shaft 41b, and a rotatable take-up pulley 48b engaging a run of the belt 44b and rockable with a shaft 25b carrying the arms 24b supporting the floating roller 23b. As in the described unwinding roll stand, floating roller 23b is sensitive to variations in the tension of web W between the processing unit 131 and the rewinding roll stand 40b and responds to any variation of such tension from a predetermined value, as established by the force exerted by the spring 49b, to correspondingly vary the transmission ratio between shafts 41b and 46b, and thereby to vary the speed of belt 66b so that the tension in web W sensed by floating roller 23b is restored to the desired value.

In the machine illustrated in FIG. 2, shaft 41b of the rewinding roll stand is rotatably driven at a constant speed from main drive shaft 35a, for example, by a belt 39b running around a pulley 36b fixed to the main drive shaft and a pulley 40b fixed to shaft 41b.

If desired, the machine of FIG. 2 may be provided with additional idler rollers 146 and 147 rotatably carried by side frames 16a at locations between the drive rollers 28a and 29a and the processing unit 131 so that, when it is desired to by-pass the processing unit, the registered web W can be passed around idler rollers 146 and 147 prior to engaging idler roller 26b of the rewinding roll stand where the registered web is simply rewound to form the storage roll 11b.

In the embodiments of the invention described above with reference to FIGS. 1A and 1B and FIGS. 2A and 2B, respectively, the desired automatic control of the registration of a web has been achieved by the combined effect of displacement of drive rollers 28 and 29 or 28a and 29a and of varying the rotational speed of such drive rollers so as to advance or retard the web in response to the detection of a register error, while the supply roll from which the pre-printed web is unwound has been

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driven at a varying speed in order to maintain a desired value of tension in the web between the supply roll and the drive rollers as register errors are corrected. In such previously described embodiments, changes in the tension in the web between the supply roll and the drive rollers are sensed by the floating roller 23 or 23a which is correspondingly displaced to control the mechanism by which the unwinding roll stand is driven at a variable speed.

However, in machines embodying the present invention, the error signal resulting from the detection of a register error may be employed to directly control the speed at which the unwinding roll stand is driven and to simultaneously directly control the length of a loop formed in the web between the unwinding supply roll and the processing station for retarding or advancing the web relative to the processing station so that restoration of the correct registration then results from the combined effect of direct retardation or advancement of the web and of variation of the speed at which the web is unwound from the supply roll. Such an arrangement embodying the invention will now be described with reference to FIGS. 3A and 3B of the drawings, which are hereinafter referred to together as FIG. 3 and wherein a machine is illustrated that is operative to register, process and collate a plurality of pre-printed webs W₁, W₂, W₃ and W₄ which are unwound from respective supply rolls.

The machine of FIG. 3 has a number of substantially identical parts associated with the several webs, respectively, and each of those parts has some components which are generally similar to corresponding components of the machine illustrated in FIG. 1 and which are identified by the same reference numerals, but with the letter "c" appended thereto. FIG. 3 illustrates the structural details of only that part of the machine handling the web W₁, but it is to be understood that the machine also includes generally similar parts for handling the other webs which are to be registered, individually processed and then brought together with web W₁ for a collation process.

It will be seen that supply roll 11c from which web W₁ is unwound is supported in an unwinding roll stand 40c which is generally similar to the unwinding roll stand 40 previously described in detail with reference to FIG. 1, but having the following differences. Thus, in roll stand 40c, although floating roller 23c, around which the web W₁ extends after passage over the idler roller 22c, is also carried by arms 24c fixed to a rockable shaft 25c, that rockable shaft is not free to be angularly displaced in response to the tension in the web engaging roller 23c, and is, instead, positively rocked in response to the detection of a register error which causes operation of the reversible correction motor 90c. Motor 90c is connected, by a universal joint 88c to an adjustment screw 87c which is threadably received in a nut 86c mounted at the free end of a radial arm 148 fixed to shaft 25c. Thus, arms 24c supporting roller 23c are rocked with shaft 25c, in one direction or the other, in response to rotation of the shaft of motor 90c upon the detection of a register error.

The roll stand 40c further includes a take-up pulley 48c supported by a radial arm 47c fixed to shaft 25c, with such take-up roller engaging a run of a belt 44c connecting a variable diameter pulley 43c on shaft 46c with a pulley 45c on shaft 41c so that, when shaft 25c is rocked, as described above, to effect positive displacement of roller 23c, there is a simultaneous corresponding displacement of pulley 48c for varying the tension in belt 44c and thereby varying the radius of contact of that belt with pulley 43c.

As in the machine of FIG. 1, the several parts of the machine now being described with reference to FIG. 3 are all driven from a single electric motor 31c rotating a pulley 32c which drives a main drive shaft 35c in each part of the machine by way of a drive belt 33c running

around pulley 32c and a pulley 34c on the main drive shaft.

Rotation of shaft 35c is transmitted to an intermediate drive shaft 149 by way of a non-slip belt 150 running around pulleys 151 and 152 fixed on shafts 35c and 149, respectively. Shaft 41c is rotated at a constant speed from shaft 149 by way of a V-belt 39c running around pulleys 36c and 42c on shafts 149 and 41c, respectively. Since pulley 45c on shaft 41c is rotated at a constant speed, changes in the radius of contact of belt 44c with pulley 43c effected in the above described manner result in corresponding changes in the speed at which belt 66c is driven from shaft 64c, shaft 64c having a geared connection 62c and 63c to the shaft 46c carrying pulley 43c.

The described parts of unwinding roll stand 40c are arranged so that displacement of roller 23c, toward the left, as viewed in FIG. 3, is accompanied by a reduction in the speed at which web W_1 is unwound from supply roll 11c, while displacement of roller 23c toward the right, as viewed in FIG. 3, causes an increase in the speed at which the web is unwound from its supply roll.

After passing from roller 23c around an idler roller 26c, the pre-printed web W_1 successively travels under an idler roller 153, through a processing unit 154, under an idler roller 155, around drive rollers 28c and 29c, and finally under an idler roller 30c, whereupon web W_1 is directed upwardly for collation with the other registered and individually preprocessed webs.

The web register control of the machine illustrated in FIG. 3 includes a photoelectric scanning head 95c mounted adjacent the run or length of web W_1 between idler rollers 26c and 153 and operative, as in the case of the head 95 of the first described embodiment, to emit an electrical impulse or signal whenever a register mark R on the web W_1 passes the location of the scanning head, with each electrical pulse or signal from head 95c being fed to a register control panel 106c where it is compared with a corresponding electrical pulse or signal emitted from the selector switch 99c which is driven from intermediate drive shaft 149 by way of a non-slip belt 102c running around a pulley 38c on shaft 149 and a pulley 103c on shaft 101c carrying the slotted disc 100c of the selector switch.

Any deviation between the occurrence of the electrical signals or pulses from head 95c and selector switch 99c, respectively, is converted into an error signal by register control panel 106c, and that error signal causes operation of correction motor 90c in a suitable direction to restore proper registration of the web. Thus, if the register mark scanned by head 95c is in advance of its correctly registered position, for example, as indicated at R_1 , the resulting error signal causes motor 90c to displace roller 23c toward the left, as viewed in FIG. 3, and to decrease the unwinding speed of supply roll 11c, so that the displacement of roller 23c and the change of the unwinding speed both cooperate to retard web W_1 . On the other hand, if the scanned register mark lags behind its correctly registered position, as indicated at R_2 , the resulting error signal causes operation of motor 90c in the direction for moving roller 23c toward the right, as viewed in FIG. 3, and for also increasing the unwinding speed of supply roll 11c, so that the displacement of roller 23c and the change in the unwinding speed both cooperate to advance the scanned register mark.

Thus, in the embodiment of FIG. 3, the register correction imparted to the web is also a combination of the effect of a direct displacement of the web and of a proportional change in the web speed, and this register correction tends to over-correct for the initially detected register error so that it gives rise to a relatively smaller detected register error in the direction opposed to the initial register error and causing the generation of an error signal tending to return roller 23c to its original position. In this manner these recurring web register errors become progressively smaller in magnitude during

the corrective actions until the desired web register condition is achieved, and that condition is thereafter maintained within very close limits.

Although the arrangement described above with reference to FIG. 3 permits the tension in web W_1 between processing unit 154 and supply roll 11c to vary as long as register connections are being made, such variations in the web tension become very small or inconsequential after precise register has been achieved and subsequently maintained within very close limits. It should be understood that at no time do the web tension variations exceed the inherent resiliency of the web, i.e., the inherent ability of the web to expand and contract in small amounts during variations in web tension.

In order to permit initial registration of the successive register marks R with the processing unit 154 at the time of starting of the machine, idler roll 26c preferably is supported, at its opposite ends, by arms 156 extending generally upward from a shaft 157 having its opposite ends journaled in side frames 16c, and an arm 158 extends radially from shaft 157 and carries a nut 159 at its free end for threadably receiving an adjustment screw 160 which is provided with a hand wheel 161 at its upper end and is rotatably supported in a bracket 162 extending from the adjacent side frame. Thus, rotation of adjustment screw 160 rocks arms 156 supporting roller 26c to move the latter toward and away from roller 23c and thereby advance or retard the web in relation to processing unit 154.

Web processing unit 154 may be any conventional arrangement for printing, perforation, slitting or cutting the registered web passing therethrough and, as shown in FIG. 3, may include lower and upper web processing cylinders 163 and 164 between which the registered web is made to pass. Lower cylinder 163 is driven from shaft 149 by way of a non-slip belt 165 running around a pulley 166 on shaft 149 and a pulley 167 fixed rotatably to the lower cylinder 163. Since web processing unit 154 is driven from the same shaft 149 as selector switch 99c of the web register control, it is apparent that the latter will act to maintain the desired registration between the repetitive pre-printed matter on web W_1 and the additional processing applied to the web by unit 154.

It will be seen that drive rollers 28c and 29c around which the web passes following emergence from processing unit 154 is part of a variable speed device which is preferably of the kind disclosed fully in U.S. Letters Patent No. 2,787,463, issued April 2, 1957, to W.F. Huck. The purpose of this variable speed device is to maintain constant tension in the web between processing unit 154 and the point where the web W_1 is collated with the other similarly processed webs without altering the effective web length between these two points. This device is therefore capable of maintaining constant web tension without in any way disturbing the accuracy of register relationship between successive operations on the web. The variable speed device includes a carriage 83c having bearings 168 which are slidable on support rods 169 suitably carried by side frames 16c so that carriage 83c is movable rectilinearly parallel to the lengths of the web extending to and from the variable speed device. A double armed lever 170 is rockably mounted, intermediate its ends, on a rockably supported shaft 171, and one end of lever 170 is pivotally connected, as at 172, to a link 173 which is pivotally connected to carriage 83c, as at 174. The other end of lever 170 is connected to one end of a tension spring 175, while the opposite end of that tension spring is connected, as at 176, to a bell crank 177. Bell crank 177 is rockably supported at 178 and carries a nut 179 threadably receiving an adjustment screw 180 which is rotatably supported in a bracket 181 extending from the adjacent side frame and which has a hand wheel 182 at its upper end by which screw 180 can be manually adjusted to effect rocking of the bell crank. Such rocking of the bell crank varies the force

exerted by spring 175 on lever 170, with such force being transmitted, by way of link 173, to carriage 83c, and thereby varies the tensioning effect imparted to the web. It will be apparent that, in the arrangement of FIG. 3, carriage 83c is in a condition of equilibrium when the sum of the force exerted on the carriage by link 173 as a result of the action of spring 175 and of the tension in web W_1 between rollers 29c and 30c is equal to the tension in the web between rollers 28c and 155. However, if the tension in the lengths of the web respectively extending from roller 29c and to roller 28c deviate from predetermined values established by the adjustment of spring 175, carriage 83c is suitably displaced along its support rods 169, and such displacement of the carriage is relied upon to vary the speed at which rollers 28c and 29c are rotatably driven.

In order to vary the speed at which rollers 28c and 29c are rotatably driven, a gear 112c rotatable with roller 28c meshes with a gear 113c rotatably fixed relative to roller 29c and also meshes with a gear 111c fixed to a rotatable shaft 110c which is journaled in the carriage 83c. Shaft 110c is driven from main drive shaft 35c by way of a V-belt 108c running around a pulley 36c on shaft 35c and a variable diameter pulley 109c on shaft 110c.

The runs of belt 108c between pulleys 36c and 109c are engaged by take-up pulleys 183 and 184 which are rotatably supported by suitably adjustable mountings 185 and 186, respectively, carried by side frames 16c, and which are adapted to vary the initial tension in belt 108c for determining the initial rotational speed of rollers 28c and 29c and for compensating wear in belt 108c or in pulleys 36c and 109c. It will be seen that, in the position of equilibrium of carriage 83c illustrated in FIG. 3, a vertical plane passing through the axis of shaft 110c lies ahead of the axis of shaft 35c considered in the direction of travel of web W_1 from roller 29c.

In order to avoid hunting of the above described variable speed device when operating at high web processing speeds, there is preferably provided an arm 187 rockable with lever 170 and pivotally connected to the plunger 188 of a dash pot 189.

From the above description of the arrangement of the variable speed device, it will be apparent that the occurrence of an excessive increase in the tension of the web extending from drive roller 29c and causing displacement of carriage 83c toward the left, as viewed in FIG. 3, tends to increase the distance between the axis of shafts 35c and 110c, whereby the radius of contact of belt 108c with variable diameter pulley 109c is decreased to correspondingly increase the rotational speed at which rollers 28c and 29c are driven. The increased rotational speed of rollers 28c and 29c is sufficient to restore the desired value of tension in the web extending from drive roller 29c. A similar action occurs in the event of an excessive decrease in the value of tension in the web extending to drive roller 28c and, in that case, the increased rotational speed of drive rollers 28c and 29c is effective to restore the desired value of tension in the length of the web between rollers 28c and 155. Conversely, if there is an excessive increase in the value of tension in the web between rollers 28c and 155, or an excessive decrease in the value of tension in the web extending from drive roller 29c, the resulting displacement of carriage 83c toward the right, as viewed in FIG. 3, serves to decrease the speed at which rollers 28c and 29c are rotatably driven, and such altered speed of rotation is sufficient to restore the tensions to the desired values. This tension regulation is continually maintained without altering the length of web path (and, hence, the registered relationship) between web processing unit 154 and the point of collation of web W_1 with the other similarly processed webs.

In the above described embodiment of FIG. 3, the values of tension in the lengths of web W_1 leading to drive roller 28c and extending from drive roller 29c are main-

tained constant by reason of the fact that both of such lengths extend parallel to the direction of movement of carriage 83c to permit variations in the tension in both lengths of the web to influence the position of carriage 83c. However, as illustrated in FIG. 4, wherein the various parts corresponding to those described with reference to FIG. 3 are identified by the same reference numerals, but with the letter "d" appended thereto, the arrangement of the web W_1 in relation to the drive rollers 28d and 29d may be modified so that only the tension in the length of the web leading to drive roller 28c is maintained constant, while the tension in the length of the web extending from drive roller 29c is uncontrolled.

In the modified arrangement of FIG. 4, the length of web W_1 leading to drive roller 28d extends horizontally, that is, parallel to the direction of movement of carriage 83d slidable on support rods 169d, while the web passes vertically upward, that is, in a direction substantially perpendicular to the direction of movement of carriage 83d, upon leaving drive roller 29d and passes over a fixed idler roller 190 prior to passing under the idler roller 30d. The additional idler roller 190 is supported by a suitable bracket 191 at a location substantially above drive roller 29d.

Since the length of web W_1 leading to drive roller 28d extends parallel to the direction of movement of carriage 83d, it is apparent that any change or variation of the tension in such length of the web from a desired value causes displacement of the carriage, as previously described, to produce a compensating change in the rotational speed of drive rollers 28d and 29d. However, since the length of the web extending from drive roller 29d is at right angles to the direction of movement of carriage 83d, it is apparent that any change in the tension in such length of the web cannot produce displacement of carriage 83d along its support rods 169d so that the tension variation remains uncorrected. It should be understood that with this modified arrangement (FIGURE 4), the length of web path between processing unit 154 and the web collation station is not maintained constant and, hence, the registered web relationship between these two points is upset.

Although the automatic web register control embodying the invention is illustrated in FIG. 3 as being applied to a machine handling a plurality of webs, it is to be understood that such embodiment of the invention is also applicable to machines processing a single pre-printed web, for example, as illustrated in FIGS. 5A and 5B which are hereinafter jointly referred to as FIG. 5. In the single web processing machine of FIG. 5, the various parts corresponding to those described above with reference to FIG. 3 are identified by the same reference numerals, but with the letter "e" appended thereto.

In the machine of FIG. 5, the single web W passes under a fixed idler roller 192 after leaving drive roller 29e of the variable speed device provided for maintaining constant tension in the length of the web extending from web processing unit 154e. After passing under idler roller 192, the web travels over a movable roller 23f and then downwardly before engaging a web driving roller 193 of a further web processing unit generally identified at 131f.

The web processing unit 131f may be any conventional unit, for example, the sheeting unit 131 described with reference to FIG. 2 of the drawings, which is effective to cut the web into repetitive lengths and to collect these lengths or wind the same into individual coils. As in the case of the unit 131 of FIG. 2, the unit 131f of the machine illustrated in FIG. 5 may perform operations on the web other than sheeting, for example, perforating, slitting or additional printing operations, and, in those cases, the continuous processed web may be rewound into a storage roll on a rewind roll stand corresponding to the roll stand 40b of FIG. 2.

In order to insure that the pre-printed web processed in the unit 154e is correctly registered with respect to

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the further processing unit 131f, the machine of FIG. 5 further preferably includes a photoelectric scanning head 95f corresponding to the previously described scanning head 95 and located adjacent the run of web W between floating or movable roller 23f and web driving roller 193 to emit electrical signals in response to the passage of the register marks R on the web. Such signals from scanning head 95f and electrical signals from a selector switch 99f, which corresponds to the previously described selector switch 99, are fed to register control panel 106f, which corresponds to the previously described register control panel 106. In the register control panel 106f, the signals from the scanning head and selector switch, respectively, are compared and an error signal is generated in response to any deviation between the occurrence of the related signals. The generated error signal is employed for operating a reversible electric motor 90f which drives an adjustment screw 87f, by way of a universal joint 88f, thereby to angularly adjust arms 24f which are pivoted at 25f and which carry movable roller 23f and a nut 86f threadably receiving the adjustment screw. Thus, a detected register error gives rise to generally vertical displacement of movable roller 23f and thereby either advances or retards the length of web W leading to web processing unit 131f in order to correct such register error.

In order to ensure the synchronous operation of web processing unit 131f and the associated automatic web register control with respect to the other parts of the machine handling web W, web driving roller 193 is driven from an intermediate drive shaft 194 by way of a non-slip belt 195 running around pulleys 196 and 197 rotatably fixed to roller 193 and shaft 194, respectively, and shaft 194 is, in turn, rotatably driven from main drive shaft 35e of the machine by way of a non-slip belt 198 running around pulleys 199 and 200 rotatably fixed on shafts 194 and 35e, respectively. Further, selector switch 99f which determines the timing of the electrical pulses establishing the desired timed relationship between the web W and the operation of web processing unit 131f is driven from web driving roller 193 of that unit by way of a non-slip belt 201 running around a pulley 202 and a pulley 203 rotatably fixed to roller 193 and to the shaft 101f of the slotted disc 100f of selector switch 99f, respectively.

From the above detailed description of illustrative embodiments of the invention, it will be apparent that, in each case, the desired correction of a register error is achieved by the combined effect of displacement of the web along its path of travel and of variation of the speed of travel of the web, and that the correction of a register error is preferably accompanied by a compensation for excessive changes that may occur in the tension in the web by reason of the correction.

Although illustrative 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, except as defined in the appended claims.

What is claimed is:

1. In a machine for feeding at least one continuous web provided with register marks at spaced apart locations therealong from a source thereof in a predetermined timed relationship and in register with respect to a function performed at a station of the machine to which the web is to be fed continuously, the combination of:

guiding means engageable with the web and defining a feeding path for the latter extending from the source of the web to said station

variable speed drive means controlling the speed of movement of the web along said path

web displacing means moveable to vary the length of the portion of said path between said drive means

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and said station and thereby cause displacement of the web along said path

means for detecting said register marks as they pass through a predetermined point in said path at which a predetermined positional relationship of said marks to said point corresponds to correct register between the web and said station

means for generating signals at a uniform frequency synchronized to the rate of performance of said function

and register control means responsive to signals from said detecting means and to the signals from said generating means and operative upon variations of the relationship in time of the respective signals, corresponding to deviations of the positions of said marks relative to said point from said predetermined positional relationship, to vary the speed of said drive means and simultaneously move said web displacing means in the sense for restoring said positional relationship, whereby to correct any substantial errors of registration.

2. In a machine for feeding at least one continuous, repetitively pre-printed web from a source thereof in a predetermined timed relationship and in register with respect to a function performed at a station of the machine to which the web is to be fed continuously; the combination of guiding means engageable with the web and defining a feeding path for the latter extending from the source of the web to and beyond said station, variable speed drive means controlling the speed of movement of the web along said path, web displacing means movable to vary the length of the portion of said path between said drive means and said station and thereby cause displacement of the web along said path, register control means detecting any deviation in the feeding movement of the web from the predetermined timed relationship with respect to the function of the machine and operative, in response to the detected deviation, to both vary the speed of said drive means and move said web displacing means in the sense for restoring the predetermined timed relationship, and means engageable with the web in a portion of said path wherein the tension in the web is affected by movements of said web displacing means, and movable in response to variations of the tension in the web in said path portion, to compensate for such movements and maintain a substantially constant value of tension in the web along at least a portion of said path.

3. In a machine for feeding at least one continuous, repetitively pre-printed web from a supply roll thereof with a predetermined timed relationship between the feeding movement of repetitive printed patterns on the web and a function performed at a station of the machine to which the web is to be fed continuously; the combination of means for rotatably supporting the supply roll to permit unwinding of the web from the latter, guiding means engageable with the web and defining a feeding path for the latter as the web is unwound from the supply roll, said path extending from said supply roll to and beyond said station, variable speed drive means controlling the speed of movement of the web along said path, web displacing means movable to vary the length of the portion of said path between said drive means and said station and thereby cause displacement of the web along said path, photoelectric means detecting any deviation of the feeding movement of the repetitive printed patterns on the web from the predetermined timed relationship with respect to the function of the machine, control means responsive to the detection of a deviation by said photoelectric means to vary the speed of said drive means and to move said web displacing means in the sense for restoring said predetermined timed relationship, and means maintaining a substantially constant value of tension in the web along at least a portion of said path as the web is displaced along the latter and has its speed of move-

ment varied to restore said predetermined timed relationship.

4. In a machine for feeding at least one continuous web provided with register marks at spaced apart locations therealong from a supply roll thereof with a predetermined timed relationship between the feeding movement of the web and rotation of a drive shaft of the machine, the combination of:

means for rotatably supporting the supply roll to permit unwinding of the web from the latter

guiding means engageable with the web and defining a feeding path for the latter as the web is unwound from the supply roll

variable speed drive means engageable with the supply roll and controlling the speed of movement of the web from the roll along said path

web displacing means engageable with the web to form a loop therein and being moveable to vary the size of the loop and thereby cause displacement of the web along said path

means for detecting said register marks as they pass through a predetermined point in said path at which a predetermined positional relationship of said marks to said point corresponds to correct register between the web and a web processing device driven by said shaft

means for generating signals at a frequency synchronized to the rate of rotation of said drive shaft,

and register control means responsive to signals from said detecting means and to the signals from said generating means and operative upon variations of the relationship in time of the respective signals, corresponding to deviations of the positions of said marks from said predetermined positional relationship, to vary the speed of said drive means and simultaneously move said displacing means in the sense for restoring said positional relationship, whereby to correct any substantial errors of registration.

5. In a machine for feeding at least one continuous, repetitively pre-printed web from a supply roll thereof with a predetermined timed relationship between the feeding movement of repetitive printed patterns on the web and the rotation of a drive shaft of the machine; the combination of means for rotatably supporting the supply roll to permit unwinding of the web from the latter, guiding means engageable with the web and defining a feeding path for the latter as the web is unwound from the supply roll, variable speed drive means engageable with the supply roll and controlling the speed of movement of the web from the roll along said path, web displacing means engageable with the web to form a loop in the latter and being moveable to vary the size of the loop and thereby cause displacement of the web along said path, photo-electric means detecting any deviation of the feeding movement of the repetitive printed patterns on the web from the predetermined timed relationship with respect to the rotation of the drive shaft, control means responsive to the detection of a deviation by said photoelectric means to vary the speed of said drive means and to move said web displacing means in the sense for restoring said predetermined timed relationship, and means maintaining a substantially constant value of tension in the web along at least a portion of said path as the web is displaced along the latter and has its speed of movement varied to restore said predetermined timed relationship.

6. In a machine for feeding at least one continuous, repetitively pre-printed web from a source thereof in a predetermined timed relationship with respect to a function of the machine; the combination of guiding means engageable with the web and defining a feeding path for the latter extending from the source of the web, variable speed drive means engaging the web at a location along the feeding path and controlling the speed of movement of the web along said path, said variable speed drive

means being bodily movable to cause displacement of the web along said path, and register control means detecting any deviation in the feeding movement of the web from the predetermined timed relationship with respect to the function of the machine and operative, in response to the detected deviation, to both vary the speed of said drive means and to bodily move the latter in the sense for restoring the predetermined timed relationship between the feeding movement of the web and the function of the machine.

7. In a machine for feeding at least one continuous, repetitively pre-printed web from a supply roll thereof with a predetermined timed relationship between the feeding movement of repetitive printed patterns on the web and the rotation of a drive shaft of the machine; the combination of means for rotatably supporting the supply roll to permit unwinding of the web from the latter, guiding means engageable with the web and defining a feeding path for the latter as the web is unwound from the supply roll, variable speed drive means engaging the web at a location along the feeding path and controlling the speed of movement of the web along said path, said variable speed drive means being bodily movable to cause displacement of the web along said path, photoelectric means detecting any deviation of the feeding movement of the repetitive printed patterns on the web from the predetermined timed relationship with respect to the rotation of the drive shaft, and control means responsive to the detection of a deviation by said photoelectric means to simultaneously vary the speed of said drive means and bodily move the latter in the sense for restoring said predetermined timed relationship.

8. In a machine for feeding at least one continuous, repetitively pre-printed web from a supply roll thereof with a predetermined timed relationship between the feeding movement of repetitive printed patterns on the web and the rotation of a drive shaft of the machine; the combination of means for rotatably supporting the supply roll to permit unwinding of the web from the latter, guiding means engageable with the web and defining a feeding path for the latter as the web is unwound from the supply roll, variable speed drive means engaging the web at a location along the feeding path and controlling the speed of movement of the web along said path, said variable speed drive means being bodily movable to cause displacement of the web along said path, photoelectric means detecting any deviation of the feeding movement of the repetitive printed patterns on the web from the predetermined timed relationship with respect to the rotation of the drive shaft, control means responsive to the detection of a deviation by said photoelectric means to simultaneously bodily move said drive means and vary the speed of said drive means in the sense for restoring said predetermined timed relationship, and variable speed unwinding means controlling the unwinding speed of the supply roll and responsive to the tension in the web along the portion of said feeding path between the supply roll and said drive means for maintaining a substantially constant value of tension in said portion of said path as the web is displaced along the latter and has its speed of movement varied to restore said predetermined timed relationship.

9. In a machine of the described character having guiding means defining a feeding path for at least one continuous web provided with register marks at spaced apart locations therealong; an arrangement for ensuring correct longitudinal registration of the successive register marks with respect to a function of the machine as the continuous web moves along said path, said arrangement comprising variable speed drive means controlling the speed of movement of the web along said path, web displacing means movable to cause displacement of the web along said path, means detecting the presence of each of the successive register marks at a predetermined location

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along said path, means generating signals with uniform intervals therebetween at a frequency related to said function of the machine, and register control means responsive to any deviation between the presence of a register mark detected at said location and the occurrence of a related signal to both vary the speed of said drive means and move said web displacing means in the sense for restoring correct registration of the detected register mark with respect to said function of the machine.

10. In a machine of the described character having guiding means defining a feeding path for at least one continuous web provided with register marks at spaced apart locations therealong; an arrangement for ensuring correct longitudinal registration of the successive register marks with respect to a function of the machine as the continuous web moves along said path, said arrangement comprising variable speed drive means controlling the speed of movement of the web along said path, web displacing means movable to cause displacement of the web along said path, photoelectric means detecting the presence of each of the successive register marks at a predetermined location along said path, means generating signals with uniform intervals therebetween at a frequency related to said function of the machine, register control means responsive to any deviation between the presence of a register mark detected at said location and the occurrence of a related signal to both vary the speed of said drive means and move said web displacing means in the sense for restoring correct registration of the detected register mark with respect to said function of the machine, and means responsive to the tension in the web along at least a portion of said path and operative to maintain the tension in said portion at a predetermined value as correct registration is restored by said register control means.

11. In a machine of the described character having guiding means defining a feeding path for at least one continuous web provided with register marks at spaced apart locations therealong; an arrangement for ensuring correct longitudinal registration of the successive register marks with respect to a function of the machine as the continuous web moves along said path, said arrangement comprising variable speed drive means engaging said web and controlling the speed of movement of the web along said path, said drive means being bodily movable along said path to cause corresponding displacement of the web, photoelectric means detecting the presence of each of the successive register marks at a predetermined location along said path, means generating signals with uniform intervals therebetween at a frequency related to said function of the machine, and register control means responsive to any deviation between the presence of a register mark detected at said location and the occurrence of a related signal to both vary the speed of said drive means and bodily move the latter in the sense for restoring correct registration of the detected register mark with respect to said function of the machine.

12. In a machine of the described character having guiding means defining a feeding path for at least one continuous web unwound from a supply roll and provided with register marks at spaced apart locations therealong; an arrangement for ensuring correct longitudinal registration of the successive register marks with respect to a function of the machine as the continuous web moves along said path, said arrangement comprising variable speed drive means engaging said web and controlling the speed of movement of the web along said path, said drive means being bodily movable along said path to cause corresponding displacement of the web, photoelectric means detecting the presence of each of the successive register marks at a predetermined location along said path, means generating signals with uniform intervals therebetween at a frequency related to said function of the machine, register control means responsive to any deviation between the

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presence of a register mark detected at said location and the occurrence of a related signal to both vary the speed of said drive means and bodily move the latter in the sense for restoring correct registration of the detected register mark with respect to said function of the machine, variable speed unwinding means engaging the supply roll and controlling the speed at which the continuous web is unwound for travel along said path, and means responsive to a deviation from a predetermined value of the tension in the web along the portion of the feeding path between the supply roll and said drive means to vary the speed of said unwinding means in the sense for restoring said predetermined value of tension in the web.

13. In a machine of the described character having guiding means defining a feeding path for at least one continuous web unwound from a supply roll and provided with register marks at spaced apart locations therealong; an arrangement for ensuring correct longitudinal registration of the successive register marks with respect to a function of the machine as the continuous web moves along said path, said arrangement comprising variable speed drive means engaging the supply roll and controlling the unwinding speed of the roll and, hence, the speed of movement of the web along said path, web displacing means engaging the web to form a loop in the latter and being movable to vary the size of the loop and thereby cause displacement of the web along said path, photoelectric means detecting the presence of each of the successive register marks at a predetermined location along said path, means generating signals with uniform intervals therebetween at a frequency related to said function of the machine, and register control means responsive to any deviation between the presence of a register mark detected at said location and the occurrence of a related signal to both vary the speed of said drive means and move said web displacing means in the sense for restoring correct registration of the detected register mark with respect to said function of the machine.

14. In a machine of the described character having guiding means defining a feeding path for at least one continuous web unwound from a supply roll and provided with register marks at spaced apart locations therealong; an arrangement for ensuring correct longitudinal registration of the successive register marks with respect to a function of the machine as the continuous web moves along said path, said arrangement comprising first variable speed drive means engaging the supply roll and controlling the unwinding speed and, hence, the speed of movement of the web from the roll along said path, web displacing means engaging the web to form a loop in the latter and being movable to vary the size of the loop and thereby cause displacement of the web along said path, photoelectric means detecting the presence of each of the successive register marks at a predetermined location along said path, means generating signals with uniform intervals therebetween at a frequency related to said function of the machine, register control means responsive to any deviation between the presence of a register mark detected at said location and the occurrence of a related signal to both vary the speed of said first drive means and move said web displacing means in the sense for restoring correct registration of the detected register mark with respect to said function of the machine, second variable speed drive means engaging said web at a portion of said path spaced from said location in the direction of the movement of the web, and means responsive to a deviation from a predetermined value of the tension in the web along said portion of the path to vary the speed of said second drive means in the sense for restoring said predetermined value of tension in the web.

15. In a machine for processing at least one continuous, repetitively pre-printed web provided with register marks in fixed relation to the repeated printed matter on the web and which is unwound from a supply roll; the combi-

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nation of means for rotatably supporting the supply roll during unwinding of the web therefrom, a processing device for repeatedly processing the web at locations bearing a predetermined relation to the repeated printed matter, guide means defining a feeding path for the web from the supply roll to said processing device, variable speed drive means controlling the speed of movement of the web along said path, web displacing means movable to vary the length of the portion of said path between said drive means and said device and thereby cause displacement of the web along said path, photoelectric detecting means responsive to the presence of each of the successive register marks at a predetermined location along said path to emit a corresponding signal, signal generating means driven in synchronism with said processing device and emitting signals which coincide with signals from the detecting means when the web is longitudinally registered with respect to the processing device, and register control means responsive to any time differential between the signals from said detecting means and said signal generating means, respectively, to both vary the speed of said drive means and move said web displacing means in the sense for restoring coincidental occurrence of the respective signals, thereby to bring the repeated printed matter of the web into correct registration with the repeated processing of the web by said device.

16. In a machine for processing at least one continuous, repetitively pre-printed web provided with register marks in fixed relation to the repeated printed matter on the web and which is unwound from a supply roll; the combination of means for rotatably supporting the supply roll during unwinding of the web therefrom, a processing device for repeatedly processing the web at locations bearing a predetermined relation to the repeated printed matter, guide means defining a feeding path for the web from the supply roll to said processing device, variable speed drive means engaging the web between the supply roll and said processing device and controlling the speed of movement of the web along said path, said drive means being bodily movable along said path to cause corresponding displacement of the web, photoelectric detecting means responsive to the presence of each of the successive register marks at a predetermined location along said path to emit a corresponding signal, signal generating means driven in synchronism with said processing device and emitting signals which coincide with the signals from the detecting means when the web is longitudinally registered with respect to the processing device, and register control means responsive to any time differential between the signals from said detecting means and said signal generating means, respectively, to both vary the speed of said drive means and bodily move the latter in the sense for restoring coincidental occurrence of the respective signals, thereby to bring the repeated printed matter of the web into correct registration with the repeated processing of the web by said device.

17. In a machine for processing at least one continuous, repetitively pre-printed web provided with register marks in fixed relation to the repeated printed matter on the web and which is unwound from a supply roll; the combination of means for rotatably supporting the supply roll during unwinding of the web therefrom, a processing device for repeatedly processing the web at locations bearing a predetermined relation to the repeated printed matter, guide means defining a feeding path for the web from the supply roll to said processing device, variable speed drive means engaging the supply roll to control the unwinding speed thereof and, hence, the speed of movement of the web along said path, web displacing means engaging the web to form a loop in the latter and being movable to vary the size of the loop and thereby cause displacement of the web along said path, photoelectric detecting means responsive to the presence of each of the successive register marks at a predetermined location following said loop along said path to emit a corresponding signal, signal gen-

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erating means driven in synchronism with said processing device and emitting signals which coincide with the signals from the detecting means when the web is longitudinally registered with respect to the processing device, and register control means responsive to any time differential between the signals from said detecting means and said signal generating means, respectively, to both vary the speed of said drive means and move said web displacing means in the sense for restoring coincidental occurrence of the respective signals, thereby to bring the repeated printed matter of the web into correct registration with the repeated processing of the web by said device.

18. In a machine for processing at least one continuous, repetitively pre-printed web provided with register marks in fixed relation to the repeated printed matter on the web and which is unwound from a supply roll; the combination of means for rotatably supporting the supply roll during unwinding of the web therefrom, a main drive shaft, a processing device driven from said shaft for repeatedly processing the web at locations bearing a predetermined relation to the repeated printed matter, guide means defining a feeding path for the web from the supply roll to said processing device, variable speed drive means driven from said main drive shaft and engaging said web for controlling the speed of movement of the web along said path, said drive means being bodily movable along said path to cause corresponding displacement of the web, photoelectric detecting means responsive to the presence of each of the successive register marks at a predetermined location along said path to emit a corresponding signal, signal generating means driven from said main drive shaft in synchronism with said processing device and emitting signals which coincide with the signals from the detecting means when the web is longitudinally registered with respect to the processing device, register control means responsive to any time differential between the signals from said detecting means and said signal generating means, respectively, to both vary the speed of said drive means and bodily move the latter in the sense for restoring coincidental occurrence of the respective signals, thereby to bring the repeated printed matter of the web into correct registration with the repeated processing of the web by said device, variable speed unwinding means driven from said main drive shaft and engaging the supply roll to control the unwinding speed of the latter, and control means varying the speed of said unwinding means in response to deviation of the tension from a predetermined value in the web between the supply roll and said drive means in order to restore the tension to said predetermined value.

19. In a machine for processing at least one continuous, repetitively pre-printed web provided with register marks in fixed relation to the repeated printed matter on the web and which is unwound from a supply roll; the combination of means for rotatably supporting the supply roll during unwinding of the web therefrom, a main drive shaft, a processing device driven from said shaft for repeatedly processing the web at locations bearing a predetermined relation to the repeated printed matter, guide means defining a feeding path for the web from the supply roll through said processing device, variable speed drive means drive from said shaft and engaging the supply roll to control the unwinding speed thereof and, hence, the speed of movement of the web along said path, web displacing means engaging the web to form a loop in the latter and being movable to vary the size of the loop and thereby cause displacement of the web along said path, photoelectric detecting means responsive to the presence of each of the successive register marks at a predetermined location following said loop along said path to emit a corresponding signal, signal generating means driven from said main drive shaft in synchronism with said processing device and emitting signals which coincide with the signals from the detecting means when the web is longi-

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gradually registered with respect to the processing device, register control means responsive to any time differential between the signals from said detecting means and said signal generating means, respectively, to both vary the speed of said drive means and move said web displacing means in the sense for restoring coincidental occurrence of the respective signals, thereby to bring the repeated printed matter of the web into correct registration with the repeated processing of the web by said device, drive rollers engaging the web following passage of the latter through said processing device, means mounting said drive rollers for bodily movement parallel to an adjacent portion of said feeding path so that said drive rollers are adapted to be bodily displaced in response to variations in the tension in the web along said adjacent portion of the path, and variable speed transmission means driving said drive rollers from said main drive shaft and controlled in response to bodily displacement of said drive rollers for varying the rotational speed of the latter in the sense necessary to maintain a substantially constant value of web tension along said adjacent portion of the feeding path.

20. In a machine for collating a plurality of continuous, repetitively pre-printed webs each unwound from a supply roll and provided with register marks spaced apart along the web in fixed relation to repeated printed matter thereon; the combination of means rotatably supporting each supply roll to permit unwinding of the web therefrom, guide means defining feeding paths for the webs unwound from the related supply rolls with said paths coming together to define a collating zone, variable speed drive means for each web controlling the speed of movement of the latter along the related feeding path, web displacing means for each web movable to vary the length of the portion of the path of that web between its drive means and said collating zone and thereby cause displacement of that web along its feeding path, photoelectric detecting means for each web responsive to the presence of each of the successive register marks of the related web at a predetermined location along the related feeding path between the supply roll and the collating zone to emit a corresponding signal, signal generating means emitting signals with uniform intervals therebetween, and register control means for each web responsive to any time differential between the occurrence of said signals from the related detecting means and said generating means, respectively, to both vary the speed of the related drive means and move the related web displacing means in the sense for restoring coincidental occurrence of the respective signals, thereby to register the repeated printed matter on the respective webs at said collating zone.

21. In a machine for collating a plurality of continuous, repetitively pre-printed webs each unwound from a supply roll and provided with register marks spaced apart along the web in fixed relation to repeated printed matter thereon; the combination of means rotatably supporting each supply roll to permit unwinding of the web therefrom, guide means defining feeding paths for the webs unwound from the related supply rolls with said paths coming together to define a collating zone, variable speed drive means for each web engaging the latter between the supply roll and said collating zone and controlling the speed of movement of the web along the related feeding path, said drive means being bodily movable parallel to adjacent portions of the related feeding path to cause displacement of the engaged web along the related feeding path, photoelectric detecting means for each web responsive to the presence of each of the successive register marks of the related web at a predetermined location along the related feeding path between the supply roll and the collating zone to emit a corresponding signal, signal generating means emitting signals with uniform intervals therebetween, register control means for each web responsive to any time differential between the occurrence of said

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signals from the related detecting means and said generating means, respectively, to both vary the speed of the related drive means and bodily move the latter in the sense for restoring coincidental occurrence of the respective signals, thereby to register the repeated printed matter on the respective webs at said collating zone, variable speed unwinding means for each web engaging the related supply roll and controlling the unwinding speed of the latter, and control means for said unwinding means responding to a deviation from a predetermined value of the tension in the web between said drive means and the supply roll to correspondingly vary the speed of said unwinding means for restoring said predetermined value of web tension.

22. In a machine for collating a plurality of continuous, repetitively pre-printed webs each unwound from a supply roll and provided with register marks spaced apart along the web in fixed relation to repeated printed matter thereon; the combination of means rotatably supporting each supply roll to permit unwinding of the web therefrom, guide means defining feeding paths for the webs unwound from the related supply rolls with said paths coming together to define a collating zone, first variable speed drive means for each web engaging the related supply roll and controlling the unwinding speed of the latter and, hence, controlling the speed of movement of the web from the roll along the related feeding path, web displacing means for each web engaging the latter to form a loop therein and being movable to vary the size of the loop and thereby cause displacement of the latter along the related feeding path, photoelectric detecting means for each web responsive to the presence of each of the successive register marks of the related web at a predetermined location along the related feeding path between the supply roll and the collating zone to emit a corresponding signal, signal generating means emitting signals with uniform intervals therebetween, register control means for each web responsive to any time differential between the occurrence of said signals from the related detecting means and said generating means, respectively, to both vary the speed of the related first drive means and move the related web displacing means in the sense for restoring coincidental occurrence of the respective signals, thereby to register the repeated printed matter on the webs in said collating zone, second variable speed drive means for each web engaging the latter at a portion of the related feeding path spaced from said predetermined location of the detecting means in the direction of movement of the web, and means responsive to a deviation from a predetermined value of tension in the web along said portion of the path to vary the speed of said second drive means in the sense for restoring said predetermined value of tension in the web.

23. In a machine for processing and collating a plurality of continuous, repetitively pre-printed webs each unwound from a supply roll and provided with register marks spaced apart along the web in fixed relation to repeated printed matter thereon; the combination of means rotatably supporting each supply roll to permit unwinding of the web therefrom, guide means defining feeding paths for the webs unwound from the related supply rolls with said paths coming together to define a collating zone, a processing device engaging each web between the related supply roll and said collating zone, variable speed drive means for each web controlling the speed of movement of the latter along the related feeding path, web displacing means for each web movable to vary the length of the portion of the path of that web between its drive means and the related device and thereby cause displacement of that web along its feeding path, photoelectric detecting means for each web responsive to the presence of each of the successive register marks of the related web at a predetermined location along the related feeding path between the supply roll and the collating zone

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to emit a corresponding signal, means synchronizing the operation of the processing devices, signal generating means emitting signals with uniform intervals therebetween at a frequency coordinated with said operation of the processing devices, and register control means for each web responsive to any time differential between the occurrence of said signals from the related detecting means and said generating means, respectively, to both vary the speed of the related drive means and move the related web displacing means in the sense for restoring coincidental occurrence of the respective signals, thereby to register the repeated printed matter on each web with respect to the operation of the related processing device and with respect to the repeated printed matter on the other webs in said collating zone.

24. In a machine for processing and collating a plurality of continuous, repetitively pre-printed webs each unwound from a supply roll and provided with register marks spaced apart along the web in fixed relation to repeated printed matter thereon; the combination of means rotatably supporting each supply roll to permit unwinding of the web therefrom, guide means defining feeding paths for the web unwound from the related supply rolls with said paths coming together to define a collating zone, a processing device acting on each web between the related supply and said collating zone, first variable speed drive means for each web engaging the related supply roll and controlling the unwinding speed thereof and controlling the speed of movement of the web along the related feeding path, web displacing means for each web engaging the latter to form a loop thereon and being movable to vary the size of the loop and thereby cause displacement of the latter along the related feeding path, photoelectric detecting means for each web responsive to the presence of each of the successive register marks of the related web at a predetermined location along the related feeding path between the supply roll and the collating zone to emit a corresponding signal, means synchronizing the operating speeds of the processing devices, signal generating means emitting signals with uniform intervals therebetween at a frequency coordinated with said operating speeds of the processing devices, register control means for each web responsive to any time differential between the occurrence of said signals from the related detecting means and said generating means, respectively, to both vary the speed of the related first drive means and move the related web displacing means in the sense for restoring coincidental occurrence of the respective signals, thereby to register the repeated printed matter on each web with respect to the operation of the related processing device and with respect to the repeated printed matter on the other webs in said collating zone, second variable speed drive means for each web engaging the latter at a portion of the related feeding path between the related processing device and said collating zone, and means responsive to a deviation from a predetermined value of tension in each web along said portion of the feeding path to vary the speed of the related second drive means in the sense for restoring said predetermined value of tension in the web.

25. In a machine for processing at least one continuous, repetitively pre-printed web provided with register marks in fixed relation to repeated printed matter on the web and which is unwound from a supply roll; the combination of an unwinding roll stand for rotatably supporting the supply roll during unwinding of the web therefrom, a processing device for repeatedly processing the web at locations bearing a predetermined relation to the repeated printed matter, guide means defining a feeding path for the web from the supply roll through said processing device, variable speed drive means controlling the speed of movement of the web along said path, web displacing means movable to cause displacement of the web along said path, photoelectric detecting means responsive to the presence of each of the successive register marks

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at a predetermined location along said path to emit a corresponding signal, signal generating means driven in synchronism with said processing device and emitting signals which coincide with the signals from the detecting means when the web is longitudinally registered with respect to the processing device, register control means responsive to any time differential between the signals from said detecting means and said signal generating means, respectively, to both vary the speed of said drive means and move said web displacing means in the sense for restoring coincidental occurrence of the respective signals, thereby to bring the repeated printed matter on the web into correct registration with the repeated processing of the web by said device, a rewinding rollstand receiving the web from said processing device to form the processed web into a storage roll, variable speed rewinding means controlling the winding speed of the storage roll, and control means responsive to a deviation from a predetermined value of tension in the web between said processing device and the storage roll to vary the speed of said rewinding means in the sense for restoring said predetermined value of tension in the web.

26. In a web processing apparatus, the combination of: a source of the web

means for positively delivering the web from said source first and second web processing devices

means for continuously driving and guiding the web from said source through said devices successively, including roller means engaging the web between said devices for positively pulling it from said first device means for driving in synchronism said delivering means, said devices and said roller means

means responsive to variations of the pull of the web section between said roller means and said first device for varying the speed of said roller means so as to keep said pull substantially constant

first and second web positioning means acting upon respective portions of the web between said source and said first device and between said roller means and said second device

first and second register detecting means respectively for sensing errors in the position of said first web portion relative to said first device and errors in the position of said second web portion relative to said second device

means responsive to the sensing of errors by said first detecting means for displacing said first web positioning means and varying the speed of said web delivering means so as to keep said first web portion in register with said first device

and means responsive to the sensing of errors by said second detecting means for displacing said second web positioning means so as to keep said second web portion in register with said second device.

27. In a web processing apparatus, the combination of: a web feeding rollstand

an endless driving belt peripherally engaging the periphery of a roll of the web on said rollstand

first and second rotary web processing devices

means for continuously driving and guiding the web from said rollstand through said devices successively, including roller means engaging the web between said devices for positively pulling it from said first device

means for driving in synchronism said driving belt, said devices and said roller means

means responsive to variations of the pull of the web section between said roller means and said first device for varying the speed of said roller means so as to keep said pull substantially constant

first and second web positioning means acting upon respective portions of the web between said rollstand and said first device and between said roller means and said second device

first and second register detecting means respectively for sensing errors in the position of said first web portion relative to said first device and errors in the position of said second web portion relative to said second device 5

means responsive to the sensing of errors by said first detecting means for displacing said first web positioning means and varying the speed of said driving belt so as to keep said first web portion in register with said first device 10

and means responsive to the sensing of errors by said second detecting means for displacing said second web positioning means so as to keep said second web portion in register with said second device.

28. In a web processing apparatus, the combination of: 15

a source of the web

means for positively delivering the web from said source

first and second rotary web processing devices

means for continuously driving and guiding the web from said source through said devices successively, including roller means engaging the web between said devices for positively pulling it from said first device 20

means for driving in synchronism said delivery means, said devices and said roller means 25

means responsive to variations of the pull of the web section between said roller means and said first device, including a reciprocable carriage biased against said pull and on which said roller means are mounted for movement in a path substantially parallel to said web section, for varying the speed of said roller means so as to keep said pull substantially constant 30

first and second web positioning means acting upon respective portions of the web between said source and said first device and between said roller means and said second device 35

first and second register detecting means respectively for sensing errors in the position of said first web portion relative to said first device and errors in the position of said second web portion relative to said second device 40

means responsive to the sensing of errors by said first detecting means for displacing said first web positioning means and varying the speed of said web delivering means so as to keep said first web portion in register with said first device 45

and means responsive to the sensing of errors by said second detecting means for displacing said second web positioning means so as to keep said second web portion in register with said second device. 50

29. An apparatus as claimed in claim 28 wherein the web leaves said roller means in a direction substantially parallel to said path. 55

30. An apparatus as claimed in claim 28 wherein the web leaves said roller means in a direction substantially transverse to said path.

31. An apparatus as claimed in claim 19 wherein the web leaves said drive rollers in a direction substantially parallel to said adjacent portion. 60

32. An apparatus as claimed in claim 19 wherein the web leaves said drive rollers in a direction substantially transverse to said adjacent portion.

33. In a machine for feeding at least one continuous, repetitively pre-printed web from a source thereof in a predetermined timed relationship and in register with respect to a function performed at a station of the machine to which the web is to be fed continuously, the combination of: 65

guiding means engageable with the web and defining a feeding path for the latter extending from the source of the web to and beyond said station 70

variable speed drive means controlling the speed of movement of the web along said path 75

web displacing means movable to vary the length of the portion of said path between said drive means and said station and thereby cause displacement of the web along said path

register control means detecting any deviation in the feeding movement of the web from the predetermined timed relationship with respect to the function of the machine and operative, in response to the detected deviation, to both vary the speed of said drive means and move said web displacing means in the sense for restoring the predetermined timed relationship

and means engageable with the web in a portion of said path wherein the tension in the web is affected by the variations in the speed of said drive means and the movements of said web displacing means and operative to maintain the tension in that portion substantially constant without disturbing said timed relationship.

34. In a web processing apparatus, 30

means engaging the web to guide it through a web path

said means including

web driving means controlling the speed of movement of the web

and web displacing means movable bodily to vary the position of a part of the web path

variable speed drive means for rotating said web driving means

said drive means including

an endless belt

and means moved in response to variations in the tension of said belt to vary correspondingly the speed of said web driving means

means for sensing a variation of a condition of the web at a point in said path and operative to generate a signal in response to such variation, and means operated in response to said signal to move said web displacing means and simultaneously to vary said tension and thereby the speed of said web driving means whereby to alter both the position of the web in said part of its path and the web speed in compensation for the varied condition of the web at said point.

35. Apparatus as claimed in claim 34, 35

said web driving means and said web displacing means both being constituted by rollers engaging the web and movable bodily in a direction transverse to their axes.

36. Apparatus as claimed in claim 34, 36

said web driving means and said web displacing means both being constituted by rollers engaging the web and movable bodily in a direction transverse to their axes

said drive means including

a tensioning member bearing against said belt and a pulley driven by said belt and moved with said rollers to displace said belt relative to said tensioning member.

37. Apparatus as claimed in claim 36: 37

said rollers and said pulley being mounted on a carriage a lever member pivotally mounted intermediate its ends and having one of its ends connected with said carriage to move the latter

said operated means including a reversible rotary electric motor operated in response to said signal and means interconnecting said motor and the other end of said lever and operative to convert rotary movement of said motor into pivotal movement of said lever.

38. Apparatus as claimed in claim 37, 38

said drive means further including a second pulley driving said belt,

said second pulley having an axis of rotation coincident with the pivotal axis of said lever.

39. Apparatus as claimed in claim 34,
said web displacing means including means engaging
the web to form a loop therein and being movable
to vary the position of the loop
and a tensioning member carried by said displacing 5
means and movable therewith to vary the tension in
said belt.
40. A web handling apparatus comprising:
web driving rollers engaging the web and movable
bodily in a direction transverse to their axes 10
and variable speed drive means for said rollers includ-
ing
an endless belt,
a tensioning member bearing against said belt,
a pulley driven by said belt and moved with said 15
rollers to displace said belt relative to said ten-
sioning member,
means driving said belt,
and means responsive to the variations of the
tension of said belt to vary the speed of said 20
driven pulley.
41. A web handling apparatus comprising:
a lever member pivotally mounted intermediate its ends,
web driving rollers carried at one end of said lever 25
member
variable speed drive means for said rollers including
an endless belt,
a tensioning member bearing against said belt,
and a pulley driven by said belt and carried by 30
said one end of said lever member so that
movement of said lever member about its pivotal
axis displaces said belt relative to said tensioning
member
and means secured to the other end of said lever mem- 35
ber and operative to move said lever member about
its pivotal axis.
42. A web handling apparatus as claimed in claim 40,
said drive means further including a second pulley
driving said belt,
said second pulley having an axis of rotation coin- 40
cident with the pivotal axis of said lever.
43. In a machine for processing at least one continuous

web provided with register marks at spaced locations
therealong:
guide means defining a feeding path for the web ex-
tending from a source thereof through a station of
the machine where the web is to be in accurate
register,
continuously operative means for driving the web
through said path,
variable speed drive means engaging a portion of the
web in said path for controlling the speed of move-
ment of the web along said path,
web displacing means movable to vary the length of
the portion of said path between said variable feed
drive means and said station and thereby cause dis-
placement of the web along said path,
driven means operative to generate control signals at
a frequency proportional to its speed,
power supply means for driving in synchronism said
web driving means, said variable speed drive means,
and said signal generating means,
means for generating web signals in response to the
passage of said register marks past a predetermined
point in said path,
and control means for sensing the relationship in time
between occurrences of said web signals and of said
control signals and operative upon variations of said
relationship, corresponding to deviations of positions
of said register marks relative to said point, to vary
the speed of said variable speed drive means and
simultaneously move said web displacing means in
the sense to correct any substantial error of registra-
tion.

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