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[56]

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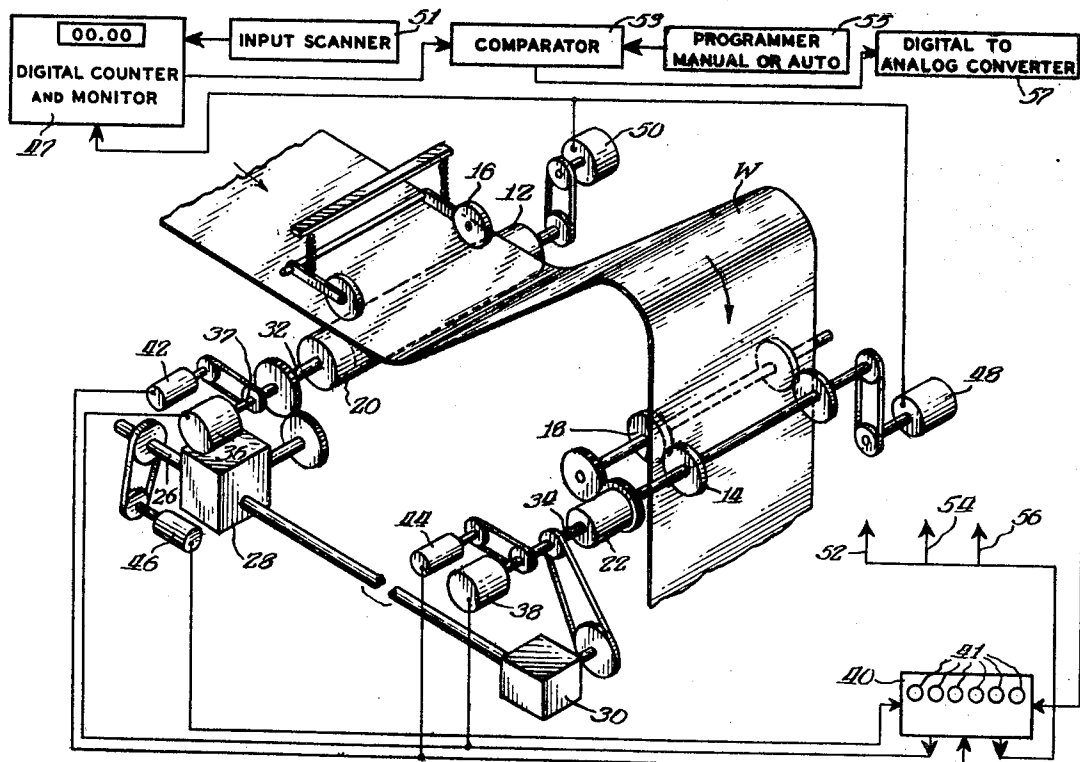
[54] WEB CONTROL SYSTEM 5 Claims, 2 Drawing Figs.

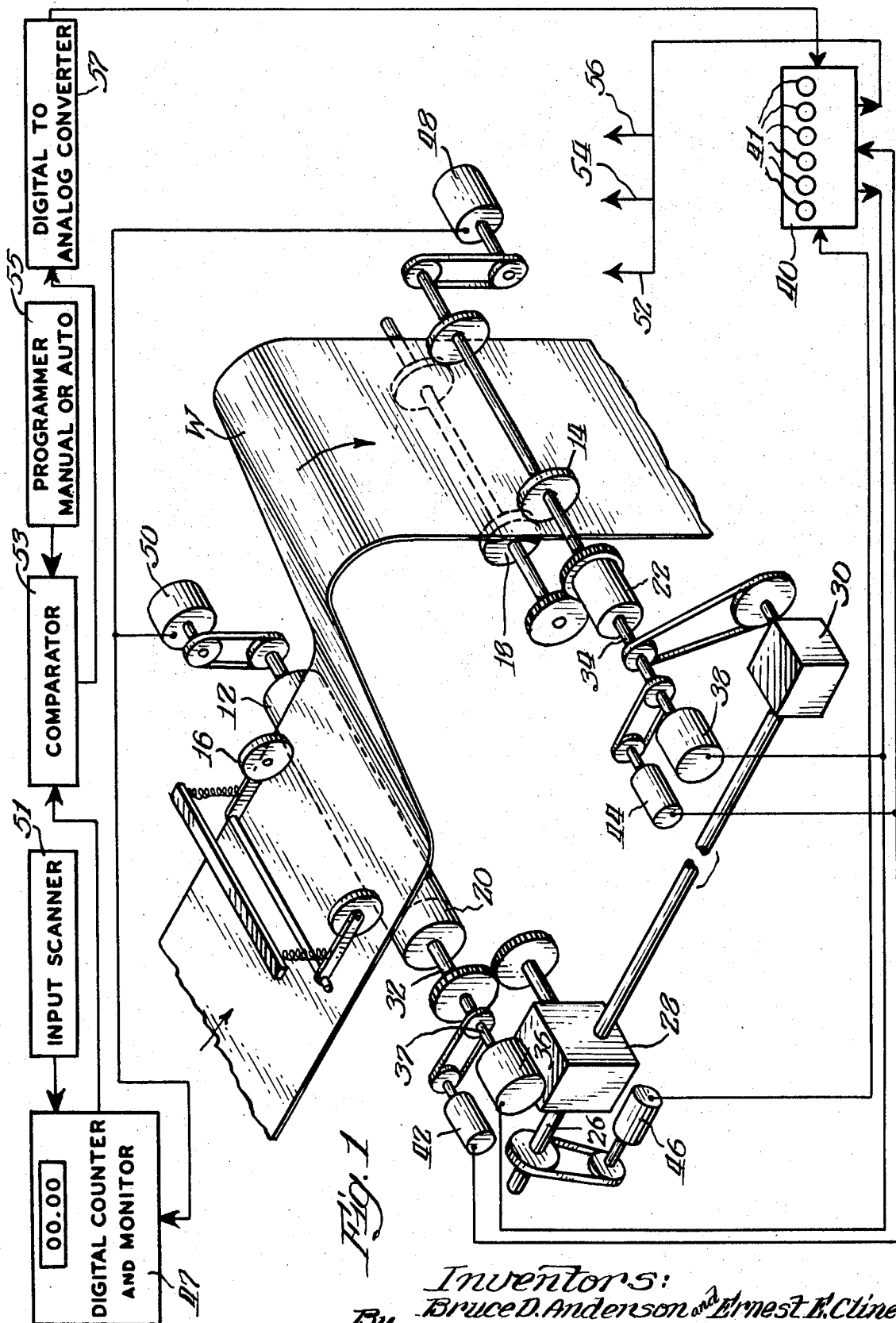
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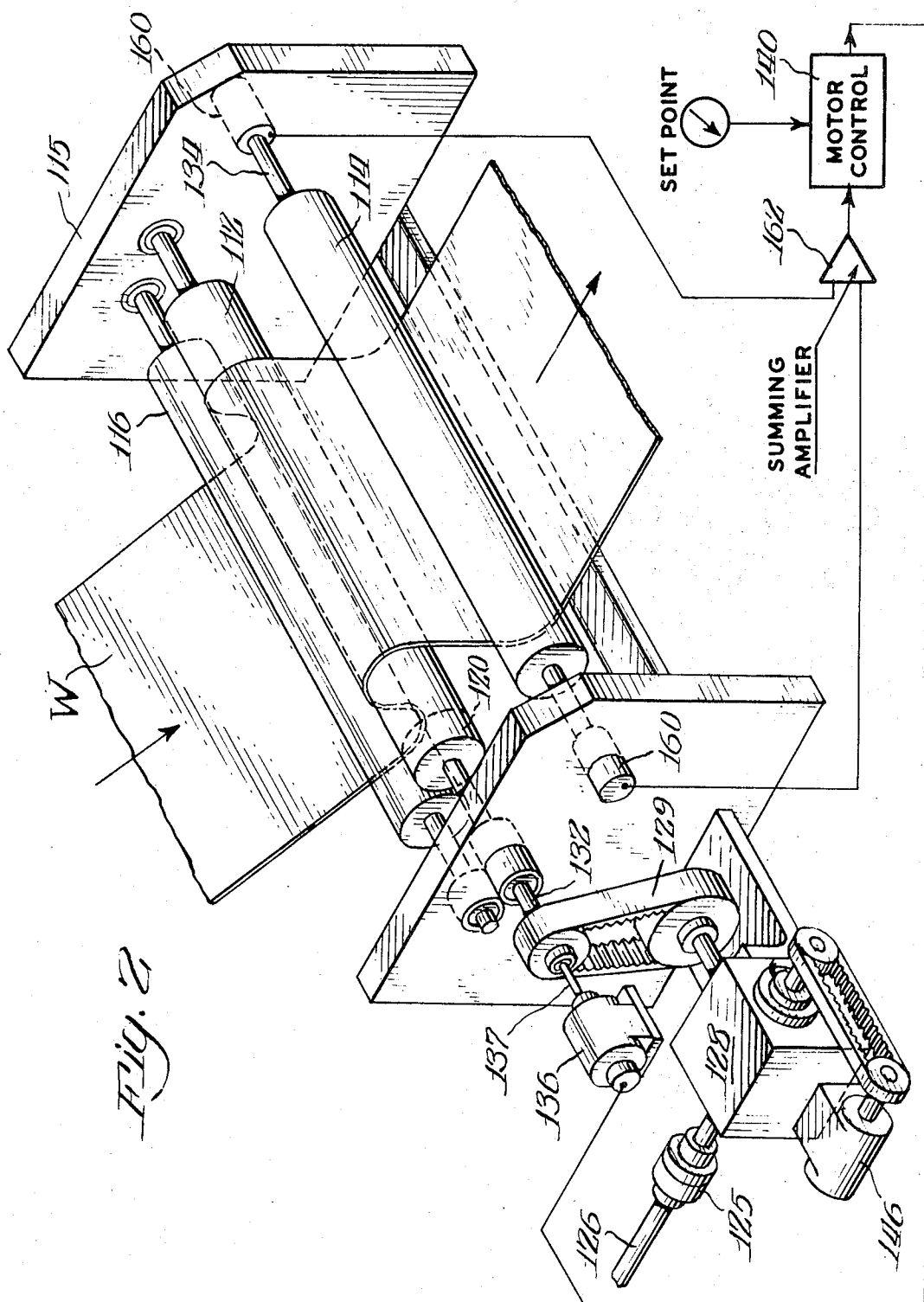
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ABSTRACT: A web control system for accurately controlling the high-speed movement of a web in a printing press or like device. The web passes over a driven control roller which is connected with a differential harmonic drive means. A variable speed drive operatively connected to the differential harmonic drive means precisely controls the speed of the control roller. The variable speed drive is operated by a control means responsive to a feedback tachometer operatively coupled to the variable speed drive.







In witness whereof:
Bruce D. Anderson
and Ernest E. Cline
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WEB CONTROL SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a web processing machine and, more particularly, to an improved control system for such machine.

One form of web processing machine to which the present invention may be applied is a high-speed web printing press. In a web printing press, it is essential that the tension on the web be carefully controlled at a number of places in the press, for example, at the feeding of the web into the press, at the blanket cylinder, at the chill rolls, and at the folder.

Different types of systems have been employed to control web tension. One arrangement utilized driven rollers whose diameters were sized in order to give a percentage over or under line speed. Another system used mechanical variable speed drives to change the ratio of overspeeds or underspeeds. Still another system employed electrical motors in electronic speed-controlled drive systems to give desired control.

These previous systems had disadvantages that became more apparent as the web processing machines became more complex and as operating speeds increased. The fixed diameter-driven rollers cannot be readily changed to accommodate different ratios of overspeed or underspeed required for different materials being processed. The mechanical variable speed drives do not have sufficiently high accuracy line load regulation to be useable in a variety of situations. Those mechanical variable speed drives having high accuracy are large, bulky and relatively costly. Electronic controls in the range of accuracy suitable for web processing machines become extremely costly when compared to the prior systems referred to above.

Thus, an object of the present invention is to provide an improved web control system for accurately controlling web movement in response to a predetermined web condition that is relatively small and is less costly than comparable accuracy systems. Other objects and advantages of the present invention will be made more apparent hereinafter.

BRIEF DESCRIPTION OF THE DRAWING

Presently preferred forms of the present invention are shown in the attached drawing in which:

FIG. 1 is a schematic view of a web control system embodying principles of the present invention; and

FIG. 2 is a schematic view of a modified web control system embodying principles of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown a web control system embodying the present invention. As was pointed out above, there are a number of difficult areas within a web printing press where the speed of the moving web must be closely controlled. These areas include the infeed unit, the blanket cylinder, the chill rolls, the roller stand, the nip rollers for the folder and the stacker.

FIG. 1 of the drawing illustrates the present invention as applied to the folder area of a printing press installation which occurs just before the severing of the web by cutting cylinders. As shown, the web W passes over driven control rollers 12 and 14 and is held in engagement with the driven rollers 12 and 14 by means of the "nips" or nipping rollers 16, 18. The nipping rollers are, in general, narrow width rollers on the orders of one-half inch to three-eighths inch. Nipping rollers 16, 18 are spring-biased, or otherwise urged against the web W to grip the web securely between the nipping rollers and the drive rollers 12, 14. If desired, a nipping roller may cooperate with a roller, such as 12, to provide a S-wrap of the web. See FIG. 2, for example. If the proper feed rate is not maintained, the web will be cut out of register. In actual practice, the nipping rollers 16, 18 must be changed frequently to ones having a different diameter in order to maintain control. If control is not proper and the nipping rollers do not adequately bear upon the web, then the web will slip. Furthermore, during extended

use, the nipping rollers, which are commonly made of steel, must be changed due to the formation of flat spots on the exterior surfaces of the nipping rollers. Repair and replacement of the nipping rollers is expensive when considering both the actual expense of replacement and the downtime of the printing press.

In accordance with the present invention, a differential harmonic drive is provided in the end of each driven roller 12 and 14. The differential harmonic drives 20 and 22 are preferably of the type disclosed and claimed in the copending U.S. Pat. application of Ernest E. Cline, Ser. No. 710,769, filed Mar. 6, 1968, and assigned to the same assignee as the present application. The differential drive means 20 and 22 are harmonic drive means which incorporate a flexible spline member enclosing a wave generator and which is surrounded by a rigid circular spline member. The splines of the two spline members engage each other and the circular spline member is located within and directly engages with the associated roller 12 and 14, respectively. Each harmonic differential drive means 20, 22 is operatively connected to the press drive shaft 26 through gearboxes 28, 30, respectively, suitably connected to the shafts 32, 34 of driven rollers 12, 14. The flexible spline member within the harmonic differential drive means is rotated at a constant predetermined speed. The flexible spline member in turn drives the circular spline member and the roller 12 or 14 at a normally constant predetermined speed. The speed of the roller 12, 14 is varied by driving the variable speed motor or wave generator 36, 38 that is connected with each harmonic differential drive means through a variable speed adjustment shaft 37 at selectively variable speeds. The rotational speeds of the variable drive motor means 36, 38 generates a signal which is fed back to a control panel 40 from separate feedback means or feedback tachometers 42, 44 operatively connected to each of the roller speed drive means 36, 38. A reference tachometer 46 is shown associated with press drive shaft 26 for returning an input signal to the control means 40.

The control means 40 may be a separate control panel or may be part of the amplifier control center in the web press console. Included in the control means 40 are ratio controls 41 for presetting a predetermined ratio of speed or rate of speed between the respective rollers 12 and 14 (or between selected other driven shafts in the installation) to maintain a desired web tension on the web exiting from the roller 14. It will be understood that the ratio controls 41 on the control means 40 are suitably electrically connected to each of the variable speed-driven motors 36, 38 for adjusting the speed of such motors.

The present invention provides a variable controlled tension to the web W by precisely controlling the drive to the rollers 12 and 14. By way of example, assume that the roller 14 has a circumference of one foot. At a web speed of 1,000 f.p.m. the shaft 32 of the roller means 12 would be turning at 1,000 r.p.m. If it is desired to apply a gain of one per cent on the driven roller 12, the ratio control 41 for the variable speed-driven motor 36 would be adjusted so that the motor 36 will rotate at 1,800 r.p.m. This gives a differential input of 800 r.p.m. through an 80:1 reduction which increases the roller speed to 1,010 r.p.m., or one per cent over line speed.

If the variable speed input regulator is only plus or minus five per cent, or within a total range of 10 per cent the differential will vary a total of 180 r.p.m. at this speed. Through the 80:1 speed reduction, this amounts to a total of 2.25 r.p.m., on the driven roller 12, or a final reduction of 0.113 per cent plus or minus.

This precision can still be further increased through utilization of a digital counter and monitor. As shown in FIG. 1, a digital counter and monitor 47 may be electrically connected to a digital pulse generator 48 operatively connected to the shaft 34. A similar digital pulse generator 50 may be operatively connected to the driven roller 12. The digital pulse generators 48 and 50 send respective signals to the digital counter and monitor 47. Also, fed to the digital counter and

monitor 47 is a signal from an input scanner 51. The output signal from the digital counter and monitor 47 is fed to a comparator 53 which correlates the information with that supplied from a programmer 55 which may be either manual or automatic. The output signal from the comparator 53 is fed to a digital to analog converter 57 which in turn supplies a signal to the control means 40. It will be noted that a plurality of separate outputs 52, 54, 56 are shown from the control means for supplying power to other variable speed-driven motors in the web printing press or like installation.

As noted in the copending U.S. Pat. application, Ser. No. 710,796 of Ernest E. Cline, now U.S. Pat. No. 3,487,722, the harmonic differential drive means 20, 22 is compact and may be within a conventional driven roller, for example, roller 12 so as to provide a precision controlled driven roller. The cost of the present system utilizing a harmonic differential drive means is relatively low due in part to the fact that a relatively complex piece of equipment can easily be tuned for optimum performance without guesswork and special technical knowledge. The present system can be readily adapted to existing equipment with relatively no change to the framework or to the drive arrangement.

Turning now to FIG. 2, there is illustrated a modified arrangement embodying principles of the present invention. The rollers 112, 114 and 116 are suitably journaled in a framework 115 indicated generally by dotted lines. The web W is trained over the nipping roller 116 and roller 112 with an S-wrap to insure maintenance of web pressure against the roller 112. A harmonic differential drive means 120 is incorporated in an end of the driven infeed roller 112 and such harmonic differential drive means is operatively connected to a variable speed drive DC motor 136. Input power is supplied to the driven roller 112 from the press-driven shaft 126 through gearbox means 128 and belt and pulley means 129, which includes a driven gear on the output from gearbox means 128 and a driven gear on shaft means 132. Shaft 132 is driven at a constant speed. Adjustment of the roller speed is provided by variable speed motor 136 connected to the harmonic differential drive by variable speed adjustment shaft 137 which is concentric with shaft 132. The press drive shaft 126 is connected to gearbox 128 through a drive coupling 125.

The roller 114 is not driven by separate drive means, but, rather, is driven by the web W trained thereover. Secured at each end within the framework 115 and operatively connected to the ends of the shaft 134 for supporting the roller 114 are sensing means or load cell 160 which are responsive to either the tension of the web, or the torque, so as to supply a feedback signal to a summing amplifier 162. Such signal is fed from the sensing amplifier to the motor control 140 where it is correlated with a predetermined set point or set value and the resultant signal is fed from the motor control 140 to the variable speed drive or wave generator 136 to vary the speed of the harmonic differential drive means 120 to thereby precisely control the rotation control roller 112. It is seen that the torque or tension of the web W is fed back by means of sensing means 160 to the motor control 14 so that the rate of movement of the web W is precisely controlled.

There has been provided by the present invention an improved web control system incorporating a harmonic differential drive means that is adapted to be contained inside of

a roller and which may be operated in conjunction with the other control components to precisely control web speed. Included in the web control system is a small variable speed motor which may be either hydraulic, pneumatic, electrical or mechanical and which is coupled to the input shaft to the harmonic differential drive means to vary the speed of the associated driven roller. Because the reduction of the differential input to the roller is 80:1 or more, the torque of the variable speed drive need only be one-eightieth of the torque necessary to drive the roller. The same is true of the accuracy, that is, the accuracy is improved 80 times as compared to a variable speed input system. The present invention may be applied to existing high-speed web printing equipment with no special modification of the framework or drive system.

While we have shown a presently preferred form of the invention, it will be understood that the invention is not limited thereto, since it may be otherwise embodied within the scope of the following claims.

We claim:

1. A web control system comprising a driven control roller over which the web passes, differential harmonic drive means for rotating the control roller, a variable speed drive for controlling the differential harmonic drive means to vary the speed of the control roller, the variable speed drive being responsive to a control means which is operated in response to a predetermined condition of the web, the differential harmonic drive means driving the control roller at a normally constant predetermined speed, and the variable speed drive comprising a wave generator coaxing with the differential harmonic drive means for selectively changing the normally constant predetermined speed of the control roller.

2. A web control system as in claim 1, wherein feedback means are operatively connected to the variable speed drive for sensing the speed of the variable drive means and feeding such information to said control means.

3. A web control system as in claim 2 wherein the feedback means comprises a feedback tachometer coupled to the variable drive means.

4. A web control system comprising a driven control roller over which the web passes, differential harmonic drive means for rotating the control roller, a variable speed drive for controlling the differential harmonic drive means to vary the speed of the control roller, the variable speed drive being responsive to a control means which is operated in response to a predetermined condition of the web, a second control roller spaced from the first control roller, second differential harmonic drive means for rotating the second control roller, a second variable speed drive for controlling the second differential harmonic drive means to vary the speed of the second control roller, the second variable speed drive being responsive to the control means, the control means maintaining a predetermined ratio of speeds between the first and second control rollers.

5. A web control system as in claim 1 including digital pulse generator means associated with each control roller for sensing the speed thereof and generating a pulse and digital control means operatively associated with said control means for increasing the accuracy of the control means in maintaining predetermined conditions of the web.