United States Patent

Pfeiffer

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[54] ELECTRONIC WEB TENSION MEASURING AND CONTROLLING SYSTEM

[72] Inventor: **John David Pfeiffer,** Downingtown, Pa.

[73] Assignee: **Beloit Corporation,** Beloit, Wis.

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[58] **Field of Search**.....242/75.51, 75.5, 75.44, 75.53; 318/6; 73/95.5, 159

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Primary Examiner—George F. Mautz

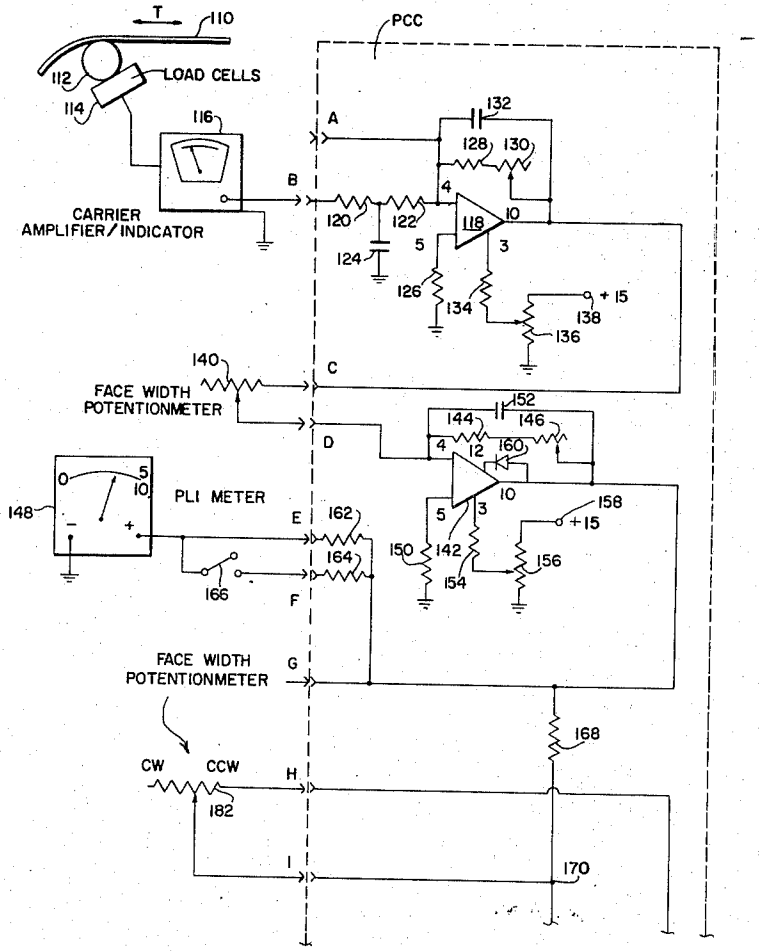
Assistant Examiner—Gregory A. Walters

Attorney—Larson, Taylor & Hinds

[57] **ABSTRACT**

An electronic web tension measuring and controlling system is provided which is stable, fast-responding, and convenient to operate, and which produces an output in meaningful units, the system displaying the actual operating web tension directly in units of pounds per lineal inch (p.l.i.). The actual p.l.i. signal is compared with a set point tension signal dialed in by the operator in p.l.i. units. Any error signal produced is multiplied by a signal proportional to the face width of the web so that a "pounds" error signal is produced. Brake operating time is minimized by utilizing an E/P converter located at the brake.

16 Claims, 2 Drawing Figures



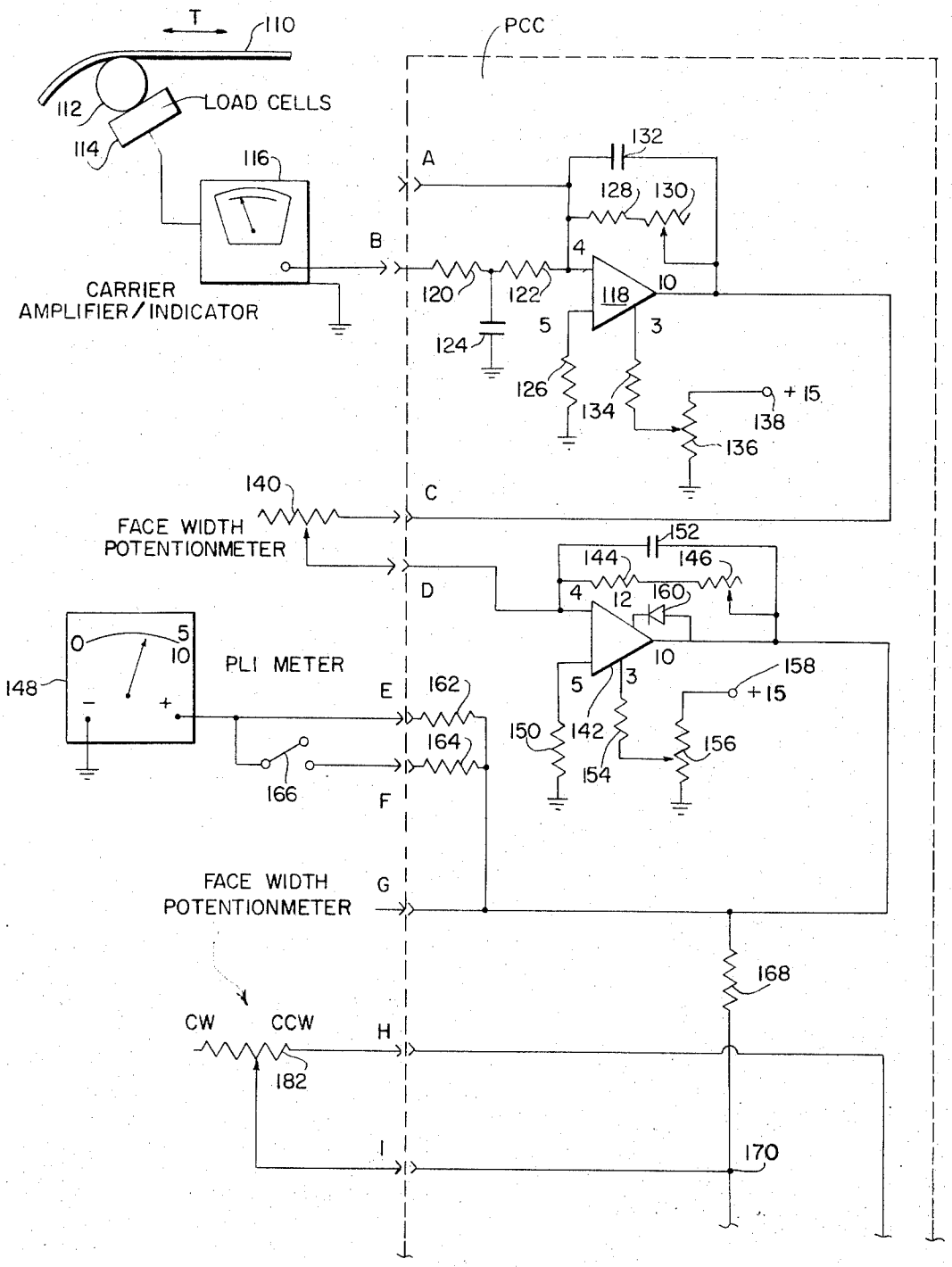


FIG. 1A

INVENTOR
JOHN DAVID PFEIFFER

BY Larson and Taylor
ATTORNEYS

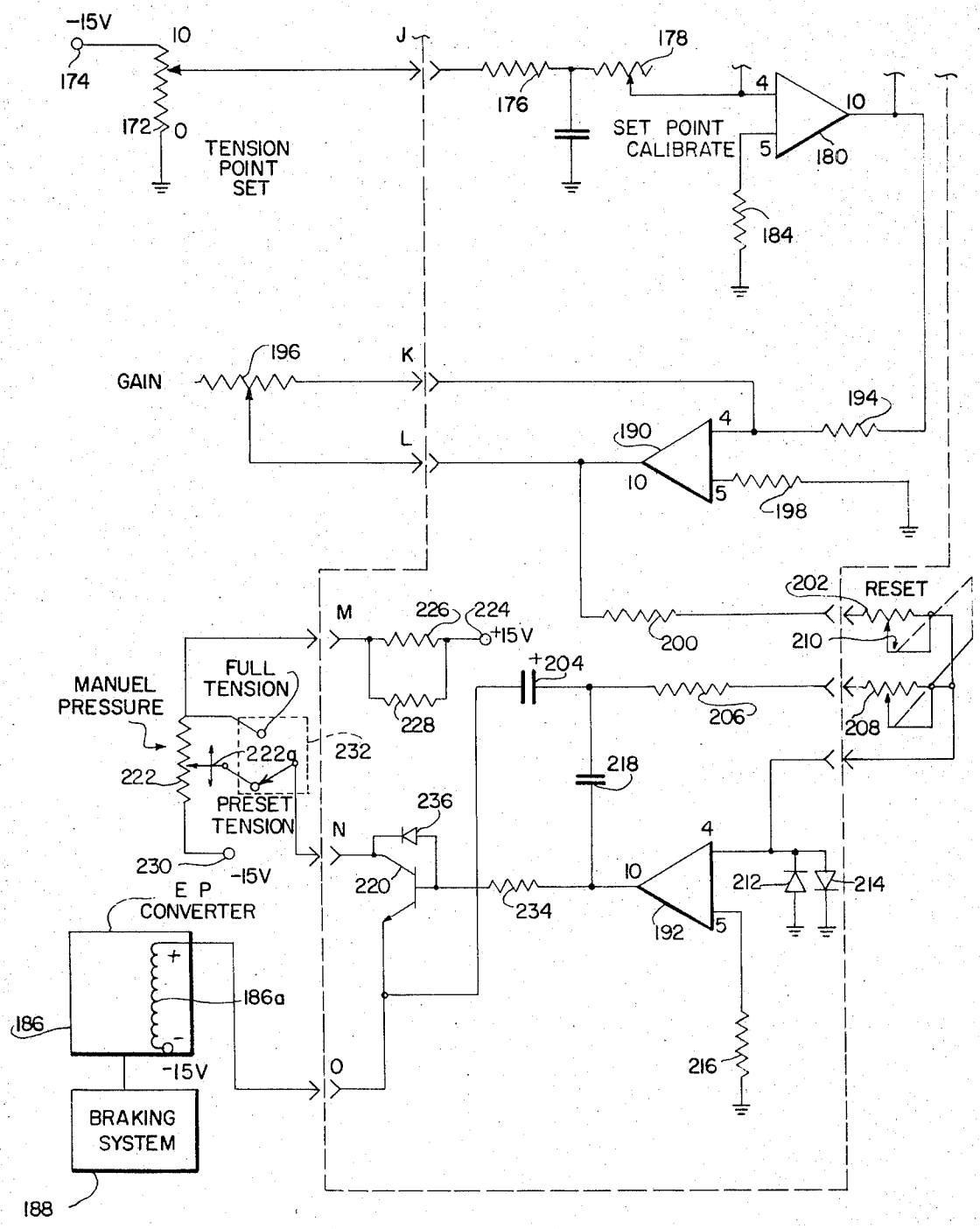


FIG. 1B

INVENTOR
JOHN DAVID PFEIFFER

BY Larson and Taylor
ATTORNEYS

ELECTRONIC WEB TENSION MEASURING AND CONTROLLING SYSTEM

FIELD OF THE INVENTION

The present invention relates to web tension measuring and control systems particularly as used to control the web tension in a two drum winder or bi-wind machines.

BACKGROUND OF THE INVENTION

In machines such as two drum winders, sheeters and the like, it is necessary to closely control the tension in the web span as the web travels between the unwinding roll and the winding station at which the building or rewinding roll contacts the winder roll. A number of systems have been provided for measuring and controlling the web tension. In general, these systems suffer from various disadvantages particularly regarding reliability, response time and the type of output provided. However, it is thought that, rather than specifically discuss the shortcomings of the prior art systems, the advantages of the system of the invention and the deficiencies of the prior art systems can be best appreciated from a consideration of the various features of the system of the invention.

SUMMARY OF THE INVENTION

In general, in accordance with the present invention an electronic web tension measuring and controlling system is provided which overcomes the disadvantages of prior art systems as well as provides a number of important new features and advantages.

In accordance with one feature of the invention, the actual or present web tension is displayed directly in units of force per unit width of the web such as pounds per lineal inch (p.l.i.). These units are directly related to the straining or elongation of the web material and hence the use of these units is desirable in considering the tension effects on the traveling web. A set point adjustment which is used to control the web tension is also calibrated in force per unit width or, more specifically, p.l.i., these units being the most realistic to an operator.

In accordance with a further feature of the invention, the control device for the tensioning or braking system which may, for example, be a conventional electrical to pressure (E/P) converter, is made responsive to a total pounds error signal rather than a p.l.i. signal so that the total system gain is stable.

A "proportional plus reset" control for the tensioning system is also provided which continually adds correction responsive to a persisting error signal so that long term errors are eliminated. This control includes an electronic integrator which provides a substantially higher gain than is furnished by a pneumatic controller so that steady state errors are reduced to negligible values.

The system of the invention also permits an operator to select a preset amount of unwind brake pressure before winding is begun. To understand this feature, it should be noted that with an ordinary system, the brakes will be at full pressure when an attempt is made to apply a specific tension before winding starts because the web is not moving. Thus, some time, perhaps 10 seconds, will be required to bring the brakes down from full pressure as winding begins. By selecting a preset amount of brake pressure, 5 or 10 pounds for example, the delay discussed above is eliminated. A series of push-button switches are preferably provided at a number of locations or stations so that the brake pressure limit may be applied or removed at these stations independently.

The system also permits information regarding the width of the web to be dialed in directly by the operator through a digital turns-counting dial so that the operator can set the width exactly without referring to conversion charts or without interpolating between scale divisions.

In accordance with yet another feature of the invention, the system enables automatic programming of the tension in accordance with a predetermined pattern, commonly called "-taper tension," by merely feeding an electrical signal into the system having the desired pattern as a function of time.

A number of other advantages are provided by the use of electrical signals, rather than conventional air pressure signals transmitted through tubing, particularly regarding response time, space requirements, cost and maintenance. Further, the conversion from electrical signals to pneumatic pressure for operating the braking device can be effected at the braking device itself so that only very short pressure connections are required. The system also utilizes integrated circuit operational amplifiers with ceramic encapsulation which assure operation reliability, stability of the settings and eliminate amplifier drift. It has been found that once the system is set up and calibrated, recalibration is not required for well in excess of 6 months.

Other features and advantages of the invention will be set forth in or apparent from the detailed description of a preferred embodiment thereof found hereinbelow.

BRIEF DESCRIPTION OF THE DRAWINGS

The single figure in the drawings formed by joining FIGS. 1A and 1B is a schematic circuit diagram of a web tension measuring and controlling system in accordance with a presently preferred embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the single, composite figure formed by Figures 1A and 1B, a presently preferred embodiment of a tension measuring and controlling apparatus is shown. The system under consideration is a two drum or bi-wind system and includes a web **110** which is shown passing over a drum **112**. A series of strain gauge load cells denoted **114** are used to provide an electrical output in accordance with the tension on web **110**. The actual number of cells **114** used is a matter of design although the use of at least two cells is preferred so the tension across the entire web can be measured. It often occurs that where the web is stretched out the tension at one edge of the web may be high and the tension at the other edge may be low; so that a single gauge sensing the tension at either edge would provide an erroneous indication of the effective tension. To avoid this, the tension reaction at several load points on the roll is averaged together by connecting the load cells in parallel so that an indication of the total web tension is provided. It will be appreciated that systems using hydraulic or air pressure controllers require the use of a totalizer device to produce the same effect as is produced by merely connecting the load cells in parallel.

Load cells **114** are energized by the carrier frequency of a standard carrier amplifier/indicator **116**. Amplifier/indicator **116** may comprise a Hewlett-Packard model **311A** amplifier/indicator which provides a 2,400-cycle carrier frequency of 5-volt amplitude. The use of a carrier signal avoids signal drift due to thermoelectric effects and prevents the pick-up of 60-cycle hum. Although the load cell/transducer combination discussed above is preferred, particularly from a standpoint of ease of totalizing the tension effects, other suitable load cell/transducer combinations may be used.

Amplifier/indicator **116**, is connected to terminal B of a printed circuit card PCC and from terminal B to one input of an operational amplifier **118** through 4.7K resistor **120**, a 6.8K resistor **122** and a 2-microfarad capacitor **124**. It will be appreciated that although specific component values are given these values are merely illustrative, the use of specific values, as will be seen hereinbelow, being helpful in explaining the operation of the particular embodiment under consideration. It is noted that terminal A which is shown as open may be used in connecting further load cell/transducer combinations to operational amplifier **118** where the use of a greater number of load cells is required or desired.

For a nominal system having a web width of 100 inches or less and 10 p.l.i. (pounds per lineal inch) maximum full scale

range amplifier/indicator **116** is set to provide a 3.0-volt output for a 1,000-pound web tension. It is noted that width multipliers and full scale tension multipliers may be supplied so that a large number of web grades and machine widths can be accommodated by the system.

Operational amplifier **118**, similarly to the further operational amplifiers described hereinbelow, preferably comprises a ceramic encapsulated 14-pin dual in-line package. The system power supply provides terminal voltages of plus 15 volts and minus 15 volts which are supplied to terminal pins **11** and **6**. These connections along with the connection a series combination of a 1.5K resistor and a 4,700-picofarad capacitor between pins **12** and **3** used in stabilizing the frequency compensation for large amounts of feedback, and the connection of a 200-picofarad capacitor between output pin **10** and pin **9** for the same purpose, have been eliminated for purposes of clarity. Similar connections are, of course, also provided for the further operational amplifiers described hereinbelow.

As will be appreciated by those skilled in the art amplifier **118** is connected as a summing amplifier whose output voltage is equal to minus the feedback resistance multiplied by the sum of all input voltages divided by the input resistances, input pin **5** being grounded through a resistor **126** and negligible current flowing into pin **4**. The feedback resistance is formed by a fixed 10K resistor **128** and a 50K potentiometer **130**. Thus, where the input resistance to pin **4** is about 11K as set forth above and the input voltage at terminal B is 3 volts, the feedback resistance is set, by varying the setting of potentiometer **130**, to be ten-thirds of the input resistances or about 36.6K, so that a minus 10-volt output is provided with a plus three volt input. A 0.47-microfarad capacitor **132** connected in the feedback path and capacitor **124** mentioned above serve in preventing any frequencies above about 30 Hz. from passing through the system. A zeroing arrangement for nulling out the output of amplifier **118** includes a 470K resistor **134** and a 50K potentiometer **136** connected to a plus 15-volt supply terminal **138**, although it should be noted that this zeroing arrangement is relatively unimportant in that even where no such arrangement is provided the output is in error by only about 10 millivolts.

The output of amplifier **118** is connected through card terminal C to a face width potentiometer **140** the output of which is connected through a card terminal D to a second operational amplifier **142**. Potentiometer **140** serves in controlling the output of amplifier **118** to produce a signal which is proportional to or a function of the web width. More specifically, potentiometer **140** is used to dial in a resistance which is proportional to web width so that an output signal is produced which is proportional to force per unit length or, for the example under consideration, pounds per lineal inch. Thus, considering a system where the width multiplier is **1**, potentiometer **140** may be a ten-turn **50K** potentiometer, with 10 turns = 50K = 100 inches and the counting dial (not shown) graduated in tenths of inches directly, the resistance setting being directly proportional to web width. Potentiometer **140** will, of course, take other forms when different multipliers are used.

The total feedback resistance of operational amplifier **142** which is formed by a fixed 18K resistor **144** and a variable 50K potentiometer **146** is chosen to be 50K so that the output of amplifier **142** is plus ten volts for the full face setting of potentiometer **140**. It will be appreciated that as the width setting is reduced by varying the setting of the potentiometer slide, the output of amplifier **2** will increase in proportional to 1/width, the resistance of potentiometer **140** being, as stated, directly proportional to width. Thus, by connecting a suitable meter **148** to the output of amplifier **142** a direct indication of the actual tension in p.l.i. can be provided.

Input pin **5** of amplifier **142** is grounded through an 18K resistor **150** whereas a 0.0068-microfarad capacitor **152** is connected in the feedback path of amplifier **142** to prevent high frequency oscillations which might arise because of the capacity to ground of the shielded connecting cable. A nulling arrangement, similar to that described above and including a 470K resistor **154** and a potentiometer **156** connected to a plus fifteen volt supply terminal **158**, is also provided. A diode **160** connected between pins **10** and **12** is used to prevent possible "latch-up" or saturation of the operational amplifier **142** caused by large signal received over the connecting wires from face width potentiometer **140**.

Meter **148** is designed to read full scale on the high range scale for a plus ten volt output from amplifier **142**. Meter **148** is connected to amplifier **142** through card terminal E and a first 100K resistor **162** and through a second parallel-connected 100K resistor **164** connected in series with a range switch **166**. Range switch **166** in the first, open position thereof provides high range zero to 10 p.l.i. full scale readings and in the second position thereof provides a half scale zero to 5 p.l.i. reading, the current through the meter being doubled with switch **166** in the second position.

An output voltage directly proportional to p.l.i. can be taken off at card terminal G. This voltage may be used in a number of ways in supervisory control and may be read off at a remote location to provide an indication as to whether the winder operator is using the proper web tension or may be fed into a recorder as part of a further system to provide an indication of the rolls per day produced by an operator.

The output of amplifier **142** is also used in providing control of the web tension, this output being compared with a desired or "set point" tension. The output of amplifier **142** connected through a 10K resistor **168** to a summing point **170** at which the actual p.l.i. signal produced by amplifier **142** is compared with a desired or tension set point signal produced by a set point potentiometer **172**. One input terminal of potentiometer **172** is connected to a minus 15-volt supply terminal **174** whereas the output thereof is connected to summing point **170** through card terminal J and a 15K resistance formed by a fixed 6.8K resistor **176** and a 10K set point calibration potentiometer **178** set at 8.2K. Set point potentiometer **172** includes a zero-to-10 p.l.i. scale and, for a 10 p.l.i. setting, will produce a minus 1-milliampere current at summing point **170**. It will be appreciated that the full scale 10-volt output of amplifier **142** will be reflected in a plus 1-milliampere current at summing point **170** so that there will be no net current flow out of point **170**. It will, of course, be understood that the resultant or net current will be zero for any instance where the equal and opposite currents flow into point **170** thus indicating that the actual p.l.i. is equal to the set point p.l.i., irrespective of whether full scale currents are involved.

One input of a third operational amplifier **180**, specifically pin **4**, is connected to summing point **170** whereas the feedback resistance of amplifier **180** is formed by a further face width potentiometer **182** (a further section of the face width potentiometer **140** described hereinabove). Hence the feedback resistance, which is proportional to width, multiplied by the error signal at point **170**, which is proportional to p.l.i., produces an output in total pounds error, this multiplication being performed, of course, by amplifier **180** which is connected as a summing amplifier. As discussed hereinabove the use of an error signal proportional to pounds rather than p.l.i. provides increased stability. The output of face width potentiometer **182** is connected through card terminal I to summing point **170**, the output of amplifier **180** being connected through card terminal H to the fixed terminal end thereof.

In addition to the common connections shared by all of the operational amplifiers, a 5.6K resistor **184** connects pin **5** of amplifier **180** to ground. A 5-microfarad capacitor **186** connects a point on the junction between resistors **176** and **178** to ground.

Considering the operation of amplifier **180**, an actual tension signal which is, for example, too low by one-tenth milliampere will produce a plus 5-volt error signal at the output of amplifier **180** for a full scale feedback resistance of 50K, the output voltage being equal to the minus the net current multiplied by the feedback resistance. Similarly, with a half width setting a 2.5-volt output is produced.

In general, the positive output of amplifier **180** is used to control a standard E/P converter **186***a* which in turn controls the braking system represented by block **188**, this output undergoing two sign inversions during the passage thereof through fourth and fifth operational amplifiers **190** and **192**. The output of amplifier **180** is connected to one input of amplifier **190** through a 22K resistor **194**, the feedback resistance of amplifier **190** being formed by a 100K logarithmic potentiometer **196** connected across pins **4** and **10** of amplifier **190** through card terminals K and L. A logarithmic potentiometer is used because, among other advantages in this application, the output thereof provides a constant percentage correction at every point on the dial. Potentiometer **196** serves in adjusting the mechanical torque gain in braking system **190** and provides operating stability under low stability conditions such as when the web nears running out on the core of the unwinding roll. The other input of amplifier **190** is connected to ground through a 15K resistor **198** whereas the output thereof is connected through a 2.2K resistor **200** and a 100K variable reset resistor **202** to one input of operational amplifier **192**.

Amplifier **192** would provide unity gain, if a 5-microfarad capacitor **204** were not included in the feedback path thereof, in that the feedback resistance formed by a 2.2K fixed resistor **206** and a 100K variable reset resistor **208** is equal to the input resistance provided by resistors **200** and **202** and in that resistor **208** is mechanically ganged with resistor **202** to form a dual potentiometer arrangement generally denoted **210**. Potentiometer **210** is provided with a screwdriver-type adjustment located on the card cage itself and the setting thereof is controlled by a mill supervisor rather than the operator.

Because of the feedback current flowing therein capacitor **204** will charge up and the output voltage of amplifier **192** will rise at a constant rate due to this charging. Hence, in this way, the rate of reset of the tension is controlled. The rate of reset itself is controlled by reset potentiometer **210**, the slope of the change in voltage being determined by the charging current dictated by a particular potentiometer setting. This arrangement produces a reset having a 0.5-second time constant for full adjustment or setting of the reset potentiometer **210**. Thus, for a 1-volt error, another volt of output will be produced for each half second and for a 10-volt error, another ten volts of output will be produced every half second, the slope or rate of rise of the output being 1 volt per half second and 10 volts per half second in the respective examples. The control provided by amplifier **192** and the attendant circuitry was described hereinabove as proportional plus reset control, the "proportional" part of this control being provided by the equal input and feedback resistances. Hence a step input to amplifier **192** will be reflected in a proportional step output followed by a ramp voltage corresponding to the charging of capacitor **204**. It is noted that it has been found in practice that the variable reset potentiometer **210** can be replaced by, for example, two 10K fixed resistors and the gain adjustment used to provide system stability although the reset system discussed adds substantial flexibility.

A pair of oppositely poled diodes **212** and **214** are connected across the input to amplifier **192** to prevent saturation of amplifier **192** should capacitor **204** charge up to the supply voltage. A 10K resistor **216** is used to ground pin **5** of amplifier **192** whereas a 0.01-microfarad capacitor connected in the feedback path of amplifier **192** prevents high frequency transients from occurring in the output of amplifier **192** when an emitter follower discussed hereinabove is non-conducting.

Capacitor **204** is actually driven through a 2N3391A NPN transistor **220** connected in an emitter follower configuration, the negative plate of capacitor **204** being directly connected to the emitter of transistor **220**. The emitter follower arrangement ensures that there is a negligible loss in the voltage signal from pin **10** of amplifier **192**. The emitter of transistor **220** is connected through card terminal O to the input coil **186***a* of E/P converter **186** which in turn controls the braking system **188** in accordance with the output of amplifier **192**.

The supply voltage for transistor **220** is provided by a 5K manual pressure potentiometer **222** one end of which is connected to a plus 15-volt supply terminal **224** through card terminal M and a 2.2K resistor **226** and 5.6K resistor **228** connected in parallel, and the other end of which is connected to a minus 15-volt supply terminal **230**. The collector of transistor **220** is connected through card connector terminal N to a switch **232** which in the first or "preset tension" position thereof connects transistor **220** to the wiper arm **222***a* of potentiometer **222** and in the second or "full tension" position thereof bypasses potentiometer **222**. Thus, if wiper **222***a* of potentiometer **222** is moved toward a minus 15-volt setting, the supply voltage for transistor **220** is removed and the current flowing to E/P converter **186** is thus limited. In this way the pressure output of converter **186** is limited to the value dictated by the voltage on card terminal N.

A 22K resistor **234** connected between the output of amplifier **192** and the base of transistor **220** and a diode **236** connected between the base and collector of transistor **220** prevent excess currents and prohibit the emitter from being driven more positive than the collector.

Manual pressure potentiometer **222** is used to starting winding of the web at a low or limited brake pressure so that rotation of the unwind roll may begin sooner and so that tension is provided as soon as the slack in the web is taken up. As soon as p.l.i. meter **148** begins to provide an indication, wiper arm **222***a* can be turned fully clockwise so as to short out potentiometer **222** and thus permit a full brake pressure swing. Switch **232** in the "full tension" position provides this same effect and avoids the need for varying the setting of potentiometer **222** for each roll set. It is noted that remote control of the pressure setting may be obtained by utilizing push-button switches at various locations or stations about the system. These push-button switches are preferably wired similarly to three-way light switches so that where "preset" tension is called for by an operator at one station, an operator at another station, by throwing the switch to reverse the active wires, can call for the "full" tension condition. A second three-way wiring arrangement is preferably provided to power indicating lamps at the various push-button stations to signal the status of the switches.

It will be appreciated from the foregoing that the system of the invention provides an operator with maximum control over the web tension although only a minimal number of controls have to be attended to by the operator himself. Further, by displaying the operating web tension directly in p.l.i. at meter **148**, located at the operator's bench, the operator is given meaningful units with which to work. Similarly, the fact that the tension set point control provided by potentiometer **172**, also located at the operator's bench, is also calibrated in p.l.i. enables the operator to select a desired working p.l.i. tension without the necessity of resorting to tables or graphs to convert gauge pressures into p.l.i. as is required by conventional systems. As stated hereinabove, the use of error signal proportional to total pounds error, rather than to p.l.i., produced by multiplying the p.l.i. error signal by web width at potentiometer **182**, maintains the stability of the total system gain. The proportional plus reset control provided by reset potentiometer **210**, operational amplifier **192** and attendant circuitry reduces steady state errors to negligible values. As discussed hereinabove, manual pressure potentiometer **222** located at the operator's bench enables the operator to select a predetermined amount of unwind pressure before winding starts and thus eliminates delays found in other systems. Further, switch **232** may be duplicated in push-button form at remote stations located about the system to provide independent control. Potentiometer **140** permits information relative to the width of the web to be dialed in directly through a digital turns-counting dial (not shown) so that the operator can set the width exactly with reference to conversion charts and without interpolating between scale divisions. Finally, automatic programming of the tension by connecting an appropriate input to card terminal pin I. For example, feeding in

a one-tenth milliampere current into pin I will reduce the effective tension set point by one-tenth of the full scale p.l.i., the offset provided being directly proportional to the amount of current supplied.

Although the invention has been described in detail with particular reference to a preferred embodiment thereof, it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

I claim:

1. A web tension control system for controlling the web tension in a traveling web comprising sensing means for sensing the actual tension on the web at a predetermined station during the travel of said web, and for producing a first electrical output signal in accordance with the actual tension, set point control means for producing a second electrical signal proportional to a desired web tension per unit width of the web, said set point control means comprising adjustable means calibrated directly in tension force per unit width of the web means for producing a third signal proportional to actual web tension per unit length of the web comprising adjustable control means for controlling said first signal as a function of the width of said web, means for summing said second signal and said third signal and for producing an error signal in accordance with the difference between said second and third signals, and web tension control means responsive to said error signal for controlling the web tension in accordance therewith.

2. A system as claimed in claim 1 wherein said adjustable control means for producing said third signal comprises potentiometer means directly calibrated in units of web width and wherein said tension set point control means comprises potentiometer means calibrated in units of web tension per unit web width.

3. A system as claimed in claim 1 further comprising means for multiplying said error signal by a factor proportional to the width of the web to produce an error signal proportional to the total web tension error.

4. A system as claimed in claim 3 wherein said multiplying means comprises an operational amplifier connected as a summing amplifier and having variable resistance means connected in the feedback circuit thereof, the setting of said variable resistance means being calibrated in terms of web width.

5. A system as claimed in claim 1 further comprising indicating means responsive to said third signal for providing a visual indication of the actual tension in units of force per unit width.

6. A web tension control system for controlling the tension in a traveling web comprising sensing means for sensing the actual tension on the web at a predetermined station during the travel of said web, and for producing a first electrical output signal in accordance with the actual tension, set point control means for producing a second electrical signal proportional to a desired web tension per unit width of the web, means for producing a third signal comprising adjustable control means for controlling said first signal as a function of the width of said web, means for summing said second signal and said third signal and for producing an error signal in accordance with the difference between said second and third signals, and web tension control means responsive to said error signal for controlling the web tension in accordance therewith, said system further comprising means for providing proportional plus reset control of said error signal, said proportional plus reset control means comprising an operational amplifier connected as a summing amplifier, a first variable resistance device connected in an input circuit of said amplifier a second variable resistance device connected in the feedback circuit of said operational amplifier, means for ganging said variable resistance devices together so that a change in the setting of one of the devices is accompanied by a corresponding change in the setting of the other device and a capacitor connected in the feedback path of said amplifier for controlling the output voltage of said amplifier in accordance with the rate of charging thereof as determined by the setting of said variable resistance devices.

7. A system as claimed in claim 6 further comprising a transistor connected in an emitter-follower configuration with the base electrode thereof connected to the output of said operational amplifier and the emitter electrode connected to one plate of said capacitor and to said web tension control means.

8. A system as claimed in claim 7 further comprising means for controlling the biasing of said transistor to limit the output thereof and to thereby limit the magnitude of the error signal transmitted to said web tension control means.

9. A system as claimed in claim 8 wherein said biasing control means comprises a potentiometer the output of which is connected to the collector electrode of said transistor, the input ends of said potentiometer being respectively connected to positive and negative supply voltage terminals, said system further comprising switching means for controlling the connection of said potentiometer to said transistor, said switching means including at least one switch having a first position wherein the output of said potentiometer is connected to said collector electrode and a second position wherein said potentiometer is bypassed and said collector electrode is directly connected to said positive supply voltage terminal.

10. A system as claimed in claim 9 wherein said switching means comprises a plurality of said switches, said switches being located positions remote from each other to provide independent control.

11. A web tension control system for controlling the tension in a traveling web comprising sensing means for sensing the actual tension on the web at a predetermined station during the travel of said web, and for producing a first electrical output signal in accordance with the actual tension, set point control means for producing a second electrical signal proportional to a desired web tension per unit width of the web, means for producing a third signal comprising adjustable control means for controlling said first signal as a function of the width of said web, means for summing said second signal and said third signal and for producing an error signal in accordance with the difference between said second and third signals, and web tension control means responsive to said error signal for controlling the web tension in accordance therewith, said system further comprising preset means for presetting the amount of tension to be applied by said tension control means before winding of said web is begun, said preset means including a manually-operated override circuit for limiting the amount of tension to be applied by said tension control means so as to enable the operator to select a predetermined amount of unwind tension prior to winding.

12. A system as claimed in claim 11 further comprising an operational amplifier connected to the output of said summing means, said preset means comprising a transistor having the base electrode thereof connected to the output of said operational amplifier and the emitter electrode connected in the feedback path of said operational amplifier and to said web tension control means and means for controlling the biasing of said transistor to limit the output thereof and to thus limit the error signal transmitted to said web tension control means.

13. A system as claimed in claim 11 wherein said override circuit includes a potentiometer and a switch for shorting out the potentiometer so as to permit full tension to be applied by said tension control means.

14. A system as claimed in claim 11 further comprising an operational amplifier connected to the output of said summing means and a capacitor connected in a feedback path of said operational amplifier, said override circuit comprising circuit means, including a potentiometer, for limiting the output of said operational amplifier and for driving said capacitor.

15. A web tension responsive system comprising a web tension measuring means for measuring the tension on a traveling web comprising transducer means for sensing the actual tension on the web at a predetermined station along the travel of said web and for producing an electrical signal in accordance

with the actual tension, operational amplifier means for amplifying said output signal, adjustable control means for controlling said output signal as a function of the width of the web, and indicating means responsive to the output of said control means for producing an output proportional to the tension pressure exerted on the web as a function of the lineal width of said web, said adjustable control means comprising a potentiometer the settings of which are calibrated in units of web width and said operational amplifier means comprising a first operational amplifier connected between the output of said transducer means and the input of said potentiometer and a second operational amplifier connected between the output of said potentiometer and the input of said indicating means, said operational amplifiers being connected as summing amplifiers.

16. A system as claimed in claim **15** further comprising web tension control means comprising tension set point potentiometer means for producing an electrical output signal in accordance with a desired tension, summing means for algebraically summing said desired tension signal and the output signal of said second operational amplifier to produce an error signal and means responsive to said error signal for controlling the web tension.

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