

May 1, 1962

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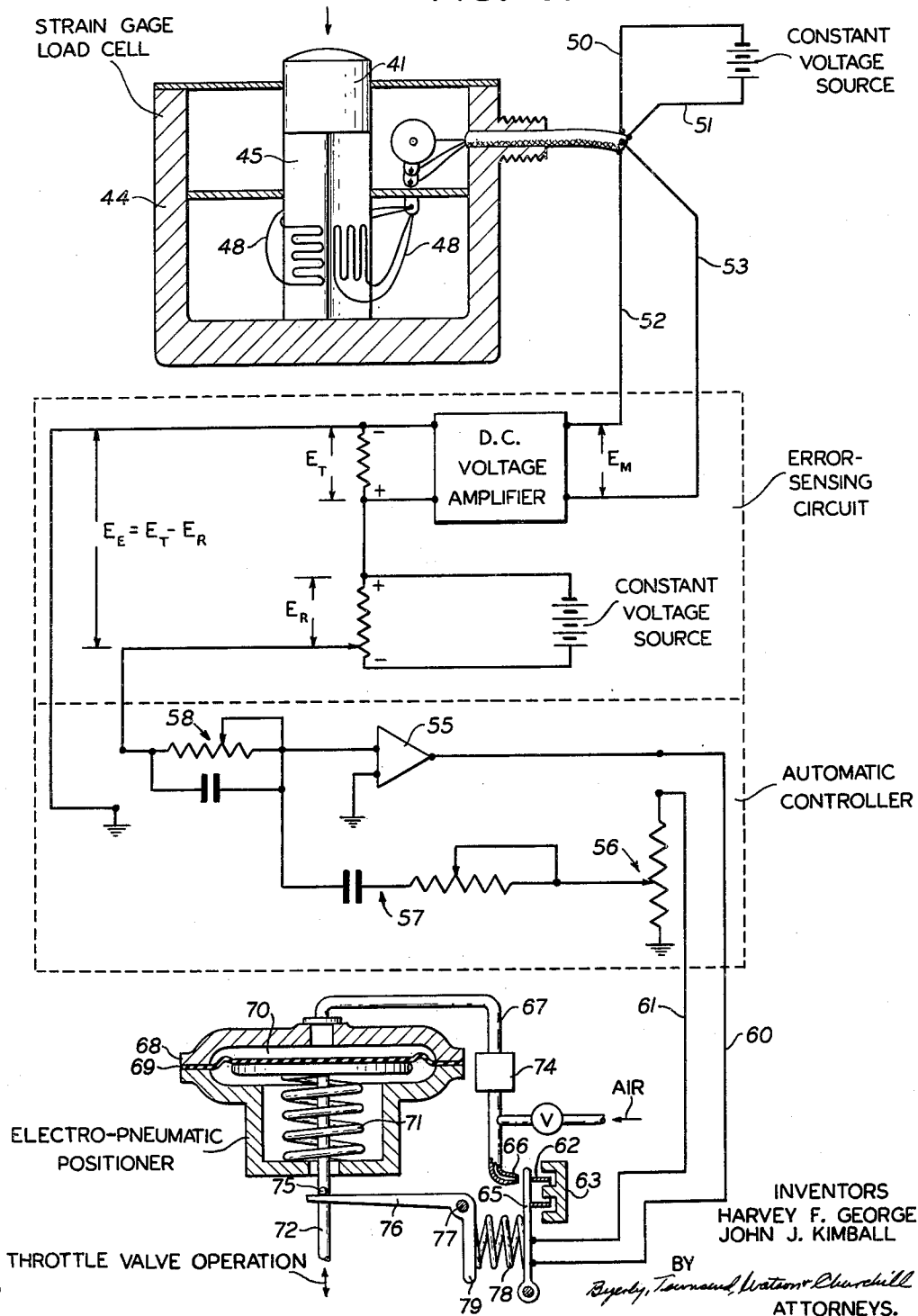
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APPARATUS FOR CONTROLLING WEB TENSION

Filed April 25, 1960

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FIG. 3.



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FIG. 9.

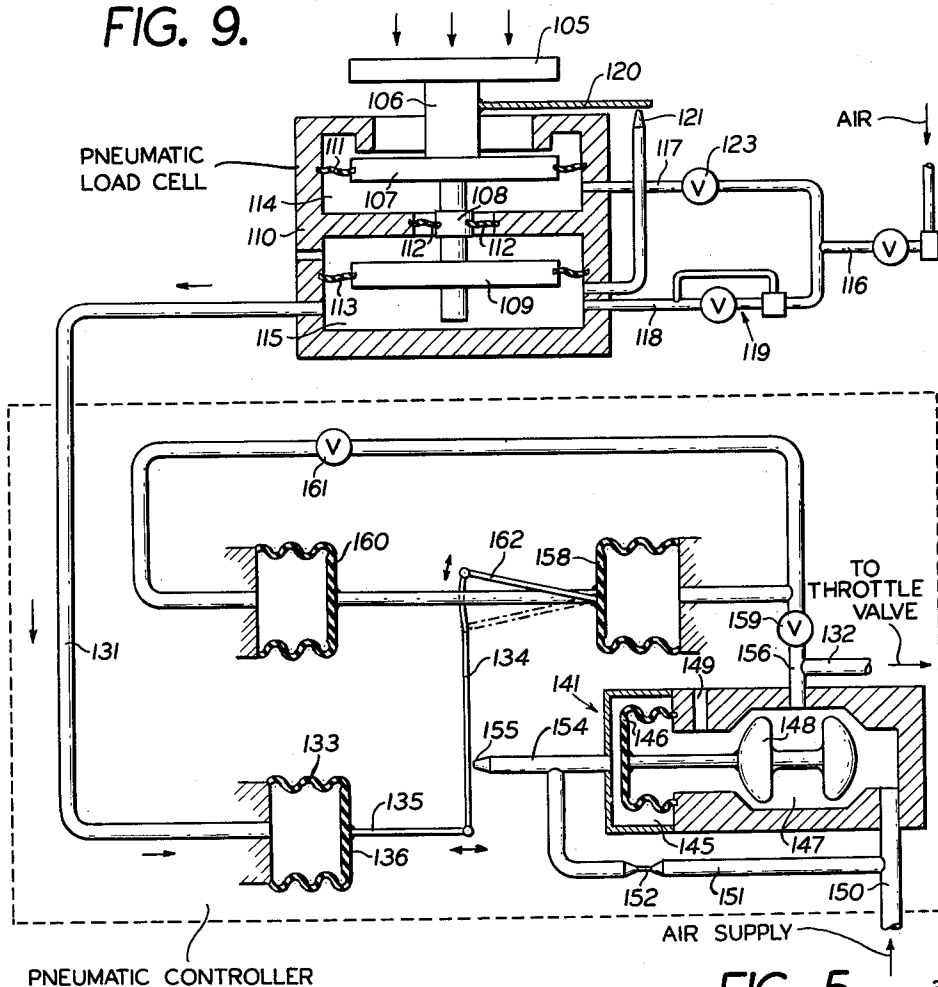


FIG. 4.

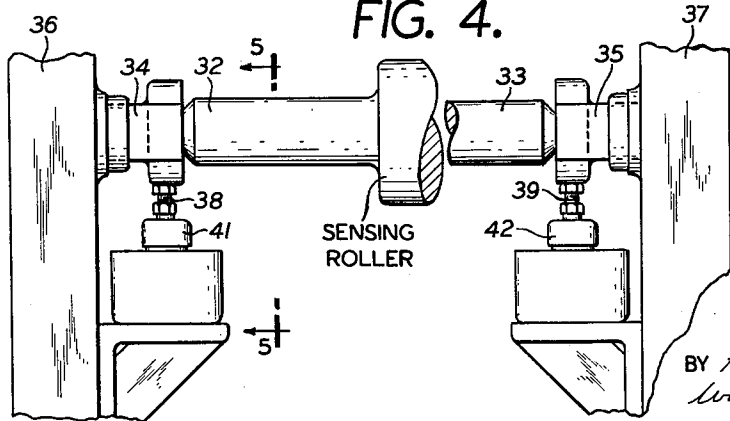
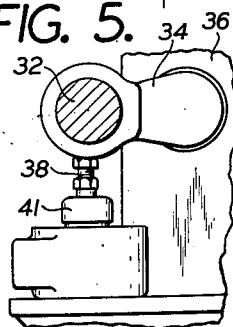


FIG. 5.



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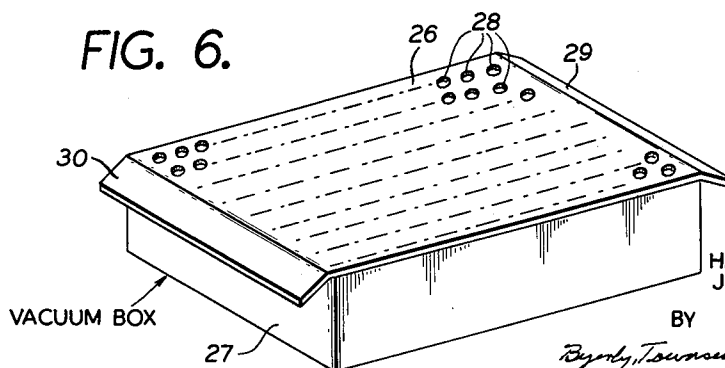
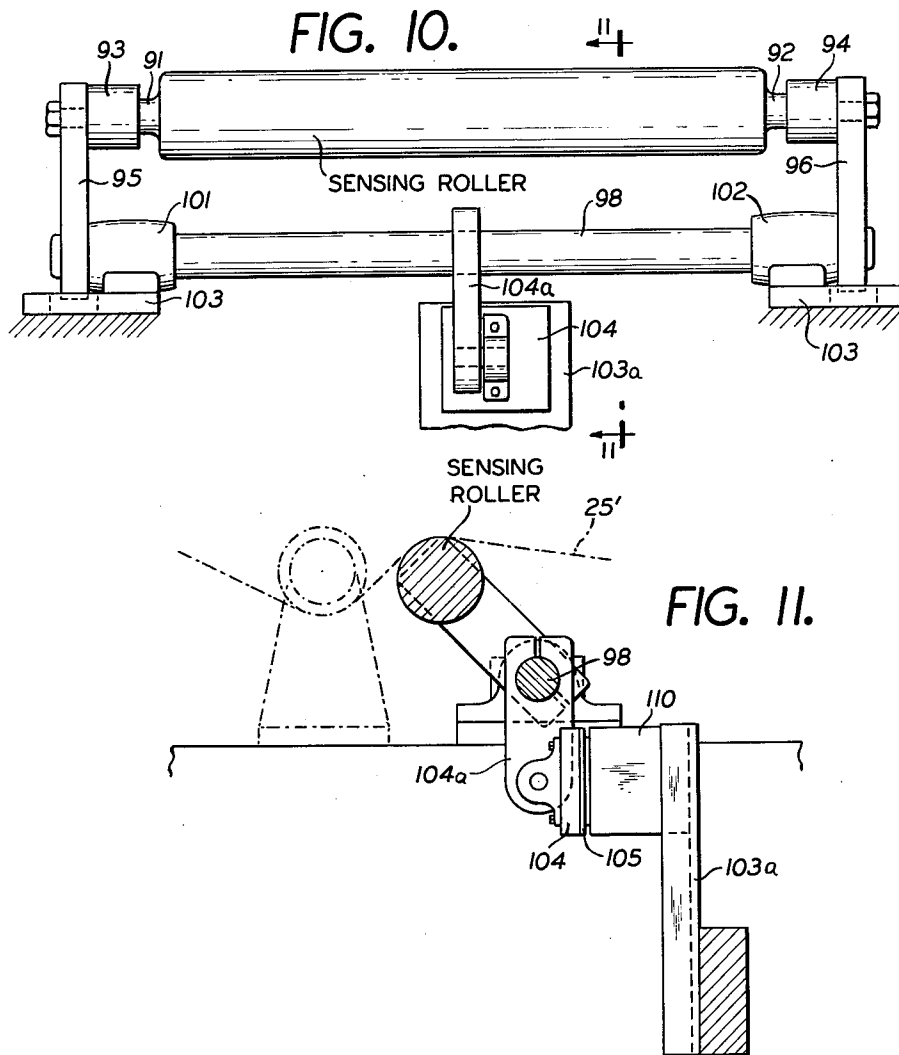
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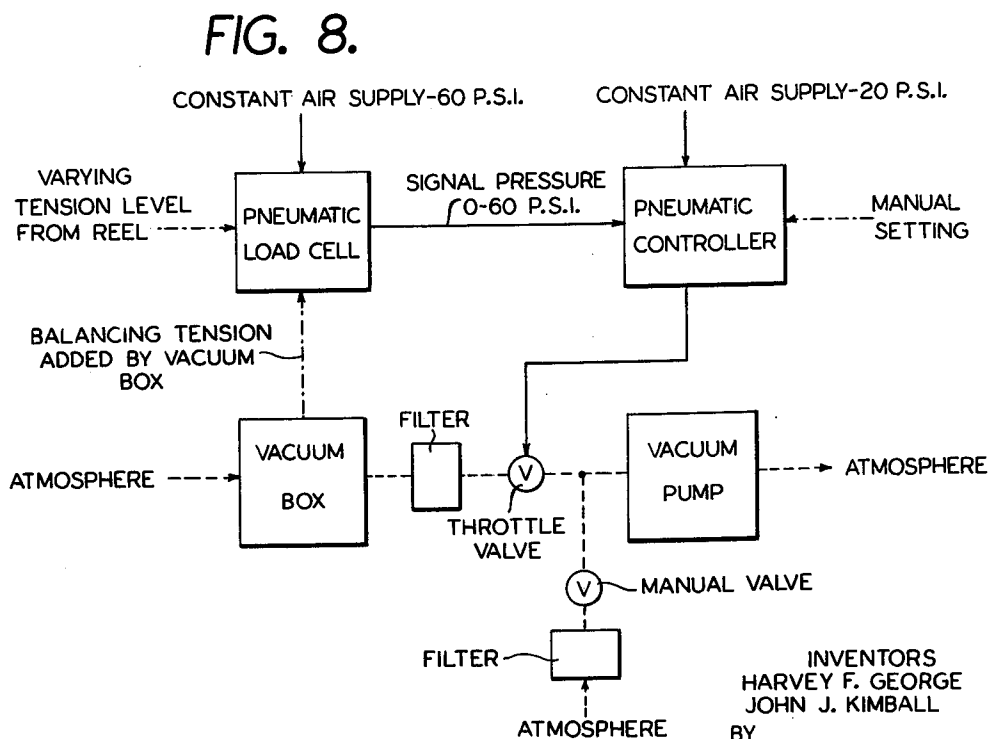
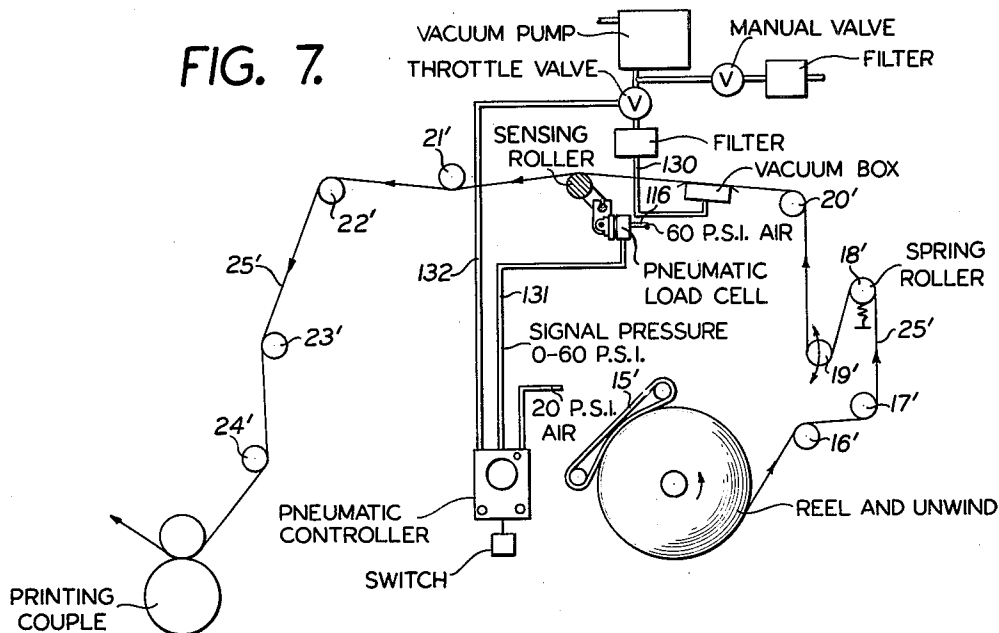
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APPARATUS FOR CONTROLLING WEB TENSION

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5 Sheets-Sheet 5



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3,032,245

APPARATUS FOR CONTROLLING WEB TENSION
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22 Claims. (Cl. 226—39)

This invention relates to machinery for handling material in web form and aims to provide apparatus for correcting variations from a selected level in the tension of a travelling web. While our invention may be practiced with advantage in conjunction with the handling of a variety of flexible materials such as paper, cardboard, plastic film and metal foil, it is a particular feature of our invention that it can be used to suppress variations in the tension of a travelling web of paper on a rotary printing press.

In the operation of a rotary printing press, one of the conditions that must be maintained as nearly uniform as possible, if satisfactory printing is to be achieved, is the tension to which the web of paper is subjected as it travels through the press. Variations in the paper itself or in the treatment which it receives on the press may result in fairly wide fluctuations in the web tension. For instance, variations in web tension caused by flying pasters when a new roll of paper is spliced to the end of the web of an expiring roll of paper at running speeds on multicolor presses used for the printing of magazines may result in colors being so badly out of register that it is commonly necessary to scrap anywhere from several dozen to several hundred of the magazines because they are printed in out of register colors during the flying splice.

Various expedients have been resorted to in the past to attempt to mitigate the difficulties created through variations in the tension of a web travelling through a rotary printing press but they have been far from successful. Apparatus that has been used in the past in an attempt to gain some measure of control over web tension has not only been costly and subject to excessive wear but it has also been possessed of excessive inertia so that the response to the necessity of effecting corrections of tension variations has been too slow.

We have discovered that it is possible to apply a regulable tension to a web as it travels through a rotary printing press by means of a stationary brake whose action is governed through a system of basic control units that are readily available at moderate cost, and wherein there are a very few moving parts which are of such small size that the inertia of the apparatus is negligible and web tension variations are sensed and compensated for as they occur. In accordance with our invention, a transverse vacuum box equipped with a perforated cover plate is located along the path of the paper web so that, as the web travels through a printing press, it slides across that cover plate. Air is evacuated from the vacuum box to maintain sub-atmospheric pressure within the box. The friction between the paper web and the cover plate against which the web is pressed by atmospheric pressure causes the vacuum box to function as a brake for the web, the amount of the braking effect exerted by the web being a function of the difference between the pressure inside the vacuum box and atmospheric pressure.

The rate at which air is evacuated from the vacuum box is regulable so that the braking exerted by the vacuum box can be adjusted to produce a selected net tension upon the web during normal operating conditions. Variations from the selected web tension level are sensed by automatic means that cause a controller to vary the rate at which air is evacuated from the vacuum box. When the web tension sinks below the selected level, the controller causes the rate at which air is evacuated from the

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vacuum box to be increased. When the web tension rises above the selected level, the controller causes the rate at which air is evacuated from the vacuum box to be decreased. In this manner the web tension is immediately restored to the selected level when variations occur therein.

Apparatus embodying our invention in the form which we now prefer is illustrated in the accompanying drawings in which:

FIG. 1 is a diagrammatic view in elevation of one form of the web tension correcting apparatus embodying our invention;

FIG. 2 is a block diagram illustrating the interrelationship of the control units for the web tension correcting apparatus shown in FIG. 1;

FIG. 3 is a circuit diagram of the control apparatus illustrated in FIG. 2 including vertical sections of the strain gage load cells and electropneumatic positioner forming part of such control apparatus;

FIG. 4 is a front elevation, broken away in part, of the sensing roller that actuates the pair of strain gage load cells illustrated in FIG. 3;

FIG. 5 is a section along the lines 5—5 of FIG. 4;

FIG. 6 is an isometric view of a vacuum box;

FIG. 7 is a diagrammatic view in elevation of another form of web tension correcting apparatus embodying our invention;

FIG. 8 is a block diagram illustrating the interrelation of the control units shown in FIG. 7;

FIG. 9 is a vertical section of the pneumatic load cell and pneumatic controller illustrated diagrammatically in FIG. 8;

FIG. 10 is a front elevation of the sensing roller that actuates the pneumatic controller illustrated in FIG. 9; and

FIG. 11 is a section along the lines 11—11 of FIG. 10.

The web tension correcting apparatus illustrated in FIG. 1 is located between the web supply reel and the first printing couple of a rotary printing press. The portion of such a press that is illustrated in FIG. 1 includes, in addition to the printing couple and the supply reel, a belt 15 to govern the speed of the supply reel as it unwinds and rollers 16, 17, 18, 19, 20, 21, 22, 23 and 24, all of conventional construction, across which the web 25 is drawn as it travels from the supply reel to the press. The vacuum box and sensing roller forming part of the web tension correcting apparatus are located between the rollers 20 and 21 and above the plane along which the web 25 contacts those rollers so that the web 25 slides across the upper cover plate 26 of the vacuum box and presses downwardly against the sensing roller.

The vacuum box extends transversely across the path of the web and has a rectangular body 27 whose cover plate 26 is provided with a series of perforations 28. The ends 29, 30 of the cover plate 26 are bent downwardly so they will not interfere with the sliding movement of the web across it. The vacuum box is connected with a vacuum pump through a conduit 31 which contains a throttle valve so that air is evacuated from the vacuum box by the vacuum pump at a rate that is governed by the position of that throttle valve.

The sensing roller has its ends 32, 33 journaled in the outer ends of a pair of arms 34, 35 whose inner ends are pivoted to the side frame members 36, 37 of the press. The outer ends of the arms 34, 35 are connected, through set screws 38, 39, with buttons 41, 42 extending from the tops of the strain gage load cells, as best illustrated in FIGS. 4 and 5, so that the sensing roller is supported in level position. Each strain gage load cell, as illustrated in FIG. 3, includes a housing 44 that contains a high strength steel column 45 that is capped by the button 41. As the web 25 travels past the sensing roller the tension

to which that web is subjected causes it to exert a downward force on the sensing roller placing the column 45 of the strain gage load cells under compression. Such compression will be increased with increases in the tension of web 25 and decreased with decreases in that web tension.

Four strain gages, each of which consists of a continuous length of fine resistance wire 48, are bonded to the surface of the column 45 and they are electrically connected to each other in the form of an initially balanced Wheatstone bridge. A constant voltage circuit, such as an ordinary battery, is connected to the two input terminals of the bridge circuit. The resistance of the wires 48 varies in accordance with changes in the height of column 45 as the compressive force applied to button 41 is increased or decreased. When the strain gages are connected as by means of the line 50, 51 to the constant voltage source, the net output of the two strain gage load cells used in our tension correcting apparatus is a measure of the compressive force applied to the button 41 and varies directly with variations in the tension of web 25. Strain gage load cells that are well adapted for use in the practice of our invention are marketed by Baldwin-Lima-Hamilton Corp. of Waltham, Mass. (see Baldwin-Lima-Hamilton Corp. Bulletin 4355, "SR-4 Load Cells and Load Beams").

Variations in the sum of the output voltages of the two strain gage load cells are utilized to correct the variations in web tension that cause them. To accomplish this the strain gage load cells are connected through the line 52, 53 with an error sensing circuit. Since the voltages (E_M) derived from the strain gage load cells are of the order of millivolts, the lines 52, 53 are connected to the terminals of a direct current voltage amplifier included in the error sensing circuit. The error sensing circuit also includes a constant voltage source which, in combination with a potentiometer, provides an adjustable set point voltage (E_R) that opposes the output voltage (E_T) of the direct current voltage amplifier so that variations in the amplifier voltage (E_T) will produce an error signal (E_E) whose magnitude and polarity are governed by the magnitude and type of change in the voltage (E_T).

That error signal (E_E) is fed to the input of a controller which consists of a servo-amplifier containing a set of three controls, namely, a proportional gain control, a rate control, and a reset time control. Such a servo-amplifier is marketed by Taylor Instrument Companies of Rochester, New York (see Taylor Instrument Companies Catalog 98335 of August 1959). As illustrated diagrammatically in FIG. 3, it includes, an addition to the amplifier 55, a proportional gain control indicated generally at 56, a rate control indicated generally at 57, and a reset control indicated generally at 58.

The output of the controller is utilized to actuate an electro-pneumatic positioner which regulates the throttle valve located in conduit 31 connecting the vacuum box with the vacuum pump. To effect this, the controller is connected through the line 60, 61 with the winding of a coil 62 that is associated with a permanent magnet 63 to provide a voice coil motor. The coil 62 is mounted adjacent the end of a balance beam 65 pivoted at one end so that it may be moved toward or away from nozzle 66 of the conduit 67 that communicates with the interior of the electro-pneumatic positioner. The electro-pneumatic positioner includes a casing 68 that houses a flexible transverse partition 69 forming an expansion chamber 70. The air pressure in expansion chamber 70 is normally balanced by a coil spring 71 located between the lower face of partition 69 and the lower wall of casing 68. The stem 72 of the vacuum pump throttle valve located in conduit 31 is attached to the lower face of the partition 69 and extends from the casing 68 to that throttle valve. Longitudinal movement of this valve stem 72 when the air pressure in expansion chamber 70 is increased moves the throttle valve in conduit 31 toward closed position,

while a decrease in the pressure in expansion chamber 70 causes that throttle valve to be moved toward open position.

The operation of the apparatus that we have described, and which is illustrated in FIGS. 1-6, inclusive, is as follows:

The tension to which a paper web is normally subjected as it travels through a rotary printing press is about one pound per inch of web width. It will be assumed that half of this tension is to be produced by the vacuum box and that the balance of this tension will be produced through the normal operation of other components of the press. The controls are adjusted so that air is evacuated from the vacuum box at a rate that will maintain a pressure therein that will exert a braking effect that is the equivalent to one-half pound per inch of web width. Then, when the amplified load cell voltage (E_T) is 10 volts, the balancing set point voltage (E_R) is also 10 volts.

If the operating conditions of one of the press components were to change so that it would increase the web tension by one-quarter pound per inch, while the vacuum box was producing a web tension of one-half pound per inch, the net web tension would then total one and one-quarter pounds per inch. This would cause the amplified cell voltage (E_T) to increase from 10 volts to 12½ volts. As the set point voltage (E_R) remains at 10 volts, the voltage (E_E) will now be 2½ volts with a positive polarity. If the tension had decreased by one-quarter pound per inch, the voltage (E_E) would be 2½ volts with a negative polarity. The 2½ volt error signal (E_E) is fed to the controller which is now required to emit a signal which will cause the vacuum box tension to be reduced to one-quarter pound per inch so that the total web tension returns to one pound per inch. When this has been done, the voltage (E_T) returns to 10 volts and the error signal voltage returns to 0.

The controller circuit is arranged so that a positive error signal (E_E) will cause the vacuum pump throttle valve to be moved toward closed position while a negative error signal (E_E) will cause that valve to be moved toward open position and the proportional gain control 56 is adjusted so that the correct amount of valve movement will be effected. When there is a rapid and substantial change in the web tension because of a change in operating conditions, a proportional initial change in control output voltage would result in an undesirably slow realization of the desired web tension correction. The rate control 57 overcomes this by making it possible for the controller to deliver an initial voltage change that is disproportionately greater than that which would occur in the absence of such a control, which voltage change is then gradually reduced until the desired proportional voltage is reached. This rate control 57 is made adjustable in order that it may be readily accommodated to the characteristics of the particular system in which it is installed.

It is desired that for a change in press operating conditions the controller should adjust the vacuum tension so as to completely compensate for the change in press operating conditions and maintain constant web tension. The action of the proportional gain control 56 is such that for each value of web tension there is a corresponding throttle valve opening. This relationship between web tension and valve opening is adjustable to suit the characteristics of the particular system and press operating conditions. For each error signal, or deviation of actual web tension from the desired web tension, the valve is moved to a new position proportional to the magnitude of the error signal. If the press operating conditions change from those for which the proportional control is set originally, then it is apparent that when the proportional voltage corresponding to the error signal is reached the control valve will reach a throttle position that will not completely eliminate the web tension error.

The residual web tension error is called offset and is compensated for by the reset control. The reset control continues to change the controller output voltage, hence the valve throttle position, in the same direction as did the proportional control until a new valve position is reached that makes the error signal zero.

When the output voltage of the controller is increased, the voice coil motor is actuated to move balance beam 65 toward the nozzle 66. Such movement increases the back pressure at nozzle 66 to produce, in conjunction with the action of a pilot valve 74, a proportional increase in the pressure in expansion chamber 70. This moves valve stem 72 in a direction to close the throttle valve for the vacuum pump. Such movement is resisted by the coil spring 71 which creates a fixed throttle valve opening for each value of pressure in compression chamber 70.

The valve stem 72 carries a pin 75 that bears against arm 76 of bell crank lever 77. A spring 78 urges arm 79 of the bell crank lever 77 away from the balance beam 65 so that a point is reached when the forces produced by the pressure from nozzle 66 and the feed back spring 78 balance the force exerted by the voice coil motor. Hence, the vacuum pump throttle valve will remain in the position to which it is shifted by virtue of a variation in the web tension so long as the controller output voltage corresponding thereto is applied to the voice coil motor and the mechanism automatically compensates for changes in air supply pressure such as are due to air leakages and the like.

The web tension correcting apparatus illustrated in FIG. 7, like that illustrated in FIG. 1, is located between the web supply reel and the first printing couple of a rotary press which is equipped with belt 15' to govern the speed of the supply reel as it unwinds and rollers 16', 17', 18', 19', 20', 21', 22', 23' and 24', all of conventional construction, across which the web 25' is drawn as it travels from the supply reel to the press. The apparatus illustrated in FIG. 7 also includes a vacuum box and a sensing roller located between the rollers 20' and 21', and above the plane along which the web 25' contacts those rollers so that the web 25' slides across the upper cover plate of the vacuum box, which is also of the construction illustrated in FIG. 6, and presses downwardly against the sensing roller whose ends 91, 92 are journaled in bearings 93, 94 mounted on the upper ends of arms 95, 96. The lower ends of the arms 95, 96 are fixed to a shaft 98 mounted in bearings 101, 102 that are supported by the frame 103 of the press.

The web 25' exerts a downward pressure on the sensing roller that urges it to rotate shaft 98. The extent to which shaft 98 may be rotated through the downward pressure exerted by web 25' on the sensing roller and the direction of such rotation are a function of the tension to which the web 25' is subjected. Variations in this tension are measured by a pneumatic load cell of known construction which is attached to a support 103a that is carried by the frame of the press.

Such measurements are accomplished by mounting a head 104 on a link 104a fixed to shaft 98 so that the head 104 bears against the loading platform 105 of the pneumatic load cell. The loading platform 105 is mounted on a plunger 106 that is supported by partition members 107, 108 and 109 which are respectively connected to the load cell casing 110 through flexible diaphragms 111, 112 and 113 to provide a tare chamber 114 and a compression chamber 115 in the pneumatic load cell, as best illustrated in FIG. 9. Air is supplied at a constant pressure through the conduit 116 which communicates with tare chamber 114 and compression chamber 115, respectively, through branch conduits 117, 118. A constant differential pressure regulator, indicated generally at 119, maintains a constant flow of air through conduit 118 to compression chamber 115. The plunger 106 supports a flapper 120 that extends outwardly above

the nozzle 121 so that air is permitted to escape from compression chamber 115 through nozzle 121 with a back pressure that is dependent upon the proximity of flapper 120 to that nozzle. The pressure of the air in tare chamber 114 may be regulated through manual valve 123 so that it will counterbalance the force normally exerted on loading platform 105 by the head 104 and the flapper 120 is maintained at a selected distance from nozzle 121 so long as the force exerted on loading platform 105 remains unchanged.

Air is evacuated from the vacuum box through conduit 130 at a rate that is governed by the pneumatically actuated throttle valve located in that conduit. The position of that pneumatically actuated throttle valve is governed by a pneumatic controller (illustrated in FIG. 9) that is located between the pneumatic load cell and the pneumatically actuated throttle valve and which is connected to the pneumatic load cell by conduit 131 and to the pneumatically actuated throttle valve by conduit 132.

The conduit 131 leads from the compression chamber 115 to the bellows 133 in the pneumatic controller. The pneumatic controller also includes a pilot valve, indicated generally at 141, whose action is governed by the position of flapper 134, which is adjustably pivoted at one end to link 135 fixed to the movable end 136 of bellows 133. Pilot valve 141 communicates through the conduit 132 with the pneumatically actuated throttle valve located in the vacuum line 130.

The pilot valve 141 includes an air chamber 145 that surrounds bellows 146 and a valve chamber 147 that contains valve plug 148 which is supported by the movable end of bellows 146. The pilot valve 141 also has an exhaust port 149 leading from chamber 147 and which is closed when the plug 148 is moved from the position shown in FIG. 9 to the left side of chamber 147. Compressed air at fixed pressure is supplied to the chamber 147 through conduit 150 except when plug 148 is positioned at the right side of chamber 147. A bypass 151 containing a restriction 152 communicates with the conduit 154 leading from air chamber 145 to nozzle 155. There are also connected to valve chamber 147 through conduit 156, for a purpose to be explained, a negative feedback bellows 158 and associated adjustable valve 159 and a positive feedback bellows 160 and associated adjustable valve 161. A link 162 that extends from the movable end of negative feedback bellows 158 is adjustably pivoted to flapper 134.

The operation of the apparatus illustrated in FIGS. 7-11 is as follows:

The controls are adjusted so that the tension to which the web is subjected under normal operating conditions is set at a value which will be selected, for purposes of illustration, as one pound per square inch of web width, and it may be assumed that one-half pound thereof is contributed through the braking action of the vacuum box. In this condition the pressure in the tare chamber 114 just balances the force, other than the web tension force, exerted against loading platform 105 by the head 104; the pressure in the chamber 115 balances the web tension force; and the entire system is in balance. If the operating conditions of one of the press components were to change so that it would increase the web tension by one-quarter pound per inch while the vacuum box was producing a web tension of one-half pound per inch, the net web tension would then total one and one-quarter pounds per inch.

A 25% increase in web tension also changes the total force applied to the pneumatic load cell through the pressure of the head 104 against platform 105 by 25%. As a consequence, the platform 105 is displaced bringing the flapper 120 into contact with the nozzle 121 so that air may not escape from that nozzle. This results in an increase in the pressure in compression chamber 115 until it reaches a value that lifts the loading platform 105 and moves flapper 120 away from the nozzle to permit

a small air flow. The increase in pressure in the compression chamber 115 is transmitted through conduit 131 to the bellows 133, expanding the bellows and moving flapper 134 toward nozzle 155. As a consequence, there is an increase in the back pressure at that nozzle accompanied by a change in the pressure differential between chambers 145 and 147, shifting valve plug 148 to a position where the pressure in conduit 132 is proportionately decreased. This decrease in pressure in the conduit 132 causes the pneumatically actuated throttle valve located in vacuum line 130 to be closed by a corresponding amount, thus reducing the rate at which air is evacuated from the vacuum box and effecting a corresponding decrease in the braking effect of that vacuum box. When the force exerted on the pneumatic load cell platform 105 is reduced, the action of the control system is the converse.

In order that the pneumatic control may alter the rate at which air is evacuated from the vacuum box to just the extent necessary to correct a variation in the web tension, the pneumatic controller is provided with a proportional gain control, a rate control and a reset control, each of which is adjustable, and whose functions correspond, respectively, to the functions of the proportional gain control, rate control and reset control included in the electronic system that is contained in the embodiment of our invention which is illustrated in FIGS. 1-6, inclusive, of the drawings:

For each tension change the movable end 136 of bellows 133 is repositioned causing the combination of flapper 134, nozzle 155, negative feedback bellows 158 and pilot valve to produce a pressure change in conduit 132 proportional to the magnitude of the tension change or error. The pressure change in conduit 132 causes the throttle valve to move to a new position also proportional to the magnitude of the error signal.

The proportional gain control is adjusted by changing the point on the flapper 134 at which the link 162 is pivoted thereto. Accordingly, the amplitude of the response of the vacuum pump throttle valve to given changes in the position of the moveable end 136 of bellows 133 can be set at the appropriate value by locating the pivotal connection between link 162 and flapper 134 at the appropriate distance from the upper end of the latter.

Rate control is effected by the extent to which valve 159 is opened since the bellows 158 is adapted to produce a negative feedback. When the pressure in conduit 132 is changed as a result of the action of bellows 133, there is a lag in the rate at which the pressure in negative feedback bellows 158 reaches that level because of the restriction that is provided by the adjustable valve 159. As a result of this lag, the action of negative feedback bellows 158 in moving the upper pivot of flapper 134 is gradual, thereby effecting a delay in the corresponding change in the back pressure at nozzle 155 to the point where the desired proportional pressure in conduit 132 is reached.

When the proportional valve position described above is reached the web tension error will have been eliminated for only one initial load or tension level; at all other tension levels the error or deviation has been reduced but not eliminated. This residual error is called offset and is compensated for by the reset control.

The reset control, which is effected through the positive feedback bellows 160 in conjunction with the adjustable valve 161 is used to reduce the offset error to zero. When the flapper 134 has been repositioned at the stable proportional pressure level through the action of the negative feedback bellows 158 there is a pressure differential across the valve 161 as a result of the restriction provided thereby. As air gradually flows through valve 161 the change in pressure in positive feedback bellows 160 causes the flapper 134 to be moved in a direction to effect the desired change in the output pressure in conduit 132. This change in pressure causes a continuing

change in the valve throttle position, in the same direction as the proportional control action, until a throttle position is reached that will reduce the web tension error to zero.

While the tension control shown in the drawing is located in front of the first printing couple of a rotary press, it will be appreciated that such a control may be combined with a press at other locations, such as the point at which a printed web enters a folder; indeed our tension control may be used with advantage with web handling machinery other than printing presses. Also, it is to be understood that the terms that have been used in describing the illustrative embodiment of our invention that is shown in the accompanying drawings are terms of description and not of limitation and various changes can be made therein without departing from the spirit of our invention as it is defined in the appended claims.

What is claimed is:

1. Apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level; and a controller responsive to said sensing means for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

2. Apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall, a pump adapted to evacuate air from said vacuum box to maintain reduced pressure therein, and a throttle valve located between the vacuum box and the pump for regulating the rate at which air is evacuated from said vacuum box; means for sensing variations from the selected web tension level; a pneumatic positioner for said throttle valve; and a controller responsive to said sensing means adapted to cause said pneumatic positioner to actuate the throttle valve so that the rate at which air is evacuated from the vacuum box is increased when the web tension sinks below the selected level and the rate at which air is evacuated from said vacuum box is decreased when the web tension rises above said selected level to restore the web tension to said level.

3. Apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; a sensing roller mounted along the path of said web for perpendicular movement with respect thereto so that it is caused to move perpendicularly by a change in the tension of said web; and a controller responsive to perpendicular movement by said sensing roller for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

4. Apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing

variations from the selected web tension level; and a controller provided with an adjustable proportional gain control and responsive to said sensing means for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

5. Apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level; and a controller provided with an adjustable rate control and responsive to said sensing means for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

6. Apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level; and a controller provided with an adjustable reset control and responsive to said sensing means for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

7. Apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level; and a controller provided with adjustable proportional gain, rate and reset controls and responsive to said sensing means for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

8. The combination with web handling machinery of apparatus for correcting variations from a selected level in the tension of a flexible web traveling through said machinery including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level; and a controller responsive to said sensing means for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

9. The combination with a rotary printing press of apparatus for correcting variations from a selected level in the tension of a web of paper traveling through said press including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web

so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level; and a controller responsive to said sensing means for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

10. Electronic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level including a sensing roller and a strain gage actuated by said sensing roller to produce an output voltage whose magnitude is proportional to the tension of said web; and a controller responsive to changes in said output voltage for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

11. Electronic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level including a current supply whose output voltage is proportional to and changed by variations in the tension of said web, and an error sensing circuit adapted to produce a signal upon a change in said output voltage whose magnitude and polarity are governed by the magnitude and type of said change; and a controller responsive to said signal for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

12. Electronic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level and adapted to deliver a signal whose magnitude and polarity are governed by the magnitude and type of said variations; and a controller including an adjustable proportional gain control and responsive to said signal for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

13. Electronic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected

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web tension level and adapted to deliver a signal whose magnitude and polarity are governed by the magnitude and type of said variations; and a controller including an adjustable rate control and responsive to said signal for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

14. Electronic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level and adapted to deliver a signal whose magnitude and polarity are governed by the magnitude and type of said variations; and a controller including an adjustable reset control and responsive to said signal for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

15. Electronic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level and adapted to deliver a signal whose magnitude and polarity are governed by the magnitude and type of said variations; and a controller including adjustable proportional gain, rate and reset controls and responsive to said signal for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

16. Electronic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall, a pump adapted to evacuate air from said vacuum box to maintain reduced pressure therein, and a throttle valve located between the vacuum box and the pump for regulating the rate at which air is evacuated from said vacuum box; means for sensing variations from the selected web tension level and adapted to produce a signal whose magnitude and polarity are governed by the magnitude and type of said variations; an electro-pneumatic positioner for said throttle valve; and a controller responsive to said signal and adapted to cause said positioner to actuate the throttle valve so that the rate at which air is evacuated from the vacuum box is increased when the web tension sinks below the selected level and the rate at which air is evacuated from said vacuum box is decreased when the web tension rises above said selected level to restore the web tension to said level.

17. Pneumatic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected

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web tension level including the sensing roller and a pneumatic load cell actuated by said sensing roller to deliver air at a pressure which is proportional to the tension of said web; and a controller responsive to changes in the pressure of the air delivered by said sensing means for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

18. Pneumatic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level and adapted to deliver air at a pressure which is proportional to the tension of said web; and a controller including an adjustable proportional gain control and responsive to changes in the pressure of the air delivered by said sensing means for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

19. Pneumatic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level and adapted to deliver air at a pressure which is proportional to the tension of said web; and a controller including an adjustable rate control and responsive to changes in the pressure of the air delivered by said sensing means for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

20. Pneumatic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level and adapted to deliver air at a pressure which is proportional to the tension of said web; and a controller including an adjustable reset control and responsive to changes in the pressure of the air delivered by said sensing means for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

21. Pneumatic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall and a pump adapted to evacuate air from said vacuum box at a regulable rate to maintain reduced pressure therein; means for sensing variations from the selected web tension level and adapted to deliver air at a pressure which is proportional to the tension of said

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web; and a controller including adjustable proportional gain, rate and reset controls and responsive to changes in the pressure of the air delivered by said sensing means for increasing the rate at which air is evacuated from the vacuum box when the web tension sinks below the selected level and for decreasing the rate at which air is evacuated from said vacuum box when the web tension rises above said selected level to restore the web tension to said level.

22. Pneumatic control apparatus for correcting variations from a selected level in the tension of a traveling web including: a brake comprising a transverse vacuum box having a perforated wall located along the path of said web so that the web slides across the surface of said wall, a pump adapted to evacuate air from said vacuum box to maintain reduced pressure therein, and a throttle valve located between the vacuum box and the pump for regulating the rate at which air is evacuated from said

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vacuum box; means for sensing variations from the selected web tension level and adapted to deliver air at a pressure that is proportional to the tension of said web; a pneumatic positioner for said throttle valve; and a controller responsive to the pressure of the air delivered by said sensing means and adapted to cause said positioner to actuate the throttle valve so that the rate at which air is evacuated from the vacuum box is increased when the web tension sinks below the selected level and the rate at which air is evacuated from said vacuum box is decreased when the web tension rises above said selected level to restore the web tension to said level.

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