March 15, 1966 P. W. JACOBSEN 3,240,410

PROPORTIONAL EDGE ALIGNMENT CONTROL SYSTEM

Filed Dec. 6, 1963 3 Sheets-Sheet 1

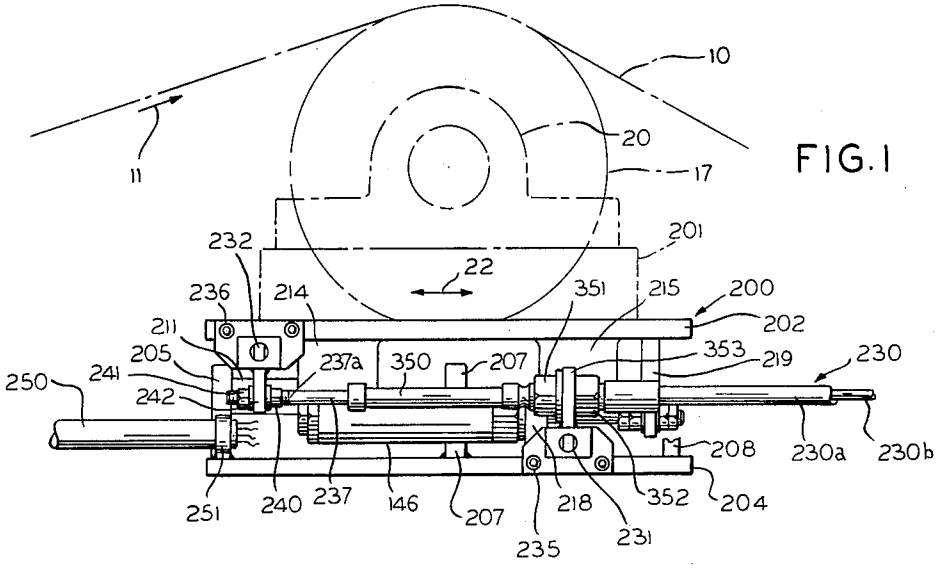


FIG. 1

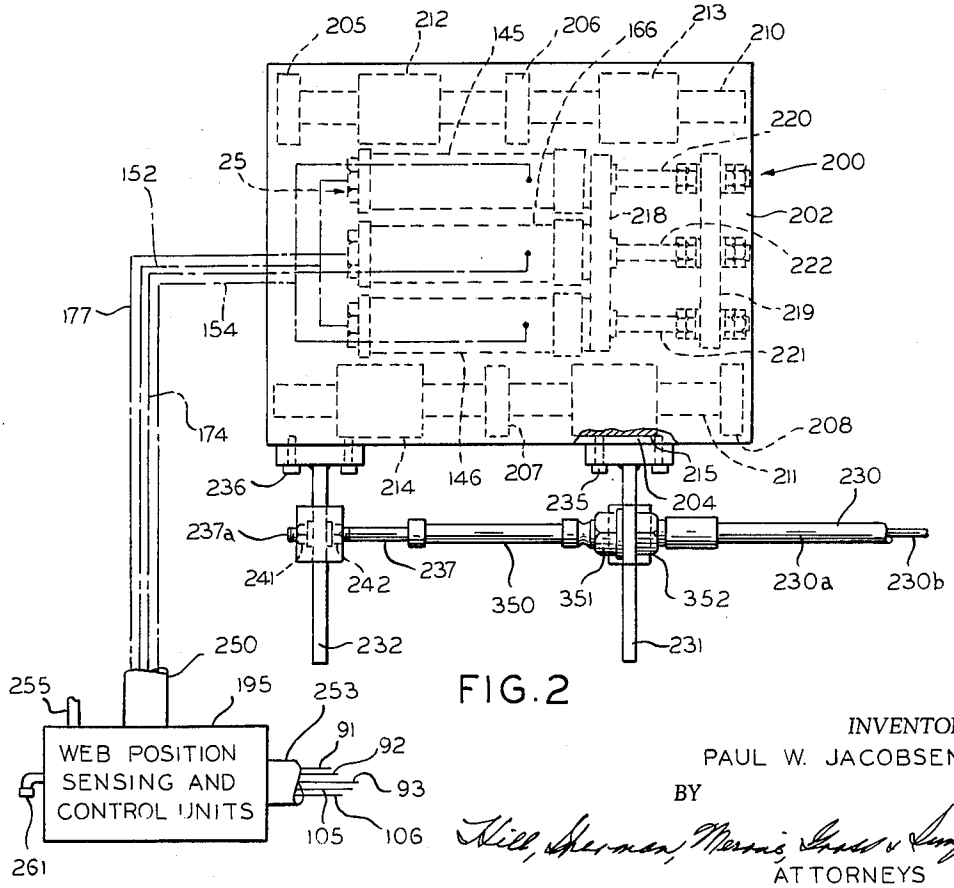


FIG. 2

INVENTOR.
PAUL W. JACOBSEN
BY
Hill, Sherman, Meroni, Gross & Simpson
ATTORNEYS

March 15, 1966 P. W. JACOBSEN 3,240,410

PROPORTIONAL EDGE ALIGNMENT CONTROL SYSTEM

Filed Dec. 6, 1963 3 Sheets-Sheet 2

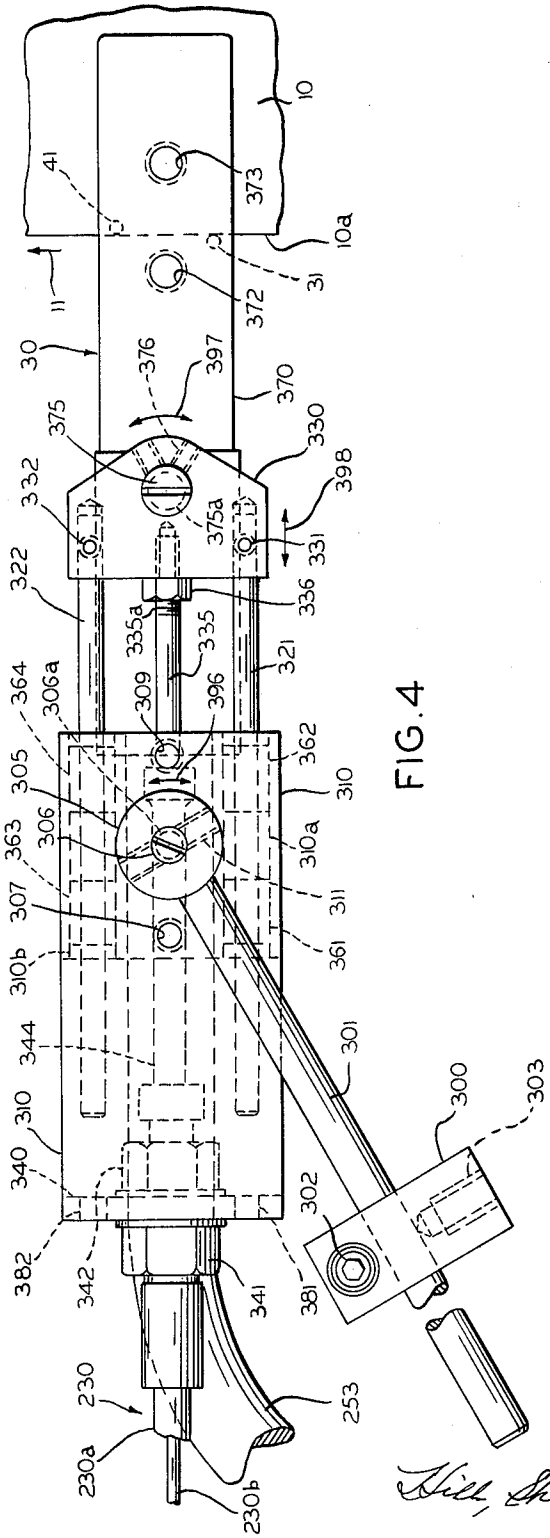


FIG. 4

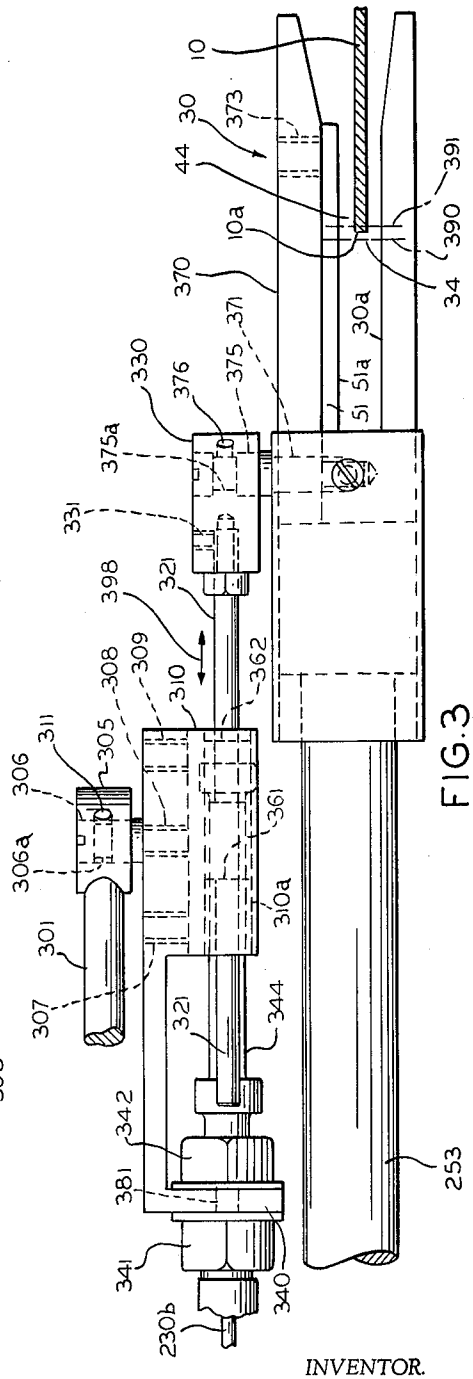


FIG. 3

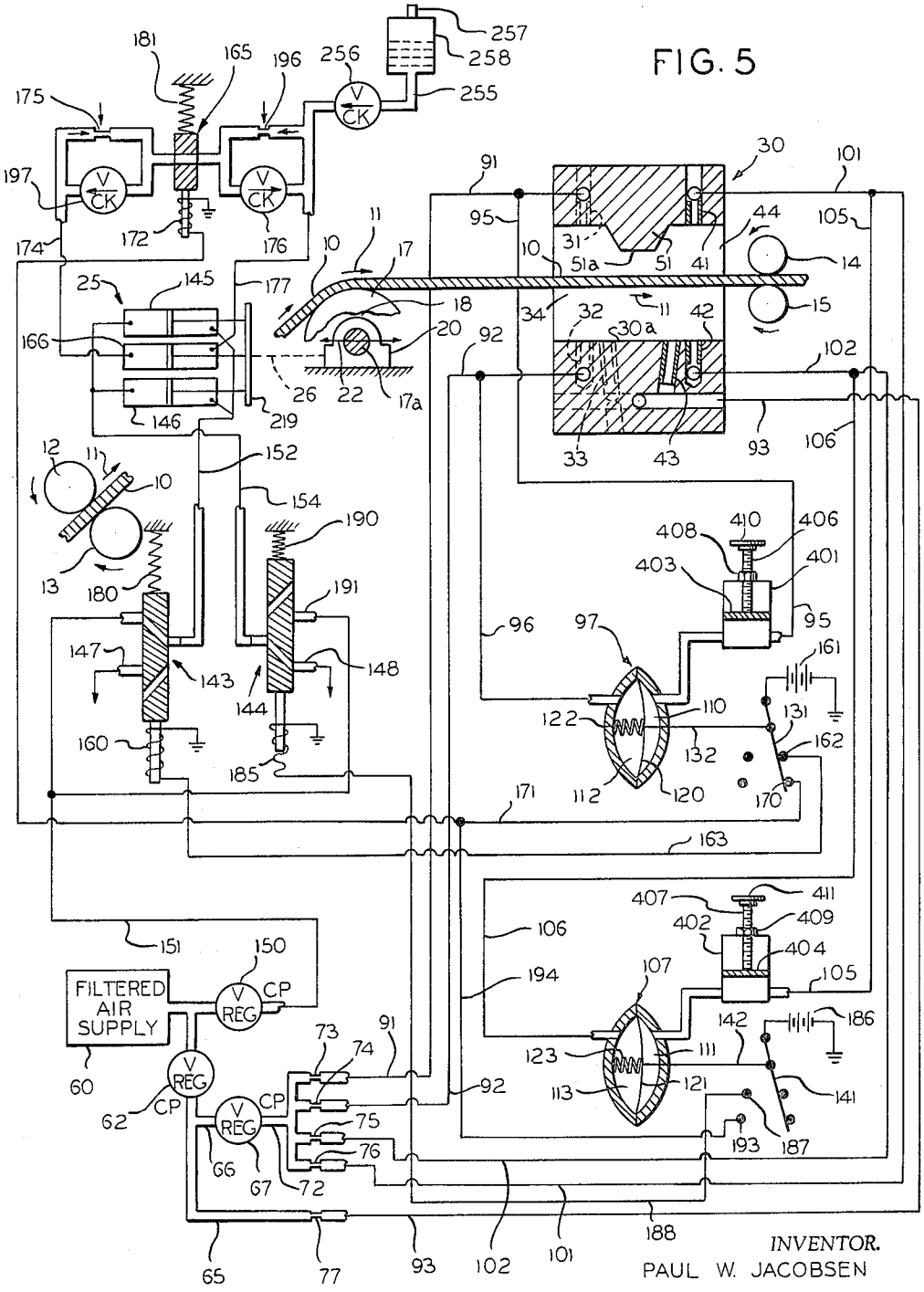
INVENTOR.
PAUL W. JACOBSEN
BY
Hill, Sherman, Meroni, Gross & Simpson
ATTORNEYS

March 15, 1966 P. W. JACOBSEN 3,240,410

PROPORTIONAL EDGE ALIGNMENT CONTROL SYSTEM

Filed Dec. 6, 1963 3 Sheets-Sheet 3

FIG. 5



INVENTOR.
PAUL W. JACOBSEN

BY

Hill, Sherman, Meroni, Gross & Simpson

ATTORNEYS

United States Patent Office 3,240,410 Patented Mar. 15, 1966

3,240,410
PROPORTIONAL EDGE ALIGNMENT CONTROL SYSTEM

Paul W. Jacobsen, Kiel, Wis., assignor to H. G. Weber and Company, Inc., Kiel, Wis., a corporation of Wisconsin

Filed Dec. 6, 1963, Ser. No. 328,652
9 Claims. (Cl. 226—3)

The present application is a continuation-in-part of my copending application Serial No. 280,600 filed May 15, 1963.

This invention relates to a web alignment control system and particularly to a proportional edge alignment control system wherein an edge sensing device senses deviations of an edge of a moving web from a predetermined neutral range of positions and controls a web guide means in such a way as to tend to maintain the web in the neutral range of positions, and wherein the edge sensing device itself is shiftable in proportion to corrective movements of the web guide means so as to move the neutral zone of the edge sensing device toward the edge of the web.

It is an object of the present invention to provide an improved web alignment control system particularly adapted to the control of endless belt type webs wherein a substantial amount of hunting of the web is to be tolerated by the system.

Another object of the invention is to provide a simple and economical proportional edge alignment control system wherein the position of the neutral zone of the edge sensing device is adjusted in accordance with errors in web position sensed by the device.

A further object of the invention is to provide a proportional edge alignment control system wherein the proportion of web correcting movement which is transmitted to the edge sensing device is readily adjustable.

A still further object of the invention is to provide an edge alignment system wherein the rate of response of the system to errors in web position is readily and conveniently adjustable.

Still another and further object of the invention is to provide a proportional edge alignment control system wherein the proportional movement of the edge alignment sensing device is adjustable in a simple and convenient manner and wherein the extent of the neutral zone of the edge sensing device is also readily adjustable separately from the adjustment of the proportion of web corrective movement applied to the edge sensing device.

Other objects, features and advantages of the present invention will be apparent from the following detailed description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a somewhat diagrammatic side elevational view of the guide roll shifting mechanism for an edge alignment system in accordance with the present invention;

FIGURE 2 is a somewhat diagrammatic top plan view of the structure of FIGURE 1;

FIGURE 3 is a somewhat diagrammatic fragmentary side elevational view of an edge position sensing assembly operatively associated with the structure of FIGURES 1 and 2;

FIGURE 4 is a fragmentary top plan view of the structure of FIGURE 3; and

FIGURE 5 is a diagrammatic view illustrating the fluid pressure actuating circuit for the guide roll of FIGURE 1 and the fluid pressure circuit associated with the edge position sensing device of FIGURES 3 and 4 and showing the electrical connections therebetween.

Description of web position sensing head and control circuits as shown in FIGURE 5

In the illustrated embodiment, a web **10** such as a

Fourdrinier wire or a felt of a paper machine is driven in the direction of arrow **11** by any suitable means such as diagrammatically indicated by cooperating pairs of driven rollers **12, 13** and **14, 15** in FIGURE 5. The lateral position of the web may be controlled by means of a guide roll **17** which may have its bearing at one side mounted for pivotal movement on a vertical axis such as indicated at **18** in FIGURE 5 and may have its opposite bearing indicated at **20**, FIGURES 1 and 5, mounted for linear reciprocation in a horizontal direction as indicated by double-headed arrow **22**, FIGURE 5. The shaft **17***a* of the guide roll must, of course, be axially slidable in bearing **20** to accommodate the reciprocation of the bearing. Suitable means have been indicated generally at **25** in FIGURE 5 for shifting bearing **20** horizontally. A mechanical coupling between the means **25** and the bearing **20** has been indicated diagrammatically by the dash line **26** in FIGURE 5.

A sensing head **30** may be disposed relatively close to a supported portion of the web **10** such as the portion of the web supported by guide roll **17**. The sensing head **30** has a plurality of sets of cooperating fluid jets, each set of fluid jets being responsive to the presence or absence of an obstructing material. In the illustrated embodiment the jets are located on opposite sides of a receiving space so that an obstructing material interposed in the receiving space acts as a complete or partial fluid barrier depending on its permeability to the fluid and prevents interaction of the jets.

In the illustrated embodiment as seen in FIGURE 5, there are three jets in each cooperating group, one on one side of a receiving space and two on the opposite side. Two sets of such cooperating jets are shown. Specifically the two sets of cooperating jets have respective fluid jet defining means **31, 32** and **33**, and **41, 42** and **43**, FIGURE 5. The fluid jet means may comprise suitable fluid nozzles or conduits having fluid passages terminating in fluid orifices for delivering fluid in a stream or jet into respective material spaces **34** and **44**, FIGURE 5. The axes of the fluid jet means **32, 33** and **42, 43** may be directed toward the fluid jet means **31** and **41**, respectively, so that in the absence of an obstructing material in the receiving spaces **34** and **44**, the fluid jets converge adjacent the orifices of fluid jet means **31** and **41**, respectively, so as to create fluid barriers across the orifices of fluid jet means **31** and **41** which inhibit discharge of fluid from fluid jet means **31** and **41**.

In FIGURE 5, jet means **32, 33** and **42, 43** lie in respective planes which are parallel to each other but offset with respect to a direction at right angles to the direction of travel of the web indicated by the arrow **11**.

As shown in FIGURE 5, the axes of jet means **31, 32** and **41, 42** may be offset in the longitudinal direction indicated by arrow **11**. An isolating rib **51** may be interposed between the orifices of jet means **31** and **41** to prevent interaction between the jets produced by jet means **31–33** and **41–43**.

Where air is to be supplied to the jet means, a plant air source **60** may be used as a source of fluid under pressure. Air is supplied through a filter within the supply **60** and through a pressure reducer **62** to a pilot line **65**. The outlet of pressure reducer **62** is also connected via a line **66** through a pressure reducer **67** to a line **72** which then branches into four lines which together with line **65** lead to respective flow metering orifices **73–77**.

The metering orifices are so proportioned that output lines **91** and **101** from orifices **73** and **76** have a lesser static pressure, as sensed at lines **95** and **105**, than the static pressures of lines **92** and **102** leading from orifices **74** and **75**, as sensed at lines **96** and **106**, when no pressure is supplied to pilot line **93** and the receiving spaces **34** and **44** are completely unobstructed. Output line **93** is

shown as connected with jet means 33 and 43 and in normal operation has a sufficient flow velocity to cause the static pressure in lines 95 and 105 to greatly exceed the static pressure in lines 96 and 106 when the jets from jet means 33 and 43 are present adjacent the orifices of jet means 31 and 41.

In the specific illustrated system, differential pressure operated switches 97 and 107 are provided having chambers 110 and 111 referenced to lines 95 and 105 and having chambers 112 and 113 referenced to lines 96 and 106. Diaphragms 120 and 121 separate the respective chambers and are acted upon by compression springs 122 and 123 in chambers 112 and 113. The devices 97 and 107 include electric switches 131 and 141 which are mechanically coupled with the diaphragms 120 and 121 as diagrammatically indicated at 132 and 142 so as to be actuated in accordance with the differential pressure conditions between chambers 110, 112 and 111, 113.

As indicated in FIGURE 5, the static pressure lines 95, 96, 105, 106 preferably tap lines 91, 92, 101, 102 near the sensing head 30 so that pressure fluctuations at source 60 have a minimum effect as sensed by devices 97, 107.

The orifice ends of tubular inserts defining jet means 33 and 43 may have a 10 degree bevel so that the ends thereof defining the orifices will lie flush with surface 30*a*. By maintaining the velocity of the fluid throughout the system, the entrance of foreign matter into the interior passages of the sensing head is made very unlikely. Further, the jets 31 and 41 are directed generally normally to the plane of the web and generally toward the jets produced by jet means 32, 33 and 42, 43 so as to positively resist the forcing of foreign material into the jet means 31 and 41 even though the zones 34 and 44 may be unobstructed. Further, of course, the static pressure lines which do not involve rapidly moving fluid are entirely offset with respect to the axes of jet means 31 and 41 so that there is no possibility of forcing foreign matter directly into the static pressure lines such as 95 and 105.

The switches 131 and 141 may control the energization of suitable solenoid valves 143 and 144 for directing air under pressure to the respective actuating chambers of air cylinders 145 and 146 of guide roll actuating means 25. By way of example, when the two solenoid valves 143 and 144 are deenergized, both actuating chambers of the cylinders 145 and 146 are connected to atmosphere via ducts 147 and 148. When switch 131 is closed, as shown in FIGURE 5, indicating an obstruction in zone 34, pressure is supplied to the right-hand actuating chambers of cylinders 145 and 146 from air supply 60 through regulator valve 150, air pressure line 151, valve 143 and air pressure line 152. The left-hand chambers of cylinders 145 and 146 are connected to atmosphere via line 154, valve 144 and duct 148. The electric circuit for energization of solenoid 160 controlling valve 143 is indicated diagrammatically as extending from a current source 161 through switch 131, stationary contact 162 and electrical conductor 163. Of course, in practice the switches 97 and 107 may control the energization of relays which in turn control energization of the various solenoid valves.

A solenoid operated hydraulic shut-off valve 165 in the hydraulic circuit of a hydraulic cylinder 166 is shown as being actuated by means of an energizing circuit extending from current source 161 through switch 131, stationary contact 170, electrical conductor 171 and solenoid 172 of shut-off valve 165. Thus, as the piston means associated with air cylinders 145 and 146 is driven to the left, hydraulic fluid is forced from the left-hand chamber of hydraulic cylinder 166 through hydraulic line 174, adjustable flow control orifice 175, shut-off valve 165, check valve 176 and hydraulic line 177 to the right-hand chamber of hydraulic cylinder 166. The hydraulic cylinder thus serves to control the rate of shifting of the bearing 20. When the web 10 is shifted out of obstructing relation to zone 34, the static pressure in line 95 will exceed the static pressure in line 96 to shift the diaphragm 120 of pressure responsive switch 97 to the left, opening switch 131 and deenergizing solenoid 160 and solenoid 172. Deenergization of solenoid 160 allows a tension spring 180 to shift the position of valve 143 so that line 152 is connected to duct 147 and atmosphere. Deenergization of solenoid 172 allows tension spring 181 to return shut-off valve 165 to a closed position, locking the piston of hydraulic cylinder 166 and thus the bearing 20 in a new position.

Similarly, if switch 141 is closed indicating removal of the obstruction from zone 44, the other solenoid valve 144 is actuated applying pressure to the left-hand chambers of air cylinders 145 and 146 to move the bearing 20 in the direction of web movement until the web again obstructs zone 44. The electric circuit for solenoid 185 of valve 144 is shown as extending from a current source 186 through stationary contact 187 of switch 141 and electric conductor 188. Energization of solenoid 185 moves the valve member of valve 144 downwardly against the action of tension spring 190 so as to interconnect air pressure chamber 191 of the valve 144 with air pressure line 154. Stationary contact 193 of switch 141 is connected by electrical conductor 194 with electrical conductor 171 so as to energize solenoid 172 of hydraulic shut-off valve 165 to open the valve. As the piston means of the actuating means 25 is driven to the right, hydraulic fluid is forced from the right-hand chamber of hydraulic cylinder 166 through line 177, adjustable flow control valve 196, shut-off valve 165 and check valve 197 to line 174 connecting with the left-hand chamber of the cylinder 166. When the web 10 is again in obstructing relation to the zone 44, switch 141 will move to the right deenergizing solenoids 172 and 185, the hydraulic cylinder 166 locking the guide roll 17 in a new position.

The foregoing portions of the system of the present invention are described in my copending application Serial No. 280,600, filed May 15, 1963, and the disclosure of said copending application is incorporated herein by reference in its entirety. The foregoing copending application includes specific quantitative examples of the various parameters of the system which are hereby made part of the present disclosure.

Referring to FIGURES 1 and 2, a specific guide roll shifting mechanism is indicated at 200. This mechanism mounts the guide roll bearing 20 by means of a suitable support indicated at 201 so as to shift the bearing 20 in opposite longitudinal directions as indicated by the double-headed arrow 22. In FIGURE 2, the air pressure cylinders 145 and 146 and the hydraulic cylinder 166 are shown as being coupled to a web position sensing and control units component 195 by means of air pressure lines 152 and 154 and hydraulic lines 174 and 177. It will be understood that component 195 may comprise the units shown in FIGURE 5 as previously described.

Description of guide roll shifting mechanism of FIGURES 1 and 2

Referring to FIGURES 1 and 2, it will be observed that the shifting mechanism 200 comprises an upper platform 202 carrying the support 201 for the guide roll bearing 20. The upper platform 202 is movably mounted by means of a lower platform or base 204. The base 204 has a series of four upstanding integral lugs 205–208. The lugs 205 and 206 mount a fixed horizontal shaft 210, and the lugs 207 and 208 mount a fixed horizontal shaft 211. The upper platform 202 has depending lugs 212–215 with cylindrical apertures through which the shafts 210 and 211 extend. Suitable ball bushings are secured within the cylindrical apertures of lugs 212–215 and receive the shafts 210 and 211 so as to mount the upper platform 202 for shifting movement longitudinally on the shafts 210 and 211.

The base 204 is also provided with an upstanding elongated lug 218 which serves to mount the casings of cylinders 145, 146 and 166 in fixed relation to the base. The

upper platform **202** has a depending lug **219** to which is secured the piston rods **220**, **221**, and **222** of the cylinders **145**, **146** and **166** so that an extension and retraction of the piston rods **145** and **146** shifts the upper platform **202** relative to the base **204**.

For the purpose of controlling the position of the edge sensing device **30**, a push-pull flexible control cable **230** has its outer part **230***a* secured to a bracket **231** fixed to the base **204** and has its inner movable part **230***b* secured to a bracket **232** fixed to the upper movable platform **202** of the guide roll mounting assembly. Thus, shifting of the upper platform **202** will correspondingly shift the inner push-pull cable member **230***b* relative to the outer casing **230***a*. Suitable fastening means for securing the bracket **231** to the base **204** are indicated at **235** in FIGURES 1 and 2, and suitable fastening means are indicated at **236** for securing the bracket **232** to the upper platform **202**. The axial position of the moving cable part **230***b* relative to bracket **232** is shown as being adjustable by means of suitable threads **237***a* on a rigid part **237** connected with the flexible cable part **230***b*. Nuts **240** and **241** lock the threaded portion **237***a* at a selected position relative to a fitting **242** secured to the bracket **232**.

By way of example, the web position sensing and control units of component **195** may be located in a suitable control cabinet to which is connected a cable **250** containing the lines **152**, **154**, **174**, and **177**, which cable is shown in FIGURE 1 as being secured to the base plate **204** by means of a suitable bracket **251**. A cable has also been indicated at **253** in FIGURE 2 which contains the air pressure lines **91**, **92**, **93**, **105** and **106** and which cable connects with the cabinet housing the units of component **195**.

In the illustrated embodiment, it will be understood that the static pressure lines **95**, **96**, **105** and **106** are coupled with lines **91**, **92**, **101**, and **102**, respectively, within the cabinet housing the units of component **195** in FIGURE 2. The cabinet may be connected with an external oil reservoir by means of a conduit indicated at **255** in FIGURES 2 and 5, the cabinet including the check valve **256** indicated in FIGURE 5, for example. An oil make-up reservoir has been indicated at **258** in FIGURE 5 which would be located at the highest point of the hydraulic circuit. The oil reservoir **258** may be provided with a sonic silencer as indicated at **260** and a similar silencer **261** has been indicated in FIGURE 2 associated with the discharge ducts **147** and **148** of the pneumatic system.

The upper platform **202** may be of cast construction and may be provided with a multiplicity of elongated apertures disposed at different angles for facilitating the attachment of the upper platform **202** to many different existing guide roll bearings. Similarly, the base **204** may be provided with a multiplicity of elongated apertures and cylindrical apertures and a multiplicity of notches about the perimeter thereof for facilitating the quick and removable mounting of the base **204** to the machine frame of many different types of paper machines and the like. By way of example, all of the circular apertures in the upper platform **202** and the base **204** may have a minimum diameter of $\frac{9}{16}$ inch and the elongated apertures may have semicircular ends of minimum diameter of $\frac{9}{16}$ inch. Similarly, the notches along the perimeter of the base **204** may have semicircular ends with a minimum diameter of $\frac{9}{16}$ inch. The elongated apertures in the base **204** may have their axes parallel either to the long sides of the base or the short sides of the base and may consist of eight elongated apertures with axes parallel to the long side and three with axes parallel to the short sides of the base. The distance between the centers of curvature at the opposite ends of these elongated apertures may be approximately 1 inch. Additionally, there may be approximately seven circular apertures in the base **204**, and six notches along each of the long sides of the base and three notches along each of the short sides of the base. The upper platform **202** may have seven circular apertures, four elongated apertures with axes parallel to the short sides, two of a length of $1\frac{1}{4}$ inches, and two of a length of $\frac{3}{4}$ inch. There may be eight elongated apertures with axes parallel to the long sides of the upper platform **202** and with length dimensions of $\frac{3}{4}$ inch and 1 inch. Additionally, there may be seven elongated apertures disposed at an angle of 45° and directed toward the upper left corner of the upper platform as viewed in FIGURE 2, and two elongated apertures disposed at an angle of 45° and directed toward the upper right corner of the upper platform as viewed in FIGURE 2. These elongated apertures may have a length dimension between the centers of curvature at the opposite ends thereof of about 1 inch. Of course, the particular arrangement of the various apertures will depend on the particular machines to which the present invention is to be adapted. By means of the multiplicity of different sizes and orientations of apertures and notches, one design in accordance with the present invention may be adapted to be applied to a very substantial number of different paper machines, for example.

Description of web position sensing mechanism of FIGURES 3 and 4

Referring to FIGURES 3 and 4, it will be observed that the edge sensing device **30** is mounted by means of a clamp bracket **300** having a screw **302** for fixedly clamping a shaft **301** in a desired position. The clamping bracket **300** may be secured to a suitable portion on the frame work of the machine by means of a screw (not shown) engaging in the threaded hole **303** of the clamping bracket **300**.

The shaft **301** is provided with a boss **305** having a central cylindrical aperture for receiving a mounting pin **306** which may be threadedly engaged with any of the threaded holes **307–309** of a mounting bracket **310**. The mounting pin **306** is provided with a reduced diameter groove centrally thereof, as indicated at **306***a*, which receives a setscrew indicated at **311** for fixing the angular position of the bracket **310** relative to the shaft **301**.

As seen in FIGURES 3 and 4, the sensing head assembly **30** is carried by the bracket **310** by means of a pair of horizontal shafts **321** and **322** which are reciprocally mounted in the bracket part **310**. The shafts **321** and **322** are threadedly engaged with a sensing head mounting block **330** and are secured against rotation by means of setscrews **331** and **332** extending in threaded holes in the mounting block **330**. The mounting block **330** also receives a threaded end portion **335***a* of a rigid inner push-pull cable part **335** and a nut **336** serves to lock the threaded end **335***a* in a threaded hole in the block **330**. The outer push-pull cable part **230***a* is secured to a depending leg portion **340** on the bracket **310** by means of nut members **341** and **342**. The nuts **341** and **342** serve to rigidly mount a rigid casing part **344** of the push-pull cable **230**. The flexible cable part **230***b* of the push-pull cable **230** is coupled to movable part **335** which is of rigid construction and is guided by a sliding fit within fixed casing part **344**. Referring to FIGURES 1 and 2, it will be observed that the push-pull cable **230** includes a similar rigid casing part **350** secured to a fitting **353** on bracket **231** by means of nut members **351** and **352** and receiving the rigid movable part **237** having the threaded end **237***a* integral therewith and coupled with the flexible movable cable part **230***b*. It will thus be apparent that movement of the upper platform **202** by means of the fluid pressure actuated cylinders **145** and **146** is transmitted by means of push-pull cable parts **237**, **230***b* and **335** to the block **330** mounting the sensing head assembly **30**. Suitable ball bushing means may be provided within the bracket **310** as indicated at **361–364** for facilitating the axial shifting

movement of the shafts **321** and **322** within cylindrical apertures **310***a* and **310***b* of the bracket **310**.

The sensing head assembly **30** comprises a housing part **370** having a plurality of threaded apertures such as indicated at **371** in FIGURE 3 and at **372** and **373** in FIGURE 4 for receiving a mounting pin **375** having an intermediate reduced diameter groove **375***a*. A setscrew, as indicated at **376**, is threadedly engaged in the block **330** and has its inner end engaging the reduced diameter portion of mounting pin **375** so as to retain the housing **370** at a desired angular position in relation to the mounting block **330**. As indicated at **381** in FIGURE 3 and at **381** and **382** in FIGURE 4, the depending flange part **340** of bracket **310** may have cylindrical apertures axially aligned with the shafts **321** and **322** so as to provide clearance for the shafts in their extreme retracted positions.

The centerlines of the jet means **31**, **32** and **41**, **42** shown in FIGURE 5 have been indicated in FIGURE 3 at **390** and **391**, and the positions of sensing jet means **31** and **41** have been diagrammatically indicated in FIGURE 4 for the case where the edge **10***a* of the web **10** is within the neutral range of positions wherein switch means **131** and **141** are both in the inactive positions. In FIGURE 5, the switches are shown in the positions they would occupy when the web **10** has its edge **10***a* obstructing the sensing jet means **31** as well as the sensing jet means **41**. While the angular adjustment of the sensing head **30** relative to the edge **10***a* of the web **10** has been indicated as being one where the longitudinal axis of the sensing head **30** is at right angles to the edge **10***a*, it will be understood that the sensing head **30** may be angularly adjusted with respect to the axis of mounting pin **375** either in the counterclockwise or clockwise direction relative to the position indicated in FIGURE 4. If the sensing head **30** is rotated in the counterclockwise direction relative to the axis of mounting pin **375**, the separation between the centerlines on the sensing jets **31** and **41** in the direction at right angles to the direction of web movement indicated by the arrow **11** is reduced to reduce the neutral range of positions of the edge **10***a* where no corrective action will be initiated. Conversely, the sensing head **30** may be rotated in the clockwise direction relative to the axis of mounting pin **375** so as to increase the separation of the centerlines of jets **31** and **41** with respect to a direction at right angles to edge **10***a* so as to increase the neutral range of positions of the edge **10***a* where no corrective action will be initiated.

Also, in the orientation of the bracket **310** with respect to the mounting pin **306** shown in FIGURES 3 and 4, shifting movement of the guide roll bearing **20** will result in an equal amount of shifting of the sensing head **30** at right angles to the direction of web movement indicated by the arrow **11**. If, however, the longitudinal axis of the bracket **310** extends at an angle to the direction of web movement indicated by the arrow **11**, then a given amount of shifting of the bearing for the guide roll **17** will result in a lesser but proportionate shifting of the sensing head **30** with respect to the direction at right angles to the direction of web movement indicated by arrow **11**. The double-headed arrow designated by the reference numeral **396** indicates the angular adjustment of bracket **310** with respect to the axis of mounting pin **306**, the double-headed arrow **397** indicates the angular adjustability of the edge position sensing device **30** with respect to the axis of mounting pin **375**, and the double-headed arrow **398** indicates the linear adjustability of the mounting block **330** relative to bracket **310**. The adjustments indicated by arrows **397** and **398** are independent of each other in the sense that the extent of the neutral range of positions as selected by adjustment in the direction of arrow **397** is maintained regardless of the adjustment of block **330** in the direction of arrow **398**. On the other hand, angular adjustment of bracket **310** as indicated by arrow **396** will alter the extent of the neutral range of positions and require readjustment of the angular position of sensing device **30** with respect to the axis of pin **375** if the same extent of range of neutral positions is desired in a new adjustment of the bracket **310** relative to the axis of mounting pin **306**. The proportion adjustment indicated by arrow **396**, however, may be selected arbitrarily irrespective of the desired range of neutral positions which is to be utilized, and in this sense the two adjustments are separate.

In the illustrated embodiment, only the lines **91**, **92**, **93**, **105** and **106** are in the cable **253**, FIGURES 2, 3 and 4, which connects with housing **370**. The housing **370** has longitudinal passages connecting the lines **91**, **92**, **93**, **101** and **102** of cable **253** with the jet means **31**, **32**, **33** and **43**, **41** and **42**, respectively. The construction of the edge sensing device **30** may be as disclosed in my copending application Serial No. 280,600, and the disclosure of the sensing nozzle as shown in said copending application is specifically incorporated herein by reference. As described in said copending application, the high pressure jet means **33** and **43** may be defined by sleeves having internal diameters of $\frac{1}{32}$ inch where jets **31**, **32**, **41** and **42** have internal diameters of $\frac{1}{8}$ inch. The clearance between the inner face **51***a* of rib **51** and the opposite surface **30***a* of the head may be $\frac{1}{2}$ inch.

Description of means for varying the rate of response of the web alignment control system

In general, the reaction of the edge alignment control system to errors in web position can be slowed in the following ways.

(1) The volume in the fluid pressure system shown in FIGURE 5 and associated with the jet means **31** and **41** may be increased by adding small accumulator air tanks as indicated at **401** and **402** in FIGURE 5 so that it will take a longer time for the differential pressures to build up and shift the diaphragms **120** and **121** of the differential pressure actuated switch mechanisms **97** and **107**. This slowing of reaction time cannot be accomplished by simply increasing the diameter of the lines such as **95** and **105**, since while it is true that the volume in the system would be increased, there would be an offsetting decrease in the frictional resistance to fluid flow in the lines. It has been found that within the realm of reasonable line cross sections, the gain in reaction time due to reduced friction in the lines considerably exceeds the reaction delay resulting from the increased volume in the system as the line diameter is increased. In FIGURE 5, the volume of the tanks **401** and **402** communicating with the lines **95** and **105** is indicated as being adjustable by means of pistons **403** and **404** which are axially adjustable within the tanks by means of threaded shafts **406** and **407** cooperating with fixed nut members **408** and **409** and rotatable by means of hand operated knobs indicated at **410** and **411**.

(2) The reaction time can be slowed by decreasing the diameter of the lines **95** and **105** between the sensing nozzle **30** and the differential pressure switches **97** and **107**.

(3) The reaction time of the system can be slowed by increasing the length of the lines **95** and **105** between the sensing nozzle **30** and the diaphragm pressure switches **97** and **107**.

(4) The reaction time of the system can be slowed by decreasing the pressure downstream of the flow control orifice **77** thus supplying reduced pressure to the pilot line **93** and pilot jet means **33** and **43**.

(5) The reaction time of the system can be slowed by increasing the pressure in the lines **92** and **102** so as to increase the velocity of the fluid jets produced by jet means **32** and **42**.

Examples of reaction times under varying conditions are given in my copending application Serial No. 280,600

and this quantitative information is specifically incorporated herein by reference.

Where the aligning of wires and felts are concerned on paper machines, the consensus of opinion of paper makers is that the wires and the felts should be allowed to hunt or to find new tracking centerlines within a reasonable range, for example a range of ½ inch. It is the general feeling of paper manufactures that an edge alignment system which opposes minute position changes in the tracking of the wires or felts is, in fact, detrimental, and that greater life expectancy of the wires and felts can be attained by permitting these wires and felts to find their natural running positions as long as these new running positions are within an acceptable range.

Another factor is the trend in recent years to purposely weave a slight sine wave in the longitudinal threads of the wires so that the wire belt will weave back and forth a slight amount, the objective being to avoid having the wire belt track in a particular and constant position. This trend is predicated on the belief that the rolls over which the belt is traveling will have less chance of developing grooves or impressions from the longitudinal wires. It is also believed that the belts themselves will last longer where they are designed for intentional weaving.

The illustrated system conforms with the foregoing objectives by making possible an adjustment in the proportional movement on the edge sensing device **30** in response to guide roll corrections and in providing a convenient adjustment of the neutral range of positions by rotation of the sensing device **30** about the axis of mounting pin **375**, FIGURES 3 and 4. The slowing down of the reaction time of the system, as just described, may also be utilized to accommodate a slight weaving movement of the wires and felts in paper machinery.

In operation of the illustrated system, as the web shifts from the neutral zone in either direction, a signal is sent to the guide roll actuating means **25** via a system such as illustrated in FIGURE 5 and previously described herein. The actuating means **25** begins to shift the upper platform **202**, FIGURES 1 and 2, in a direction to return the web to the neutral zone, but in the course of such shifting, the push-pull cable **230** is actuated so as to move the neutral range of positions of the sensing head toward the edge of the web. If the web continues to move away from the neutral zone of the sensing head in either direction, the upper guide roll mounting platform **202** will, of course, continue to shift, and by the same token, the sensing head will continue to move its neutral zone toward the edge of the web and in the direction that the edge of the web is drifting. Thus, in a situation where the edge of the web has shifted ¼ of an inch from the neutral zone of the sensing head in either direction, the upper guide roll mounting platform **202** may shift ¼ of an inch, for example, and the sensing head will have moved ¼ of an inch so that the edge of the web will again be within the neutral zone of the sensing head. The motion of the upper guide roll mounting platform **202** would then be stopped, establishing a new neutral zone of positions of the web, and it is possible that the edge of the web might remain within the new neutral zone for ten minutes or more. In the new condition, the web guide roller will have been shifted ¼ of an inch and will remain in the new position until some further action is called for by the sensing head **30**. Because the guide roller **17** has been shifted ¼ of an inch and remains in the canted position (assuming it was initially in a right angle position relative to the direction of movement of the web), it is likely that when the web shifts again out of the neutral range of positions, it will shift in a direction opposite to its previous direction of shifting, since it is being urged to do so by the canted guide roller.

If, when the web shifts ¼ of an inch from the neutral zone of the sensing head **30**, and the upper guide roll mounting platform **202** and the sensing head **30** have correspondingly shifted ¼ inch, the ¼ inch canting of the guide roller **17** is not sufficient to maintain the web in a desirable range of positions, it would be necessary to arrange the system so as to require a greater travel of the mounting platform **202** in response to this web error. For example, the system might be such that when the web moves ¼ of an inch from the neutral zone of the sensing head, it might be desired to have the mounting platform **202** shift ½ inch instead of ¼ inch. To achieve this, the bracket **310** would be rotated relative to the axis of pin **306**, FIGURE 4, so that the axes of shafts **321** and **322** were directed at an oblique angle to the direction of web travel indicated by the arrow **11**. For example, the bracket **310** might be rotated through 60° in the counterclockwise direction. The sensing head **30** would then be rotated 60° in the clockwise direction with respect to the axis of mounting pin **375** to obtain the same range of neutral positions as illustrated in FIGURE 4. In the new angular adjustment, a ½ inch shifting of the mounting platform **202** will still move the sensing head **30** ½ inch, but the component of this movement at right angles to the direction of movement of the web will only be ¼ inch. By way of example, in the illustrated embodiment, the upper mounting platform **202** has a total range of travel of 3 inches. It will be understood that any proportion from zero to 1:1 may be attained between the travel of the guide roll mounting platform **202** and the effective travel of the sensing head **30** at right angles to the direction of movement of the web.

By way of example, cables **250** and **253**, FIGURE 2, may have a length of the order of 20 feet between the cabinet represented by component **195**, and the cylinders **145**, **146**, **166** and the sensing head **30**, respectively.

Summary of operation

In summary, with the web **10** being driven in the direction of arrow **11** by drive means **12**, **13** and **14**, **15**, FIGURE 5, if the edge of the web should begin moving in a direction to obstruct the sensing zone **34** between jet means **31** and **32**, the pressure in static line **95**, FIGURE 5, will be reduced allowing closure of switch **131** and consequent energization of solenoid **160** of solenoid valve **143** to supply air pressure to the right-hand ends of actuating cylinders **145** and **146**. This action shifts bearing **20** of roller **17** in the left-hand direction as viewed in FIGURES 1 and 5, tending to move the web **10** back toward the neutral range of positions defined by the sensing head **30**. The movement of the guide roll supporting upper platform **202**, FIGURES 1 and 2, is transmitted by means of push-pull cable **230** to the sensing head **30** so as to tend to move the sensing head **30** to the left as viewed in FIGURE 4. This movement of the sensing head tends to move the neutral zone of the sensing head into alignment with the edge **10*a*** of the web **10**.

The amount of shifting of the neutral zone of the sensing head **30** for a given shifting of the upper platform **202** for guide roll **17** is adjustable by swinging bracket **310**, FIGURE 4, about the axis of mounting pin **306**. The sensing head **30** is adjusted in an opposite direction about mounting pin **375** so as to maintain the same extent of neutral range of positions as represented by the distance between jet means **31** and **41** in FIGURE 4 in the direction at right angles to the direction of web movement indicated by arrow **11**.

The speed of response of the system to errors in web position may be slowed by various means, for example by providing small accumulator air tanks as indicated at **401** and **402** in FIGURE 5 in the static pressure lines **95** and **105**. It is found that simply increasing the cross section of the lines **95** and **105** does not reduce reaction time because of a reciprocal decrease in the friction presented by the lines with increasing diameter. In fact, the increase in speed of reaction as a result of reduced friction with an increased diameter line considerably exceeds the reaction delay introduced by the increased

volume in the system. The speed of response of the system can be slowed by decreasing the diameter of the lines **95** and **105** (because of the increased friction effect), by increasing the length of the lines **95** and **105**, by decreasing the pressure supplied to the pilot jet means **33** and **43**, and by increasing the pressure supplied to the sensing jets **32** and **42**.

It will be apparent that many modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

1. A web alignment control system comprising

(a) web position correction means shiftable in opposite directions in the execution of web correction commands calling for web corrective movement in respective opposite directions,

(b) web position error sensing means defining a correct web position and producing web correction commands in response to errors in web position in respective opposite directions from said correct web position and controlling said web position correction means to tend to return the web to the correct web position,

(c) said web position error sensing means being capable of mechanical actuation in respective opposite directions to shift said correct web position defined thereby in respective opposite directions, and

(d) push pull cable means mechanically coupling said web position correction means and said web position error sensing means for mechanically actuating said web position error sensing means in response to movement of said web position correction means to shift said correct web position defined by said error sensing means in a direction to tend to reduce the error in web position.

2. An edge alignment control system comprising

(a) web position correction means shiftable in opposite directions in the execution of respective web correction commands calling for web corrective movement in respective opposite directions,

(b) a sensing head having edge sensing means defining a correct edge position for the edge of a web travelling thereacross and responsive to deviations of the edge of the web from the correct edge position in respective opposite directions to produce respective web correction commands,

(c) means coupled to said edge sensing means and controlling said web position correction means and responsive to the respective web correction commands to shift said web position correction means in respective opposite directions so as to tend to move the edge of the web back to the correct edge position,

(d) means mounting said edge sensing means for movement in opposite directions transversely to the direction of web movement thereacross to shift the correct edge position defined by said edge sensing means in respective opposite directions, and

(e) push-pull cable means connecting said edge sensing means with said web position correction means to shift the edge sensing means in said mounting means in response to the shifting of said web position correction means and in a direction to tend to move the correct edge position defined by the edge position sensing means toward the edge of the web.

3. An edge alignment control system comprising

(a) web position correction means shiftable in opposite directions in the execution of respective web correction commands calling for web corrective movement in respective opposite directions,

(b) edge sensing means defining a correct edge position for the edge of a web travelling thereacross and producing respective web correction commands in response to deviation of the edge of the web from the correct position in respective opposite directions,

(c) means coupled to said edge sensing means and controlling said web position correction means and responsive to the respective web correction commands to shift said web position correction means in respective opposite directions so as to tend to move the edge of the web back to the correct edge position,

(d) means mounting said edge sensing means for linear movement in opposite directions along an axis of movement to shift the correct edge position defined by said edge sensing means, and

(e) means connecting said edge sensing means with said edge position correction means for moving the edge sensing means along said axis of movement in proportion to the movement of the web position correction means and in a direction to tend to reduce the deviation of the edge of the web from the correct edge position.

4. An edge alignment control system comprising

(a) web position correction means shiftable in respective opposite directions in the execution of respective web correction commands to produce web corrective movement in respective opposite directions,

(b) edge sensing means defining a correct edge position for the edge of a web travelling thereacross and producing respective web correction commands in response to deviation of the edge of the web from the correct edge position,

(c) means coupled to said edge sensing means and controlling said web position correction means and responsive to the respective web correction commands to shift said web position correction means in respective opposite directions so as to tend to move the edge of the web back to the correct edge position,

(d) first means mounting said edge sensing means for linear movement in opposite directions along an axis of movement to shift the correct edge position defined by said edge sensing means,

(e) second means mounting said first means for angular adjustment to change the angle between said axis of movement of said edge sensing means and the direction of movement of the web within a substantial range of angles, and

(f) means connecting said edge sensing means with said edge position correction means for moving the edge sensing means along said axis of movement thereof in proportion to the movement of the web position correction means and in a direction to tend to reduce the deviation of the edge of the web from said correct edge position.

5. An edge alignment control system comprising

(a) web guide roll means shiftable in respective opposite directions for producing web corrective movement in respective opposite directions,

(b) guide roll mounting means comprising upper and lower platforms which are relatively shiftably horizontally in shifting the position of said web guide roll means,

(c) edge sensing means having fluid discharge orifice means defining a neutral range of positions of said web and providing respective error signals in response to deviation of the edge of said web from said neutral range of positions in respective opposite directions,

(d) edge sensing mounting means for mounting said edge sensing means for linear movement in opposite directions along an axis of movement to shift said fluid discharge orifice means and thereby to shift the neutral range of positions defined thereby, and

(e) web control means responsive to the respective error signals from said edge sensing means to relatively shift said platforms in respective horizontal directions tending to return the edge of the web to said neutral range of positions,

(f) push-pull cable means having fixed and movable parts at one end connected to the respective platforms of said guide roll mounting means for driving of said movable part in accordance with the shifting movement of said guide roll means and having its movable part connected at the opposite end thereof with said edge sensing means and its fixed part connected with said edge sensing mounting means for shifting of said edge sensing means along the axis of movement thereof in accordance with the shifting movement of said guide roll mounting means and in a direction to tend to move the fluid discharge orifice means of said edge sensing means toward the edge of the web,

(g) means mounting said edge sensing mounting means for angular adjustment through at least about 90% to correspondingly adjust the angle of the axis of movement of said edge sensing means relative to the direction of movement of the web thereacross, and

(h) means providing for substantial angular adjustment of said edge sensing means in any given adjusted position of the axis of movement of the edge sensing means to enable adjustment of the orientation of the fluid discharge orifice means relative to the edge of the web in each angular orientation of said axis of movement.

6. The method of sensing web alignment which comprises

(a) establishing first and second sets of opposed fluid jets at spaced locations to define a neutral range of positions of the edge of a web travelling in a plane located between the respective jets of each set,

(b) sensing the change in the relative internal pressures in the pressure supply lines to the first set of jets by means of sensing fluid circuits coupled therewith when the first set of jets has no web therebetween to generate a first actuating signal and sensing the change in relative internal pressures in the pressure supply lines to the second set of jets by means of sensing fluid circuits coupled therewith when the second set of jets has the web therebetween to generate a second actuating signal,

(c) applying corrective forces to the web in response to the first and second actuating signals to tend to restore the edge of the web to the neutral range of positions, and

(d) adjusting the fluid pressure transmission characteristics of the sensing fluid circuits connected with the pressure supply lines of the first and second sets of jets to adjust the time required to generate an actuating signal in response to a deviation of the edge of the web from said neutral range of positions.

7. Apparatus for sensing web alignment comprising

(a) a sensing head having first and second sets of opposing fluid jets with the fluid jets of each set directed toward each other and separated by a receiving space for receiving an edge of a web,

(b) fluid pressure supply lines connected with the respective fluid jets for supplying fluid under pressure thereto for discharge into said receiving space,

(c) sensing fluid circuits coupled with the respective supply lines to sense the pressures in said lines,

(d) fluid pressure responsive means connected with the sensing fluid circuits associated with the respective sets of fluid jets and responsive to the pressure differential between the first set of jets in the absence of a web therebetween to generate a first actuating signal and responsive to the pressure differential between the second set of jets with the edge of the web in obstructing relation therebetween to generate a second actuating signal, and

(e) adjustable volume accumulator tank means in at least one of the sensing fluid circuits of each of the first and second sets of heads for selectively providing a substantial range of reaction times for said fluid pressure responsive means.

8. Apparatus for sensing web alignment comprising

(a) a sensing head having fluid jets directed toward each other and separated by a receiving space for receiving an edge of a web traveling past said sensing head,

(b) fluid pressure supply lines connected with the respective fluid jets for supplying fluid under pressure thereto for discharge into said receiving space,

(c) sensing fluid circuits coupled with the respective supply lines to sense the pressure in said lines,

(d) fluid pressure responsive means connected with said sensing fluid circuits and responsive to the pressure differential therebetween to generate an actuating signal when the web edge changes between an obstructing position in said space between said jets and a non-obstructing position, and

(e) means providing for a change in the volume of at least one of said fluid circuits over a substantial range to provide for adjustment of the reaction time of the system to transitory changes in the position of the edge of the web with respect to said receiving space between said jets.

9. Apparatus for sensing web alignment comprising

(a) a sensing head having fluid jets directed toward each other and separated by a receiving space for receiving an edge of a web traveling past said sensing head,

(b) fluid pressure supply lines connected with the respective fluid jets for supplying fluid under pressure thereto for discharge into said receiving space,

(c) sensing fluid circuits coupled with the respective supply lines to sense the pressure in said lines,

(d) fluid pressure responsive means connected with said sensing fluid circuits and responsive to the pressure differential therebetween to generate an actuating signal when the web edge changes between an obstructing position in said space between said jets and a non-obstructing position, and

(e) fluid accumulator means connected to at least one of said sensing fluid circuits and separate from the fluid pressure responsive means and having a cross section substantially greater than the cross section of the fluid circuit itself to increase the time for response of said system to changes in the position of the edge of the web with respect to said receiving space between said jets.

References Cited by the Examiner

UNITED STATES PATENTS

2,552,189	5/1951	Kuehni	226—45 X
2,814,487	11/1957	Medkeff	226—19 X
2,884,495	4/1959	Frankel	226—45 X

FOREIGN PATENTS

525,230	5/1956	Canada.

M. HENSON WOOD, JR., *Primary Examiner.*

ROBERT B. REEVES, *Examiner.*