

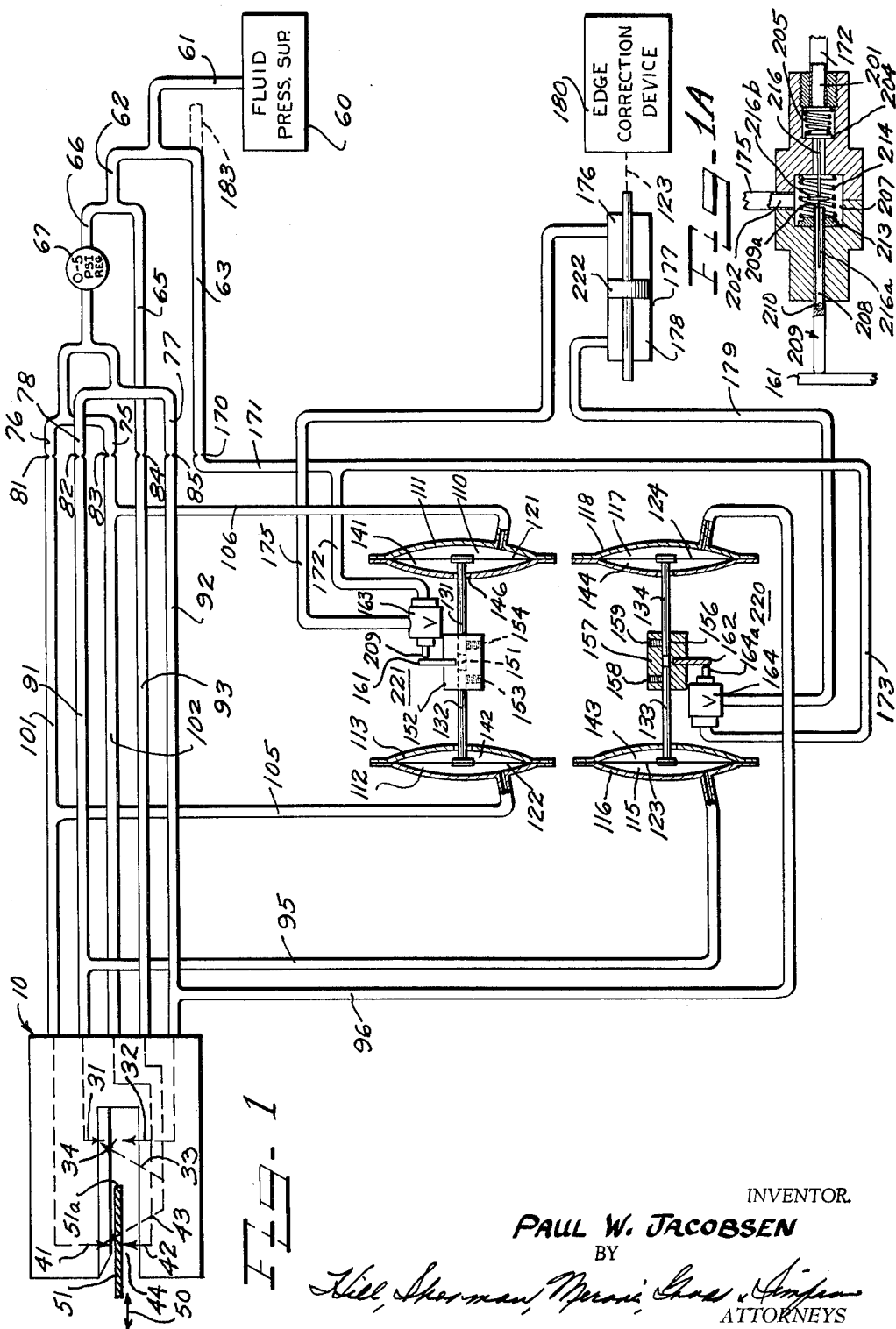
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FLUID PRESSURE OPERATED SENSING SYSTEM

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FLUID PRESSURE OPERATED SENSING SYSTEM
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This invention relates to an edge alignment control system and particularly to such a system which establishes a neutral range of edge positions and which responds to errors in web position in each of two opposite lateral directions from the neutral range of positions.

It is an object of the present invention to provide edge alignment control systems utilizing mechanically actuated switching means responsive to relatively slight mechanical output movements from fluid pressure error sensing means associated with the web position sensing head.

It is another object of the present invention to provide an edge alignment control system which avoids electrical components so as to be particularly advantageous for use in explosive areas and the like.

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 view of a first edge alignment control system in accordance with the present invention; and

FIGURE 1A is a diagrammatic sectional view of a suitable air switch for use in a preferred embodiment of the system of FIGURE 1.

The present invention relates particularly to improvements over the edge alignment control systems illustrated in my copending applications Serial No. 280,600 filed May 15, 1963, and Serial No. 328,652 filed December 6, 1963. As disclosed in detail in said copending applications, a sensing head 10 in accordance with the present invention may be provided with a plurality of sets of multiple cooperating fluid jets, each set of fluid jets being responsive to the presence or absence of a material. In one embodiment, there are only two opposed jets in each set, but in the preferred embodiment, 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 may be provided for defining a neutral zone of web positions therebetween. Thus, referring to FIGURE 1, there are diagrammatically indicated jet defining means 31, 32 and 33 and 41, 42 and 43. The fluid jet means 31-33 and 41-43 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 receiving spaces 34 and 44. 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 a material in the receiving spaces 34 and 44, respectively, 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 an actual physical embodiment, the jet means 32, 33 and 42, 43 may preferably lie in respective offset planes directed longitudinally of the direction of web movement. The actual arrangement is preferred since it enables the jets to be very closely spaced in the lateral direction indicated by the double headed arrow 50 in FIGURE 1. A portion of the web is indicated at 51 having an edge 51a which is located in the neutral zone between the two sets of fluid jets 31-33 and 41-43.

As illustrated in FIGURE 1, where a gas such as air is applied to the jet means, a plant air source 60 of about 80 to 100 pounds per square inch above atmospheric pres-

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sure may be used as a source of fluid under pressure. The plant air is suitably filtered and delivered to a conduit 61 which branches into a pair of conduits 62 and 63. The conduit 62 branches into conduits 65 and 66, and the conduit 66 is provided with a 0 to 5 pound per square inch pressure regulator component 67. The component 67 provides pressures in lines 75, 76, 77 and 78 between 0 and 5 pounds per square inch. A series of metering orifices 81-85 are provided for regulating the flow rates in lines 91, 92, 93, 101 and 102 (the reference characters designating the respective lines corresponding to the reference characters designating similar lines in said copending application Serial No. 280,600). Static pressure lines 95, 96, 105 and 106 preferably tap lines 91, 92, 101, 102 so as to provide a measure of the static pressure in these lines which lead to the fluid jet means 31, 32, 41, 42, respectively.

The metering orifices 81-85 are so proportioned that when the pilot jets 33, 43 are obstructed output lines 91 and 101 have a lesser static pressure as sensed at lines 95 and 105 than the static pressures of lines 92 and 102 as sensed at lines 96 and 106. These static pressures are with respect to the condition where the receiving spaces 34 and 44 are completely obstructed. Output line 93 is shown as connected with jet means 33 and 43 and 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 pilot jets 33 and 43 are present adjacent the orifices of jet means 31 and 41.

With the pilot jet means obstructed, however, as illustrated for the pilot jet means 43 in FIGURE 1, the static pressure associated with the sensing jet means such as 41 is reduced relative to the static pressure associated with the reference jet means such as 42. Thus, in the condition of the system illustrated in FIGURE 1, the pressure in chamber 110 of diaphragm actuator 111 exceeds the pressure in chamber 112 of diaphragm actuator 113. Similarly because of the unobstructed condition of pilot jet means 33, the pressure in sensing line 95 exceeds the pressure in reference line 96, and the pressure in chamber 115 of diaphragm actuating means 116 exceeds the pressure in chamber 117 of diaphragm actuating means 118. In the illustrated embodiment, the diaphragms 121-124 may be considered to be of a resilient material to accommodate axial shifting of the rods 131, 132 and 133, 134 connected therewith in the axial direction for a required distance in each direction from a central position. The opposite chambers 141-144 of the devices 111, 113, 116 and 118 may be considered as being vented to atmosphere by means of apertures in the walls thereof through which the respective rods 131-134 extend and as indicated at 146 for rod 131.

The rods 131 and 132 may be considered as extending into opposite ends of a cylindrical bore 151 of a block 152. Set screws are indicated at 153 and 154 for adjusting the overall length of the mechanical output means associated with diaphragm actuating means 111 and 113. Similarly, the rods 133 and 134 extend into a cylindrical bore 156 of a block 157 and are locked at selected positions by means of set screws 158 and 159 to determine the overall length of the mechanical output means associated with diaphragm actuating means 116, 118. The blocks 152 and 157 carry actuator members 161 and 162 which cooperate with respective air switches 163 and 164. The system is so arranged that air switch 163 is actuated when the edge 51a of the web 51 moves to the right of its correct position so as to obstruct the pilot jet from pilot jet means 33, while the air switch 164 is actuated when the edge 51a of web 51 moves to the left from the correct position and moves out of obstructing relation to the pilot jet associated with pilot jet means 43.

In the illustrated fluid pressure system, the fluid pressure line 63 from the fluid pressure supply 60 connects with a metering orifice 170 and a line 171 which branches into lines 172 and 173. When switch 163 is actuated, air under pressure is supplied to line 175 which leads to the right hand chamber 176 of an actuating cylinder 177. The left hand chamber 178 of the cylinder 177 is connected with a line 179 which under these circumstances may be vented to atmosphere through switch 164 which is in its normal non-actuated condition. Conversely, when switch 164 is actuated, fluid under pressure is supplied from line 173 via line 179 to the chamber 178 of cylinder 177 while chamber 176 is vented to atmosphere through line 175 and switch 163. The cylinder 177, of course, merely represents one typical component for actuating an edge correction device indicated generally at 180. The edge correction device 180 may take the form of a shiftable web guide roll as disclosed in said copending application Serial No. 280,600. The device 177 may comprise any suitable fluid pressure actuated mechanism such as pressure switches, air oil hydraulic systems, air reversing rotary motors, air reversing rotary gear head motors, air cylinders, pilot operated valves, velocity pressure actuated systems or static pressure actuated systems, for example.

The reference number 183 indicates a separate lubricated plant air supply for the system in event that lubrication is required.

FIGURE 1A illustrates very diagrammatically a suitable commercially available air switch identified commercially as model MAV-3 and manufactured by Clippard Instrument Laboratory, Inc. Since valves 163 and 164 are identical in structure, only valve 163 will be described in detail. The structure of the valve 164 will be entirely obvious from the description of the valve 163. The valve 163 comprises an inlet port 201 connected with line 172 and an outlet port 202 connected with 175. A valve member is diagrammatically indicated at 204 which is urged by means of spiral spring 205 into seating relation so as to close the inlet port 201 with respect to the central chamber 207. The chamber 207 is exhausted to atmosphere in the position shown through a central bore 208 of an actuating rod 209. Radial passages are indicated at 210 and 211 communicating the interior of bore 208, with atmosphere in the position of the actuating rod 209 shown in FIGURE 1A. A collar member 213 is rigidly fixed to the actuating rod 209 and has a compression spring 214 acting thereon to resiliently urge the rod 209 to the position shown. The valve member 204 is fixed to a rod 216 having an extension 216a within the bore 208 but of substantially smaller external diameter than the internal diameter of the bore 208. A valve member 216b is on the end of rod 216.

When the web 51 moves out of obstructing relation to the pilot jet means 43 in FIGURE 1, the pressure in chamber 112 will exceed the pressure in chamber 110, and actuating rods 131 and 132 together with block 152 and member 161 will move to the right from a central position as illustrated in FIGURE 1A to shift the stem 209 of valve 163 axially. Shifting of the stem 209 first engages the inner annular end 209a of stem 209 with the valve member 216b to close the passage 208 leading to atmosphere. Further axial shifting of the stem 209 shifts the valve operating rod 216 to unseat valve member 204, connecting passage 172 with the central chamber 207 and thence with the outlet line 175. Air under pressure is thus applied to the actuating chamber 176 in FIGURE 1 to shift a web guide roll, for example, in such a direction as to tend to move the web 51 back to the neutral position, that is to the right for the case under discussion. When the web 51 returns to the position indicated in FIGURE 1, again obstructing the pilot jet means 43, the actuating rods 131, 132 associated with diaphragms 121 and 122 will at least return to a central neutral position corresponding to the case where the pressures in chambers

110 and 112 are equal, for example. Alternatively, the pressures or areas of the respective diaphragms may be such that the diaphragms 121 and 122 are displaced to the left as viewed in FIGURE 1A from their central vertical disposition. In any event, it is preferred that with the web 51 positioned as shown in FIGURE 1, the actuating rods 131 and 132 together with member 161 will assume a position with the member 161 substantially in abutting contact with the end of stem 209 as illustrated in FIGURE 1A. With this arrangement and with the valve specified, the minimum stem travel of $\frac{1}{16}$ inch for actuating the air switch will take place as soon as the actuating system including member 161 travels its first $\frac{1}{16}$ inch from its normal or initial position. The air switch 163 may provide for $\frac{1}{32}$ inch overtravel after it is fully actuated so that the member 161 may travel a total distance of $\frac{3}{32}$ inch. By way of example, the input pressure at line 172 may be 50 pounds per square inch and with this line pressure a force of 1.5 pounds is required on the stem 209 to produce full stem travel. The air switch illustrated may have an air flow rating at 50 pounds per square inch of 4.5 cubic feet per minute.

Summary of operation of the embodiment of FIGURE 1

In the embodiment of FIGURE 1, when the web 51 moves to the right from its neutral position indicated so as to obstruct the pilot jet means 33, the pressure in chamber 117 of the diaphragm actuating means generally designated by the reference numeral 220 will exceed the pressure in chamber 115 so as to shift the member 162 coupled with the diaphragms 123 and 124 to the left actuating air switch 164 so as to supply fluid pressure from the source 60 via lines 61, 63, 173 and 179 to the actuating chamber 178 of the actuating device 177. The shifting of the piston member 222 to the right is coupled mechanically as indicated at 223 with an edge correction device 180 so as to actuate a web guide roll or the like in a direction so as to tend to move the web 51 to the left as viewed in FIGURE 1 so as to return the edge 51a of the web to the neutral position indicated in FIGURE 1. When the web has returned to the neutral position, the diaphragm actuating device 220 may return to the position shown in FIGURE 1A with the member 162 still substantially in abutting contact with the actuating stem 164a of the valve but with the valve connecting the line 179 to atmosphere and closing the line 173 from the source 60.

If the web deviates to the left from the correct position indicated in FIGURE 1, the pilot jet means 43 becomes unobstructed and increases the internal pressure in the line 101, increasing the pressure in actuating chamber 112 of the diaphragm actuating means 221 so as to shift the member 161 to the right connecting air line 172 with the actuating chamber 176 of the actuating device 177 via line 175. Actuation of the piston member 222 to the left may shift a web guide roll or the like in such a direction as to tend to return the web to the neutral range of positions. When the web has returned to the position shown in FIGURE 1, the actuating member 161 will return to the position shown in FIGURE 1 with the member 161 substantially abutting the stem 209 of valve 163, FIGURE 1A, but with the line 175 vented to atmosphere through the bore 208 of stem 209 and through radial passages 210 and 211, FIGURE 1A. The position of the actuating members 161 and 162 with the web in the neutral position shown in FIGURE 1 is preferably such that the actuating members are substantially in abutting contact with the stem members 209 and 164a, with the stems at positions corresponding to the beginning of their working travel. In this event, a slight shifting of the members 161 and 162 will actuate the respective air switches 163 and 164 with a minimum time delay. By way of example, the stems 209 and 164a may actuate the respective valves in response to a stem travel of $\frac{1}{16}$ inch, the valves accommodating a further overtravel of the stems of an additional $\frac{1}{32}$ inch. Thus, beginning in the

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positions of the members 161 and 162 shown in FIGURE 1 corresponding to the neutral position of the web, the first $\frac{1}{16}$ inch travel of the member 161 or 162 will actuate the air switch 163 or 164. A further $\frac{1}{32}$ inch travel of the member 161 or 162 will be accommodated by an over-travel of the associated stem.

It is found that with the specific parameters given herein by way of example, in the illustrated system, all of the jets are of the discharging type thus preventing the entry of foreign matter into the ducts associated with the sensing head. A strong signal is obtained from the diaphragm actuators 220 and 221 with an extremely short reaction time of the order of 50 milliseconds. Since no electricity is involved, the system is excellent in explosive areas and the like.

The system is poised for fast action at all times while in operation since the sensing head 10 constantly maintains air pressure in the actuating chambers 110, 112, 115 and 117. The relative pressures in the opposing chambers are such that there is substantially no wasted travel of the diaphragms 121-124 as the diaphragms are actuated between their respective operating positions. This condition contributes to the fast reaction time as a prime factor.

When the system of FIGURE 1 is used with a liquid actuating medium, such as a city water supply, it is preferred to omit the pilot jets 33 and 43 and to connect only the sensing jet water lines 91 and 101 to the diaphragm actuators 220 and 221. Thus with a water system, jets 31 and 32 and 41 and 42 would be used and water lines 91 and 101 would be coupled to the diaphragm chambers 112 and 115 by water lines 95 and 105 as shown in FIGURE 1. It is preferred, however, to introduce air at a predetermined adjustable pressure in the chambers 110 and 117 rather than connecting these chambers to water lines 92 and 102 as with an air system. The pockets of air under pressure in chambers 110 and 117 serve to rapidly shift the diaphragms to the left when the water jets 32 and 42 are obstructed. Spring means could be placed in chambers 110 and 117 instead of using air pressure biasing.

A water pressure sensing system is particularly advantageous in sensing the edge of a wire or other web in a paper making machine where there are large amounts of water present in any event. In either an air pressure or water pressure sensing system where such water is present at the sensing location, it is preferred that a raised boss surround each jet so that such water will tend to flow away from the jet orifices rather than accumulating at such orifices and interfering with the jets.

Where the triple jet nozzle of FIGURE 1 is used without change in a water actuated system, source 60 could be a city water supply and components 67, and 81-85 would be of suitable construction for water, but the system would otherwise be substantially the same. Line 63, however, would be connected to a source of air pressure where components 163, 164 and 177 are to be pneumatically operated. Bosses would preferably be used around the jets in a triple jet water system under the conditions described above where substantial amounts of water are present in the vicinity of the sensing head.

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

I claim as my invention:

1. An edge alignment control system comprising

- (a) an edge alignment control means for controlling the position of a moving web of material and capable of actuation in respective opposite senses to tend to move the web laterally in respective opposite directions,
- (b) an edge position sensing head having fluid pressure output means for sensing edge position and generating respective first and second differential pres-

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sure outputs in response to errors of web position in respective opposite directions from a correct position of the web defined by said head,

- (c) first and second fluid pressure responsive devices coupled to said fluid pressure output means of said head and responsive to said first and second differential pressure outputs respectively to provide respective first and second mechanical outputs,
- (d) first and second mechanically actuated switching devices coupled respectively to said first and second fluid pressure responsive devices and actuated respectively by said first and second mechanical outputs therefrom, and
- (e) means for connecting said first and second mechanically actuated switching devices to said edge alignment control means for actuation thereof in respective opposite directions in response to said first and second mechanical outputs to tend to maintain said web in said correct position as defined by said head.

2. An edge alignment control system comprising

- (a) an edge alignment control means for controlling the position of a moving web of material and capable of actuation in respective opposite senses to tend to move the web laterally in respective opposite directions,
- (b) an edge position sensing head having fluid pressure output means for sensing edge position and generating respective first and second differential pressure outputs in response to errors of web position in respective opposite directions from a correct position of the web defined by said head,
- (c) first and second fluid pressure responsive devices coupled to said fluid pressure output means of said head and responsive to said first and second differential pressure outputs respectively to provide respective first and second mechanical outputs,
- (d) first and second mechanically actuated switching devices coupled respectively to said first and second fluid pressure responsive devices and actuated respectively by said first and second mechanical outputs therefrom,
- (e) means for connecting said first and second mechanically actuated switching devices to said edge alignment control means for actuation thereof in respective opposite directions in response to said first and second mechanical outputs to tend to maintain said web in said correct position as defined by said head, and
- (f) means comprising said first and second mechanically actuated switching devices for providing a response time to errors in web position of the order of 50 milliseconds.

3. An edge alignment control system comprising

- (a) an edge alignment control means for controlling the position of a moving web of material and capable of actuation in respective opposite senses to tend to move the web laterally in respective opposite directions,
- (b) an edge position sensing head having fluid pressure output means for sensing edge position and generating respective first and second differential pressure outputs in response to errors of web position in respective opposite directions from a correct position of the web defined by said head,
- (c) first and second fluid pressure responsive devices coupled to said fluid pressure output means of said head and responsive to said first and second differential pressure outputs respectively to provide respective first and second mechanical outputs,
- (d) first and second mechanically actuated switching devices coupled respectively to said first and second fluid pressure responsive devices and actuated re-

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- spectively by said first and second mechanical outputs therefrom,
- (e) means for connecting said first and second mechanically actuated switching devices to said edge alignment control means for actuation thereof in respective opposite directions in response to said first and second mechanical outputs to tend to maintain said web in said correct position as defined by said head, and
- (f) said first and second fluid pressure responsive devices comprising diaphragm actuating means having first and second actuating chambers referenced to the fluid pressure output means of said head and having mechanical output means providing the respective first and second mechanical outputs, and said first and second mechanically actuated switch-

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ing devices comprising fluid pressure switches actuated by output displacements of said mechanical output means of approximately $\frac{1}{16}$ inch.

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