

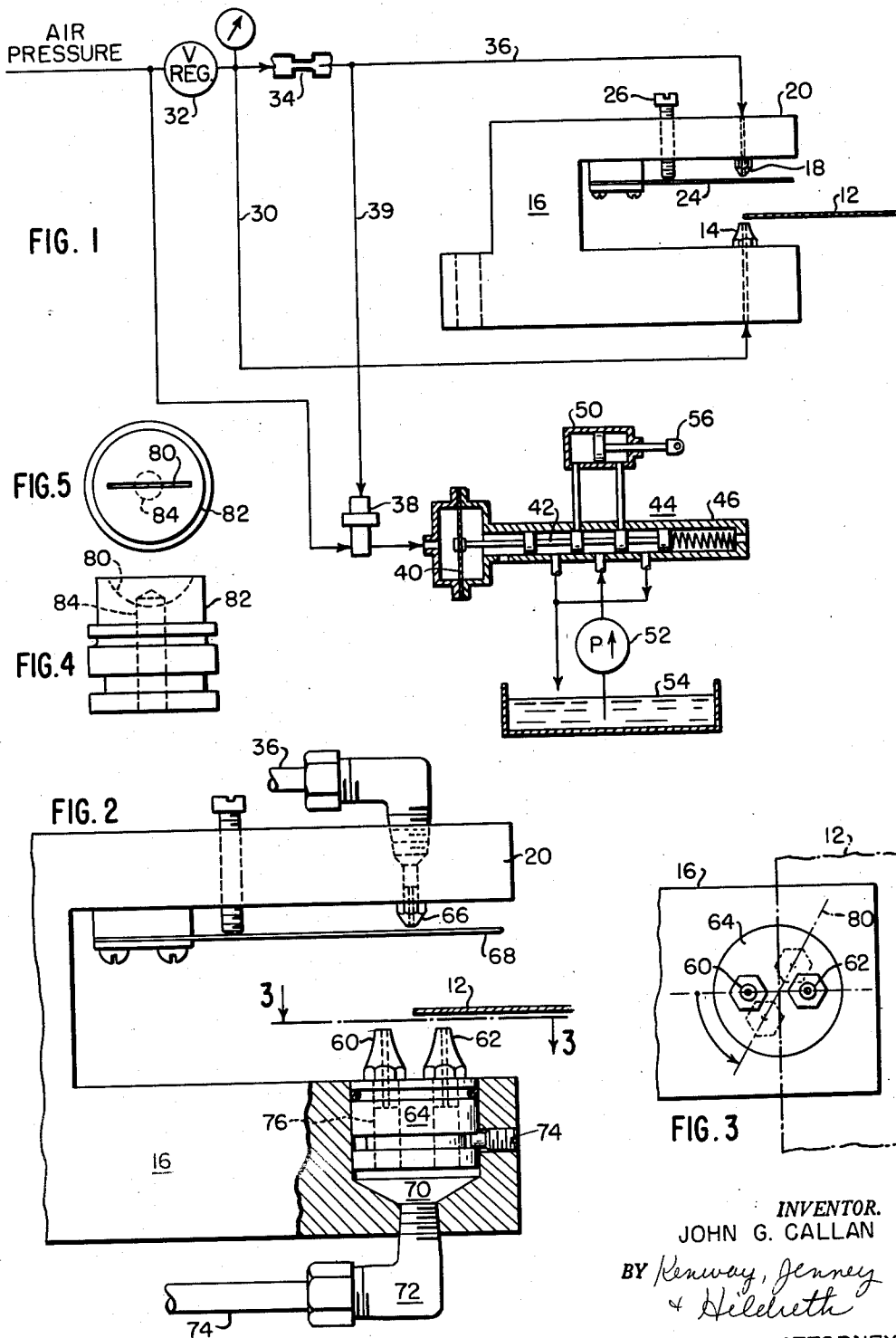
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WEB EDGE CONTROL DEVICE

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WEB EDGE CONTROL DEVICE

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The present invention relates to an edge guide control for moving webs, and is concerned more particularly with an improved edge sensing means for deriving a control signal from the position of the margin of a sheet or web.

In web handling and feeding apparatus, it is frequently important that the web position transversely of the direction of web advance be accurately maintained, for example in relation to a wind-up roll. Rather than guiding the web by a guide wall or rolls in predetermined fixed position at the web edge, it is customary to employ controllable positioning means by which the web position may readily be adjusted as required during web advance. Actuation of the web positioning means is effected by power-operated mechanisms, and it is desirable that such mechanisms be controlled automatically by sensing means accurately responsive to web edge position, but not requiring actual contact with the web edge.

The present invention accordingly has as its object the provision of novel web edge sensing means of the pneumatic type that provides an accurate indication of web edge position, without requiring mechanical engagement with the web.

More specifically, the invention has as an object the provision of web edge sensing means of a type which permits the sensitivity or operating limits of the sensing means readily to be adjusted to suit the requirements of the system.

The invention likewise contemplates the provision of a sensing and positioning system of the pneumatic-hydraulic type wherein high gain is available for accurate control, and wherein the edge sensing is effected by a novel form of jet pipe valve which is accurately responsive to web edge position, yet is free of clogging tendency and is capable of effective operation over long periods of time.

In the drawings illustrating the invention,

FIG. 1 is a diagram, partly schematic, showing the control system and particularly the pneumatic edge sensing valve;

FIG. 2 is a view on a somewhat larger scale than FIG. 1 of another form of edge sensing valve;

FIG. 3 is a top plan detail view of the jet nozzle portion of the valve, taken on the line 3—3 of FIG. 2;

FIG. 4 is a view in elevation of another form of jet nozzle suitable for use in the edge sensing means of the invention, and

FIG. 5 is a top plan detail of the jet nozzle shown in FIG. 4.

Referring to FIG. 1, the left marginal portion of a web to be guided is indicated at 12, and this is to be considered as advancing in a direction perpendicular to the plane of the drawing. Such web may be of metal, paper, cardboard or the like, and may be in some instances relatively thin and delicate, as in the case of the newly-formed paper web in a paper making machine. The web supporting and feeding mechanism, forming no part of the invention, is not shown.

To sense the position of the edge of the web during its advance, and to derive a control signal which may be utilized to correct the web position upon a deviation from the desired position, sensing means utilizing an air jet is employed. The air jet is discharged from a nozzle 14 mounted in one arm of frame 16 of the web edge sensing device. The frame 16 is mounted on or in relation to the web handling mechanism so that the axis of

the nozzle discharge passage intersects or grazes the web edge when the web is in the desired lateral position.

Instead of employing a receptor passage to receive the air jet from the air supply nozzle, as modified by the presence or absence of the web margin in the jet path, the present invention makes use of an intermediate member that results in a marked improvement in operating characteristics over the conventional jet pipe valve. A second nozzle 18, supplied with air at reduced pressure as hereinafter described, is mounted in the other arm 20 of the sensing means frame 16. While the nozzle 18 is shown positioned in substantial alignment with the jet nozzle 14, this is not essential to the operation of the device.

Disposed in closely spaced relation to the nozzle 18 is a flapper 24 arranged for hinging of flexing movement toward and away from the nozzle tip under the influence of the opposing air jets. The flapper may be formed of thin resilient material supported at one end on a spacer block on the arm 20, with an adjusting screw 26 engaging the flapper near its clamped end.

The sensing means is adapted to operate at relatively low air pressure, and is supplied with air in accordance with the diagrammatic showing. The jet nozzle 14 receives air at constant pressure (of the order of 10 lbs. per sq. in., by way of example), through conduit 30 and pressure regulator 32 connected to a pressure source, not shown, while the supply to the sensor nozzle 18 includes a flow-reducing orifice or restriction 34 in the line 36 from regulator 32.

A multiplying air relay of conventional construction 38 is connected by conduit 39 to the line 36 so as to respond to variations in pressure in line 36 as the flapper 24 is moved toward and away from nozzle 18. The air relay, in turn, controls the air pressure that is applied to one side of a diaphragm 40 in control of the position of the movable valve spool 42 of hydraulic valve 44. A spring 46 provides an opposing force, with the result that the valve spool moves to one side on the other of its median or null position as the air pressure on the diaphragm is raised or lowered under the control of the air relay 38.

Valve 44 is employed as the first stage of a hydraulic amplifier, the power stage of which is indicated at 50, with fluid supplied under pressure by pump 52 from sump 54. The output member 56 of the power stage is connected to the web-positioning mechanism of the web handling apparatus. As such mechanism is conventional and forms no part of the present invention, no illustration is made thereof in the drawings beyond the showing of the power-actuated driving member 56.

The operation of the positioning system utilizing the sensing valve of the invention may be described as follows: Air at reduced pressure supplied through reducer valve or orifice 34 escapes between the tip of nozzle 18 and the resilient flapper 24 at a rate determined by the clearance existing at any particular moment. By reason of the flow restriction produced by orifice 34, the static pressure in line 36, and consequently the control pressure applied to air relay 38, varies over a substantial range with small variations in flapper position, and the hydraulic amplifier, with its output member 56, is actuated accordingly.

The clearance between flapper 24 and nozzle tip 18 is an extremely sensitive function of the exposure of the flapper to the air blast from jet nozzle 14. The extent of the impingement of the air jet on the flapper, in turn, is determined by the amount of masking or shielding that results from the margin of the web. That is, as the web during its advance moves laterally one way or the other, the air jet striking the flapper increases or decreases. Upon a movement of the web to the left, as

viewed in FIG. 1, the air jet on the flapper is diminished, and the flapper moves away slightly from the nozzle 18 under the influence of the relatively low pressure air stream flowing therefrom. The increased flow volume brings about a marked decrease in pressure which acts on the air relay to generate a pressure change on the hydraulic amplifier and thereby actuate the output member 52 in a direction to restore the web to its proper lateral position.

Conversely, if the web moves to the right, as viewed in FIG. 1, from a position in which the web edge partially shields the flapper 24 from the jet discharging from nozzle 14, the effect of the increased exposure to the air jet is to cause the flapper to approach the nozzle 18 more closely. The reduced clearance between nozzle 18 and the flapper cuts down the air flow and brings about an increase in pressure at the control inlet of the air relay. There results a corresponding left-wise correcting movement in the web position through appropriate action by the hydraulic amplifier.

At some intermediate position of the web, partially obstructing the jet, an equilibrium position is possible wherein the flapper position is such that the air pressure at the air relay corresponds to the neutral zone or position of the valve spool 42, in which oil flow to the power cylinder is cut off and the web positioning means maintains its setting. Upon any departure of the web laterally from such intermediate position, the flapper immediately responds to the variation in the air jet thereon, and the change in pressure drop across the restriction 34 provides a corrective control signal to the air relay. If, as indicated in the drawing, the air passage in nozzle 14 is of relatively small diameter, the response to positional changes in the web is extremely sensitive and the web edge position may be maintained to very close tolerances, though there may be a slight oscillation in the overall system as a result of the sharp response characteristic of the sensing means, if the rest of the system has high gain.

For applications where it is only necessary to position a web or sheet within certain limits, without attempting to reposition the web so long as its margin remains within those limits, a modified nozzle arrangement may be employed to advantage. Such construction is illustrated in FIGS. 2 and 3, wherein the air jet is seen to involve dual spaced jets, instead of a single jet as in FIG. 1.

As illustrated in FIG. 2, the two air jets are generated by spaced nozzles 60, 62 mounted in a cylindrical block 64 received in a bore in the frame 16. Preferably the center line of the bore corresponds to the center line of the nozzle 66 on the opposite side of the flapper 68 from the air jet nozzles 60, 62. An air supply connection is made to the chamber 70 rearwardly of the block 64 through elbow 72 and tubing 74, by way of illustration. An O-ring seal is provided between block and frame, and a set screw 74 may be employed if desired, although at the low air pressures which are commonly employed, the frictional engagement provided by the O-ring seal will hold the block in adjusted position. Passages 76 through the block provide for the supply of air from the inlet chamber 70 to the nozzles 60, 62, regardless of the rotational setting of the nozzle block.

In the operation of this embodiment, the system will be adjusted so that with one nozzle shielded from the flapper by the web edge, the hydraulic system is in neutral position and the web positioning mechanism holds its position. If the web should shift far enough to cover both nozzles, the flapper will move away from nozzle 66 and thereby initiate a correcting movement of the web to the right, while a shift in web position that uncovers the outer nozzle 62 brings about activation of the web-positioning servo system in the other direction.

By rotating the nozzle block in the frame, the width of the null zone may be adjusted. As illustrated in FIG. 3, the maximum width of null zone is with the line through the two nozzle centers perpendicular to the web

margin, as represented by the full-line showing of the nozzles. If the block is turned 90° so that the line through the two nozzles is parallel to the web edge, the sensitivity will be substantially that of a single nozzle, as in the FIG. 1 embodiment, and there will be no appreciable null region. At some intermediate setting, as represented by the dot and dash line 80, the null region will be determined by the separation of the nozzle centers in a direction perpendicular to the web edge.

Still another form of jet nozzle is illustrated in FIGS. 4 and 5. In this embodiment, which is adapted for mounting in the frame 16 of the sensing device in the same manner as the cylindrical block 64 of FIG. 2, a single air jet is generated. This jet is given a non-circular configuration by means of a narrow discharge slot 80 at the tip of the block 82. The slot 80 communicates with the inlet chamber 70 by central passage 84. The provision of a single elongated discharge slot permits a control wherein the pressure in air line 36, and hence the control pressure at the air relay 38, may vary in a continuous manner with the web position as the latter shifts over an appreciable range. Thus a proportional or throttling type control is provided, as compared with the relatively sharp On and Off response of the FIG. 1 embodiment, or the neutral zone with steep response at the limits, provided by the dual jet nozzle of FIGS. 2 and 3.

By changing the rotational position of the nozzle block 82 in the frame 16, the steepness of the throttling characteristic may be adjusted. Thus, with the nozzle slot perpendicular to the web edge, the control range of air pressure variation in terms of web shift may be substantially the length of the slot, while a setting of the slot parallel to the web edge gives a response that is substantially On or Off, as with the single small nozzle passage of FIG. 1. Intermediate angular positions are available for control ranges less than the full length of the nozzle slot.

The invention thus comprises a novel form of pneumatic valve, characterized by a resilient flapper disposed adjacent the sensor nozzle and responsive to variations in exposure to an air jet from an opposing jet nozzle. Such variations in exposure of the flapper to the air jet cause a flapper movement relative to its adjacent sensor nozzle such as to vary the pressure in the sensor nozzle supply line over substantially the full range between zero pressure and the regulated pressure upstream of the flow-reducing orifice, and such wide range in pressure provides a sensitive and accurate control signal. Furthermore, the response characteristic of the device may be adjusted to cover a wide variety of requirements by selection of jet nozzle configurations and orientation, and the invention contemplates the provision of various jet nozzle constructions and arrangements within the scope of the appended claims.

I claim as my invention:

1. A pneumatic edge-sensing device for detecting the position of the margin of a web or sheet, comprising a jet nozzle having a discharge passage disposed in a direction generally perpendicular to the plane of the web in the vicinity of the margin thereof, a sensor nozzle disposed in spaced opposed relation to the jet nozzle, a resilient flapper disposed between the nozzles in close proximity to the sensor nozzle and responsive to the impingement of the air discharge from the jet nozzle as affected by the position of the margin of the web material to vary the clearance between flapper and sensor nozzle, the jet nozzle having a pair of spaced discharge passages.

2. A pneumatic edge-sensing device for detecting the position of the margin of a web or sheet, comprising a jet nozzle having a discharge passage disposed in a direction generally perpendicular to the plane of the web in the vicinity of the margin thereof, a sensor nozzle disposed in spaced opposed relation to the jet nozzle, a resilient flapper disposed between the nozzles in close proximity to the sensor nozzle and responsive to the impingement

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of the air discharge from the jet nozzle as affected by the position of the margin of the web material to vary the clearance between flapper and sensor nozzle, the jet nozzle comprising a nozzle block having a pair of spaced discharge passages, said nozzle block being mounted for rotational adjustment to vary the difference in spatial relation between each nozzle and the margin of the web.

3. A pneumatic edge-sensing device for detecting the position of the margin of a web or sheet, comprising a jet nozzle having a discharge passage disposed in a direction generally perpendicular to the plane of the web in the vicinity of the margin thereof, a sensor nozzle disposed in spaced opposed relation to the jet nozzle, a resilient flapper disposed between the nozzles in close proximity to the sensor nozzle and responsive to the impingement of the air discharge from the jet nozzle as affected by the position of the margin of the web material to vary the clearance between flapper and sensor nozzle, the jet nozzle having an elongated narrow discharge slot.

4. A pneumatic edge-sensing device for detecting the position of the margin of a web or sheet, comprising a jet nozzle having a discharge passage disposed in a direction generally perpendicular to the plane of the web in the vicinity of the margin thereof, a sensor nozzle disposed in spaced opposed relation to the jet nozzle, a resilient flapper disposed between the nozzles in close proximity to the sensor nozzle and responsive to the impingement of the air discharge from the jet nozzle as affected by the position of the margin of the web material to vary the clearance between flapper and sensor nozzle, the jet nozzle comprising a nozzle body having an elongated narrow discharge slot, said nozzle block being mounted for rotational adjustment to vary the orientation of the nozzle discharge slot relative to the margin of the web.

5. A pneumatic edge-sensing device for detecting the position of the margin of a web or sheet, comprising a jet nozzle having a jet flow discharge along an axis substantially perpendicular to the plane of the web at the margin thereof, a resilient flapper having a portion exposed to

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the jet flow from the jet nozzle and generally perpendicular to the axis thereof, and a sensor nozzle close to the resilient flapper and having a flow discharge along an axis intersecting said flapper, the portion of the resilient flapper exposed to the jet flow from the jet nozzle being on the opposite side of the web from the jet nozzle and responsive to the impingement of said jet discharge from the jet nozzle past the web edge as affected by the position of the web edge to vary the clearance between flapper and sensor nozzle.

6. A pneumatic edge-sensing device for detecting the position of the margin of a web or sheet, comprising a jet nozzle having a jet flow discharge along an axis substantially perpendicular to the plane of the web at the margin thereof, a resilient flapper having a portion exposed to the jet flow from the jet nozzle and generally perpendicular to the axis thereof, and a sensor nozzle close to the resilient flapper and having a flow discharge along an axis intersecting said flapper, the portion of the resilient flapper exposed to the jet flow from the jet nozzle being on the opposite side of the web from the jet nozzle and responsive to the impingement of said jet discharge from the jet nozzle past the web edge as affected by the position of the web edge to vary the clearance between flapper and sensor nozzle, the jet nozzle having a jet flow cross-sectional shape wider in one dimension than transversely thereof, said nozzle being mounted for rotational adjustment about the nozzle axis to vary the angular relation of the jet flow cross-sectional shape relative to the web edge.

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