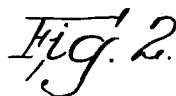
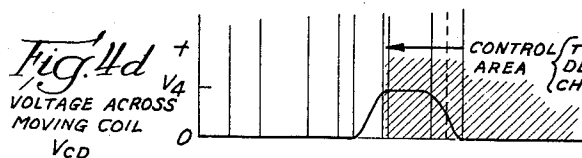
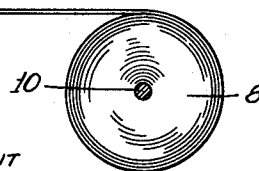
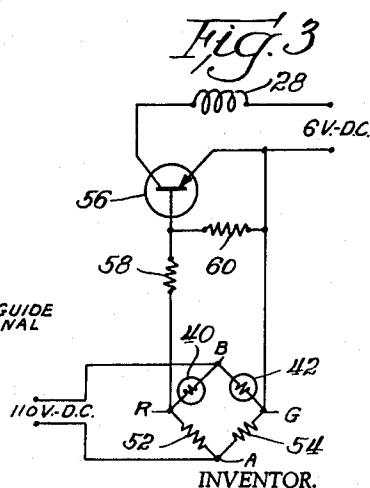


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## CONTROL SYSTEM

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## CONTROL SYSTEM

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This invention relates to a control system and more particularly to a control system for controlling a web of material having adjacent and continuous portions of different density whereby a line defined by the junction of the portions is maintained in a given lateral position during longitudinal movement of the web.

The invention has particular application for use with a web of material having adjacent and continuous portions of different density wherein the variation in density change of each portion is interrelated, that is, both change substantially the same amount and in the same direction.

Briefly, the invention contemplates the use of two photo-electric cells arranged on one side of the web, and two light sources, or lamps, on the opposite side of the material, each lamp being in alignment with one of the photo-electric cells. One of the photo-electric cells, hereinafter referred to as a reference head or cell, is stationed over the portion of the web which is less dense, while the other photo-electric cell, hereinafter referred to as a guide head or cell, is stationed in the region of the material wherein the less dense and more dense portions of the web join. A jet pipe regulator is arranged for lateral control of a roll which supports the web, whereby lateral movement of the roll will position the web relative to the photo-electric cells. A floating coil is arranged to contribute to the operation of the regulator, whereby the latter will position the roll in accordance with an electric signal received by the floating coil from the photo-electric cell circuitry. In such manner, any lateral deviations of the moving web from a predesignated lateral position during longitudinal movement of the web, will result in a correcting movement of the web by the roll in accordance with demand of the photo-electric circuitry, all in a manner that is automatic and which affords rapid and precision lateral positioning of the web during longitudinal movement thereof.

A principal object of the invention is to provide a control system for handling a web of material having adjacent and continuous portions of different density whereby a line defined by the junction of the portions is maintained in a given lateral position during longitudinal movement of the web.

A further object of the invention is to provide a control system for use in controlling the lateral position of a duo-density material during longitudinal movement thereof, which system is automatic and which affords rapid and precision positioning of the web during said movement thereof.

These and further objects and features of the invention will become more obvious from the following description and accompanying drawing wherein:

Fig. 1 is a partially schematic plan view of a control system illustrative of an embodiment of the invention;

Fig. 2 is a section view generally as seen from line 2—2 in Fig. 1;

Fig. 3 is a diagram of an electrical circuit used in the control system of Fig. 1; and

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Figs. 4a and 4d are graphs illustrating certain voltage relationships generated by the circuit of Fig. 3.

Referring now to the drawing, numeral 6 identifies a web of material which is being unwound from a roll 8 in the direction of the arrow for processing, said roll being supported by a shaft 10, which is arranged for reciprocal movement provided by a piston 12 slidably arranged in a cylinder 14. Movement of the piston 12 is controlled by an electro-hydraulic relay, such as a jet pipe regulator 16, the operating principles of which are well known, and which are set forth in detail in the recent patent to W. G. Holzbock, No. 2,814,183, dated November 26, 1957. Briefly, the regulator 16 includes a jet pipe 18 which is pivoted at one end and is further arranged to cause a stream of pressurized liquid to be ejected from the opposite end toward two receiving orifices 20 and 22 forming the end openings of pipe means 24 and 26 respectively which lead to and open unto the ends of cylinder 14 on opposite sides of the piston 12. An electro-motive means in the form of a floating or moving coil 28 and permanent magnet 30 is arranged so that when current flows in the coil it will be displaced resulting in movement of the jet pipe in one direction, while an adjustable compression or biasing spring 32, is adapted to urge the jet pipe in the opposite direction. Any given position of the jet pipe 18 is dependent upon the resultant force of the electro-motive means and the spring means 32, all as will be more clearly understood from the description to follow.

The web of material 6 has adjacent and continuous portions 34 and 36 of different densities caused by a difference in weave or the number of threads per square inch, portion 34 being less dense than portion 36. A longitudinal line 38 is formed at the junction of the two portions. It may be assumed that neither edge of the web is of sufficiently uniform distance from line 38 to serve as a satisfactory reference for web guiding purposes. Also, it will be borne in mind that there is a generally corresponding change in density of the portions 34 and 36 along the length of the web of material. A pair of photo-electric sensing heads 40, 42 are positioned on one side of the web 6, while light sources in the form of a pair of lamps 44, 46 are positioned on the opposite side of the web in alignment with the sensing heads 40, 42 respectively.

Sensing head 40, which operates as a reference head, is arranged over the less dense portion of the web, i.e., 34, while sensing head 42, which operates as a guide head, is arranged over the web in the region of the line 38. While the sensing heads 40, 42 are shown mounted on separate and rigidly fixed arms 48, 50 respectively, it is understood that both of the sensing heads may be mounted on a single arm, and further, either or both sensing heads may be adjustably positioned on its supporting arm.

As best seen in Fig. 3, each photo-electric cell serves as one leg of a bridge circuit, the other two legs of the bridge circuit containing resistances 52 and 54. The junction points of the bridge circuit are identified as R, B, G and A. A transistor 56 serves as an unbalance detector and current amplifier for driving the floating coil 28, while a limiting resistance 58, and a biasing resistance 60 are arranged in the circuit as shown. A 110 volt D.C. power source is applied to the bridge at point A and B, while a 6 volt D.C. power source is applied to the transistor 56.

With equal light intensity on both photo-cells 40, 42, the bridge circuit is in balance and the voltage at points R and G will be zero. Under such condition, there will be practically no emitter to base current and no emitter to collector current. With an unbalance of light intensities on the guide heads, such as when the light intensity on the reference head 40 is greater than on guide head

42—a normal operating condition since the reference head is normally positioned over the less dense material 34—the resistance of the guide head 40 will be the lower and voltage across RB will be less than voltage GB. Hence there will be a voltage difference between R and G, R being lower and more negative. Under such conditions, the negative voltage on the base of the transistor 56 will allow current to flow from the emitter to the base which in turn will allow a proportionally larger current to flow from emitter to collector, thereby energizing the moving coil 28. When the more dense material 36 is under the guide head 42, there will be more than enough emitter-base current to saturate the collector. This range between cut-off and saturation is used for the control range with the nominal guide position being set at about midpoint. At this point, the force of the moving coil is counterbalanced by the bias spring 32.

The operation of the above described control system may be readily understood with reference to Figs. 4a to 4c, which graphically illustrate the voltages developed across the photocells 40, 42, the resultant voltages applied to the transistor 56 as the web 6 is moved laterally beneath the photo-cells, and the voltages imposed on the moving coil, all under various positions or conditions of web travel.

In Fig. 4a various voltage conditions across the reference photo-cell 40 are illustrated. V1 is the voltage before the web intercepts the light means as the web is moved laterally into position, which voltage is constant and is shown extending to the point identified by (a); an increase in voltage to V2 takes place between points (a—b) as the web is moved laterally to intercept the light beam, the distance between point (a) and point (b) corresponding to the length of the slot of the photo-cell 40; voltage V2 remains substantially constant between points (b—c) which corresponds to the width of web portion 36; a decrease in voltage to V3 takes place between points (c—d) which corresponds to the length of the slot of the photo-cell; voltage remains at V3 as the less dense portion 34 of the web is maintained in position to intercept the light beam during longitudinal movement of the web.

In Fig. 4b various voltage conditions across the guide photo-cell 42 are illustrated; V1 is the voltage before the web intercepts the light beam, which voltage is constant and is shown extending to the point identified by (a'); an increase in voltage to V2 takes place between points (a'—b') as the web is moved laterally to intercept the light beam, the distance between point (a') and point (b') corresponding to the length of the slot of the photo-cell 42; voltage V2 remains substantially constant between points (b'—c') which corresponds to the width of web portion 36; a decrease in voltage to V3 takes place between points (c'—d') which corresponds to the length of the slot of the photo-cell; voltage will stay at V3 as long as the less dense portion of the web i.e., portion 34 intercepts the light beam directed at photo-cell 42, however, the system is such as to automatically maintain, under nominal conditions, the line 38 at approximately the mid-length of the slot of the photo-cell 42, as shown.

In Fig. 4c the difference in voltage between that of photo-cell 40 and photo-cell 42 is illustrated. Note that the bridge control point R is negative with respect to G which therefore gives the desired negative control signal required by the transistor 56. The system will be in control from the point the line 38 leaves the reference head 40 until it reaches another density change. This is indicated by the shaded area on graphs 4c and 4d.

Fig. 4d illustrates the transistor output voltage applied to the moving coil 28. V4 occurs at saturation of transistor collector current.

During longitudinal movement of the web of material, assume that the web moves laterally toward or under the sensing heads. The control voltage on the transistor becomes less negative, and the transistor output to the

moving coil will be reduced. The biasing spring 32, which is set to equal the moving coil force under nominal conditions, will urge the jet pipe 18 so that the pressurized liquid flowing therefrom is directed more in alignment with orifice 22. This causes increase in pressure on one side of the piston 12 and decrease in pressure on the opposite side thereof, thus resulting in a movement of the roll 8 so that the web line 38 is brought back into nominal position under the guiding head 42.

The converse will happen if lateral movement of the web occurs in the opposite direction to that above described.

It will be seen from the foregoing that the control system of the invention will automatically operate to maintain a longitudinally moving web of duo-density material as defined, in a straight moving path as may be required for proper processing of the material, such as in trimming or other operations. It will also be seen that in the event of electrical power failure in the circuit, the bias spring 32 will force the jet pipe 18 into alignment with orifice 22, thus causing movement of the web away from the sensing heads and preventing damage to the machine.

The foregoing description has been given in detail without thought of limitation since the inventive principles involved are capable of assuming other forms without departing from the spirit of the invention or the scope of the following claims.

What is claimed is:

1. A control system for guiding a web of material having continuous adjacent portions of different density defining a line at the junction of said portions, said system comprising a reference photo-cell positioned over one of the portions, a guide photo-cell positioned over the line, lamp means arranged under the material and directed at said photo-cells, and a regulator arranged to receive an electrical signal and in response thereto to cause operation of a positioning means for lateral positioning of the material relative to said photo-cells, said photo-cells being arranged in an electrical circuit including a transistor means responsive to difference in voltage across said photo-cells to vary the electrical signal being transmitted from the transistor to the regulator.

2. A control system for guiding a web of material having continuous adjacent portions of different density defining a longitudinal line at the junction of said portions, said system comprising a reference photo-cell positioned over the less dense portion of the material, a guide photo-cell positioned over the longitudinal line, lamp means arranged under the material and directed at said photo-cells, and a hydraulic regulator arranged to receive an electrical signal and in response thereto to cause operation of a positioning means for lateral positioning of the material relative to said guide photo-cell, said photo-cells being arranged in a bridge circuit the voltage of which is applied across a transistor means which is responsive to differences in voltage across said photo-cells to vary the electrical signal being transmitted to the regulator.

3. A control system for guiding a web of material having continuous adjacent portions of different density defining a longitudinal line at the junction of said portions, said system comprising a reference photo-cell positioned over the less dense portion of the material, a guide photo-cell positioned over the longitudinal line, lamp means arranged under the material and directed at said photo-cells, a shaft for supporting a roll of said material, a piston slidably positioned in a cylinder said piston being arranged for longitudinal movement of said shaft, and a hydraulic regulator arranged to receive an electrical signal and in response thereto to develop a pressure differential on said piston to cause movement of said shaft in accordance with the intensity of said signal, said photo-cells being arranged in a bridge circuit adapted to apply voltage across a transistor means

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which thereby regulates the electrical signal being transmitted to the regulator.

4. A control system for guiding a web of material having continuous adjacent portions of different density defining a longitudinal line at the junction of said portions, said system comprising a reference photo-cell positioned over the less dense portion of the material, a guide photo-cell positioned over the longitudinal line, lamp means arranged under the material and directed at said photo-cells, a shaft for supporting a roll of said material, a piston slidably positioned in a cylinder, said piston being arranged for longitudinal movement of said shaft, a jet pipe regulator operable for controlling movement of said piston, said regulator including an electro-motive means and a compression spring being adapted to operate in opposition to the electro-motive means, and an electrical circuit including said photo-cells and a transistor, said photo-cells being responsive to changes in light intensity to impose a voltage upon said transistor to thereby regulate an electric signal being transmitted to said electro-motive means.

5. A control system according to claim 4 wherein said electro-motive means includes a floating coil which is adapted upon energization to cause movement in one direction of a jet pipe of the regulator, while expansion of said spring will cause movement of the jet pipe in the opposite direction.

6. A control system for guiding a web of material having continuous adjacent portions of different density defining a longitudinal line at the junction of said por-

tions, said system comprising a reference photo-cell arranged as an arm member for positioning over the less dense portion of the material, a guide photo-cell arranged on an arm member for positioning over the longitudinal line, said photo-cells being arranged at a fixed distance relative to each other, lamp means arranged under the material and directed at said photo-cells, a shaft for supporting a roll of said material and from which the material is being unwound, a piston slidably positioned in a cylinder, said piston being operative for longitudinal movement of said shaft, a jet pipe regulator operable for controlling movement of said piston, said regulator including a floating coil and a compression spring, said floating coil being arranged to move a jet pipe of the regulator in one direction, said compression spring being arranged to move said jet pipe in the opposite direction, said piston being positionable in accordance with the positioning of said jet pipe, and an electrical circuit including said photo-cells and a transistor, said photo-cells being responsive to changes in light intensity to impose a voltage upon said transistor to thereby regulate an electric signal being transmitted to said floating coil.

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