

May 5, 1964

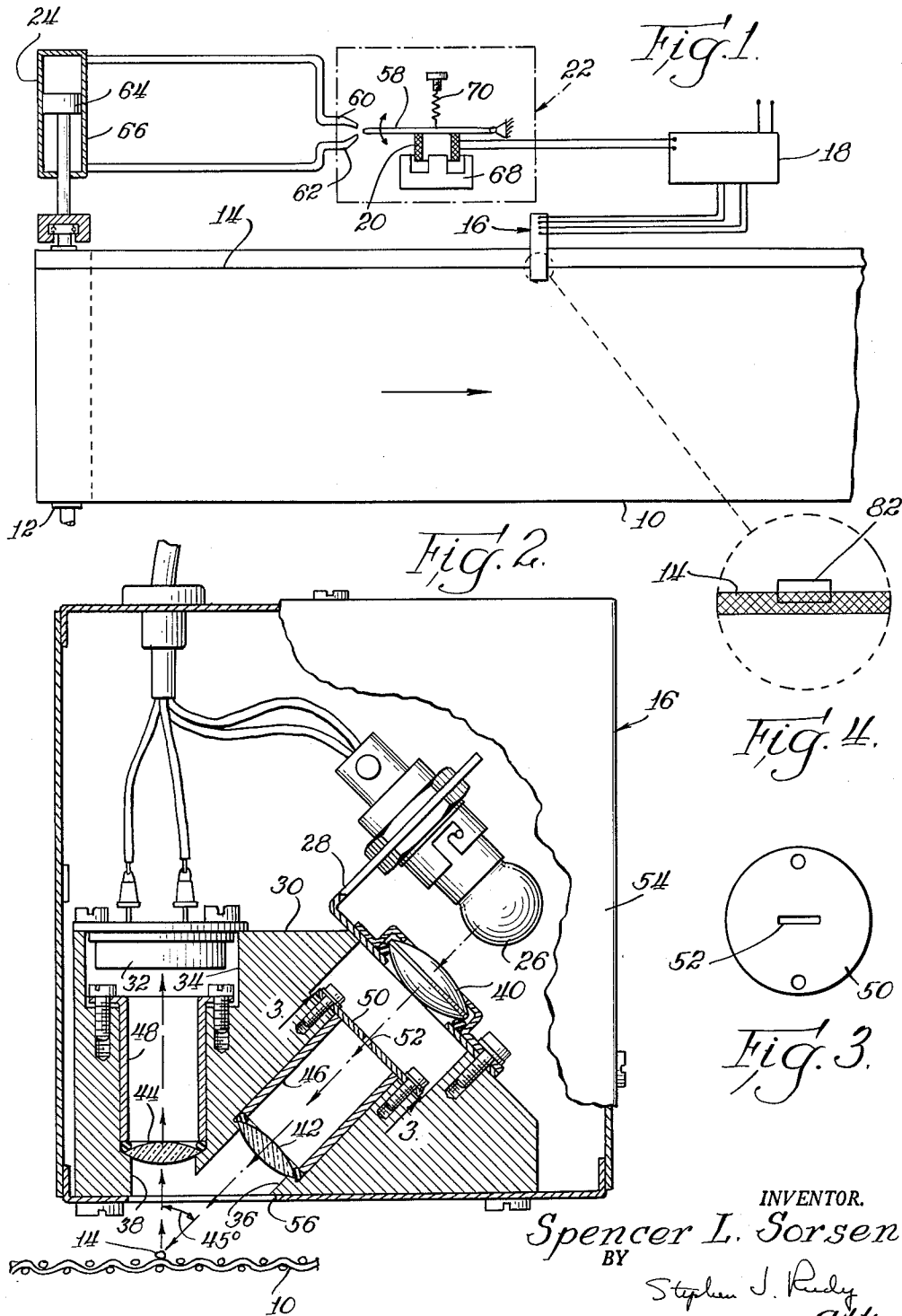
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3,132,253

WEB GUIDANCE APPARATUS

Filed July 1, 1960

2 Sheets-Sheet 1



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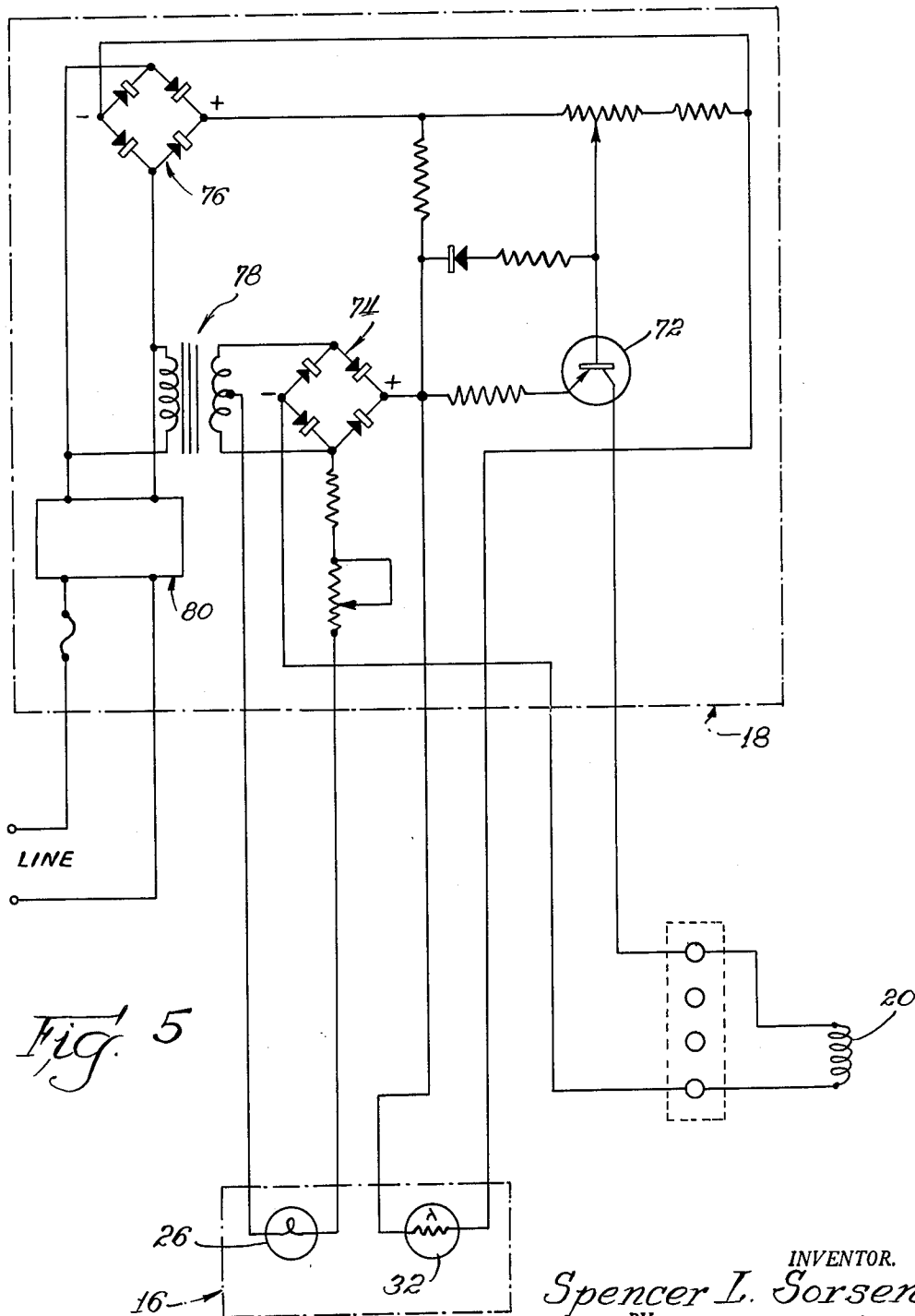
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WEB GUIDANCE APPARATUS

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Filed July 1, 1960, Ser. No. 40,202

6 Claims. (Cl. 250-219)

This invention relates to apparatus for following a line on a moving web whereby either the flight of the web may be controlled, or a movable means may be made to follow the line as the web shifts laterally during its travel between rollers.

Briefly, the apparatus of the invention includes a fixed position sensing head adapted to direct a concentrated beam of light upon a reference line which is printed, or otherwise applied to a web of material, part of said light beam being received by a photo-conductive cell after reflection by the material. The latter converts change of light intensity, due to lateral movement of the line relative to the light beam, to a change in cell resistance causing a voltage change which is applied to an amplifier. The amplifier is arranged to apply the change of control voltage to a voice coil of a "jet pipe" hydraulic regulator which functions to cause operation of a power cylinder whereby the web is moved so that the reference line will travel in a predesignated path. In such manner, the flight of the web is regulated. As an alternative, the apparatus may be arranged so that the sensing head will move and follow the travel of the reference line, whereby a movable means, such as a slitting head, will be caused to slit the web of material longitudinally in predesignated widths.

The use of a light responsive sensing head in line following for web flight control is, of course, known; however, the present invention represents an improvement in such art. More particularly, the apparatus of the present invention is much simpler in structure and operation, and provides more accurate and reliable control as compared with many of the devices and/or arrangements of the prior art intended for similar purposes. Of special interest is the manner in which the light beam is concentrated to provide extremely sensitive pickup, thus producing sharp signal response which provides superior control characteristics.

The main object of this invention is to provide line follower apparatus for controlling the lateral deviation of a web of material as it moves longitudinally.

A more specific object is to provide line follower apparatus for control of lateral deviation of a web of material as it moves between rollers, which apparatus is of simplified structure and which provides accurate and reliable control.

Another object is to provide a line follower apparatus wherein means are arranged which follow the lateral movement of a line upon a moving web of material, whereby certain operations may be rendered upon the moving web.

Still another object of the invention is to provide a line follower controller wherein a light beam is concentrated to provide extremely sensitive pickup, thus producing a sharp signal response which affords superior control characteristics.

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

FIG. 1 is a schematic illustration of a line follower controller arrangement according to the principles of the invention;

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FIG. 2 is a partial section view of a photo-electric pickup head assembly used in the arrangement of FIG. 1;

FIG. 3 is a view generally as seen along line 3-3 in FIG. 2;

FIG. 4 is an enlarged plan view illustrating the degree of overlap of a concentrated light beam upon a guide line formed on material being guided, under nominal operating conditions; and

FIG. 5 is a wiring diagram used in the line follower controller arrangement of FIG. 1.

Referring now to the drawings, and more particularly to FIG. 1, the numeral 10 identifies a sheet, or web of material, such as paper, as it is being unwound from a roll or roller 12, and is moved longitudinally toward another roller (not shown) for certain operations such as trimming, printing, slitting, or rewinding, as the case may be. A straight continuous guide line 14 has been previously printed, or otherwise placed upon the material 10 near one edge thereof and substantially parallel with the longitudinal centerline of the material, or some other desired reference, which guide line is arranged to be in contrast with the color, or shade of the material. Positionally supported on one side of the material 10 and above the line 14, is a line follower sensing head 16, which is in electrical connection with an amplifier assemblage 18. As will be more fully set forth hereinafter, the assemblage 18 is adapted to receive an electrical signal from the sensing head 16, which signal is related to the intensity of a light beam reflected from the material 10, and which is indicative of the degree of lateral movement of the line 14 during web travel. The assemblage 18 is further adapted to apply a voltage to an electromagnet coil 20 of a jet pipe regulator 22, in accordance with the signal received from the sensing head 16, whereby lateral movement of the roller 12 is effected by virtue of a hydraulic power means 24, which is under control of the jet pipe regulator 22. In such manner, corrective action is applied to control the lateral movement of the line 14, and hence the flight of the material 10 as it is being unwound from the roller 12.

The sensing head 16 includes a light source, such as an electric lamp 26, which is supported by a bracket 28 upon a mounting block 30, and a photo-conductive cell 32 positionally arranged within a cavity 34 formed in the block 30. The cell 32 is preferably of the cadmium-sulfide type, such as is available on the market under part designation RCA-7163. Intersecting passageways 36 and 38 are formed in the block 30, the former of which is in axial alignment with the lamp 26, the latter being in axial alignment with the photo-conductive cell 32, as shown. Preferably the angle of intersection between the passageways 36 and 38 is 45°; however, angles of other degrees may be required under certain conditions, such as where the material is shiny and the line to be followed is dark. A lens system including lens 40 and 42, is arranged for concentrating and directing the light through the passageway 36, while a lens 44 is arranged for concentrating and directing reflected light through the passageway 38 into the photo-conductive cell 32. A sleeve 46 is positioned in passageway 36 for holding the lens 42 in position, while a flanged sleeve 48 is arranged in passageway 38 for holding the lens 44 in position. The sleeve 46 is retained by a disc member 50 which has a rectangular slot 52 formed in the center thereof. The slot is arranged so that its longitudinal axis is parallel with the line 14, as best seen in FIG. 4. A housing means 54 is arranged for encasement of the block 30 and the elements mounted thereupon, which housing means is provided with a hole 56 on the lower

surface whereby light from the lamp 26 may be directed upon the line 14, and reflected back to the photo-conductive cell 32.

The jet pipe regulator 22 is well known in the art and reference may be had to the U.S. patent of Werner G. Holzbock, No. 2,814,183, for a more detailed description of a typical structure, as well as the operating principles of such a regulator. Briefly, the regulator 22 includes a jet pipe 58 which is pivoted at one end, the opposite end being in spaced relation to the ends of two receiver pipes 60 and 62. Hydraulic medium, such as oil, is jetted from the pipe 58 toward the openings of the pipes 60 and 62, thereby causing a pressure force upon the opposite sides of a piston 64 forming part of the hydraulic power means 24. The piston 64 will be moved and positionally maintained within a cylinder 66 in accordance with the pressure differential upon the piston 64, which results from the position of the jet pipe relative to the pipes 60 and 62 leading to opposite ends of the cylinder 66. Pivoted movement of the jet pipe 58 is caused by an electro-motive means including the movable voice coil 20 mounted, or connected to the jet pipe, and a permanent magnet 68. An adjustable compression spring 70 is arranged for regulating the set point of the jet pipe 58 in the well known manner.

The amplifier 18 includes in the main, a transistor 72, a pair of four-way bridge rectifiers 74 and 76, a transformer 78, and a constant voltage transformer 80. The amplifier is connected across a line which delivers A.C. current, as required in the design of the amplifier. The circuitry of the amplifier is sufficiently indicated so that anyone skilled in the art, could, without the exercise of inventive genius, produce an amplifier for the intended purpose. The main function of the amplifier is to regulate the current in the voice coil 20 in accordance with the intensity of the reflected light received by the photo-conductive cell 32.

Assume that under balanced operating conditions, the sensing head 16 is arranged to project a spot of light 82 (FIG. 4) upon the moving web so that approximately one third will overlap the line 14. Under a given level of light intensity, the amount of light reflected into the photo-inductive cell 32 will result in a signal current sent to the amplifier, which will be amplified and cause a certain voltage being applied to the voice coil 20. The latter will move accordingly to cause the jet pipe to assume a position whereby hydraulic fluid will be directed to the piston 64. The pressure differential upon the piston 64 will cause it to be positionally maintained so that the roller 12 will be in an axial position whereby the material being unwound therefrom will be travelling in a nominal path, i.e., with the line 14 moving under the light spot 82 in the predesignated manner. As the web of material moves so that more or less of the light spot 82 overlaps the line 14, the photo-conductive cell 32 will sense more or less reflected light. This will result in increase or decrease in the voltage across the moving coil 20 to change its force and deflect the jet pipe as required to apply a corrective movement to the piston 64 whereby the latter will shift the roller 12 to bring the line 14 back to nominal position relative to the sensing head 16. In such manner, the line follower apparatus of the invention will automatically operate to maintain the line 14 running in a straight path.

In the case of a rewind or slitting operation, the sensing head 16 will be attached to a rewind stand, or a slitting tool (not shown). The hydraulic power means 24 will be connected to, or associated with, the rewind stand, or slitting tool as the case may be. In such manner, the desired operation on the moving web will be performed in an automatic and reliable manner.

From the foregoing, it will be evident that the line follower apparatus of the invention will satisfy the objectives hereinbefore set forth.

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. Line follower control apparatus for controlling the lateral deviation of a web of material as it is moved longitudinally comprising in combination, a light source arranged for directing a concentrated beam of light at an acute angle upon a continuous reference line associated with the web of material, a single photo-conductive cell adapted to receive a portion of said concentrated beam of light by reflection from said web of material, an amplifier adapted to generate a voltage potential which is proportional to the intensity of the reflected light received by said photo-conductive cell, hydraulic power means, and a jet pipe regulator including a jet pipe and an electro-magnetic means responsive to voltage output of said amplifier whereby the jet pipe is moved to develop a pressure differential within the hydraulic power means in relation to the voltage generated by the amplifier, said hydraulic power means being operative to control the lateral deviation of said web of material, whereby the reference line associated with the web of material and the single photo-conductive cell are maintained in a fixed relationship.

2. Line follower control apparatus for controlling the lateral deviation of a web of material as it is moved longitudinally comprising in combination, a light source arranged for directing a concentrated beam of light at an acute angle upon a line formed upon the material which line is in color contrast therewith, a single photo-conductive cell adapted to receive a portion of said concentrated light beam by reflection from said web of material, an amplifier adapted to generate a voltage potential which is proportional to the intensity of the reflected light received by said photo-conductive cell, a hydraulic power means and a jet pipe regulator including a jet pipe and an electro-magnetic means responsive to voltage output of said amplifier whereby the jet pipe is moved to develop a pressure differential upon a movable piston within the hydraulic power means in relation to the voltage generated by the amplifier, said piston being operatively connected with a roller supporting said web of material so as to maintain the single photo-conductive cell and the line fixed upon the web of material in a fixed relationship.

3. Line follower control apparatus for controlling the lateral deviation of a web of material as it is being unwound from an axially movable roller comprising in combination, a sensing head including a light source arranged for directing a concentrated beam of light at an acute angle upon a reference line formed upon the material which line is in color contrast therewith, and a single photo-conductive cell adapted to receive a portion of said concentrated light beam by reflection from said web of material, an amplifier adapted to generate a voltage potential which is proportional to the intensity of the reflected light received by said photo-conductive cell, a jet pipe regulator having a jet pipe, a set-point adjustment means, and an electro-magnetic means, said electro-magnetic means including a movable coil coupled to the jet pipe and a stationary permanent magnet magnetically associated with the movable coil, said amplifier being arranged to impress a voltage upon said movable coil in accordance with the voltage potential developed in response to the light intensity received by the photo-conductive cell, and a hydraulic power means including a piston movable in response to a pressure differential generated by the jet pipe regulator to cause axial movement of said movable roller to maintain the single photo-conductive cell and the reference line formed on the material in a fixed relationship.

4. Line follower apparatus according to claim 3, wherein said light source and said photo-conductive cell are

arranged within a housing that is positioned adjacent said web of material.

5. Line follower apparatus according to claim 3, wherein the concentrated beam of light is directed at an angle of 45° relative to the plane of said reference line, while the photo-conductive cell is normal to said plane and directly above said line. 5

6. Line follower apparatus according to claim 3, wherein said concentrated beam of light is substantially rectangular in shape with the major axis thereof extending in the direction of said reference line, said beam of light overlapping said reference line a predetermined amount when the line is in a nominal lateral position relative to the sensing head. 10

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