Feb. 19, 1957 C. M. WEBSTER ET AL 2,782,030

WEB POSITIONING DEVICE

Filed June 29, 1954 2 Sheets-Sheet 1

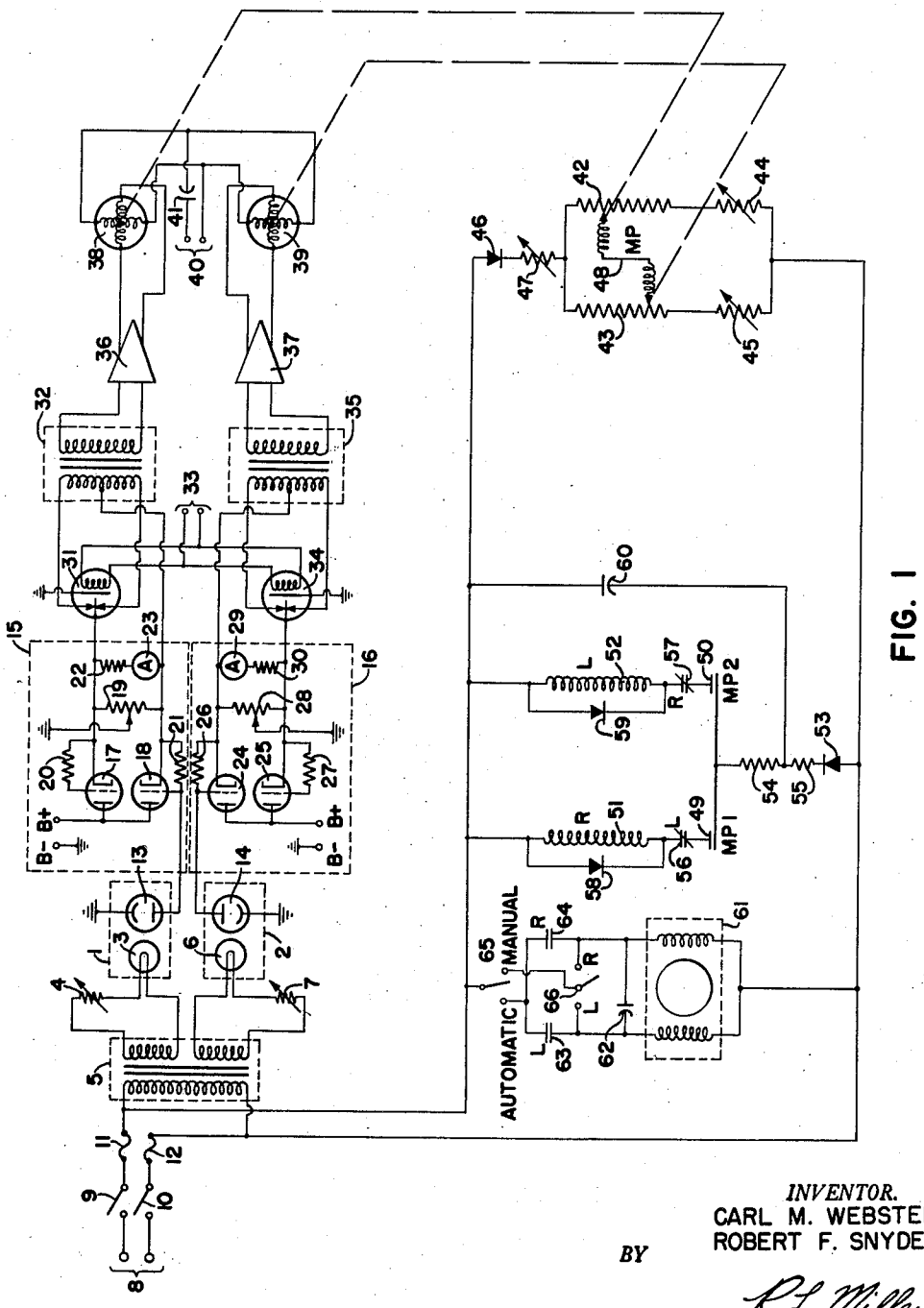


FIG. 1

INVENTOR.
CARL M. WEBSTER
ROBERT F. SNYDER

BY

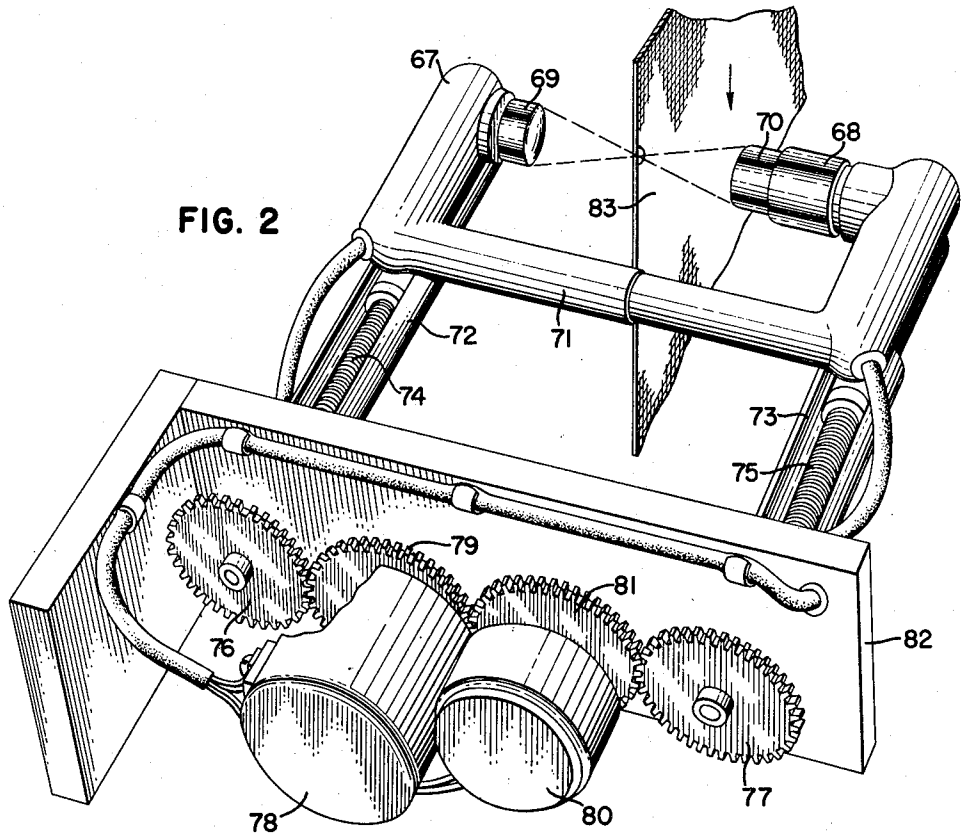
R. L. Miller
ATTORNEY

Feb. 19, 1957 C. M. WEBSTER ET AL 2,782,030

WEB POSITIONING DEVICE

Filed June 29, 1954 2 Sheets-Sheet 2

FIG. 2



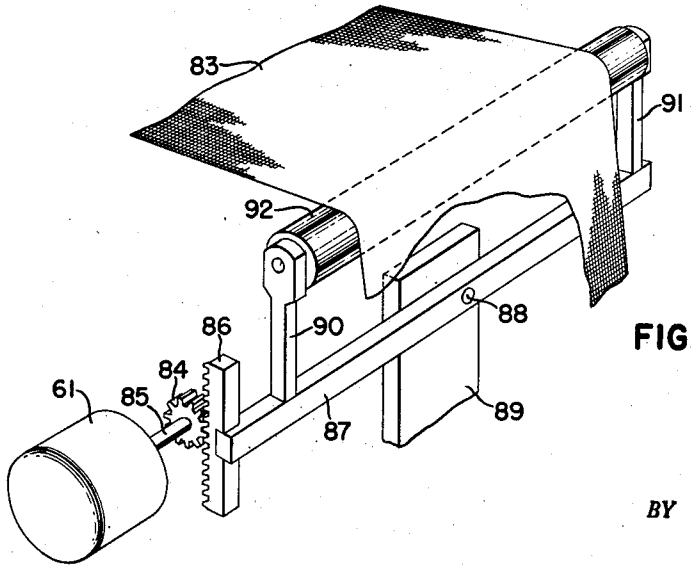


FIG. 3

INVENTOR.
CARL M. WEBSTER
ROBERT F. SNYDER

BY

R. L. Miller
ATTORNEY

United States Patent Office 2,782,030 Patented Feb. 19, 1957

2,782,030

WEB POSITIONING DEVICE

Carl M. Webster, Akron, and Robert F. Snyder, Lakemore, Ohio, assignors to The Goodyear Tire & Rubber Company, Akron, Ohio, a corporation of Ohio

Application June 29, 1954, Serial No. 440,086

5 Claims. (Cl. 271—2.6)

This invention relates to a device for positioning a moving web and more particularly to centering on a fixed line-of-travel a moving web of varying width.

It is the general object of this invention to provide a device to align a moving web of erratic and varying width relative to a series of rolls such as a calender train or the like by controlling the position of the web so as to center it on the roll sequence.

Another object of this invention is to provide a centering control that reacts rapidly to varying widths or lateral movements of a moving web, thus enabling the web to be operated at a high speed of travel.

Still another object of this invention is to provide a centering control for a rapidly-moving frangible web without physical contact with the web proper.

A further object of the invention is to provide a web-centering control that is automatic in operation and performs in a simple and efficient manner.

The aforesaid objects of the invention, and other objects which will become apparent as the description proceeds, are achieved by providing two mobile assemblies placed on opposite sides of a moving web; each assembly containing a light source and a light-sensing unit such as a photoelectric cell, and each assembly controlled so as to closely follow its respective edge. The position of each assembly relative to a fixed line-of-travel such as the centerline of the rolls whereon the web is moving, is noted electrically and a corresponding correcting signal actuates a mechanical device such as a motor-driven teeter-roll whereby the web is correctively adjusted.

In the drawings:

Fig. 1 is a diagrammatic view of the electrical mechanism employed in the device; and

Fig. 2 is an isometric sketch of the edge-follower assembly; and

Fig. 3 is an isometric sketch of a typical teeter-roll assembly.

In Fig. 1, the light source and sensing units **1** and **2** of the two edge-follower assemblies are shown. The physical details of the construction and movement of complete follower assemblies is described hereinafter in connection with Fig. 2. The unit **1** has included therein a light source **3** in series with an intensity-control potentiometer **4**; both being connected across one secondary winding of a transformer **5**. Likewise, the unit **2** includes a light source **6** in series with a potentiometer **7**, both across another secondary winding of the transformer **5**. The primary winding of the transformer **5** is energized from an alternating-current energy source at the terminals **8** passing through line switches **9** and **10** and line fuses **11** and **12** each respectively connected on a side of the line. Each of the units **1** and **2** has included light-sensitive devices such as photoelectric cells **13** and **14** respectively; the output of each of the cells **13** and **14** is in turn connected to photoelectric cell bridges **15** and **16** respectively.

The cell bridges **15** and **16** operate on the basic principle of a Wheatstone bridge. The bridge **15** consists of two triodes **17** and **18** each in one arm of the bridge.

The other two arms are formed of the non-movable resistance element of a potentiometer **19**. A B— direct-current potential is applied by a ground connection to the movable element of the potentiometer **19** and a B+ to the anodes or plates of the triodes **17** and **18**. The control elements or grids of the triodes **17** and **18** are connected to their respective cathodes through resistors **20** and **21** respectively. The cathodes of the triodes **17** and **18** are each connected to the opposite extremities of the non-movable resistance element of the potentiometer **19**. A resistor **22** and a current-indicating device such as a micro-ammeter **23** are connected in series and the whole in turn connected between the cathodes of the triodes **17** and **18**, with the resistor side connected to the cathode of the triode **17**. The output of the bridge **15** is taken from the cathodes of the triodes **17** and **18**. The input from the anode of the photoelectric cell **13** is connected to the control element of the triode **18**.

The cell bridge **16** is constructed in like manner. Two triodes **24** and **25** are utilized with the anodes thereof energized by a B+ direct-current potential. The grids of the triodes **24** and **25** are connected to their respective cathodes through resistors **26** and **27** respectively. The non-movable resistance element of a potentiometer **28** is connected at opposite extremities to the cathodes of the triodes **24** and **25**; the movable element of the potentiometer **28** is connected to B— through ground. The cathode of the triode **24** is also connected to the cathode of the triode **25** through a microammeter **29** and a resistor **30** connected in series in the order named. The output of the bridge **16** is taken from the cathodes of the triodes **24** and **25** and the output from the anode of the photoelectric cell **14** is connected to the grid of the triode **24**.

One side of the output of the bridge **15** derived from the cathode of the triode **17** is connected to the vibrating-reed of a vibrator-type converter **31**; the other side is connected to a centertap on the primary winding of an input transformer **32**. The ends of the primary winding of the transformer **32** are each connected respectively to the two stationary contacts of the converter **31**. The electrostatic shielding of the converter **31** is grounded and the driving coil is energized by an alternating-current potential applied at the terminals **33**.

In similar manner one side of the output of the bridge **16** from the cathode of the triode **25** is connected to the vibrating-reed of a vibrator-type converter **34** and the output on the other side from the cathode of the triode **24** is connected to a centertap on the primary winding of an input transformer **35**. The primary winding of the transformer **35** is connected across the two stationary contacts of the converter **34**. The electrostatic shielding of the converter **34** is grounded and the driving coil is energized from the terminals **33**.

The input to an alternating-current, high-gain, phase-sensitive amplifier **36** is taken from the secondary winding of the transformer **32**. By the term "phase-sensitive" with reference to the amplifier **36** it is meant that the phase and magnitude of the output is a function of the phase and magnitude of the input. As the details of amplifiers of this type are well-known in the art, it is not necessary to describe the amplifier circuitry per se. An identical amplifier **37** takes its input from the secondary winding of the transformer **35**. The output of the amplifier **36** is connected across one field coil of a reversible two-phase motor **38** and similarly the output from the amplifier **37** is connected to one of the field coils of another reversible two-phase motor **39**. The other field coils of the motors **38** and **39** are energized from a source of alternating-current supplied to the terminals **40** and passing through a capacitor **41**. The motors **38** and **39** are hereinafter referred to as the photoelectric cell drive motors.

The rotation of the drive motors 38 and 39 displaces the movable arms of two potentiometers 42 and 43 respectively. Each end of one side of the potentiometers 42 and 43 is directly connected together and each end of the other side of the potentiometers 42 and 43 is also connected together through two variable resistors 44 and 45 respectively. The variable resistors 44 and 45 are utilized for manual adjustment of circuit constants. An actuating potential for this circuit is provided from an alternating-current power source applied at the terminals 8. The terminals 8 are connected to line switches 9 and 10 and fuses 11 and 12 respectively. One side of the actuating potential is taken from the fuse 11 through a rectifier 46 and a variable resistor 47; the resistor 47 controlling the potential level. The other side of the actuating potential is taken from the fuse 12 and is connected to the potentiometers 42 and 43 through the variable resistors 44 and 45 respectively.

When this circuit is energized, a direct current potential exists across the potentiometers 42 and 43. The circuit is initially adjusted so that no potential difference exists across the coils of a micro-positioner relay 48 connected between the two movable elements of the potentiometers 42 and 43 and designated on the Fig. 1 as "MP." The consequent displacement of the drive motors 38 and 39 and the resulting effect on the positioning of the movable elements of the potentiometers 42 and 43 causes a potential difference across the micro-positioner relay 48 and a current flows through the coils of the relay 48. One of the micro-positioner relay contacts 49 or 50, designated in Fig. 1 as MP1 and MP2 respectively, closes depending on the direction of the current flow, thereby energizing either the right relay coil 51 or the left relay coil 52, respectively. The terms "left" and "right" (or "L" and "R" in the Fig. 1) are used herein to designate the relays and their respective contacts that control the lateral web corrective movements as will be described hereinafter in greater detail.

Activating potential for the relay coils 51 and 52 is taken from the fuse 12, through a rectifier 53, and two series-connected resistors 55 and 54 in the order named. The free end of the resistor 54 is connected to the micro-positioner contacts 49 and 50, both of which are normally open. The relay contact 49 is connected to one end of the right relay coil 51 through a left relay contact 56 which is normally closed. Likewise, the relay contact 50 is connected to one end of the left relay coil 52 through a right relay contact 57 which is also normally closed. Two rectifiers 58 and 59 are connected across the relay coils 51 and 52 in order to prevent arcing of the contacts 49 and 50 respectively. The other ends of the relay coils 51 and 52 are both connected to the fuse 11. A filtering capacitor 60 is connected between the fuse 11 and the common junction point of the resistors 54 and 55.

In operation, a higher potential level at the movable element of the potentiometer 42 than at the movable element of the potentiometer 43 results in current flow through the micro-positioner 48 and in the consequent energization of the right relay coil 51, and a contrawise potential difference in the energization of the left relay coil 52. Thus when the potentiometers 42 and 43 are positioned by the rotation of the drive motors 38 and 39, respectively, so as to cause a current flow through the micro-positioner relay 48 from the potentiometer 42 to the potentiometer 43, the contact 49 closes and current flows through the right relay coil 51. Conversely, when the current flow through the micro-positioner relay 48 is in reverse direction, the contact relay 50 closes and the left relay coil 52 is energized.

A teeter-roll drive motor 61 actuates the mechanical apparatus controlling the web lateral displacement which is described in greater detail in connection with Fig. 3. The drive motor 61, as utilized in the actual apparatus is a 110-volt, 2-phase, 60 cycle, alternating-current motor. On one side, the two motor windings are interconnected and the common junction thereof connected to the fuse 12. On the other side the two ends of the windings are interconnected through a capacitor 62 and also one end of one winding is connected to the relay contacts 63 (normally open); the other end of the other winding is connected to the relay contacts 64 (normally open). The contacts 63 and 64 are interconnected and the common junction thereof is connected to the "automatic" position terminal of a single-pole-double-throw switch 65.

The throw-arm of the switch 65 is connected to the fuse 11, and the remaining terminal of the switch 65 (marked "manual") is connected to the throw-arm of a single-pole-double-throw switch 66. One of the terminals of the switch 66 is connected to one of the windings of the motor 61 and the other terminal to the other winding of the motor 61. With the switch 65 in the "manual" position, the switch 66 can be utilized to manually control the direction and amount of rotation of the motor 61.

With the switch 65 in the "automatic" position, a correcting impulse energizes the left relay coil 52, thereby closing the contacts 63. Current now flows through one winding of the motor 61 resulting in rotation in one direction. Conversely, energization of the relay coil 51 closes the contacts 64 and causes current flow in the other winding with consequent rotation of the motor 61 in the opposite direction.

Fig. 2 shows the construction of the traveling photoelectric cell assembly. Two of these units are utilized; one for each edge of the moving web. Both assemblies are identical except for being of opposite hand; only one being shown in Fig. 2. A photoelectric cell is enclosed in a housing 67 and a light source is enclosed in another housing 68. Both housings 67 and 68 have mounted thereon adjustable lens elements 69 and 70, respectively, to focus and control the light beam originating from the housing 68.

The two housings 67 and 68 are connected by a positioning cross-member 71. The housings 67 and 68 slide upon and are guided by supports 72 and 73, respectively. Movement of the housings 67 and 68 on the housing supports 72 and 73 is accomplished by the rotation of lead screws 74 and 75, respectively. At the other extremity of the lead screws 74 and 75 are spur gears 76 and 77, respectively. The photoelectric cell drive motor 78 is shown and drives a spur gear 79 engaging the spur gear 76. The potentiometer 80 is also shown and is driven by a spur gear 81 engaging the spur gears 77 and 79. The housing supports 72 and 73 and all necessary shaftings are suitably mounted on a base plate 82.

The light beam between the lens elements 69 and 70 is focused to form a spot of light which is partially blocked off by a moving web 83. When the edge of the web 83 moves laterally in such manner that the light passing the edge of the web 83 is increased, the system reacts in such manner as will hereinafter be described to energize the drive motor 78, thereby rotating the spur gears 76 and 77 and displacing the housings 67 and 68 through the movement of the lead screws 74 and 75, respectively, resulting in the light beam spot following the lateral movement of and maintaining its alignment in relation to the edge of the web 83. A similar action occurs when the amount of light passing the edge of the web 83 is decreased.

In Fig. 3 is shown a typical teeter roll assembly driven by the teeter-roll motor 61 of Fig. 1. The motor 61 drives a spur gear 84 through a shaft 85. The spur gear 84 engages a rack gear 86 which is suitably mounted on a tilt bar 87. The tilt bar 87 pivots centrally about a pin fastening 88 fixed on a stationary fixed base plate 89.

At the extremities of the tilt bar 87 are suitably mounted two roll support brackets 90 and 91. The support brackets 90 and 91 in turn engage a roll 92 in a free rotating manner; the moving web 83 passing over the

roll 92. As rotation of the drive motor 61 displaces the tilt bar 87, the web 83 will be displaced laterally to any desired degree. Consequently, the web-displacing action of the teeter-roll mechanism will influence the centering of the web 83 relative to any subsequent roll trains. It will be understood that the design details of the teeter-roll assembly are dependent on the application of the invention. Many methods of corrective web displacement are known in the art and can be utilized with the method of the invention.

The operation of the invention can be best described by separating the two basic functions of the device. The first function relates to the "following" action of the light beam spot with reference to the edge of the moving web 83. Referring to Fig. 1, movement of the web edge due to either the web width varying and/or displacement of the web from some predetermined operating centerline, varies the light energy received by the photoelectric cells 13 and 14 which are in an adjacent relationship with each of the two web edges respectively as shown in Fig. 2.

The outputs of the photoelectric cells 13 and 14 are supplied to the cell bridges 15 and 16 respectively. A preliminary adjustment is made to balance the bridges 15 and 16 while the web edges are properly zeroed with respect to the focussed light beam. This is accomplished in each of the bridges 15 and 16 by adjusting the respective potentiometers 19 and 28 utilizing the respective meters 23 and 29. Thereafter a change in the outputs of the photoelectric cells 13 and 14 due to web displacement results in an unbalancing of the respective bridges 15 and 16 and a consequent correcting signal appearing at the bridge outputs. The signal outputs of the bridges 15 and 16 are converted into alternating current by the vibrator converters 31 and 34 respectively, and after passing through the input transformers 32 and 35 respectively, are amplified by the respective amplifiers 36 and 37. The outputs of the amplifiers 36 and 37 energize the respective photoelectric cell drive motors 38 and 39. Thus it is evident that as the light input to the photoelectric cells 13 and 14 varies due to movement of the intercepting web edges, consequent impulses proportional to the web movements actuate the respective motors 38 and 39.

In Fig. 2, the drive motor 78 corresponds to the drive motors 38 and 39 of Fig. 1. From an inspection of Fig. 2, it is evident that rotation in either direction of the drive motor 78 causes a movement of the housings 67 and 68 and consequently the focus point of the light beam existent therebetween. If the edge of the web 83 is displaced laterally in either direction, the photoelectric cell in the housing 67 receives more or less light and the drive motor 78 is thereby energized as previously described, resulting in a movement of the housings 67 and 68 so as to continuously follow the fluctuations in the positioning of the edge of the web 83.

The second function of the device relates to correctively acting on the web 83 to maintain proper positioning of the web 83 with reference to a predetermined line-of-travel. The potentiometers 42 and 43 of Fig. 1 correspond to the potentiometer 80 of Fig. 2. As can be seen from an inspection of Fig. 2, any rotation of the drive motor 78 is reflected in a change in the positioning of the potentiometer 80 which in turn varies the current flow through the micro-positioner 48 of Fig. 1. As previously described in connection with Fig. 1, a proportional change occurs in the orientation of the teeter-roll motor 61 of Figs. 1 and 3 with consequent tilting of the roller 92 of Fig. 3 and corrective repositioning of the line-of-travel of the web 83.

To summarize: as the moving web 83 changes in position and/or varies in width, the resulting change in light intensity received by the photoelectric cells 13 and 14 acts to mechanically displace the cell orientations in such manner as to continually tend to follow the web edge and simultaneously cause corrective action to occur, resulting in a repositioning of the moving web 83 so as to maintain a line-of-travel along a predetermined centerline.

The sensitivity of the invention to web movement is even more responsive when the light spot is collimated to result in a narrow bar of light impinging on the web edge and orientated lengthwise parallel to the direction of web travel in such manner that only a slight shift of the web laterally results in a radical change in the amount of light received by the light-sensitive collector.

While certain representative embodiments and details have been shown for the purpose of illustrating the invention, it will be apparent to those skilled in this art that various changes and modifications may be made therein without departing from the spirit or scope of the invention.

We claim:

1. A device for positioning a moving web relative to a fixed line-of-travel comprising a first and second exploring means each disposed adjacent to and each independently responsive to the lateral displacement of a respective opposing edge of the web, a first and second supporting means for the first and second exploring means respectively, driving means operatively associated with the first and second supporting means and responsive to the orientation of the first and second exploring means with reference to their respective web edges to maintain a fixed relationship between the first and second exploring means and their respective web edges, and means actuated by the displacement of the first and second supporting means with reference to a predetermined line-of-travel to correctively position the moving web in relation thereto.

2. A device for positioning a moving web relative to a fixed line-of-travel comprising a first and second exploring means each disposed adjacent to and each independently responsive to the lateral displacement of a respective opposing edge of the web, a first and second supporting means for the first and second exploring means respectively, a first and second driving means operatively associated with the first and second supporting means respectively and responsive to the orientation of the first and second exploring means respectively with reference to their respective web edges to maintain a fixed relationship between the first and second exploring means and their respective web edges, and means actuated by the displacement of the first and second supporting means with reference to a predetermined line-of-travel to correctively position the moving web in relation thereto.

3. A device for positioning a moving web relative to a fixed line-of-travel comprising a first and second light-sensitive means each disposed adjacent to a respective opposing edge of the web, a first and second light-source means for producing an energizing light beam fixedly disposed oppositely the first and second light-sensitive means respectively, a first and second supporting means for the first and second light-sensitive means and first and second light-source means respectively, a first and second driving means operatively associated with the first and second supporting means respectively and responsive to the first and second light-sensitive means respectively to maintain a fixed relationship between the first and second light-sensitive means and their respective web edges, and means actuated by the comparative displacement of the first and second supporting means with reference to a predetermined line-of-travel to correctively position the moving web in relation thereto.

4. A device for controlling the alignment of a moving web relative to a fixed line-of-travel comprising a first and second light-sensitive means each disposed adjacent to a respective opposing edge of the web, a first and second light-beam source partially impinging on the oppositely disposed web edges and so controlled and directed as to energize the first and second light-sensitive means re-

spectively, a first and second comparing means adapted to receive the output of the first and second light-sensitive means respectively and to correlate the characteristics thereof relative to a predetermined standard with any deviation therefrom actuating corrective signals at the respective outputs of the first and second comparing means, a first and second positioning means adapted to receive the outputs from the first and second comparing means respectively and independently position the corresponding light-sensitive means relative to their respective web edges to maintain predetermined relationships therebetween, and correcting means also adapted to receive the outputs of the first and second comparing means and to proportionally and correctively displace the moving web.

5. A device for controlling the alignment of a moving web relative to a fixed line-of-travel comprising a first and second photoelectric sensing unit each disposed adjacent to a respective opposing edge of the web, a first and second light-source each producing a light beam partially impinging on oppositely disposed web edges and controlled and directed to activate the first and second photoelectric units respectively, a first and second comparing means adapted to receive the outputs of the first and second photoelectric units respectively and correlate the characteristics thereof relative to a predetermined standard with any deviation therefrom actuating a corrective signal at the respective outputs of said first and second comparing means respectively, a first and second amplifying means each adapted to receive the output of the first and second comparing means respectively, a first and second driving means electrically receiving the output of the first and second amplifying means respectively and mechanically adjusting the positioning of the first and second photoelectriic units respectively relative to their respective web edges to maintain predetermined relationships therebetween, indicating means operatively associated with the first and second driving means to electrically supply a signal representative of the displacement of the first and second photoelectric units respectively relative to a predetermined line-of-travel, and correcting means adapted to receive the corrective signal from the indicating means output and mechanically correctively displace the moving web.

References Cited in the file of this patent

UNITED STATES PATENTS

2,534,686	Straus et al.	Dec. 19, 1950
2,566,399	Bishop	Sept. 4, 1951
2,654,599	Frisbie et al.	Oct. 6, 1953
2,666,639	Frommer	Jan. 19, 1954
2,672,198	Jones et al.	Mar. 16, 1954