April 5, 1966 I. L. FIFE ET AL 3,244,340

APPARATUS FOR MAINTAINING THE ALIGNMENT OF A MOVING WEB

Filed Sept. 30, 1963 2 Sheets-Sheet 1

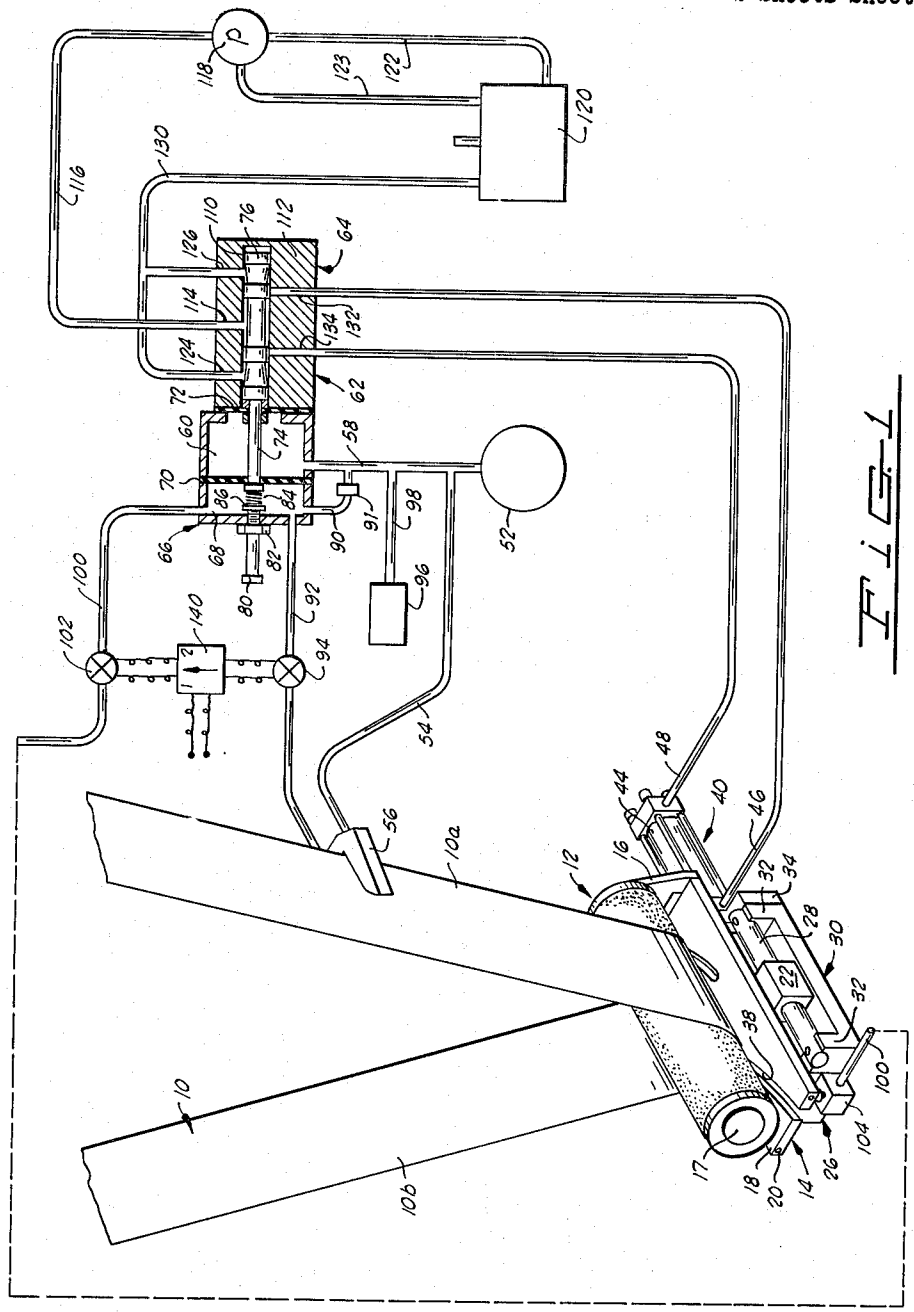


FIG 1

INVENTORS
IRWIN L. FIFE &
BRUCE A. FEIERTAG

BY Dunlap, Laney & Hubbard
ATTORNEYS

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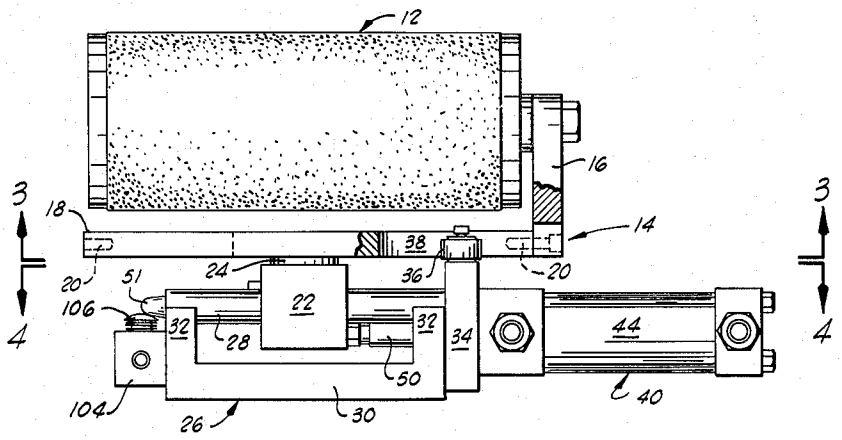


Fig. 2

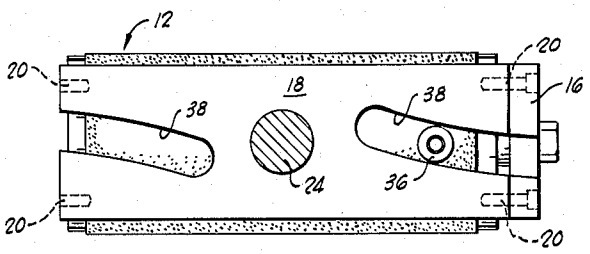


Fig. 3

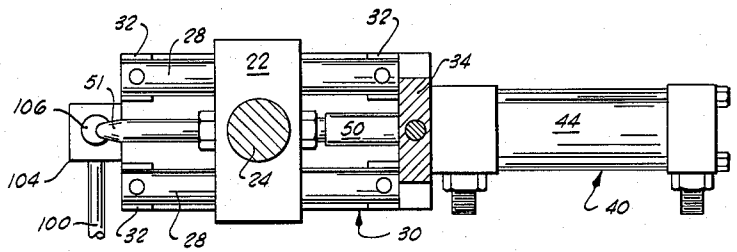


Fig. 4

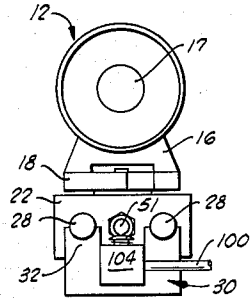


Fig. 5

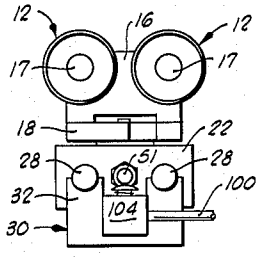


Fig. 6

INVENTORS
IRWIN L. FIFE &
BRUCE A. FEIERTAG

BY
Dunlap, Laney & Hubbard
ATTORNEYS

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3,244,340

APPARATUS FOR MAINTAINING THE ALIGNMENT OF A MOVING WEB

Irwin L. Fife and Bruce A. Feiertag, Oklahoma City, Okla., assignors to Fife Manufacturing Company, Inc., Oklahoma City, Okla., a corporation of Oklahoma

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16 Claims. (Cl. 226—22)

This invention relates generally to apparatus for shifting moving web of flexible sheet material for the purpose of maintaining the web in alignment with a predetermined path of travel. More particularly, but not by way of limitation, the present invention relates to apparatus used to automatically maintain a moving or traveling web in alignment with a predetermined path of travel by initiating a corrective shift of the web in response to an automatically detected misalignment thereof.

This application concerns web-guiding assemblies of the general type disclosed in application for United States Letters Patent Serial No. 72,050 filed November 28, 1960, now U.S. Patent 3,104,789, and assigned to the assignee of the present invention. In the cited U.S. Patent 3,104,789, a device has been described for maintaining the alignment of a moving web which generally comprises a cantilevered guide roller which bears against the web to be maintained in alignment, and which is automatically shifted in response to signals generated by departures of the web from the desired path of travel. The advantages of the cantilevered roller type web guiding device have been discussed in considerable detail in said U.S. Patent 3,104,789 and it will suffice to say at this point that such cantilevered roller web guiding devices may be used effectively in many situations where web guiding rollers supported at each of their ends either cannot be used at all, or are extremely difficult or inconvenient to use. In the embodiments of the cantilevered roller type web guiding device described in the cited U.S. Patent 3,104,789, departures of the web to be guided from the desired path of travel are sensed by means of a pneumatic sensing head which transmits signals in the form of variations in pneumatic pressure to a pressure responsive diaphragm. The diphragm in turn actuates an arm supporting the web guiding roller in the nature of a cantilever so as to shift the arm about a pivotal axis extending parallel to the bisector of the angle subtended by the spans of the web approaching and leaving the web guiding roller. The arm which is actuated in such device in response to signals from the pneumatic sensing head is an elongated member which is angled to permit the rollers to be supported therefrom as a cantilever, and to extend in a direction which permits the web to be wrapped about the roller in a certain necessary predetermined configuration. Thus, as explained in U.S. Patent 3,104,789, it is always necessary that the angle which is subtended by that portion of the periphery of the cylindrical roller contacted by the web have a bisector which extends substantially parallel to the pivotal axis of the arm which supports the roller. The actuation of the roller by the movement of the supporting arm is, in effect, one of movement in a direction which is transverse with respect to the path of travel of the web, and which is simultaneously an angling or canting movement in which the roller is pivoted about the pivotal axis of the supporting arm.

Although the embodiments of the invention described in U.S. Patent 3,104,789 are characterized by marked advantages in many types of use over the web guiding roller devices in which the roller is supported at both of its ends, the configuration and size of the roller supporting arm and the manner in which the arm and roller are mounted sometimes result in inconvenience or difficulty

in finding or developing a proper position for mounting the web guiding device in view of the path of travel which must be followed by the web as determined by the necessary location of the source and destination of the web. Moreover, the employment of a pneumatic power source for shifting the roller in response to departures of the web from the desired path of travel, while providing satisfactory operation in the case of relatively small web guiding assemblies involving less massive rollers, is not entirely satisfactory in heavier assemblies in which very large web guiding rollers must be substantially instantaneously shifted in response to slight departures of the web from precise alignment. This is due to the fact that the compressible gas used as the power fluid does not as instantaneously transmit the actuating signals in the form of pressure variations as would a non-compressible or hydraulic fluid, and is more subject to power losses due to friction in the system. These disadvantages of the compressible fluid are particularly pronounced where the power to be transmitted is relatively great and the distance between the sensing head and the arm or roller actuating structure is relatively great.

The present invention provides a roller type web guiding assembly in which the roller supporting structure and actuating mechanism is relatively compact and can be easily located in any desired position in order to accomplish a particular web guiding task. In a preferred embodiment of the invention, the roller used for guiding the web is supported in the nature of a cantilever. The web guiding roller is more easily wrapped with the web than in the case of devices constructed in accordance with the disclosure of the cited U.S. Patent 3,104,789, and the roller is actuated in its corrective movements by a noncompressible hydraulic power fluid which permits considerably more massive rollers to be shifted in instantaneous response to automatically correct departures of the guided web from a predetermined path of travel. The manner in which a roller is mounted upon its supporting assembly better adapts the roller to be actuated by the hydraulic drive system used in the invention. Moreover, the employment of the hydraulic power fluid for shifting the roller is accomplished without loss of the high sensitivity developed by pneumatic type sensing heads as used in the web guiding assembly described in said U.S. Patents 3,104.789.

In one of its broader aspects, the present invention is a web guiding system comprising a roller or generally cylindrical web guiding member which extends substantially transversely to the path of travel of the web to be guided with an arcuate portion of the periphery of the roller in frictional contact with the web; a slidably mounted bearing block which is mounted for linear, reciprocating movement in a path extending substantially transversely to the path of movement of the web, which bearing block pivotally supports an arm which rotatably journals the roller so that the axis of pivotation of such arm and the roller it carries extends through, and is substantially normal to, the axis of rotation of the roller; a camming or guiding device contacting the roller supporting means and pivoting the roller supporting means in the bearing block which supports it during the sliding movement of the bearing block during operation of the device; and means for shifting the bearing block transversely with respect to the longitudinal axis of the moving web in response to transverse movements of the web relative to its desired path of travel so that misalignment of the web from said predetermined path of travel is effectively automatically corrected. From this brief and summary description of the invention, it will immediately be perceived that the preferred embodiment of the present invention in which a cantilevered roller is used in the web

guiding assembly of the invention differs from the assembly described and depicted in said copending application in that the pivotal axis of the roller and its supporting means extends through and substantially normal to the axis of rotation of the roller as opposed to being displaced laterally from such axis. This arrangement permits the device of the present invention to be made in considerably more compact form, and ultimately results in the structure being better adapted for mounting in various positions necessitated by the particular path followed by the web which is to be guided.

To more specifically describe one embodiment of the present invention, the means which is provided for shifting the slidably mounted bearing block in response to transverse movements of the web relative to its desired path of travel includes a pneumatic sensing head which responds to transverse movements of the longitudinal edge of the moving web by developing variations in the pneumatic pressure developed across the sensing head. The pressure variations are transmitted to a servo valve system in which the pneumatic pressure is converted to hydraulic pressure which is in turn used to drive or shift the slidably mounted bearing block. The hydraulic power for driving the moving elements of the assembly is delivered to the slidably mounted bearing block through the instrumentality of a double acting hydraulic cylinder which, because of the particular mounting arrangement of the web guiding roller, can be mounted in either of two alternate positions with respect to the roller supporting structure and thereby permit the assembly to be more easily positioned properly with respect to the web which is to be guided. As an example of the power amplification which is obtainable when the pneumatic-hydraulic sensing drive system is employed for shifting the roller in response to undesirable movements of the web to be guided, we have found that a pneumatic force of 2 lbs. can control forces of as much as 1800 lbs. at the hydraulic cylinder through the instrumentality of the pneumo-hydraulic servo valve hereinafter described.

An additional feature of the present invention is the provision of an automatically actuated servo centering valve which may be used in lieu of the pneumatic sensing head to automatically precisely center the web guiding roller with respect to the desired path of travel of the web. This feature of the invention enables the web guiding roller to be centrally positioned relative to the desired path of travel prior to threading the web over the roller, and thus avoids the problem of having the roller constantly shifting during such threading procedure as a result of inadvertent shifting of the web relative to the sensing head. The procedure of threading the web into the web guiding apparatus is thus considerably expedited.

From the foregoing description of the invention, it will have become apparent that it is a major object of the present invention to provide an improved cantilevered roller type web guiding apparatus for maintaining the alignment of a traveling web according to a desired predetermined path of travel.

A further object of the present invention is to provide a cantilevered roller type web guiding assembly which is compact and which may be more easily mounted for the purpose of guiding webs which it is desired to move in fixed or inalterable paths of travel.

An additional object of the present invention is to provide an automatic web aligning device which is hydraulically actuated and therefore capable of effectively guiding webs of substantially larger transverse width and greater density and weight.

A further object of the present invention is to provide in a web guiding device, a web guiding roller which may be precisely centered with respect to the desired path of travel of the web prior to threading the web over the roller so that such threading procedure may be more easily and expeditiously accomplished.

Other objects and advantages in addition to those hereinbefore described will appear in the following detailed

description of the invention, or will be apparent from a reading thereof in conjunction with a perusal of the accompanying drawings which illustrate my invention.

In the drawings:

FIGURE 1 is a schematic illustration of one embodiment of the web guiding or aligning system of the present invention with the web guiding roller and its supporting structure illustrated in perspective.

FIGURE 2 is a side elevational view of the cantilevered web guiding roller of the present invention, and one type of supporting structure which may be used therewith.

FIGURE 3 is a view in section taken along line 3—3 of FIGURE 2.

FIGURE 4 is a view in section taken along line 4—4 of FIGURE 2.

FIGURE 5 is an end view of a single roller type of web guiding structure as the same is viewed from its end at which the servo centering valve used in one embodiment of the invention is located.

FIGURE 6 is a view similar to FIGURE 5 but illustrating a different embodiment of the invention in which two web guiding rollers are provided.

Referring now to the drawings in detail, and particularly to FIGURE 1, a web which it is desired to retain in a predetermined path of travel is designated by reference character **10**. The webs which it is the purpose of the present invention to maintain in alignment are flexible elongated sheet materials and may be constructed of paper, fibrous material, sheet metals and other materials well known in the art. Alignment of the web is maintained by contact with a cylindrical guide means or roller designated generally by reference character **12**, which roller is moved in the operation of the device in a proper direction and by a proper amount to shift the web **10** from a misaligned to an aligned condition. It will be understood, of course, the the web **10** moves from a feed roll or source roll toward a takeup or terminal roll in accordance with practices well understood in the art. The web **10** is wrapped around a portion of the arcuate periphery of the roller **12** so as to define between its incoming span **10***a* and its outgoing span **10***b*, an angle, the position of which relative to the circumference to the roller is of considerable importance and will be dealt with in greater detail hereinafter.

In the embodiment of the present invention illustrated in the drawings, the roller **12** is journaled at one of its ends in a supporting arm **14** which comprises a journaling plate or bracket **16** which rotatably receives the shaft **17** of the roller, and a base plate **18** which extends parallel to the longitudinal axis of the roller. As an alternative construction, instead of journaling the axis of the roller **12** for rotation relative to the bracket **16**, the roller shaft **17** may be fixed to the bracket **16** and the roller **12** rotatably mounted on the shaft **17** by the use of suitable bearings (not seen). In a preferred embodiment of the present invention, the base plate **18** is provided with suitable tapped recesses **20** at each of its ends so that the bracket **16** may be secured to either end of the base plate **18** by suitable threaded screws or bolts. This flexibility in the mode of mounting of the bracket **16** facilitates the use of the web guiding assembly in a variety of different positions as may be dictated by the fixed course which must be followed by the web in its travel. In other words, in some instances, the ability to mount the bracket **16** on either end of the base plate **18** may result in a much simpler and less expensive installation than were the bracket **16** to be positionable upon only one end of the base plate.

As shown in FIGURE 2, the base plate **18** is rotatably supported by a bearing block **22** which journals a shaft **24** secured to the under side of the base plate **18**. The bearing block **22** is in turn slidably mounted on a raceway assembly designated generally by reference character **26** which includes a pair of guide rods **28** upon which

the bearing block is reciprocated. The guide rods 28 extend substantially parallel to each other, are of substantially equal length and are supported by a fixed supporting structure designated generally by reference character 30. The fixed supporting structure 30 is generally U-shaped in configuration and has a pair of upstanding legs 32 which receive and support the guide rods 28.

A plate 34 is secured to one of the upstanding legs 32 and carries a roller 36 which tracks in one of a pair of arcuate slots 38 formed in the opposite ends of the base plate 18. The arcuate slots are curved so that as the bearing block 22 is reciprocated on the guide rods 28, the roller 36, which is fixed, imparts a swiveling or canting motion to the base plate and to the web guiding roller 12. The roller 36 thus acts as a cam follower and the slot 38 as a cam in imparting the swiveling or angular movement to the base plate 18 and to the cantilevered roller 12 supported thereby. In providing the arcuate slots 38 at each end of the base plate 18, the web guiding system is rendered more versatile in that the web guiding roller 12 and its supporting base plate 18 may, when the plate 34 and roller 36 are removed from the assembly, be rotated through 180° to relocate the open or unsupported end of the web guiding roller 12. The plate 34 and roller 36 may then be replaced so that the roller 36 tracks in the slot 38 at the opposite end of the roller.

Reciprocation of the bearing block 22 on the guide rods 28 is effected, in one embodiment of the invention, by a double acting hydraulic cylinder assembly designated generally by reference character 40. The double acting hydraulic cylinder assembly 40 is secured to one end of the fixed supporting structure 30 through the plate 34. The double acting hydraulic cylinder assembly 40 includes a cylinder 44 having a pair of hydraulic fluid intake and discharge conduits, 46 and 48, connected thereto, and a hydraulically actuated piston rod 50 (see FIGURE 2) which extends slidably through the plate 34 and the upstanding leg 32 and is secured to the bearing block 22. It will be perceived that actuation of the piston rod 50 by the introduction of a hydraulic power fluid to the hydraulic cylinder 44 will cause the slidably mounted bearing block 22 to be reciprocated upon the guide rods 28 with the direction of reciprocation depending upon whether the power fluid enters the cylinder 44 through the conduit 46 or through the conduit 48. At its side opposite the side to which the piston rod 50 is attached, the bearing block 22 carries an actuating rod 51 which extends parallel to the guide rods 28 and is tapered at its free end as shown in FIGURES 2 and 4 to permit it to slide upon and depress the valve stem of a servo centering valve 104 hereinafter described.

The portion of the web aligning system of the invention which, in one embodiment of the invention, is utilized to sense the departure of the web 10 from a desired predetermined path of travel and to convert such sensations to a signal employed to change the position of the guide roller 12 is illustrated in FIGURE 1. A supply of compressed air is represented by reference character 52 and preferably comprises a positive displacement, vane type compressor capable of supplying a pulsating air pressure of relatively high frequency pulsations, such as the compressor shown and described in application for United States Letters Patent Serial No. 175,590, filed February 26, 1962, now U.S. Patent 3,098,595, and assigned to the assignee of the present invention. Pulsating air pressure from the air compressor 52 is delivered via a conduit 54 to the intake port of a pneumatic sensing head 56, and by the air pressure manifold 58 to the dither fluid chamber 60 of a main servo valve designated generally by reference character 62.

A servo valve of the general type illustrated in FIGURE 1 in one embodiment of the present invention is illustrated and described in detail in U.S. Patent 3,098,595 hereinbefore cited. The servo valve 62 comprises generally a four-way hydraulic valve, indicated generally by the reference character 64, and a pneumatic servo valve actuator designated generally by reference character 66. The pneumatic servo valve actuator 66 includes the dither fluid chamber 60 and a control fluid chamber 68. The control fluid chamber 68 and dither fluid chamber 60 of the pneumatic servo valve actuator are separated or partitioned from each other by a flexible diaphragm 70. A second diaphragm 72 provides a seal around the shaft 74 of the spool 76 of the four-way hydraulic valve 64 so that the air in the dither fluid chamber 60 cannot commingle with the hydraulic fluid being passed through the four-way hydraulic valve. An adjusting screw 80 is threaded through the pneumatic servo valve actuator housing at one end thereof and is axially aligned with the valve spool 76. A locknut 82 may be provided to secure the adjusting screw 80 at any desired position. A coiled spring 84 is disposed between the diaphragm 70 and a spring plate 86 on the end of the adjusting screw.

Communication between the air pressure manifold 58 and the control fluid chamber 68 is established through a conduit 90 which contains a restricting orifice 91. The control fluid chamber 68 is also entered by a conduit 92 which passes through a suitable electrically energized solenoid valve 94 to the pneumatic sensing head 56. Reference character 96 designates an adjustable, constant pressure regulator which is connected to the manifold 58 by conduit 98 and which functions to maintain the pressure within the manifold 58 at a selected average value. The pressure regulator 96 has a low frequency response so as not to attenuate the high frequency pressure pulsations developed by the positive displacement compressor 52.

Yet another conduit which communicates with the control fluid chamber 68 is the conduit 100 which passes through an electrically energized solenoid valve 102 and is connected to a servo centering valve 104 which is positioned at one end of the raceway assembly 26 as seen in FIGURE 1 and best illustrated in FIGURES 2 and 4. The servo centering valve has a valve stem 106 which projects therefrom and cooperates with the actuating rod 51 in the manner previously mentioned. The purpose of the servo centering valve 104 will be explained in detail hereinafter.

The four-way hydraulic valve 64 may be of any suitable design, and is shown as having a valve spool 76 reciprocally mounted in a valve cavity 110 in a housing 112. A power fluid inlet port 114 communicates with the cavity 110 through the housing 112 and is connected to a conduit 116 by which the valve is supplied power fluid from a conventional hydraulic pump 118 which draws hydraulic fluid from a reservoir 120 through a hydraulic line 122. A return line 123 to the reservoir 120 is provided from the pump 118 so that when a substantial back pressure on the pump develops as a result of the complete closure of the four-way hydraulic valve 64, the pump can recycle fluid to the reservoir 120. A pair of exhaust fluid ports 124 and 126 are formed through the housing 112 and communicate with the cavity 110. The exhaust fluid ports 124 and 126 are connected via a conduit 130 to the hydraulic fluid reservoir 120. A pair of power fluid outlet ports 132 and 134 are connected via the conduits 46 and 48, respectively, to the double acting hydraulic cylinder assembly 40. The details of the construction of the four-way hydraulic valve 64 are described in copending application for United States Letters Patent Serial No. 175,590, to which reference has hereinbefore been made.

Operation

The first procedure in operating the web guiding system of the present invention is to thread the web over the web guiding roller 12. This may usually be more easily accomplished where the roller is cantilevered as shown in the accompanying drawings. The web 10 may be threaded over the roller 12 when the web guiding system of the invention is in either of two statuses. In one of these, the

system is set for automatic guiding by switching an electrical switch 140 to a position in which the solenoid valve 102 is closed so that no pneumatic pressure is delivered via the conduit 100 to the servo centering valve 104. In this position of the switch 140, the solenoid valve 94 is opened to permit the pneumatic pressure developed across the sensing head 56 to be transmitted as a static pressure through the conduit 92 into the control fluid chamber 68. The magnitude of the pressure developed in the conduit 92 and in the control fluid chamber 68 will then depend upon the position of the web 10 relative to the sensing head 56. In other words, the more of the air jet across the slot in the sensing head 56 which is intercepted or cut off by the web 10, the lesser will be the pressure developed in the control fluid chamber 68. The manner in which the sensing head 56 functions to vary the pressure in the control fluid chamber 68 is fully described in copending application for United States Letters Patent Serial No. 175,590. The pressure developed in the control fluid chamber 68 acts in opposition to the pressure developed in the dither fluid chamber 60 so that a pressure differential existing across the diaphragm 70 causes the spool 76 of the four-way hydraulic valve 64 to be shifted in the housing 112. The manner in which the fluctuations in the pressure developed in the control fluid chamber 68 are employed to correct misalignment of the traveling web 10 will be explained in greater detail hereinafter.

The second, and the preferred, status of the web guiding system at the time of threading the web 10 over the cantilevered web guiding roller 12 is that in which the control switch 140 is shifted to a second position which effectively closes the solenoid valve 94 and opens the solenoid valve 102. This permits air pressure to be transmitted through the conduit 100 to the servo centering valve 104. At the same time, the sensing head 56 is effectively removed from the system since no air can flow from the sensing head through the conduit 92 into the control fluid chamber 68. The pressure in the control fluid chamber 68 thus does not vary in response to variations in pressure resulting from the changing position of the web 10 relative to the sensing head 56. On the other hand, the fluid pressure in the control fluid chamber 68 is determined solely by the average pressure established in the manifold 58 by the pressure regulator 96 and the amount of pressure which is bled from the control fluid chamber 68 through the servo centering valve 104.

The amount of fluid which is bled through the servo centering valve 104 is in turn determined by the degree to which the valve stem 106 is depressed by the actuating rod 51. The system is designed so that by proper preadjustment of the adjusting screw 80 and proper control of the pressure in the manifold 58 by the pressure regulator 96, the fluid bled through the servo centering valve 104 may be made to be just sufficient to exactly position the spool 76 of the four-way hydraulic valve 64 in a position in which the web guiding roller 12 will be exactly centered relative to the desired path of travel of the web 10. In other words, the servo centering valve 104 is a device which functions to permit the roller 12 to be precisely centered with respect to the desired path of travel of the web so that the web may be threaded thereon at that time without the roller being constantly shifted in response to the changing position of the portion of the web which passes through the sensing head 56. The sensing head 56 is effectively isolated from the system and the only pressure variation which effects the position of the web guiding roller 12 is that which occurs as a result of the bleeding of air from the control fluid chamber 68 through the servo centering valve 104.

In threading the web 10 upon the cantilevered web guiding roller 12, the incoming and outgoing spans, 10*a* and 10*b* respectively, of the web 10 should define an angle, the bisector of which is coincident with, or lies in the plane occupied by, the pivotal axis of the roller 12. This pivotal axis is, of course, the pivotal axis of the shaft 24 which is secured to the bottom of the base plate 18 and which is rotatably journaled in the slidably mounted bearing block 22. As explained in detail in the hereinbefore identified U.S. Patent 3,104,789, this arrangement of the web relative to the pivotal axis of the web guiding roller 12 is important to the most efficient functioning of the roller 12 in correcting misalignment of the web 10.

After the web 10 has been passed partly around the roller 12, the control switch 140 is shifted to the automatic operating position in which the solenoid valve 102 is closed and the solenoid valve 94 is opened. This effectively isolates the servo centering valve 104 from the system and establishes communication between the sensing head 56 and the control fluid chamber 68. As the lateral edge of the web 10 moves transversely in the slot in the sensing head 104, it passes through the air jet developed across the sensing head by the pressurized air delivered from the conduit 54 and received by the conduit 92. The magnitude of the pressure developed in the conduit 92, and therefore of the pressure developed in the control fluid chamber 68 depends upon the degree to which the web 10 intercepts the air jet passing across the slot in the sensing head 56.

The position of the diaphragm 70 in the pneumatic servo valve actuator 66 is determined by the pressure of the air in the control fluid chamber 68 and the pressure of the air in the dither fluid chamber 60. The pressure pulsations developed by the compressor 52 are transmitted to the dither fluid in the dither fluid chamber 60 and function to vibrate the diaphragm 70 at a high frequency so that the spool 76 of the four-way hydraulic valve will not become stuck or frozen in any one position in the cavity 110. The average pressure of the dither fluid, however, is governed by the setting of the adjustable pressure regulator 96 and is adjusted to a magnitude such that the pressure induced in the fluid control chamber 68 when the lateral edge of the web 10 is in the proper position of alignment relative to the sensing head 56 will exactly balance the average pressure in the dither fluid chamber 60 combined with the mechanical pressure on the diaphragm developed by the spring 84. With the pressure on opposite sides of the flexible diaphragm 70 thus balanced, the spool 76 of the four-way hydraulic valve 64 is positioned so that no hydraulic fluid passes through either of the conduits 46 and 48 into the hydraulic cylinder 44. This position of the valve spool 76 is illustrated in FIGURE 1. The equalization of hydraulic pressure on opposite sides of the piston in the hydraulic cylinder 44 results in the piston being centered in its cylinder, and in the bearing block 22 being centered on the guide rods 28. The cantilevered guide roller 12 is thus centrally positioned with respect to the longitudinal axis of the web and is not canted or swiveled at any angle with respect to the transverse axis of the web. The described alignment of the cantilevered roller 12 will persist as long as the web 10 moves in the predetermined desired path of travel and does not shift laterally from such path in either direction.

When the web 10 commences to shift from the desired predetermined path of travel under external influences, such as vibration, air currents or other forces well known to those skilled in the art, the lateral edge of the web is also shifted relative to the pneumatic sensing head 56 which is fixed in its position. As the lateral edge of the web 10 moves farther into or out of the air jet directed across the slot in the sensing head 56, the pressure prevailing in the conduit 92 is altered, thus causing an increase or decrease in the pressure in the control fluid chamber 68.

If, for example, the web moves to the right as viewed in FIGURE 1 and thus moves farther into the slot in the sensing head 56, a greater obstruction of the air jet across the sensing head occurs with the result that the pressure in the conduit 92 is decreased. The decrease in pressure in the conduit 92 causes a corresponding de-

crease in the pressure existing in the control fluid chamber 68 of the pneumatic servo valve actuator 66. The higher pressure exerted by the dither fluid on the opposite side of the diaphragm 70 will then cause the diaphragm to flex into the control fluid chamber 68 resulting in a shift of the spool 76 of the four-way hydraulic valve toward the left. A shift by the spool 76 of this type will result in the discharge port 132 of the four-way hydraulic valve being closed and the discharge port 134 being opened to receive hydraulic fluid from the pump 118. Hydraulic fluid is thus directed through the conduit 48 to the outer end of the hydraulic cylinder 44 so that the piston rod 50 is caused to move to the left. Movement of the piston rod 50 to the left is accompanied by the discharge of hydraulic fluid through the return conduit 46 to the four-way hydraulic valve 64 and results in the slidably mounted bearing block 22 being moved toward the left as viewed in FIGURE 1. This movement of the bearing block 22 in turn causes the base plate 18 to be shifted to the left. As the base plate 18 is moved toward the left, the base plate and the cantilevered guide roller 12 which it supports are swiveled in a pivoting movement as a result of the tracking of the roller 36 in the arcuate slot 38. The curvature of the slot 38 is such that the base plate 18 and cantilevered roller 12 supported thereby will be swiveled in a direction which moves the free end of the roller in the general direction of travel of the web and the supported end of the roller in the general direction of the origin of the web. This movement, coupled with the transverse movement of the roller 12 as the bearing block 22 slides along the guide rods 28, will cause the web 10 to move outwardly in the slot in the sensing head 56.

As the web 10 moves outwardly in the slot in the sensing head 56, it presents less interference with the air jet across the sensing head slot so that the pressure in the conduit 92 is increased. The increase in the pressure in the conduit 92 is reflected by an increase in the pressure in the control fluid chamber 68 which in turn flexes the diaphragm 70 toward the dither fluid chamber 60. This moves the spool 76 and the four-way hydraulic valve toward the right as shown in FIGURE 1 with the result that the discharge of hydraulic fluid through both of the ports 132 and 134 is stopped and the piston in the hydraulic cylinder 44 is arrested when it has arrived at approximately the center of the cylinder. The web guiding roller 12 will therefore cease its movement and the web will remain in its realigned position until such time as other external influences tend to move it out of alignment with its predetermined path of travel and thus further into or out of the slot in the sensing head 56.

If the web becomes misaligned by movement in a direction which moves its lateral edge outwardly in the slot in the sensing head 56, the corrective action which occurs is the opposite of that which has been described for misalignment tending to move the web inwardly in the slot in the sensing head. In other words, the pressure in the control fluid chamber 68 is increased so that the spool 76 of the four-way hydraulic valve 64 is moved to the right. This permits hydraulic fluid to be delivered from the pump 118 through the four-way hydraulic valve 64 and into the conduit 46 which in turn delivers the fluid to the inner end of the hydraulic cylinder 44. The piston rod 15 is thus moved to the right, drawing with it the bearing block 22 which in turn causes the cantilevered web guiding roller 12 to be moved to the right or toward the sensing head 56. At the same time, the roller is swiveled in a direction which causes it to exert lesser pressure on the lateral edge of the web toward which it is moving than on the opposite edge of the web. In this manner, the movement of the web toward the left or outwardly in the slot in the sensing head is offset by the opposite movement of the roller and the web is returned to its aligned position.

From the foregoing description of the invention, it will be perceived that the embodiment of the cantilevered roller web guiding assembly hereinbefore described is a considerably more compact system than that which has been described in the copending application of which this application is a continuation-in-part. Moreover, a pneumo-hydraulic sensing power drive system has been illustrated which permits much heavier guide rolls to be moved in substantially instantaneous and rapid response to variations in the path of web travel from that which has been predetermined to be desirable. It is to be borne in mind that the novel roller supporting mechanism and pneumo-hydraulic drive system of the invention may also be employed to advantage in systems in which the roller is supported at both of its ends.

Although a number of modifications and variations may be made in the details of structure which have hereinbefore been described by way of example, it is intended that insofar as such variations and modifications do not depart from a reliance upon the basic principles which underlie the present invention, such changes are intended to be circumscribed by the spirit and scope of the present invention except as the same may be necessarily limited by the appended claims or reasonable equivalents thereof.

What is claimed is:

1. A web guiding system for guiding a traveling web comprising:
   (a) a cantilevered roller extending transversely to the path of travel of said web with an arcuate portion of its periphery in frictional engagement with said web;
   (b) a raceway assembly;
   (c) means slidably and reciprocably mounted on said raceway assembly for pivotally supporting said cantilevered roller;
   (d) means on said raceway assembly and cooperating with said roller supporting means for pivoting said cantilevered roller relative to said raceway assembly and the longitudinal axis of said web as said roller supporting means reciprocates on said raceway assembly; and
   (e) means for correlating the transverse movements of said web relative to a predetermined path of travel with movements of said cantilevered roller and roller supporting means to maintain the transverse alignment of said web.

2. A web guiding system as claimed in claim 1 wherein said slidably and reciprocably mounted roller supporting means comprises:
   (a) a bearing block slidably mounted on said raceway assembly; and
   (b) an arm pivotally journaled in said bearing block for pivotation about an axis extending substantially normal to the plane in which said bearing block slides, said arm being secured to one end of said roller and supporting said roller in the nature of a cantilever in a plane extending substantially parallel to the plane in which said bearing block slides.

3. A web guiding system as claimed in claim 1 wherein said means for correlating the transverse movements of said web relative to a predetermined path of travel with the movements of said cantilevered roller comprises:
   (a) means sensing the transverse movement of said web relative to a predetermined path of travel; and
   (b) means actuated by said sensing means for reciprocating said cantilevered roller supporting means in the opposite direction from the direction of sensed transverse movement of said web.

4. A web guiding system as claimed in claim 3 wherein said sensing means comprises:
   (a) a slotted sensing head for receiving one edge of the web;
   (b) means for developing a fluid flow across the slot in said sensing head; and
   (c) means responsive to variations in the pressure of said fluid to actuate said means for reciprocating said cantilevered roller supporting means.

5. A web guiding system as claimed in claim 3 wherein said means for reciprocating said cantilevered roller supporting means is a hydraulic power system including
(a) a double acting hydraulic cylinder having a piston therein connected to said cantilevered roller supporting means;
(b) a source of hydraulic power fluid;
(c) conduit means connecting said source of power fluid to said cylinder;
(d) a pump in said conduit means; and
(e) valve means responsive to said sensing means in said conduit means for directing varying amounts of power fluid to opposite ends of said hydraulic cylinder.

6. A web guiding system as claimed in claim 1 and further charcterized to include means for automatically positioning said roller normal to the desired path of travel of said web to facilitate threading said web thereon at the commencement of the guiding of the web.

7. A web guiding system as claimed in claim 6 wherein said means for automaticaly positioning said roller normal to the desired path of travel of said web comprises:
(a) means for disengaging said correlating means from the system; and
(b) means for automatically moving said roller supporting means to the center of said raceway assembly whereby when said raceway assembly is properly located relative to the desired path of travel of said web, said roller and said roller supporting means are positioned normal to said desired path of travel.

8. Apparatus for maintaining the transverse alignment of a moving web comprising:
(a) means sensing the transverse movement of said web relative to a predetermined path of travel;
(b) a roller extending transversely to the path of travel of said web with an arcuate portion of its periphery in frictional engagement with said web;
(c) a rigid member rotatably supporting said roller in the nature of a cantilever;
(d) a fixed supporting member;
(e) a connecting linkage slidably mounted on said supporting member and pivotally connected to said rigid member; and
(f) guide means on said rigid member cooperating with said connecting linkage to pivot said roller about an axis extending substantially parallel to the bisector of the angle subtended by said arcuate portion of the periphery of said roller.

9. In combination with a moving web, apparatus for maintaining said web in transverse alignment with a desired path of travel, said apparatus comprising:
(a) a generally cylindrical member extending across the path of travel of said web and bearing against said web to form a bight therein;
(b) an arm rotatably journaling one end of said generally cylindrical member in the nature of a cantiliver;
(c) a block pivotally supporting said arm for pivotation of said roller about an axis extending substantially parallel to the bisector of the arc formed by said bight;
(d) a fixed raceway slidably journaling said block for movement in a direction generally normal to the direction of travel of said web;
(e) means secured to said raceway and acting on said arm during movement of said block to pivot said arm and roller about said pivotal axis;
(f) means sensing the transverse movement of said web relative to a desired path of travel; and
(g) means actuated by said sensing means for sliding said block along said raceway to effect correction of the misalignment of said web.

10. The combination claimed in claim 9 wherein said sensing means comprises:
(a) a compressible fluid operated sensing head for producing a control signal which varies in accordance with the position of the lateral edge of said web relative to said sensing head, said sensing head having a fluid input port and a fluid output port for transmitting the control signal fluid pressure;
(b) means for supplying a pressure fluid to said input port;
(c) diaphragm means responsive to variations in the pressure of the fluid in said outlet port; and wherein said means actuated by said sensing means for sliding said block along said raceway comprises:
(1) a source of a liquid power fluid;
(2) a pump connected to said source;
(3) a double acting hydraulic cylinder;
(d) a piston rod connected to said block at one of its ends and having a piston on its other end disposed in said cylinder;
(e) means for conveying power fluid from said pump to each of the ends of said hydraulic cylinder; and
(f) valve means in said power fluid conveying means and connected to said diaphragm means for actuation thereby whereby the amount of power fluid conveyed to the respective ends of said cylinder is dependent upon the degree and direction of response of said diaphragm to variations in the pressure of said compressible fluid in the outlet port of said sensing head.

11. The combination claimed in claim 10 and further characterized to include means for dithering said diaphragm at a high frequency and low amplitude whereby sticking of said valve means is prevented.

12. In combination with a moving web, apparatus for maintaining said web in transverse alignment with a desired path of travel, said apparatus comprising:
(a) a generally cylindrical member extending across the path of travel of said web and bearing against said web to form a bight therein;
(b) an arm rotatably journaling one end of said generally cylindrical member in the nature of a cantilever;
(c) a block pivotally supporting said arm for pivotation of said roller about an axis extending substantially parallel to the bisector of the angle formed by said bight;
(d) a fixed raceway slidably journaling said block for movement in a direction generally normal to the direction of travel of said web;
(e) means secured to said raceway and acting on said arm during movement of said block to pivot said arm and roller about said pivotal axis; and
(f) means for shifting said block in response to transverse movements of said web relative to a desired path of travel to effect correction of the misalignment of said web.

13. Apparatus for maintaining the alignment of a moving web comprising:
(a) an elongated cantilevered guide means contacting the web along one of its surfaces in a direction transverse to the path of travel of the web;
(b) means rotatably journaling said cantilevered guide means and supporting said guide means in the nature of a cantilever;
(c) a slidably mounted bearing block pivotally supporting said cantilevered guide means supporting means for pivotation about an axis extending through and substantially normal to the axis of rotation of said cantilevered guide means;
(d) a camming device contacting said guide means supporting means and pivoting said guide means supporting means in said bearing block during sliding movement of said block; and

(e) means for shifting said block in response to transverse movements of said web relative to a desired path of travel to effect correction of the misalignment of said web.

14. A web guiding system for guiding a traveling web comprising:

(a) a cantilevered roller extending transversely to the path of travel of said web with an arcuate portion of its periphery in frictional engagement with said web;

(b) a raceway assembly;

(c) a bearing block slidably mounted on said raceway assembly;

(d) a bracket rotatably journaling said roller at its supported end;

(e) a base plate secured to said bracket and extending parallel to said roller;

(f) a shaft extending from one side of said base plate into said bearing block;

(g) means for pivoting said cantilevered roller relative to said raceway and the longitudinal axis of said web as said roller supporting means reciprocates on said raceway; and

(h) means for correlating the transverse movements of said web relative to a predetermined path of travel with the movements of said cantilevered roller and said roller journaling bracket to maintain the transverse alignment of said web.

15. A web guiding system for guiding a traveling web comprising:

(a) a cantilevered roller extending transversely to the path of travel of said web with an arcuate portion of its periphery in frictional engagement with said web;

(b) a raceway assembly;

(c) means slidably and reciprocably mounted on said raceway assembly for pivotally supporting said cantilevered roller;

(d) an arcuate cam surface on said reciprocably mounted cantilevered roller supporting means;

(e) a cam follower secured on said raceway assembly and cooperating with said arcuate cam surface during reciprocating movement of said cantilevered roller to pivot said roller; and

(f) means for correlating the transverse movements of said web relative to a predetermined path of travel with the movements of said cantilevered roller and said roller supporting means to maintain the transverse alignment of said web.

16. A web guiding system as claimed in claim 15 wherein said arcuate cam surface is formed as an arcuate slot in said cantilevered roller supporting means; and wherein said cam follower comprises a roller rotatably mounted on said raceway assembly and projecting into said arcuate slot.

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RAPHAEL M. LUPO, *Examiner.*