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Bonner

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[54] WEB SENSING AND GUIDING APPARATUS

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[52] **U.S. Cl.** **226/21**

[51] **Int. Cl.** **B65h 25/26**

[58] **Field of Search** 226/3, 18, 21, 22, 23

[56] **References Cited**

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Primary Examiner—Richard A. Schacher
Attorney—Vernon J. Pillote et al.

[57] **ABSTRACT**

A web sensing and guiding apparatus in which a web position sensor is provided to sense the lateral position of a web as it exits from a web guide roller in an exiting plane. The sensor is mounted for movement along a crosswise guideway that moves with the exiting roller to maintain the web position sensor at a preselected spacing and attitude in relation to the exiting plane of the web, and the sensor is operatively connected to a stationary structure in a manner to maintain the sensor at a preselected location laterally of the path of web travel while accommodating movement of the sensor angularly and longitudinally relative to the path of web travel.

12 Claims, 7 Drawing Figures

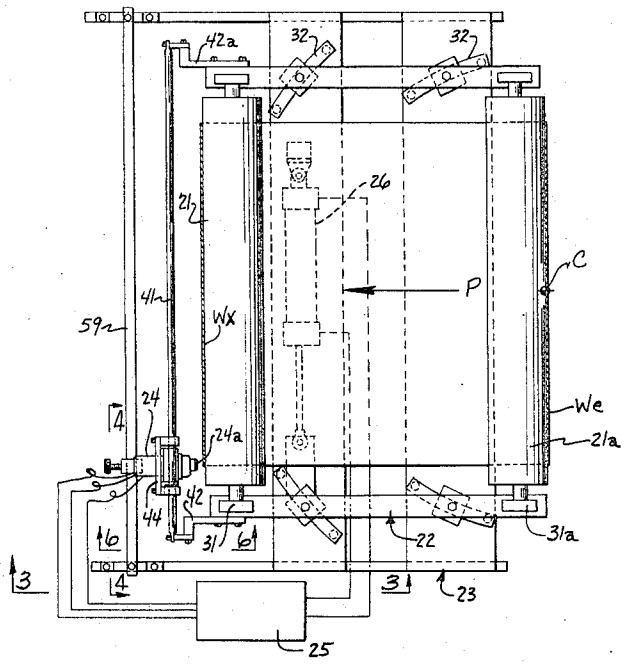
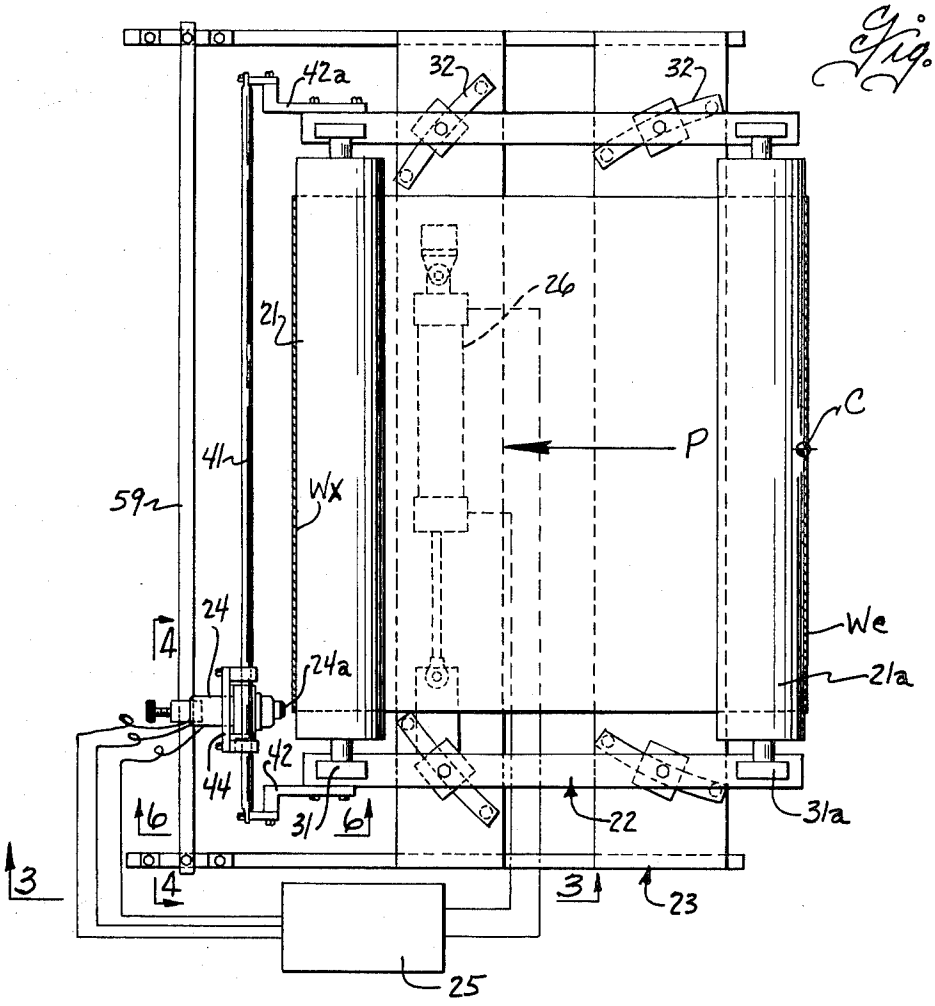


Fig. 1.


42a
32
32
26
21
C
P
41
59
Wx
We
24
24a
21a
4
42
44
31
6
22
31a
6
3
4
3
23
25

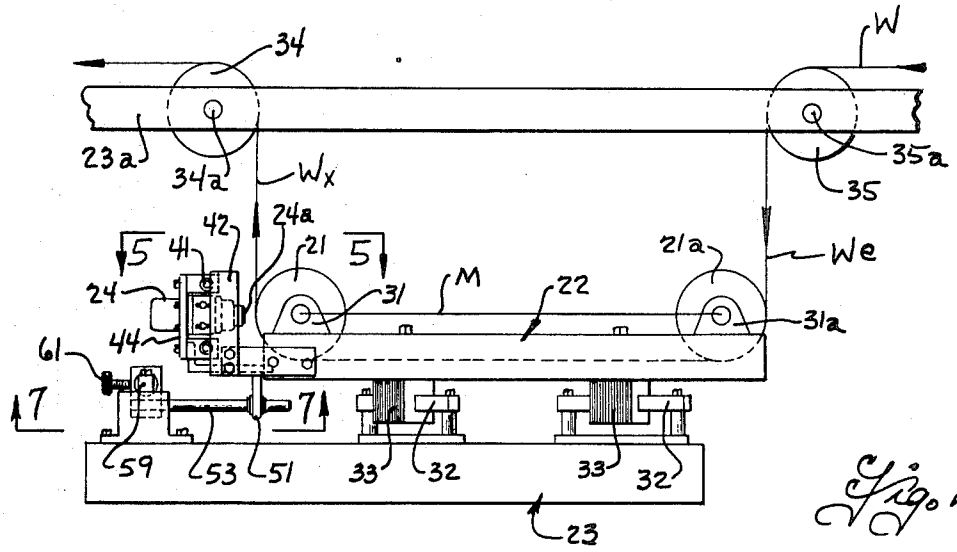

34
W
23a
34a
Wx
35a
35
42
24a
5
41
21
5
21a
We
24
M
22
31
31a
44
61
7
7
59
53
51
33
32
33
32
23

Fig. 2.

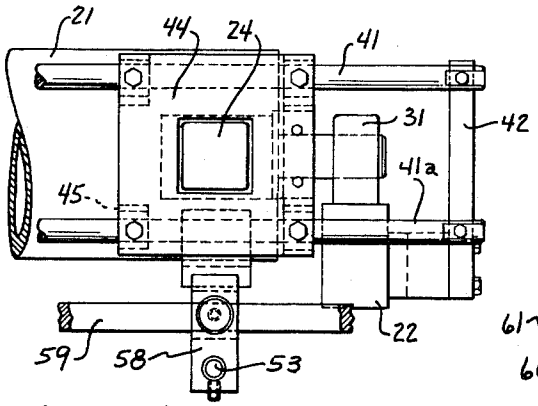


Fig. 4.

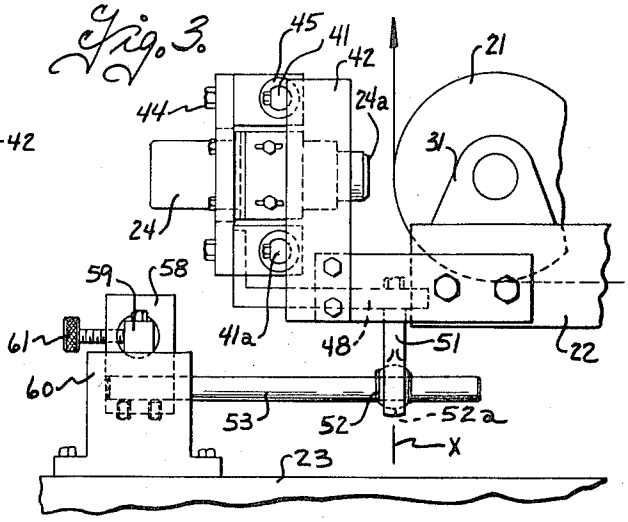


Fig. 3.

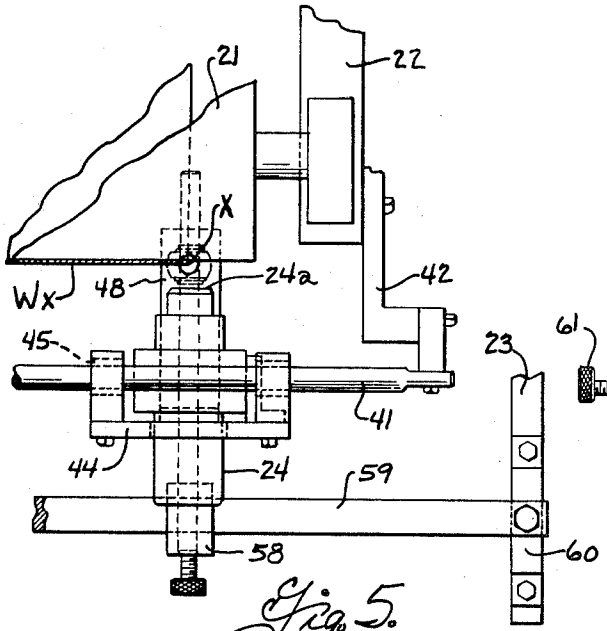


Fig. 5.

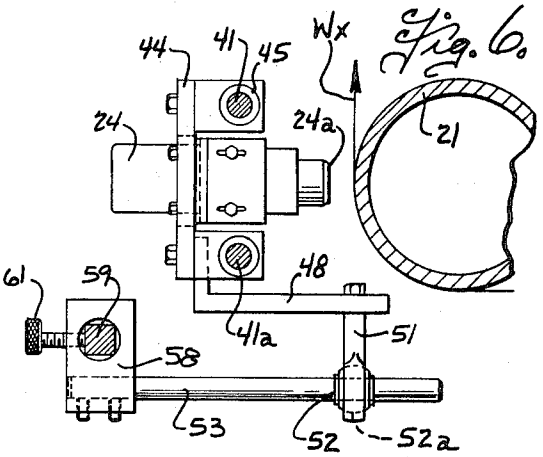


Fig. 6.

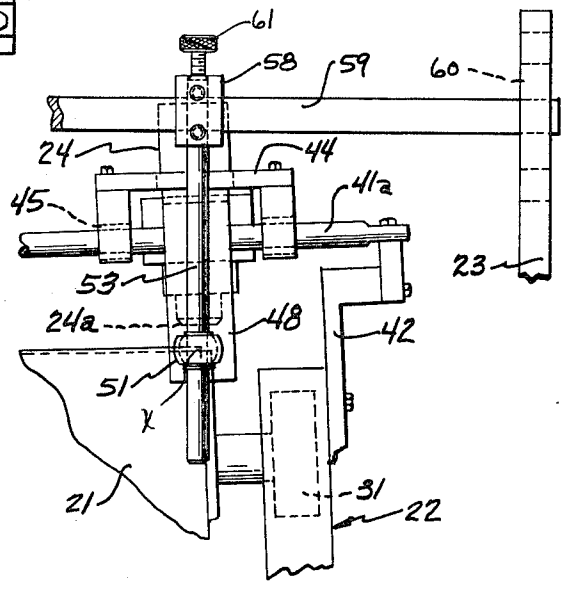


Fig. 7.

WEB SENSING AND GUIDING APPARATUS

BACKGROUND OF THE INVENTION

It is common practice in guiding longitudinally travelling webs to utilize a web guide roller mounted for combined crosswise and angular movement relative to the path of web travel, and to sense the lateral position of the web and automatically move the web guide roller in a direction to correct deviation of the web from the desired path of web travel. Although many web guide apparatus have the web position sensor located to sense the lateral position of the web in advance of the exiting web guide roller, it is desirable to sense the position of the travelling web as it exits from the exiting web guide roller so that the sensor responds to the corrected path of web travel. However, when the web leaves the web guide roller at a substantial angle to the plane of motion of the web guide roller, the exiting web undergoes a substantial shifting movement in a direction normal to the plane of the exiting web, and which movement markedly complicates the problem of sensing the position of the exiting web. Some web position sensors, such as gap type web edge sensors, can accommodate only limited shifting of the web in a direction normal to its plane, and some other sensors such as reflective-type photoelectric web edge and line detectors, can accommodate almost no shifting of the web normal to its plane.

SUMMARY OF THE INVENTION

The present invention relates to a web position sensing and guiding apparatus in which a web guide roller is mounted for combined crosswise and angular movement relative to the path of web travel. The lateral position of the web is sensed at a location in the exiting plane of the web and power mechanism is provided responsive to the web position sensor for moving the web guide roller in a direction to correct deviation of the web from a desired path of travel. The present invention is characterized by the provision of a crosswise sensor guide that parallels the web guide roller and which moves as a unit therewith in combined crosswise and angular movement relative to the path of web travel, a carriage supporting the web position sensor for movement along the crosswise guide so that the sensor remains in a uniform spatial and angular relationship to the exiting web, and a mechanism connecting the sensor carriage to a stationary support structure to maintain the sensor at a fixed location laterally of the path of web travel while accommodating movement of the sensor in a direction longitudinally and angularly relative to the path of web travel. The carriage for the web position sensor is connected to the stationary support structure by a longitudinal guide that parallels the path of web travel and a swivel connection that slidably engages the longitudinal sensor guide and swivelly engages the carriage at a location adjacent the sensing head.

An important object of this invention is to provide a web position sensing and guiding apparatus in which the sensor is arranged to sense the web position in the exiting plane of the web and wherein the sensor is mounted so as to maintain a uniform spatial and angular relationship between the web position sensor and the plane of the exiting web at a fixed location laterally of the path of web travel.

A more particular object of this invention is to provide a web position sensing and guiding apparatus in which a crosswise sensor guideway parallels the exiting web guide roller and is movable as a unit therewith in combined crosswise and angular movement relative to the path of web travel, and wherein the web position sensor is mounted for movement along the sensor guideway so as to maintain a uniform spatial and angular relationship to the plane of the web exiting from the web guide roller, and the sensor is connected to a stationary support structure in a manner to maintain the web position sensor at a present position laterally of the path of web travel while accommodating movement of the sensor longitudinally and angularly relative to the path of web travel.

Yet another object of this invention is to provide a web position sensing and guiding apparatus which enables locating the web position sensor at a location tangent to the web guide roller to sense the position of the web as it exits from the web guide roller.

Still another object of this invention is to provide a web position sensing and guiding apparatus in accordance with the foregoing objects, and which is adjustable for use with webs of different widths.

These, together with other objects and advantages of this invention will be more readily understood by reference to the following detailed description when taken in connection with the accompanying drawings wherein:

FIG. 1 is a plan view of a web position sensing and guiding apparatus embodying the present invention;

FIG. 2 is a side elevational view of the web position sensing and guiding apparatus of FIG. 1;

FIG. 3 is a fragmentary side elevational view taken on the plane 3—3 of FIG. 1 and illustrating the web position sensing apparatus on a larger scale;

FIg. 4 is a fragmentary end elevational view taken on the plane 4—4 of FIG. 1 and illustrating portions of the web position sensing apparatus on a larger scale;

FIG. 5 is a fragmentary horizontal sectional view taken on the plane 5—5 of FIG. 2 and illustrating the web position sensing apparatus on a larger scale;

FIG. 6 is a fragmentary vertical sectional view taken on the plane 6—6 of FIG. 1 and showing the parts on a larger scale; and

FIG. 7 is a fragmentary bottom view taken on the plane 7—7 of FIG. 2 and illustrating the parts on a larger scale.

The present invention relates to a web position sensing and guiding apparatus for use in a web handling system to laterally guide a longitudinally travelling web W along a predetermined longitudinal path of travel P paralleling the centerline of the web handling system, as the web exits from the web guide apparatus. The web guide apparatus includes at least one web guide roller 21 extending transverse to the longitudinal path of web travel and mounted for axial rotation as by bearings 31 on a movable guide frame 22. The guide frame 22 is mounted on a stationary support structure 23 to support the roller 21 for combined crosswise and angular movement relative to the path of web travel in a plane of motion M parallel to the roller axis, and the web guide apparatus is arranged in the web handling system so that the web exits from the roller 21 in an exiting plane Wx transverse to the plane of motion of the web

guide roller 21. A web position sensor 24 is provided for sensing a selected longitudinal characteristic of the web, such as the web edge or a line or other longitudinal characteristic of the web, and a control apparatus 25 is connected to the web position sensor 24 and responds to the signals produced thereby to operate an actuator 26 for moving the movable guide frame 22 relative to the stationary support structure 23 in a direction and amplitude to correct deviation of the web from the desired longitudinal path of web travel. In order to have the web position sensor automatically respond to corrections in the path of web travel introduced by the web guide apparatus, it is desirable to sense the lateral position of the web as it exits from the web guide apparatus. However, when the web exits from the web guide roller in a direction transverse to the plane of motion of the web guide roller, the exiting web is not only shifted laterally in the plane of the web, but is also shifted in a direction normal to the plane of the web. This last-mentioned shifting motion, in a direction normal to the plane of the web as it exits from the web guide apparatus, is herein referred to as "pass-line fluctuation" of the web. The pass-line fluctuation varies as a function of the angle through which the web guide roller is tilted and the width of the web. In many installations, particularly in those involving wide webs or web guide apparatus which tilt through substantial angles, the pass-line fluctuation becomes quite large. Many web position sensors such as gap-type photoelectric and pneumatic web edge sensors can accommodate only a limited pass-line fluctuation and others, such as vacuum type sensors and reflective-type photoelectric sensors, can accommodate substantially no pass-line fluctuation. In accordance with the present invention, the web position sensor 24 is mounted for angular movement with the web guide roller so as to maintain a preselected spacing and angular relationship between the web position sensor and the exiting web W*x*, and the web position sensor is also supported for movement crosswise of the path of web travel and parallel to the web guide roller and is operatively connected to the stationary support in a manner to maintain the web position sensor at a preselected position laterally of the path of web travel.

Various different arrangements can be utilized to support the web guide roller 21 for combined crosswise and angular movement relative to the path of web travel. In the preferred embodiment illustrated, the movable guide frame 22 is supported on the stationary support structure 23 so that, during movement of the movable guide frame, the web guide roller 21 is disposed generally tangent to an arcuate path having an effective pivot center designated C and located in advance of the web guide roller 21. The particular mechanism herein shown for supporting the web guide apparatus is generally of the type disclosed in the U. S. Pat. to Robert W. Ott, Jr. No. 3,390,823 and includes a plurality of arcuate guide bars 32 mounted on the stationary support structure 23 and followers 33 which slidably engage the respective guide bars and are connected to the movable support structure. As more fully disclosed in aforementioned patent, the arcuate guide bars 32 are formed and arranged to have their arc centers disposed at the pivot center C. The actuator 26 shown herein is of the fluid or hydraulic type and includes a cylinder connected at one end to the stationary support structure and having a piston rod connected at the other end to the movable guide frame to move the guide frame crosswise and angularly relative to the stationary support structure about the pivot center C. As previously described, the web W exits from the roller 21 in an exiting plane W*x* transverse to the plane of motion of the web guide roller 21 and, as shown in FIG. 2, passes over an idler roller 34 rotatably supported at 34*a* in a stationary support structure 23*a*. The web guide apparatus illustrated herein also includes an entering web guide roller 21*a* mounted for rotation in journals 31*a* on the movable guide frame 22, with the roller 21*a* disposed generally tangent to the pivot center C of the exiting web guide roller 21. The web W enters the web guide apparatus and passes over an idler roller 35 rotatably supported at 35*a* on the stationary support structure 23*a* at a location such that the entering web span W*e* is disposed substantially in the plane of the pivot center C and transverse to the plane of motion of the web guide rollers.

The web position sensor 24 and the control 25 therefore can be of any suitable construction capable of sensing lateral deviation of a selected longitudinal characteristic of the web relative to the head 24*a* of the sensor and may, for example, be a gap-type pneumatic web edge sensor and control such as disclosed in the U. S. Pat. to Robert W. Ott, Jr. No. 3,407,706. In the preferred embodiment, however, the web position sensing device 24 is a reflective-type photoelectric sensor in which the light transmitter and the photoelectric receiver are both located in the sensor head 24*a*. When a gap-type sensor is utilized, the sensor must be positioned slightly downstream of the exiting web guide roller 21 to enable positioning of the gap-type sensor at opposite sides of the web edge. In the reflective-type sensor, however, the sensor can be positioned adjacent the periphery of the web guide roller 21 at a location adjacent the point of tangency of the exiting web with the web guide roller. It is, of course, desirable to position the web position sensor as closely as possible to the exiting web guide roller, and preferably at the point of tangency thereto, to minimize the tendency of the web guide apparatus to hunt and to also minimize fluttering of the web in a direction normal to its plane at the sensing location.

A crosswise sensor guide is mounted on the movable guide frame 22 for crosswise and angular movement therewith and parallels the exiting web guide roller 21. In the embodiment shown, the crosswise guide comprises a pair of guide rods 41, 41*a* mounted at opposite ends by brackets 42, 42*a* on the movable guide frame 22. As shown, the guide rods 41, 41*a* are disposed in a plane generally paralleling the plane of the exiting web W*x* and are spaced outwardly from the pivot center C of the exiting web guide roller. A sensor carriage 44 is slidably mounted by bearings 45, preferably of the anti-friction type, on the guide rods 41, 41*a* for sliding movement therealong in a path paralleling the web guide roller 21. As best shown in FIGS. 3 and 6, the web position sensor 24 is disposed intermediate the guide rods 41, 41*a* and is mounted, as by fasteners 46 that extend through slotted openings in brackets 47 on the carriage, for adjustment in a direction paralleling the plane of motion of the exiting web guide roller 21

and perpendicular to the exiting plane W*x* of the web, so as to enable adjustment of the spacing of the sensing head **24***a* relative to the exiting web and web guide roller **21**. The web position sensor is thus movable along the guide rods **41**, **41***a* carried by the movable guide frame so that the web position sensor is maintained at fixed spacing and angle to the exiting web, during tilting movement of the exiting web guide roller.

Provision is made for connecting the sensor carriage **44** to the stationary support structure in such a manner as to cause the sensor carriage to move along the guide rods **41**, **41***a* during the crosswise and angular movement of the guide roller **21**, in a manner to maintain the sensing head **24***a* at a preselected position laterally of the path of web travel, while yet accommodating movement of the sensor head angularly and longitudinally relative to the path of web travel. For this purpose, the carriage **44** for the web position sensor has a bracket **48** rigid therewith and which extends to a point adjacent the plane of the exiting web W*x*, but at the side of the exiting web guide roller **21** opposite the side from which the web exits therefrom. A swivel bracket **51** is secured to the carriage bracket **48** to define a sensor pivot axis X (FIGS. **3** and **4**) which is perpendicular to the plane of motion of the web guide roller **21** and aligned with the plane of the exiting web W *x* at a location adjacent the sensing head **24***a* of the web position sensor. The sensor pivot axis is connected to the stationary support structure in a manner to maintain the pivot axis at a preselected location laterally of the path of web travel while accommodating movement of the carriage **44** in a direction longitudinally and angularly relative to the path of web travel. For this purpose, the sensor pivot bracket **51** has a follower **52** which is slidably supported on a longitudinal guide rod **53** secured to the stationary support structure to extend transverse to the plane of the exiting web. More specifically, the longitudinal guide rod extends parallel to the plane of motion of the roller **21** and parallel to the longitudinal path of travel of the web. A swivel connection is provided between the follower **52** and the bracket **51** and, in the embodiment shown, the follower is supported in a semispherical bearing **52***a* of the "self-aligning" type, which allows limited angular movement of the pivot bracket **51** relative to the follower **52** about the sensor pivot axis X. Thus, as the movable guide frame moves about the pivot center C to cause the exiting web guide roller **21** to move crosswise and angularly with respect to the path of web travel, the sensor **24** and sensor carriage **44** are maintained by the crosswise guides **41**, **41***a* at a uniform spatial and angular relationship with respect to the exiting web. However, the pivot axis X of the sensor is maintained at a preset position laterally of the path of web travel so that the sensor carriage and sensor are moved along the guides **41**, **41***a* during turning movement of the exiting web guide roller. The longitudinal guide **53** is advantageously mounted for adjustment in a direction crosswise of the stationary support structure, to accommodate webs in which the longitudinal characteristic being sensed has a different spacing than the longitudinal path of web travel, and, as shown, the guide rod **53** is attached to the bracket **58** which is slidably adjustable along a bar **59** secured to the stationary support structure by brackets **60** to extend crosswise thereof. The bar **59** preferably has a noncircular cross-section so as to nonrotatably but slidably support the bracket **58** thereon and a locking screw **61** is provided for selectively locking the longitudinal guide bar at a preselected position laterally relative to the path of web travel.

OPERATION

From the foregoing it is thought that the construction and operation of the web guide apparatus will be readily understood. The web position sensor **24** is positioned to sense a preselected longitudinal characteristic of the web such as the web edge and to produce an output signal correlative with the direction and amount of deviation of the web position relative to the head **24***a* of the web edge sensor. The control apparatus **25** operates the actuator **26** in accordance with the signal produced by the web position sensor to move the movable guide frame **22** and roller **21** crosswise and angularly relative to the path of web travel about the pivot center C in a direction and amplitude to correct deviation of the web from the desired path of travel. For example, if the web edge in the exiting plane W*x* deviates in one direction such as to the left of the effective center of the head **24***a* of the web position sensor as viewed in FIG. **1**, the sensor operates through the control **25** and actuator **26** to shift the exiting web guide roller crosswise and angularly in the opposite direction to shift the web (to the right as viewed in FIG. **1**) to correct deviation of the web from the desired path of web travel. The sensor carriage **44** will move angularly with the movable guide frame **22** so as to maintain the sensing head **24***a* in uniform spatial and angular relationship to the exiting web W*x*. However, the longitudinal guide rod **53** engaging the pivot bracket **51** maintains the pivot axis X of the sensor head at a fixed location laterally of the path of web travel. Consequently, as the exiting web guide roller **21** and guide rods **41** shift in one direction crosswise of the path of web travel, the longitudinal guide rod **53** and pivot bracket **51** will cause the web position sensor to move along the guide rods **41** in the opposite direction so as to maintain the web position sensor at a fixed location laterally of the path of web travel.

The above-described arrangement thus mounts the sensor head so as to accommodate the "pass-line" fluctuation of the web in its exiting plane W*x*, while yet maintaining the web position sensor at a fixed location laterally of the path of web travel. This, in turn, enables locating of the web position sensor at a position closely adjacent the exiting web guide roller **21** or, as in the preferred embodiment illustrated, tangent to the exiting web guide roller at the point where the web leaves the web guide roller.

The invention has been described in considerable detail with reference to the preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a web sensing and guiding apparatus for laterally guiding a longitudinally travelling web along a predetermined path of web travel including a web

guide roller extending transverse to the travelling web to have the web wrap partway around the roller and exit therefrom in an exiting plane, a movable guide frame mounting the web guide roller on a stationary support structure for combined crosswise and angular movement relative to said path of web travel, a web position sensor having a sensor head and operative to sense lateral deviation of a selected longitudinal characteristic of the web relative to said sensing head, and power means controlled by said web position sensor for moving the guide frame and web guide roller relative to said stationary support in a direction to correct deviation of said web from said desired path of web travel; the improvement comprising: means on the movable guide frame defining a crosswise guideway extending crosswise of the path of web travel parallel to said web guide roller and movable in unison with the movable guide frame in combined crosswise and angular movement relative to said path of travel, a sensor carriage mounted on said crosswise guideway for movement therealong parallel to said web guide roller, means mounting said web position sensor on said sensor carriage with said sensing head arranged to sense the lateral position of the web at a sensing location in said exiting plane of the web, and sensor positioning means connected to said stationary support structure and operatively engaging said sensor carriage at a location adjacent said sensing location for moving the sensor carriage along said crosswise guideway as the guide frame is moved relative to the stationary support structure to maintain the sensor head at a preselected position laterally of said path of web travel.

2. A web sensing and guiding apparatus according to claim 1 wherein said sensor positioning means includes a longitudinal sensor guideway mounted on said stationary support structure and extending transverse to the plane of the exiting web, and means slidably engaging said longitudinal sensor guideway and swivelly engaging said carriage at a location adjacent the plane of the exiting web.

3. A web sensing and guiding apparatus according to claim 2 wherein said longitudinal sensor guideway is mounted on said stationary support structure for adjustment crosswise of said path of web travel.

4. A web sensing and guiding apparatus according to claim 2 wherein said sensor has its sensor head positioned adjacent the periphery of said web guide roller to sense the position of the web as it exits from the roller.

5. A web sensing and guiding apparatus according to claim 1 wherein said crosswise sensor guideway includes spaced parallel guide rails mounted on said guide frame parallel to said web guide roller, said carriage being slidably mounted on said spaced guide rails.

6. In a web sensing and guiding apparatus for laterally guiding a longitudinally travelling web along a predetermined path of web travel including a web guide roller extending transverse to the travelling web to have the web wrap partway around the roller and exit therefrom in an exiting plane, a movable guide frame mounting the web guide roller on a stationary support structure for combined crosswise and angular movement relative to said path of web travel, a web position sensor having a sensor head and operative to sense lateral deviation of a selected longitudinal characteristic of the web relative to said sensing head, and power means controlled by said web position sensor for moving the guide frame and web guide roller relative to said stationary support in a direction to correct deviation of said web from said desired path of web travel; the improvement comprising: at least one crosswise guide bar mounted on said movable guide frame for movement therewith and extending crosswise of said path of web travel and parallel to said guide roller, a sensor carriage mounted on said crosswise guide bar for sliding movement therealong, means mounting said web position sensor on said sensor carriage with said sensing head arranged to sense the lateral position of the web at a sensing location in said exiting plane of the web, a longitudinal sensor guide bar mounted on said stationary support structure and extending transverse to the plane of the exiting web, and sensor positioning means slidably engaging said longitudinal sensor guide bar and swivelly engaging said sensor carriage at a location adjacent said sensing head for moving said sensor carriage along the crosswise guide bar as the guide frame is moved relative to said stationary support structure to maintain said sensing head at preset position laterally of said path of web travel.

7. A web sensing and guiding apparatus according to claim 6 wherein said web guide roller is supported for movement in a plane of motion transverse to the plane of the exiting web, said sensor positioning means defines a pivot axis transverse to said plane of motion and substantially aligned with the exiting plane of the web at said sensing location.

8. A web sensing and guiding apparatus according to claim 7 wherein said web position sensor has its sensing head positioned adjacent the periphery of said web guide roller to sense the lateral position of the web as it exits from the roller.

9. A web sensing and guiding apparatus according to claim 6 wherein said web position sensor has its sensing head positioned adjacent the periphery of said web guide roller to sense the lateral position of the web as it exits from the roller.

10. A web sensing and guiding apparatus according to claim 6 including a stationary guide bar mounted on said stationary support structure and extending crosswise of said path of travel, and means mounting said longitudinal guide bar for adjustment along said stationary guide bar.

11. In a web position sensing and guiding apparatus including an exiting web guide roller extending transverse to a travelling web, a stationary support structure, means including a movable frame mounting said exiting web guide roller for movement in a plane of motion in which the exiting web guide roller is disposed generally tangent to a curved path about an effective pivot center, said exiting web guide roller in the mid-position thereof extending perpendicular to the desired path of web travel and being arranged to have the travelling web extend partially therearound and exit therefrom in an exiting plane transverse to said plane of motion, a web position sensor having a sensor head and operative to sense lateral deviation of a selected longitudinal characteristic relative to the sensing head, and power means operated by the web position sensor for moving said movable frame and said exiting web guide roller in a direction to correct deviation of the web edge from

said preselected lateral position, the improvement comprising: at least one crosswise guide bar mounted on said movable frame for movement therewith and extending parallel to said exiting web guide roller, a sensor carriage mounted on said crosswise guide bar for sliding movement therealong, means mounting said web position sensor on said sensor carriage with said sensing head arranged to sense the lateral position of the web at a sensing location in said exiting plane of the web, a longitudinal sensor guide bar mounted on said stationary support to extend transverse to the plane of the exiting web and parallel to the plane of motion of said exiting web guide roller, a follower slidably engaging said longitudinal guide bar, and pivot means connecting said follower to said sensor carriage for relative pivotal movement about an axis perpendicular to said plane of motion of the exiting web guide roller and substantially aligned with the plane of the exiting web at said sensing location for moving said sensor carriage along the sensor guide bar as the guide frame is moved relative to the stationary support structure to maintain the sensing head at a preset position laterally of the path of web travel.

12. A web position sensing and guiding apparatus according to claim 11 including an entrance web guide roller mounted on said movable frame parallel to said exiting web guide roller and generally tangent to said effective pivot center.

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