United States Patent

Jordan

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[54] **WEB SENSING MECHANISM FOR TRACKING SYSTEMS**

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[52] **U.S. Cl.** **198/202**

[51] **Int. Cl.** **B65g 15/62**

[58] **Field of Search** 226/23, 45; 198/202; 74/241

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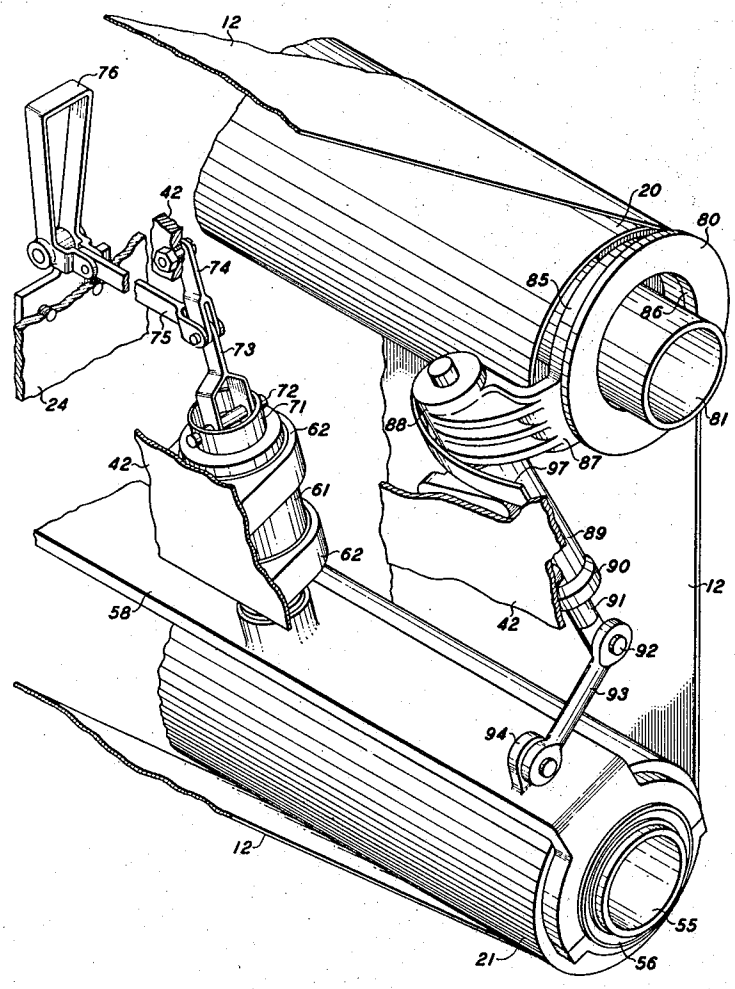
[57] **ABSTRACT**

A web sensing mechanism for use with the edge of a moving web to sense its deviation from a desired predetermined path of movement. The mechanism includes a ring formed with a tapered inner edge engageable with the sensed edge of the web and which is arranged generally concentric with the axis of a roller around which the web is guided. The ring is mounted for rotation on the end of a control lever which actuates means for correcting the web deviation.

4 Claims, 5 Drawing Figures



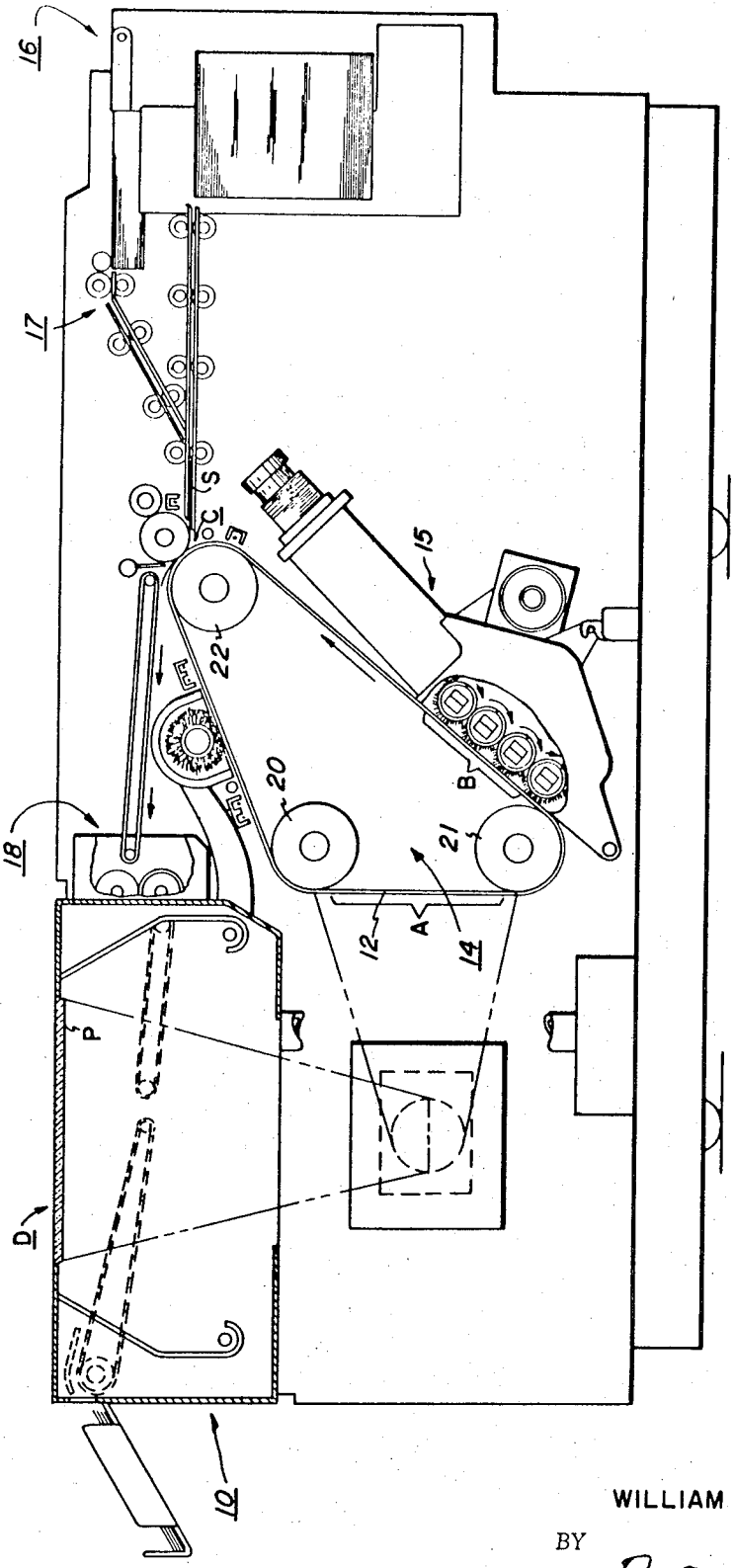


FIG. 1

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BY

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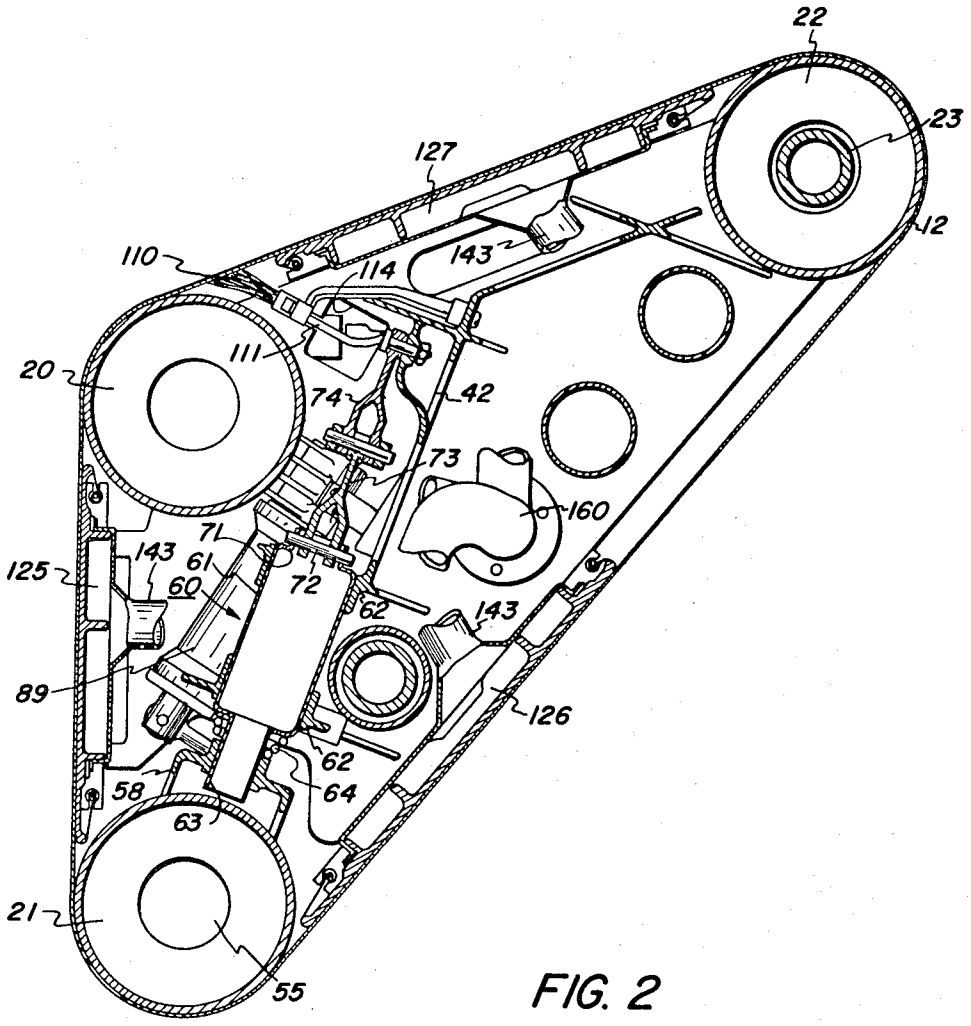
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FIG. 2

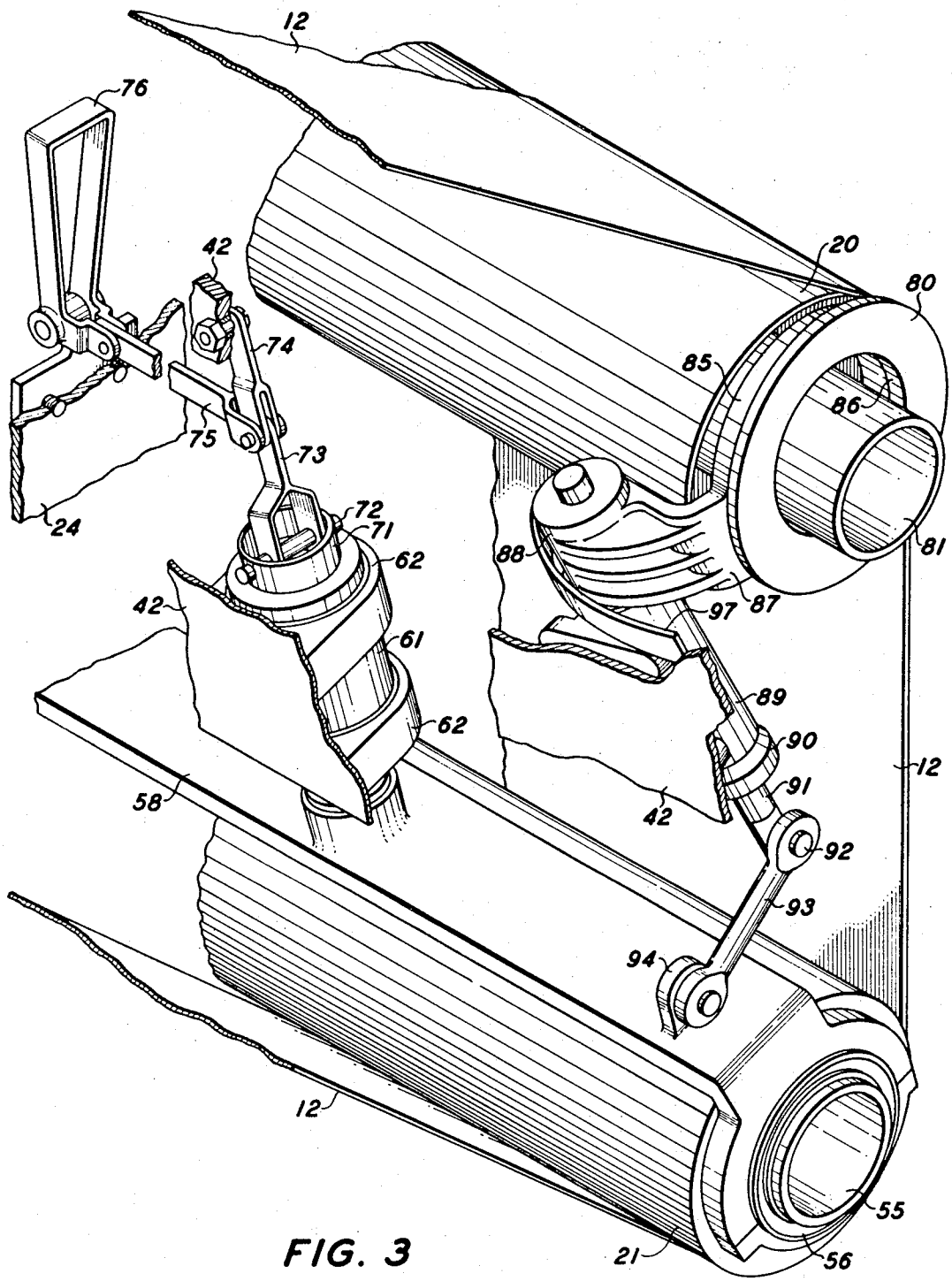
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FIG. 3

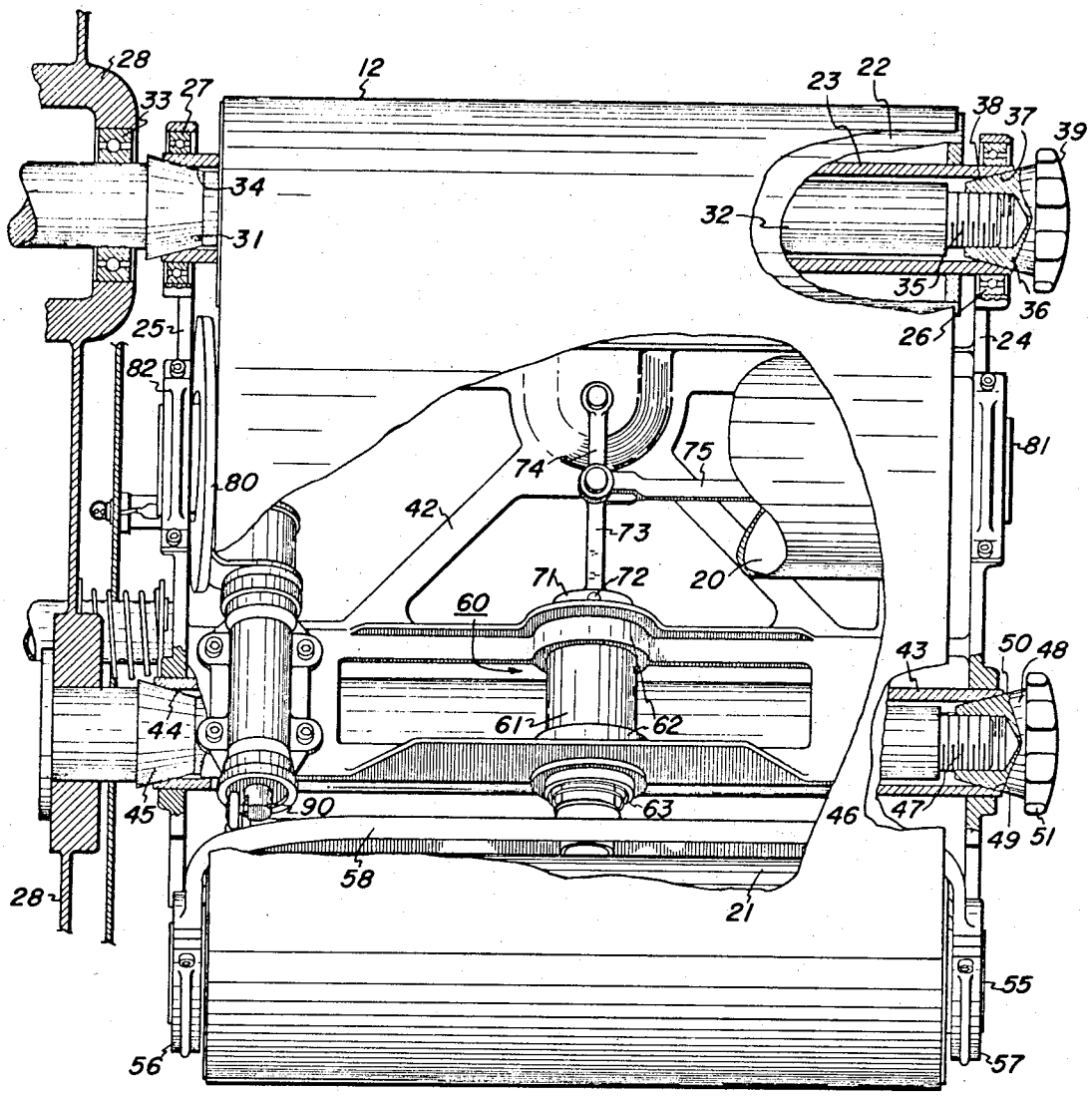
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FIG. 4

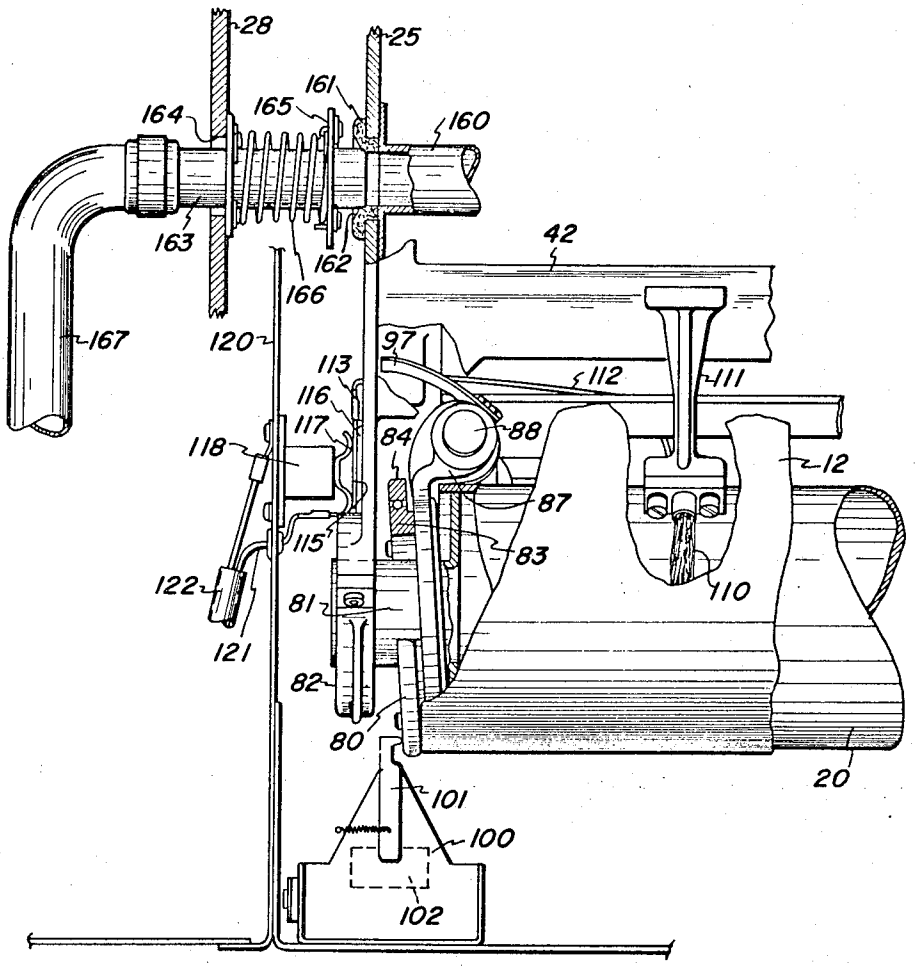
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FIG. 5

WEB SENSING MECHANISM FOR TRACKING SYSTEMS

This invention relates to sensing mechanisms and particularly to improvements in a web tracking system for an endless belt. The tracking system arranged in accordance with the present invention is particularly adapted for use with photoreceptor belts in automatic copiers/reproducers that are constructed for high speed operation and require instant response to deviations of the belt.

In order to overcome many disadvantages for high speed copying, the latest machine concept for copiers utilizes endless photoreceptor belts mounted upon a plurality of rollers and wherein a series of images are produced on the belt as the same is continuously moved about the rollers. However, the use of photoreceptor belts require extreme care in maintaining perfect alignment of the belt from processing station to processing station. Belt tracking systems utilized for this purpose must be near instantaneous in response to deviations and to utilize edge engaging devices which will not damage the sensed edge.

It is, therefore, the principal object of this invention to improve copiers/reproduction machines of the type having a photoreceptor belt by assuring accurate tracking of the belt without undue wearing of a sensed edge of the belt.

Another object of this invention is to improve sensing mechanisms for moving webs by limiting the sensing function to one edge of the web and to minimize frictional wear on this edge.

These and other objects of this invention are obtained by means of a circular member mounted on an actuating lever which controls corrective action for moving a deviating web back to a desired predetermined position. The circular member includes a ring having a tapered inner edge engageable with one edge of the web and is adapted to follow the edge in either direction of deviation in order to effect corrective action in either direction. The plane of the ring is at an angle relative to the plane of the edge of web in the vicinity of sensing so that the ring is able to sense in either direction of deviation. The ring is mounted to one race of a bearing which has its other race secured to the end of the actuating lever.

For a better understanding of the invention as well as other objects and further features thereof; reference is had to the following detailed description of the invention to be read in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic sectional view of an electrostatic reproduction machine showing the various processing stations;

FIG. 2 is a partial cross-sectional view of a belt assembly as seen from the front of the machine;

FIG. 3 is an isometric view of a portion of the belt assembly as seen from the front of the machine;

FIG. 4 is a partial sectional view of the belt assembly from the side of the machine with the belt mounted thereon partly in section to show various internal parts; and

FIG. 5 is a sectional view of a detail of the belt tracking system.

For a general understanding of the illustrated copier/reproduction machine, in which the invention may

be incorporated, reference is had to FIG. 1 in which the various system components for the machine are schematically illustrated. As in all electrostatic systems such as a xerographic machine of the type illustrated, a light image of a document to be reproduced is projected onto the sensitized surface of a xerographic plate to form an electrostatic latent image thereon. Thereafter, the latent image is developed with an oppositely charged developing material to form a xerographic powder image, corresponding to the latent image on the plate surface. The powder image is then electrostatically transferred to a support surface to which it may be fused by a fusing device whereby the powder image is caused permanently to adhere to the support surface.

In the illustrated machine, an original to be copied is placed upon a transparent support platen P fixedly arranged in an illumination assembly generally indicated by the reference numeral **10**, arranged at the left end of the machine. While upon the platen, an illumination system flashes light rays upon the original thereby producing image rays corresponding to the informational areas on the original. The image rays are projected by means of an optical system for exposing the photosensitive surface of a xerographic plate in the form of a flexible photoconductive belt or web **12** arranged on a belt assembly generally indicated by the reference numeral **14**.

As will be described below, the photoconductive belt assembly **14** is slidably mounted upon two support shafts one of which is secured to the frame of the machine and is adapted to drive a belt **12** in the direction of the arrow at a constant rate. During this movement of the belt, the reflected light image of an original on the platen is flashed upon the xerographic surface of the belt to produce electrostatic latent images thereon at an exposure station A.

As the belt surface continues its movement, the electrostatic image passes through a developing station B in which there is positioned a developer assembly generally indicated by the reference numeral **15** and where the belt is maintained in a flat condition. The developer assembly **15** provides development of the electrostatic image by means of multiple magnetic brushes as the same moves through the development zone B.

The developed electrostatic image is transported by the belt to a transfer station C whereat a sheet of copy paper is moved between a transfer roller in synchronism with the moving belt in order to accomplish transfer of the developed image solely by the electrical bias on the transfer roller. There is provided at this station a sheet transport mechanism generally indicated at **16** adapted to transport sheets of paper from a paper handling mechanism generally indicated by the reference numeral **17** to the developed image on the belt at the station B.

After the sheet is stripped from the belt **12**, it is conveyed into a fuser assembly generally indicated by the reference numeral **18** wherein the developed and transferred xerographic powder image on the sheet material is permanently affixed thereto. After fusing, the finished copy is discharged from the apparatus at a suitable point for collection externally of the apparatus.

Drive means is arranged to drive the selenium belt **12** in conjunction with timed flash exposure of an original to be copied, to effect image development, to separate and feed sheets of paper and to transport the same across the transfer station C and to convey the sheet of paper through the fuser assembly in timed sequence to produce copies of the original.

The belt **12** comprises a photoconductive layer of selenium which is the light receiving surface and imaging medium for the apparatus, on a conductive backing. The belt is journaled for continuous movement upon three rollers **20, 21** and **22** located with parallel axes at approximately the apex of a triangle. During exposure of the belt **12**, the portion thereof being exposed is that part of the belt run between the roller **20** and the lower roller **21**. As shown in FIG. **4**, the photoconductive belt assembly **14** is illustrated with the photoreceptor belt **12** partially broken away removed in order to illustrate the assembly mechanisms located adjacent the belt.

The upper roller **22** is rotatably supported on a hollow shaft **23** journaled in two side plates **24** and **25**, each having the general configuration of a triangle. The upper apex of the side plate **24** is formed with an opening for containing and supporting a bearing **26** which rotatably supports one end of the shaft **23**. At the other end, the shaft **23** is journaled in a bearing **27** supported at the upper apex for the side plate **25** in the same manner. Positioned within and along the hollow shaft **23** and projecting through a machine support frame plate **28** there is a drive shaft **30** formed with a conical element **31** and a reduced diameter extension **32**. The drive shaft is supported on the frame by a bearing **33** mounted in the frame and is connected to a drive mechanism (not shown). The conical element **31** is axially fixed and extends outwardly from the frame **28** so as to be mated with an inwardly tapered or chamfered end **34** of the hollow shaft **23** when the belt assembly is mounted on the frame. At the other end of the hollow shaft **23**, the drive shaft **30** terminates in a threaded shank **35** which cooperates with a locking member **36** formed with a conical portion **37** adapted to mate with an inwardly chamfered surface **38** of the outer end of the hollow shaft **23**. The locking member is also formed with a rotary hand-operated knob **39** for facilitating easy removal of the member for purposes to be described below.

The purpose for the extended drive shaft **32** is to aid in supporting, as will be described below, and for rotating the roller **22** and, consequently the belt, when the belt assembly **14** is in operating position; that is, when the side plate **25** is positioned against the main frame plate **28**. This arrangement also permits the easy removal of the belt assembly **14** from the machine frame.

The side plates **24** and **25** are maintained in parallel planes and rigidly supported in spaced relation for supporting the rollers **20, 21** and **22** and all of the other structures that comprise the belt assembly **14** by internal structural plates **42** and also by the hollow shaft **23** by virtue of the ends of this shaft being fixed to the inner races of the bearings **26, 27**. The plates **24** and **25** are also spaced and held in position by a hollow shaft **43** which is identical to the rotatable hollow shaft **23** except that its ends are secured to the side plates, and does not rotate. At the end adjacent the frame plate **28**, the shaft **43** is chamfered at **44** and arranged for cooperation with the conical portion **45** of a support shaft **46** positioned axially in the hollow shaft **43**. The shaft **46** is secured to the frame **28** and has its outer end formed as a threaded portion **47** which cooperates with a locking member **48**. This member is identical to the locking member **36** and is provided with an inwardly tapering or conical portion **49** which is cooperable with an inwardly chamfered surface **50** formed at the outer end of the hollow shaft **43**. A knob **51** on the member **48** allows manual locking of the inner shaft **46** relative to and within the hollow shaft **43**. From the foregoing, it will be understood that the belt assembly **14** is mounted in cantilever fashion on the frame support plate **28** by means of the hollow shafts **23** and **43**, and that by virtue of the use of tapered or conical portions **31, 37** in the case of the shaft **23** and the conical portions **45, 49** in the case of the shaft **43**, the belt assembly is adapted to be accurately positioned in its required location after movement of the assembly from the frame **28**. It will be appreciated that this structure allows quick and easy removal and replacement of the belt assembly upon the frame while still providing means for driving the belt and permit removal of the belt **12** from its supporting assembly.

The belt assembly **14** is provided with an arrangement for tracking the belt **12** in the event it deviates laterally in either direction during its movement around the rollers **20, 21, 22**. The arrangement includes the mounting of the roller **21** for rocking movement and an edge guiding device associated with the roller **20** for producing the rocking movement of the roller **21** in response to lateral deviation of the belt.

As shown in FIGS. **2** and **4**, the roller **21** is secured to a shaft **55** journaled in bearings secured to the ends of the parallel legs **56, 57** of a yoke member **58**. At the mid-point of the yoke member and extending in an opposite direction relative to the legs **56, 57**, there is mounted a shaft **60** which serves to support the yoke member for limited rocking movement about the axis of this shaft and to permit slight retraction. The shaft **60** is preferably in the form of a cylinder **61** of relatively large diameter and being rotatably mounted in spaced bearings **62** mounted on the frame **42** and having a coaxial reduced portion **63** secured to the lower cylinder **61** and secured within a suitable opening formed in the bight portion of the yoke member **58**. A relatively heavy coil spring **64** encircles the portion **63** between the yoke member and the lower surface of the lower bearing **62**. Rocking movement of the yoke member **58** about the axis of the cylinder shaft **60** will impart rotation of the cylinder **61** within the bearings **62**. The spring **64** imparts a continuous outward force upon the yoke and consequently the roller **21**, when the belt **12** is mounted on its supporting rollers thereby placing the belt under slight tension during operation. The structural connection between the yoke member and the portion **63** is slightly loose in order to allow very limited play between these parts to correct for slight edge to edge circumferential variations in the belt **12**.

Means are provided for retracting the roller **21** inwardly of the belt assembly to permit the easy removal and mounting of a belt upon the assembly. To this end,

the inner end of the cylinder **61** is connected to a quick-acting toggle arrangement which will draw the cylinder inwardly so as to carry the roller **21** therewith to a retracted position. The toggle arrangement also serves to retain the yoke member **58** and roller **21** in the belt assembly.

The upper part of the cylinder shaft **61** is formed with a tubular extension **71** axially aligned therewith. Suitable openings are formed in the sleeve in diametrically opposed positions for supporting a pin **72** which pivotally connects one end of a link **73** to this end of the cylinder **61**. The link **73** is pivotally connected at its other end to one end of another link **74** having its opposite end pivotally connected to the frame structure **42**. It will be apparent that the links **73, 74** and their respective connections form a toggle device which when actuated into alignment will cause the cylinder **61** to move outwardly and when actuated into a buckled condition will cause the cylinder to be retracted inwardly. These actuations of the toggle links are produced by a drive link **75** which is pivotally connected at one end to the pivot connection between the links **73, 74** and extends transverse of the belt assembly, through the outer wall **24** therefor and ending in a pivotal handle **76** (FIG. **3**) for actuating the link **75** axially for causing actuation of the toggle **73, 74** in either of its two operating conditions. In order to remove or to replace a belt **12**, the handle **76** is suitably manipulated to cause buckling of the toggle links **73, 74**, which action draws the cylinder **61** inwardly to retract the roller **21**. This forms sufficient slack in the belt as to permit an operator to move a belt easily relative to the rollers **20, 21** and **22**. After a belt is placed on these rollers for machine operation, the handle **76** is manipulated in the opposite direction in order to place the links **73, 74** in their aligned condition, as shown in FIG. **4**, for forcing the roller **21** against the belt **12** and locking the roller in this position. In this operation, the spring **64** serves as an overdrive and, as previously mentioned, as a tensioning means for the belt. There is another overdrive function for this spring, as will be described below.

As shown in FIGS. **2** and **4**, the axis of the shaft **60** (cylinder **61** and the portion **63**) is perpendicular to the axis of the roller **21** and in the same plane therewith. This plane, also substantially bisects the angle between the planes of the belt runs between the roller **21** and each of the rollers **20** and **22**. In the event the belt **12** starts to skew, in other words, to deviate from its predetermined set position with respect to all of its guide rollers, the resultant lateral movement of the belt will be sensed by a sensing arrangement to be described below, and this will result in positive action being utilized to skew or rock the roller **21** about the axis of the shaft **60** for returning the belt back to its original predetermined working position. This control skew is a tracking action and will effect an angular relationship of the roller **21** relative to the direction of movement of the belt thereby causing the same to steer or follow the roller surface and be displaced laterally in order to return the belt back to a centered position rather than exerting pressure on the belt adjacent one edge portion thereof. In this manner, pressure is applied equally to all portions of the belt affected during tracking action thereby minimizing the tendency of the tracking arrangement to adversely affect belt structure by exerting undue pressures of the belt structure adjacent one edge or the portion between the mid-line of the belt and one edge. With the axis of pivoting of the roller **21** lying on the bisecting plane for the planes of the photoreceptor belt runs, the deflection of the ends of the roller occurs in opposite direction to provide maximum belt correction with minimum roller skewing. Preferably the roller **21** is covered with a rubber coating which will prevent slippage of the belt as it steers during tracking. During rocking of the shaft **55**, both edges of the belt are affected equally and, as the skewing increases during tracking action, any tendency of the belt to lessen in circumference will cause movement of the roller **21** inwardly against the tension of the spring **63** which serves as an overdrive or a shock absorber for tracking action.

In the event that the belt **12** is removed and a new one applied to the belt assembly which has a slightly larger or smaller circumference, the spring **63** will always maintain the same pressure of the roller **21** upon the belt thereby insuring the same tension upon a belt regardless of its circumferential size. The arrangement also eliminates any two directional forces being applied to the belt which could have a destructive effect upon the relatively thin film of the photoconductive material on the belt. In addition, with the axis of the roller **21**, lying on the bisecting plane of the angle between the adjacent belt runs during rocking movement of this roller, there is a minimum of deflection, caused by skewing of the belt, along the exposure belt run between the rollers **20, 21** thereby minimizing the effect of belt skewing upon the imaging abilities on this run during an exposure of an original.

Sensing means are provided in the belt assembly **14** in order to initiate controlled instantaneous rocking of the shaft **55** for the roller **21** in either direction depending upon the direction of slipping of the belt axially relative to the shafts of the rollers **20, 21, 22**. Deviation of the belt is initially detected by a flat ring **80** encircling one end of the shaft **81** which supports the roller **20** for rotation in the belt assembly. The shaft **81** is preferably hollow and is rotatably mounted at each end in bearings **82** mounted in the end walls **24, 25**. The ring **80** is preferably made of wear-resistant plastic material which will not become damaged when in contact with the relatively sharp edge of the belt **12**, and yet will not cause fraying or other damage to the coacting edge of the belt. The ring **80** is mounted for rotation, which occurs during contact with the belt, in order to minimize wear of the ring. Rotation is accomplished by means of a ball bearing device comprising an inner race **83** (FIG. **5**) to which the ring **80** is axially aligned and secured and an outer race **84** which is secured to a circular plate **85** (FIG. **3**) on a sensing support structure for the ring **80**. For ease of use, the plate **85** is formed with a central opening **86** which allows the assembled structure comprising the ring **80**, the races **83, 84** and the plate **85** to accommodate and avoid the adjacent end of the shaft **81** and allow the ring **80** to engage the edge of the belt **12**.

The support plate **85** is secured to curved arm **87** which in turn is integral with the upper end of an angularly inclined shaft **88** mounted for rotation along its longitudinal axis within a fixed cylindrical casting **89**. Spaced brackets **90** integral with the casting **89** are

mounted by screws to the frame structure **42** for the belt assembly. Suitable bearings (not shown) are utilized within the casting between the same and the shaft **88** in order to facilitate the rotating relationship between these elements. At the lower end of the shaft **88**, there is formed a reduced portion **91** which is rotatable with the shaft and to which is attached an element **92** extending perpendicular relative to the axis of the shaft so to swing in either direction upon corresponding rotative movement of the shaft. The element **92** is pivotally connected to a link member **93** which in turn is connected to an ear **94** formed at one end of the yoke member **58**. It will be apparent from the foregoing description that the roller **21** is adapted for rocking movement in at least one direction when the sensing ring **80** is moved outwardly, or in that direction away from the adjacent end of the roller **20**. Upon this motion of the sensing ring, the shaft **88** is rotated about its axis due to its connection to the ring by way of the arm **87**. The corresponding rotation of the shaft **88** will impart a swinging movement to the element **92** to cause movement of the link **93**, and consequently the rocking of yoke member **58** for producing the same motion on the tracking roller **21**. This final action on the roller, which is relatively slight, will effect movement of the belt away from the ends of the rollers **20**, **21** and **22** which are adjacent the side of the belt assembly to which the sensing ring **80** is positioned. In the event the ring **80** is moved toward the adjacent end of the roller **20**, the roller **21** will be rocked in a direction that causes the belt to track toward the above referred to ends of the rollers.

Movement of the sensing ring **80** is either direction in order to produce rocking of the tracking roller **21** in either direction and thereby cause tracking of the belt **12** in a direction which is opposite that in which the sensing ring moves occurs when the edge of the belt **12** deviates from a predetermined position relative to the guide rollers which support the belt. For accurate alignment and positioning of electrostatic latent images and then corresponding developed images with respect to the processing stations of the printing machine, it is necessary that the photoreceptor belt maintain a constant and predictable path of movement. In the event the belt deviates from a prescribed path of movement, say in the direction inwardly of the frame structure **28**, the edge of the belt will engage the surface of the sensing ring **80** and cause corresponding movement of the ring toward the frame structure, or toward the right as viewed in FIG. **3**. The amount and rate of this movement of the ring is consonant with the amount and rate of deviation of the belt. As described above, with the sensing ring being moved in this manner, the tracking roller **21** will be rocked in order to cause a counter tracking of the belt so as to restore the belt to its original predetermined path of movement. Deviation of the belt in the other direction, that is, away from the frame **28**, the sensing ring will follow the away — moving edge of the belt in order to produce rocking of the tracking roller in a direction which will stop the deviation of the belt and to return it to its predetermined path. A light leaf spring **97** having one end secured to the arm **87** and its other end maintained under slight tension against the frame **42** provides a slight force upon the ring **80** in a direction toward the sensed edge of the belt in order to overcome the frictional forces in the sensing mechanisms and to insure that the ring will follow the edge if it deviates away from the ring.

The sensing arrangement and belt deviation control described above allows correction of belt deviation in either direction by positively actuating countermeasures in either direction, and to accomplish this control from only one edge of the belt. There is no need to utilize a constant spring force or the equivalent which normally causes the movement of the belt in one direction by force by rocking a yoke member in one rotation and to positively drive the belt in the opposite direction so as to maintain the desired positioning of the belt. There is also no need for using two belt sensing mechanisms, one for each belt edge. The above described sensing and control arrangement provides a double-acting single sensing control.

In addition, the sensing of belt deviation is accomplished at one roller and the actual tracking is produced at another roller, the next roller positioned downstream of belt movement. In this manner, the time lag for correction of belt deviation is almost nil with only a portion of the belt experiencing a deviation. There is no need for a full circumferential movement of the belt before correction is imposed, as is the case wherein sensing and correction occurs at the same roller.

As previously stated, wearing of the relatively delicate sensed edge of the photoreceptor belt is held to a minimum by the use of a sensing ring that is mounted for rotation along with and while in contact with the edge. In FIG. **5**, the ring **80** is shown to have inner and outer diameters which provide a relatively large and long surface area for the edge to engage and to do so without slipping off the ring or to miss it entirely. Wearing of the sensed edge is also held to a minimum by virtue of the arrangement wherein edge sensing occurs at a roller which has its axis fixed, such as the roller **20**, and whereat the belt is relatively stiff in a transverse direction so that it will not be able to buckle or curl when it engages a sensing element. Sensing between rollers where the belt may be unsupported in a transverse line with a sensing element in the path of lateral movement of the sensed edge as it deviates may result in a curling or buckling of the belt as it contacts the element and before it has sufficient stiffness force to produce movement of the sensing element. This will result in a sensing activity that lacks sensitivity, predictability and accuracy. In order to take advantage of the relative transverse stiffness of the photoreceptor belt on the roller **20**, the sensing element takes the form of the flat ring **80** which encircles the shaft for the roller at which sensing occurs and which has a mean diameter approximately equal to the diameter of the arc of the belt as it travels around the roller. It will also be noted that the plane of the sensing surface of the ring **80** is slightly canted thereby assuring that contact with the sensed edge of the belt always occurs at the same place relative to the adjacent end of the roller **20** and the ring **80**. With the ring **80** being mounted on the inner race of a ball bearing assembly, the ring will rotate and along with the edge of the belt when the same contacts the ring.

In order to prevent extreme lateral deviation of the belt during machine use, there is provided a protection

shut-off circuit (not shown) which is connected to the main power source to the machine for shutting it down with the occurrence of this sort of deviation and a switch mechanism **100** actuable in response to extreme belt deviation. The switch mechanism includes a switch arm **101** in engagement with the support plate **85** for the sensing ring **80** and which serves to actuate a suitable double acting switch **102** in the mechanism **100**. This mechanism along with the arm **101** is set to actuate the switch **102** to open the machine power circuit in the event the arm **101** is deflected in either direction beyond predetermined set limits, in response to movement of the sensing ring **80** in either direction beyond prescribed limits. Such extreme deviation may be caused by belt failure or sudden obstructions to its path of movement such as by a sheet of paper being carried around with the belt, or failure in the structure of the belt assembly.

While the invention has been described with reference to the structure disclosed, it is not confined to the details set forth; but is intended to cover such modifications, or changes as may come within the scope of the following claims.

What is claimed is:

1. In a web tracking system for a moving web having a roller in contact with the web to guide the same, and means for sensing deviation of an edge of the web from a predetermined position during movement thereof, the improvement comprising

an actuating mechanism for producing corrective movement of the web in responsive to signals indicative of web deviation in either direction, said mechanism including a control lever pivotable in either direction and the pivoting of which in either direction produces signals for said mechanism,

a circular member secured to the lever and adapted to engage the sensed edge of the web for causing said pivoting of the lever,

said member including a ring element having a tapered edge engageable with the sensed edge, said member including means for permitting rotation of the ring element as the same engages the moving sensed edge.

2. The system in claim **1** wherein the plane of the ring element is at an acute angle relative to the plane of the sensed edge adjacent said ring element.

3. The system in claim **1** wherein said circular member also includes a bearing device having two races one of which supports the ring element and the other is mounted on said lever.

4. The system of claim **1** including means operatively associated with said circular member for stopping the movement of the web in the event the same deviates beyond a predetermined limit.

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