

May 16, 1961

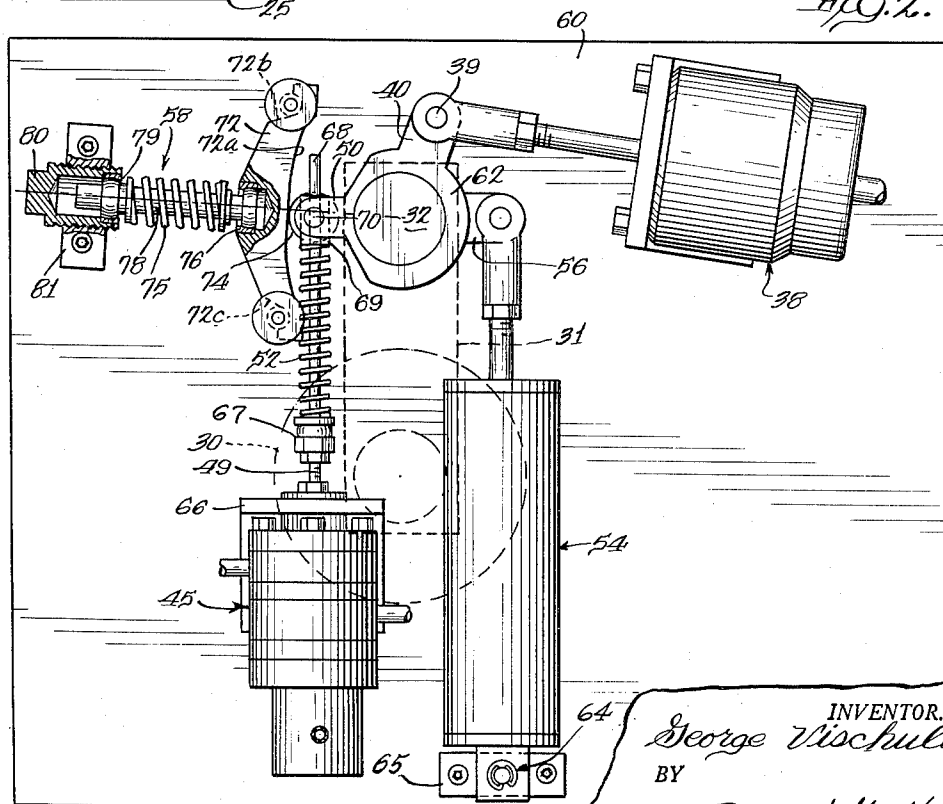
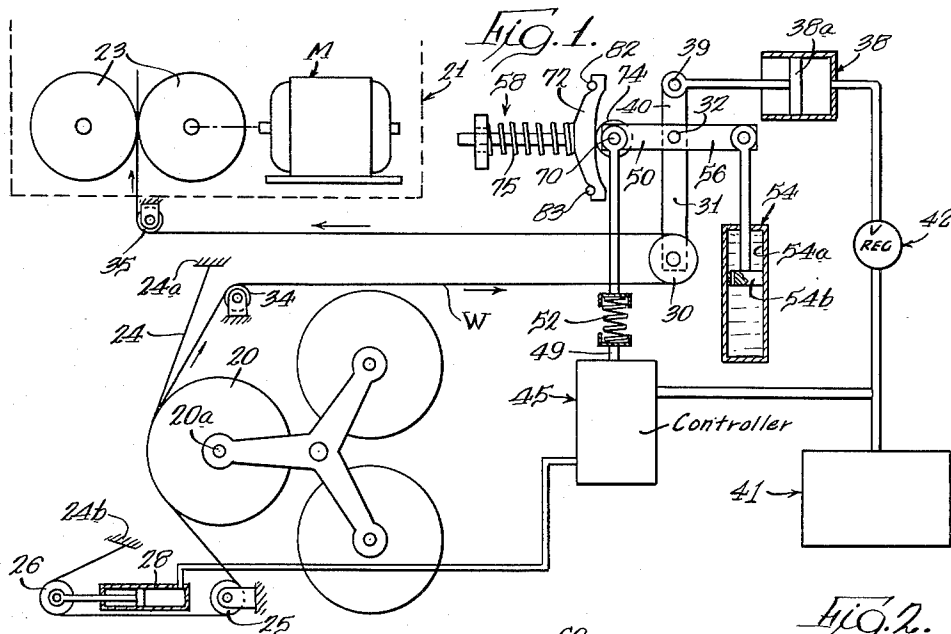
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2,984,430

FLOATING ROLLER MOUNTING FOR WEB TENSION CONTROL SYSTEMS

Filed July 10, 1958

2 Sheets-Sheet 1



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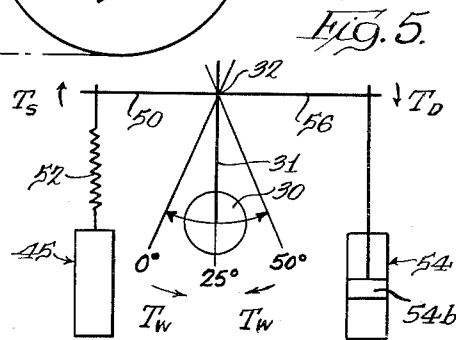
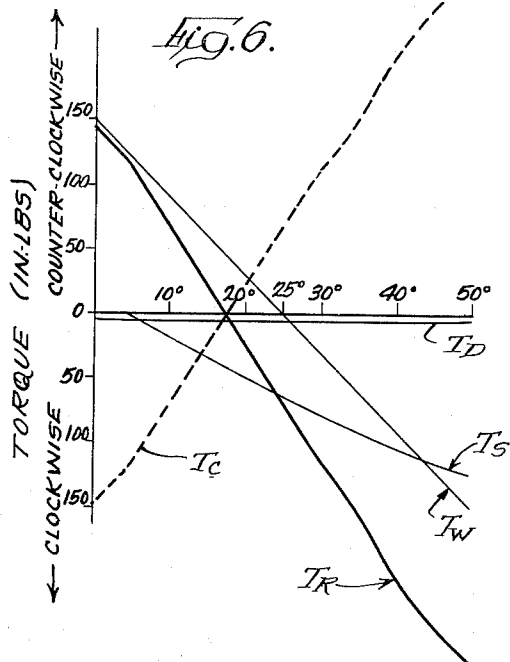
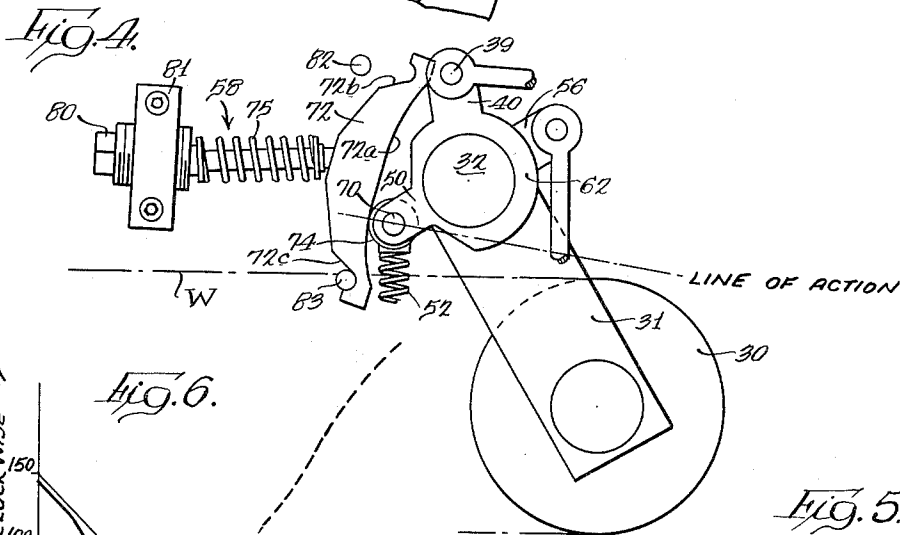
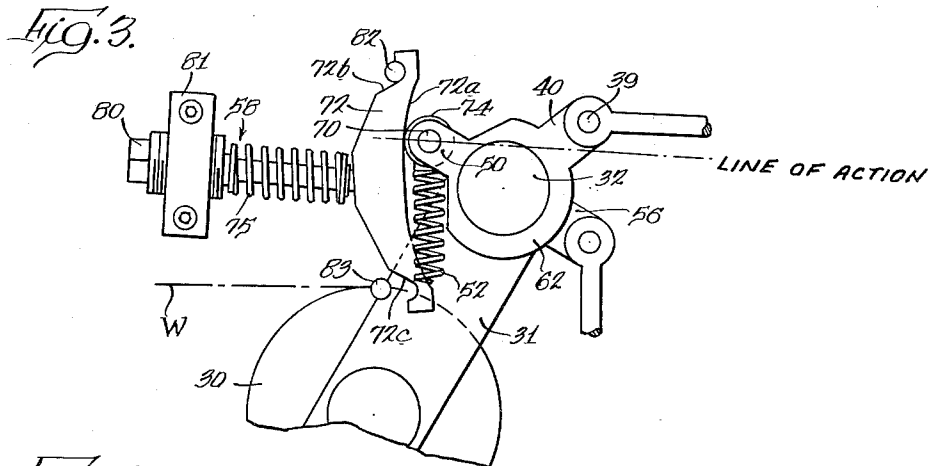
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FLOATING ROLLER MOUNTING FOR WEB TENSION CONTROL SYSTEMS

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2 Sheets-Sheet 2



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2,984,430

FLOATING ROLLER MOUNTING FOR WEB TENSION CONTROL SYSTEMS

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5 Claims. (Cl. 242—75.42)

The present invention relates generally to systems for controlling tension in running webs drawn from supply rolls into web processing apparatus. Thus the invention finds special utility in web fed printing press installations. More particularly, this invention relates to the mounting of a floating roller or a tension sensing element in such a system.

Any web tension control system essentially includes two basic components. One of these is affected by the web tension. The other effects corrective adjustment upon departure of web tension from a preselected value. The first component can be aptly termed a sensing device responsive to web tension changes. The second component, which usually includes braking means, is related to the first element in that it is responsive to its operation to maintain a particular web tension or to produce an increase or decrease thereof. Essentially then, the effectiveness of the entire system is dependent upon the sensitivity of the first element.

Conventionally a floating roller is used as the initial element of the sensing component. This roller is disposed to engage in a horizontal U-shaped loop formed in the web and is suspended for lateral movement in response to changes in web tension. Heretofore, in conjunction therewith various means such as biasing springs, shock-absorber type devices, or so-called inertia-weights have been employed. Such devices have not proved satisfactory because of their actions in urging the floating roller into the web loop with varying forces depending upon the floating roller position.

It is a general object of the present invention to provide in a web tension control system a new and improved floating roller mounting which avoids the disadvantages of prior arrangements and in which provision is made to compensate for the effect of gravity without the addition of significant mass and which varies according to the position of the floating roller regardless of that position.

It is a further object to provide a floating roller mounting which not only compensates for the effects of gravity thereon as it is translated from side to side but which also takes into account torque forces applied to the floating roller by other elements of the tension control system in which the new and improved mounting is incorporated to the end that the displacement of the floating roller from a preselected position is truly representative of web tension variations and so imparts this to the control system for appropriate corrective action.

It is also an object to achieve the foregoing by comparatively simple and reliable means which permits of economical manufacture and of application to existing printing press or other web processing installations.

Other objects and ancillary advantages are attained by the construction and arrangement shown by way of illustration in the accompanying drawings, in which:

Figure 1 is a diagrammatic representation of a web tensioning system in which the features of the present invention are incorporated.

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Fig. 2 is an elevational view of a control panel mounting certain components of the system including the novel and improved floating roller mounting.

Figs. 3 and 4 are fragmentary side elevational views similar to Fig. 2 but illustrating relative component relationships in different positions of the floating roller.

Fig. 5 is a schematic representation of some of the elements of the web tension control system and illustrating the production of turning moments or torque applied to the floating roller pivot shaft which must be compensated for.

Fig. 6 is a graphical representation of the torques according to Fig. 5 and of the compensating torque.

While the invention has been illustrated and described in considerable detail with reference to a particular embodiment, it is to be understood that it is not thereby intended that the invention be limited to such detail. On the contrary, it is intended to cover all modifications and all the alternative constructions falling within the spirit and scope of the invention as defined by the appended claims.

Referring more particularly to the drawings there is diagrammatically shown in Fig. 1 the basic elements of a control system in which the instant invention is incorporated. The control system as a whole is disclosed and claimed in applicant's co-pending application Serial No. 743,728, filed June 23, 1958. Thus it has been only fragmentarily illustrated in Fig. 1 and as controlling the tension in a paper web W drawn from a supply roll 20 into web processing apparatus here fragmentarily indicated as a printing press 21. The supply roll 20 is journaled for rotation about an axis 20a defined by a shaft extending between a pair of arms 22 of a three-arm supply reel. Two other arms are provided on the reel for carrying replacement rolls. The web is drawn on into the press 21 by a pair of cylinders 23 comprising a printing couple powered by a motor M.

In order to apply a braking or a retarding force to the supply roll 20, and thus create tension in the web W, a strap or belt 24 is provided which frictionally engages the periphery of the roll 20. The strap is anchored at its opposite ends 24a and 24b. To variably tighten the strap, it is trained over rollers 25 and 26, the former being stationary and the latter being carried by the piston of a pneumatic actuator 28. Pressure fluid, in this instance compressed air, is supplied to the actuator so that when the piston of the actuator 28 is moved to the left the roller 26 is also urged to the left to tension the strap 24 and increase the braking force applied to the roll 20 and thereby increase tension in the running web W.

It will be understood by those skilled in the art that several of the straps 24 and actuators 28 are conventionally associated with a single supply roll 20. The straps are spaced apart along the roll and the number of straps associated with a particular roll depends upon the width of that roll. The actuators 28 are supplied in parallel with controlled fluid pressure so as to effect a corresponding braking force upon the roll.

To sense the tension existing in the running web W, a floating roller 30 is utilized. The floating roller is journaled adjacent the lower ends of a pair of arms 31, only one being shown, depending from a pivot shaft 32. The web W is trained over stationary guide rolls 34 and 35 so as to define a substantially horizontal, U-shaped loop in the bight of which is engaged floating roller 30. The floating roller 30 thus tends to be moved to the left, i.e., is swung clockwise of the axis of the pivot shaft 32 by the web W with a force or torque which is proportional to web tension.

The control system includes means which is provided to exert a loading force on the floating roller 30 which

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opposes and counter-balances the force exerted thereon by the web W. As shown, this means includes pressure fluid actuator comprising a loading cylinder 38 having a piston 38a slidable therein which is pivotally connected at 39 to a radial arm 40 fixed to the floating roller pivot shaft 32. From a suitable source 41, pressure fluid is supplied by way of a manually adjustable regulator valve 42 to the cylinder 38 so as to cause the piston 38a to exert a counter-clockwise force or torque on the floating roller pivot shaft 32.

The loading actuator, therefore, exerts a reference force or torque on the floating roller pivot shaft 32. This is a constant force as determined by the setting of the regulator 42 regardless of the position of the floating roller. It thus sets the value or control point of web-tension which is to be maintained.

It will be appreciated that changes in web tension from a preselected value or control result in lateral movement of the floating roller 30 and thus angular movement of the pivot shaft 32. This angular movement is utilized to control the application of pressure fluid to the braking actuator 28 to increase or decrease the braking force applied by the straps 24 to the supply roll 20. For this purpose the illustrative control system includes a pilot controller generally designated 45. The pilot controller thus forms a control link between the floating roller 30 and the braking actuator 28, and it functions to supply pressure fluid from the source 41 to the actuator 28 in proportion to the angular displacement of the floating roller 30 from a preselected reference position. The pilot controller is equipped with a control rod 49 and interposed between it an arm 50 fixed to the pivot shaft 32 is a spring 52 imparting a force to the rod 40 that is proportional to the movement of the roller 30 for effecting movement of a valve mechanism within the controller 45 to control pressure fluid output from the controller. In other words, as the floating roller 30 and its support arms 31 are swung from a reference position, the spring 52 is compressed an amount corresponding to the angular displacement thereof and by virtue of the spring 52, the movement of the valve mechanism within the pilot controller 45 can be extremely limited. Thus the spring 52 remains in compression even though the floating roller pivot shaft 32 is angularly displaced through a considerable arc.

From the foregoing then it will be seen that the pilot controller spring 52 exerts an upward force continuously, which force acting through the arm 50 results in a clockwise torque upon the floating roller pivot shaft 32.

To impart stability to the system, damping means is provided which, too, is associated with the floating roller 30. For illustrative purposes this damping means has been shown as a double acting dashpot 54 having a fluid filled cylinder 54a in which a ported piston 54b is slidable. The piston 54b is equipped with a rod which is pivotally connected to and depends from an arm 56 extending radially from the pivot shaft 32. The weight of the piston 54b acting through the arm 56 also results in the application of a torque to the pivot shaft 32.

As hereinbefore noted, the floating roller 30 is journaled at the lower ends of supporting arms 31 which are fixed to the pivot shaft and depend therefrom. Conventionally floating rollers possess considerable weight. When the floating roller 30 is positioned directly beneath the pivot shaft, i.e., its axis and that of the pivot shaft 32 are in the same vertical plane, the force of gravity acting thereon results in the application of no torque to the pivot shaft. But when the floating roller is displaced from such position, the force of gravity causes a torque to be applied to the pivot shaft 32 which varies according to the sine of the angle of displacement. This torque is counter-clockwise in direction when the floating roller is moved to the left and is clockwise in direction when the floating roller is moved to the right of a vertical plane passing through the pivot shaft axis.

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To summarize then, the pilot controller spring 52 applies a torque in a clockwise direction to the pivot shaft 32 which varies according to the amount of compression applied to the spring which in turn corresponds to the angular displacement of the pivot shaft. There is also a clockwise torque applied to the pivot shaft as a result of the weight of the piston 54b of the damping dashpot 54. Yet another torque is applied to the pivot shaft 32 which may be either clockwise or counter-clockwise which torque results from the force of gravity acting on the floating roller when it is displaced from a vertical position beneath the pivot shaft. The resultant net torque on the pivot shaft as thus set forth could adversely affect the functioning of the floating roller as a sensing device.

In accordance with the present invention there is provided an improved floating roller mounting in which provision is made to compensate for the torque resulting from the effect of gravity upon the floating roller and which also compensates for the torques applied by the pilot controller spring 52 acting through its lever arm and the weight of the damping dashpot piston acting through its lever arm. As a result the angular displacement of the floating roller from a position, which represents the preselected tension for a given set of operating conditions including roll diameter and changing press speed, whatever that position might be, is truly representative of tension variation in the running web W. Thus there is imparted to the control system incorporating this novel mounting a signal unaffected by the aforementioned torque forces to the end that appropriate corrective action can be effected to restore web tension to the preselected value.

In carrying out the invention the improved floating roller mounting utilizes a cam mechanism, generally designated 58, which includes a cam biased into engagement with a cam follower roller which is carried by an arm that is rigid with the pivot shaft. In general terms, this mechanism is constructed and arranged to exert a torque on the pivot shaft which compensates for the resultant net torque created as hereinbefore described.

Referring more particularly to Fig. 2 of the drawings, there shown is a floating roller mounting embodying the features of the present invention as derived from one particular commercial installation. This illustrative embodiment includes a control mounting panel 60 which is adapted to be fixed to the web processing apparatus, e.g., the frame of the printing press 21. Extending through the panel 60 is one end of the floating roller pivot shaft 32. Behind the panel and fixed to the shaft 32 is one of the floating roller support arms 31 in the lower end of which is journaled the floating roller 30. Forwardly of the panel and fixed to the pivot shaft 32 is a hub 62. The lever arms 40, 50 and 56, respectively, which were diagrammatically indicated in Fig. 1, are preferably formed integral with and project radially outward from the hub 62. Both the loading cylinder 38 and the damping dashpot 54 are mounted upon the control panel and provision is made to accommodate change of pivot location due to angular displacement of the floating roller pivot shaft 32 and thus of the arms 40, 50 and 56. For example, as indicated at 64 the damping dashpot cylinder 54a is pivotally attached at its lower end to a mounting bracket 65 which is attached to the panel 60. The pilot controller 45 is fixed to the panel 60 by means of a suitable bracket 66.

As shown, the control rod 49 of the pilot controller 45 extends upwardly from the pilot controller's housing. The pilot controller spring 52 is interposed between the upper end of the control rod 49 and the hub arm 50 and a self-aligning coupling 67 is provided between the lower end of the spring 52 and the control rod 49. In order to maintain the spring in position, a guide rod 68 is provided which is seated in the coupling 67 and ex-

tends freely through a collar 69 pivoted on a pin 70 adjacent the outer end of the arm 50. The upper end of the controller spring 52 engages the collar 69. Thus, as the hub 62 is angularly displaced with the shaft 32, according to the displacement of the floating roller 30, the arm 50 moves the collar along the rod and increases or decreases the compression of the pilot controller spring to increase or decrease the force exerted thereby upon the control rod of the pilot controller.

The cam mechanism 58 includes a cam 72 having a cam face 72a which is biased into engagement with a cam follower roller 74 by a preloaded spring 75. The cam follower roller 74 is mounted on the pivot pin 70 disposed adjacent the outer end of the arm 50. Centrally of the outer side thereof the cam 72 is equipped with a self-aligning coupling 76 against which one end of the spring 75 bears and which receives one end of a spring-positioning rod 78. The other end of the rod 78 is slidably received in a self-aligning coupling 79, and against which the other end of the spring 75 bears. The latter coupling is mounted in a hollow compression adjustment nut 80 which in turn is screw-threaded into an anchor block 81 that is fixed to the panel 60.

The cam mechanism 58 is so oriented that when the floating roller pivot shaft 32 is disposed in a neutral position, i.e., when the algebraic sum of all the torques, or net torque, applied to the pivot shaft is zero, the force exerted by the cam mechanism upon the cam follower 74 acts along a line that passes substantially through the axis of the pivot shaft 32 so as to impart no torque thereto. Torque forces acting about the pivot shaft 32 are represented schematically in Fig. 5. A review of this figure will show that zero net torque results when the floating roller is displaced slightly to the left. The displacement will be such that the torque thus created will be equal in magnitude and opposite in sense to torque applied by the controller spring 52 and the dashpot piston 54b as mentioned above. As a result, when the pivot shaft is in a neutral position the arms 40 and 50 and 56 of the hub 62 are correspondingly displaced. In the illustrative embodiment when the cam mechanism is oriented so that the line of action of the force exerted thereby passes through the center line of the cam follower 74 and the axis of the shaft 32, the mechanism is angularly offset approximately seven degrees from horizontal.

It will be appreciated that as the web W is withdrawn from the supply roll and is consumed by web processing apparatus such as the illustrative printing press 21, the diameter of the supply roll 20 decreases. As it decreases, gradually, the angle of wrap of the straps 24 decreases, and thus the braking actuator 28 must exert an increasingly greater force upon the straps so as to maintain the same tension in the web as determined by the preselected reference force exerted on the floating roller 30 by the loading actuator 38. Desirably, therefore, the floating roller 30 is initially displaced to the left and gradually moves in a counter-clockwise arc so as to increase the downward force on the control rod 49 of the pilot controller 45 through the pilot controller spring 52 whereby to control the pressure fluid output from the pilot controller 45 to the braking actuator 28. It will be apparent, then, that when the floating roller is displaced to the left of a vertical plane passing through the pivot shaft axis that the force of gravity acting on the floating roller 30 produces a counter-clockwise torque upon the pivot shaft 32, and to compensate therefor the cam mechanism 58 must exert a force on the cam follower roller 74 along a line of action that results in a compensating or counter-balancing, clockwise torque. Similarly, when the floating roller has its axis displaced to the right of the pivot shaft axis, the force of gravity on the floating roller results in the production of a clockwise torque. To counterbalance this force the line of action of the cam mechanism 58 acting upon the cam

follower roller 74 must be so located as to produce a compensating counter-clockwise torque.

To this end two pivots 82 and 83 are provided for the cam 72. The pivots are spaced equidistantly on opposite sides of the center line of the mechanism for engagement by notches 72b and 72c formed on the side opposite the cam surface 72a and adjacent the ends of the cam 72. Referring to Fig. 3 of the drawings it will be seen that when the floating roller 30 is displaced to the left of the axis of the pivot shaft 32, the cam follower 74 engages the cam surface 72a between the center line of the mechanism 58, along which line the force of the spring 75 is applied to the cam 72, and the pin 82. Thus the cam pivots upon the pin 82, and the spring 75 applies clockwise torque to the pivot shaft 32 through the cam 72 and cam follower 74. Alternatively, when the floating roller 30 is displaced to the right of the pivot shaft axis engagement of the cam follower 74 with the cam surface 72a occurs between the center line of the mechanism 58 and the pin 83. In this condition, as shown in Fig. 4, the cam 72 fulcrums upon the pin 83, and counter-clockwise torque is applied to the pivot shaft 32.

From the foregoing it will be seen that the greater the angle of displacement of the floating roller 30 within its operation limits, the greater will be the distance between the center line of the mechanism and the point of engagement of the cam follower with the cam surface 72a. This results in a correspondingly increased effective lever by which the compensating force of the spring 75 is applied to the pivot shaft 32. Thus as the displacement of the floating roller increases the force applied to the cam follower is directed along a line of action as determined by the cam surface to effect the required counterbalancing or compensating torque.

It can be appreciated that the compensating torque exerted by the cam mechanism 58 on the pivot shaft 32 depends both on the force exerted by the spring 75 and the position, relative to the shaft 32, of the line of force exerted by the cam 72 against the roller 74. In the illustrated embodiment, the force of the spring 75 is controlled by the adjustment nut 80. The position of the line of force exerted by the cam 72 relative to the shaft 32 is desirably determined by the shape of the cam 72 since the cam force acts perpendicularly of the cam face 72a. In the preferred construction, the cam face 72a is slightly concave so that the proper moment arms are obtained, considering the strength of the spring 75 and the weight of the floating roller 30, to exert the proper balancing or cam torque on the shaft 32 in all angular positions assumed by the shaft.

In order to graphically illustrate the foregoing Figs. 5 and 6 have been included in the drawings. Fig. 5 schematically represents the application of torques to the axis of the pivot shaft 32 with a range of lateral or angular displacement of the floating roller 30 through an overall angle of some 50°, 25° on each side of a vertical plane passing through the pivot shaft axis. The resulting torques are plotted in Fig. 6. Therein the torque due to the weight of the damping dashpot piston 54b is represented by the line T_D . It will be noted that this is a substantially constant torque in a clockwise direction. In the illustrative device no force is exerted upon the hub 62 by the controller spring 52 when the floating roller 30 is in the limit position to the left of the pivot axis. This condition exists from the limit position until the floating roller moves clockwise through an arc of approximately five degrees. Thereafter it will be seen that this torque increases in a clockwise direction as the controller spring 52 is compressed by displacement of the floating roller axis to the right. This is indicated by the line T_S .

The torque due to the effect of gravity according to the floating roller position is indicated by the line T_W . It will be seen that at zero degrees, as indicated in Fig. 6, this torque is maximum in a counter-clockwise direc-

tion. It decreases to zero at the 25° point, when the floating roller axis occupies the vertical plane that passes through the pivot shaft axis, and then increases in a clockwise direction as the floating roller moves toward the 50° position indicated in Fig. 6. These three torques as represented by the lines T_D and T_S and T_W can be added graphically. The result of such addition is represented in Fig. 6 by the line T_R . This is the resultant net torque upon the pivot shaft axis and represents the torque which is compensated for by the cam mechanism 58 that comprises a part of the instant floating roller mounting. Thus to compensate therefor the double-pivoted, spring-biased cam 72 effects a compensating torque equal in magnitude but opposite in sense to the resultant net torque line T_R , and is represented by the line T_C .

From the foregoing it will also be seen that the preloaded spring 75 applies a substantially constant biasing force to the cam 72 because the construction and arrangement as described limits the range of physical movement of the spring. A particularly practical advantage of the foregoing construction and arrangement is that the novel floating roller mounting permits of adjustment by the single operation of positioning the adjustment nut 80 within the anchor block 81 whereby to determine the amount of preloading of the spring 75.

From the foregoing, therefore, it will be seen that the improved floating roller mounting not only compensates for the effects of gravity resulting from angular displacement of the floating roller, but it also takes into account torque forces applied by other elements of the tension control system of which the mounting is a part. As a result the displacement of the floating roller from a position representing a preselected tension is truly representative of variations in web tension and so imparts an accurate signal to the control system for appropriate corrective action. It will also be apparent that the foregoing is achieved by comparatively simple and reliable means which permits of economical manufacture and of application to existing printing press or other web processing installations. More particularly in this latter regard it avoids the necessity for changing the loading automatically to compensate for the torques mentioned previously which would be a complex and expensive undertaking. Additionally, the floating roller mounting constructed in accordance with the teachings of the present invention effects compensation in both directions of angular displacement of the floating roller with respect to the pivot shaft, yet it requires but a single preloaded biasing spring. Of especial importance is the fact that this mounting adds no significant mass to the floating roller system.

I claim as my invention:

1. In a web tension control system having a frame for carrying a floating roller which engages a loop in the web, a floating roller mounting comprising, in combination, a pivot shaft journaled in said frame, a support arm fixed to said pivot shaft for journaling the floating roller in a preselected position which is in substantially vertical depending spaced relation beneath said pivot shaft, a second arm fixed to said pivot shaft and extending radially therefrom in angularly spaced relation to said support arm, and a compensating mechanism including a spring biased cam anchored to said frame and engageable with said second arm for applying a torque to the pivot shaft equal in magnitude and opposite in direction to the torque applied thereto due to gravity as a result of displacement of the floating roller from said preselected position beneath said pivot shaft.

2. In a web tension control system having a floating roller for engaging a loop in the web, a floating roller mounting comprising, in combination, a pivot shaft, a support arm fixed to said pivot shaft for journaling the floating roller in depending spaced relation to said pivot shaft, a second arm fixed to said pivot shaft and disposed in angularly spaced relation to said first arm, and a com-

pensating mechanism including a cam engageable with said second arm, a biasing spring engageable with said cam centrally thereof for applying a force by way of said cam to said second arm along a line of action substantially through the pivot shaft axis when the same is in neutral position, a pair of fulcrum pins disposed in spaced relation to each other and on opposite sides of the aforesaid line of action for alternative fulcruming engagement therewith by the respective ends of said cam on the opposite side thereof from said second arm for applying a compensating force along lines of action on either side of and spaced from the aforesaid line of action according to the angular displacement of the shaft axis as the position of the floating roller changes so as to counteract the torque applied to the pivot shaft as a result of displacement of the floating roller from neutral position as it changes during operation of the system.

3. In a web tension control system having a floating roller for engaging a loop in the web and having a pressure fluid operated system for regulating tension in the web including a pressure fluid operated loading device and a pressure fluid supply controller having a spring biased control rod, a floating roller mounting comprising, in combination, a pivot shaft adapted for connection with the loading device, a support arm fixed to said pivot shaft for journaling the floating roller in spaced relation to said pivot shaft, a second arm fixed to said pivot shaft in angularly spaced relation to said support arm and having the force of the controller biasing spring exerted thereon, and a compensating mechanism including a cam and a preloaded spring biasing said cam into engagement with said second arm for applying a torque to said pivot shaft equal in magnitude and opposite in direction to the resultant net torque applied thereto as a result of the action of the controller biasing spring and of gravity according to the angular position of the floating roller with respect to the axis of said pivot shaft.

4. In a web tension control system having a floating roller for engaging a loop in the web and having a pressure fluid operated system for regulating tension in the web including a pressure fluid operated loading device and a pressure fluid supply controller having a spring biased control rod, a floating roller mounting comprising, in combination, a pivot shaft adapted for connection with the loading device, a support arm fixed to said pivot shaft for journaling the floating roller in spaced relation to said pivot shaft, a second arm fixed to said pivot shaft in angularly spaced relation to said support arm and having the force of the controller biasing spring exerted thereon, and a compensating mechanism including a cam and a preloaded spring biasing said cam into engagement with said second arm for applying a force to said second arm along a line of action substantially through the axis of said pivot shaft when the same is in neutral position, a pair of fulcrum pins disposed in spaced relation on opposite sides of the aforesaid line of action for alternative fulcruming engagement by said cam for applying a compensating force to said second arm along lines of action on either side of the aforesaid line of action according to the angular displacement of said pivot shaft axis as the position of the floating roller is changed so as to compensate for the resultant net torque applied to the pivot shaft by the force of the controller spring and the force of gravity according to the angular position of the floating roller with respect to said pivot shaft.

5. In a system for regulating tension in a moving web by means of a frictional retarding force applied to the periphery of a web supply roll by stationary belts, the combination comprising a floating roller swingably supported on an axis and adapted to engage in a loop in the moving web, means for applying a preselected force to the floating roller and hence to the web for positioning said roller, and a controller responsive to displacement of the floating roller, said means said floating roller and

said controller being interconnected at said support axis of the floating roller, and a mechanism for counterbalancing torque variations due to floating roller displacement during operation of the system, said mechanism including two spaced pins and a spring biased cam pivotable selectively on either of said pins for applying compensating torque about the support axis in direction and

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amount according to the displacement of the floating roller by operational variations in web tension.

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