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Bethke

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[54] **APPARATUS FOR CONTROLLING THE TENSION ON WEB MATERIAL**

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[52] **U.S. Cl.** **242/75.5**

[51] **Int. Cl.** **B65h 25/04**

[58] **Field of Search** 242/75.41, 75.42, 75, 75.1, 242/75.5, 67.2

[56] **References Cited**

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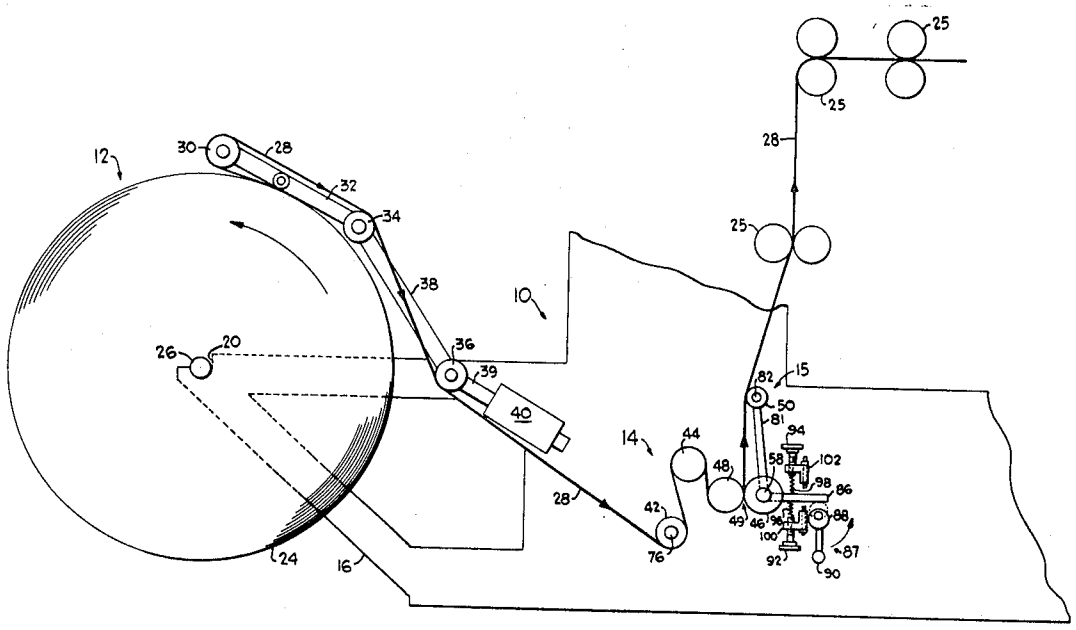
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Primary Examiner—John W. Huckert
Assistant Examiner—Edward J. McCarthy
Attorney, Agent, or Firm—Stanley J. Price, Jr.

[57] **ABSTRACT**

Web material is unwound from a roll and supplied to a web unwind unit having a tension sensing mechanism mechanically connected thereto. The web material having a desired tension is drawn by an envelope machine drive at a first preselected linear speed through the web unwind unit into abutting contact with the tension sensing mechanism. The tension sensing mechanism includes a tension sensing roll arranged for rotation with an eccentrically supported shaft by a pair of tension arms. The tension sensing roll is arranged to apply a preselected pressure upon the web material so that the tension sensing roll responds to an increase in web tension by rotating with the tension arms in clockwise direction about the eccentrically supported shaft. The eccentrically supported shaft revolves in clockwise direction to move a pressure roll rotatably supported thereon toward a feed roll urging the web material into frictional engagement therebetween. The web material is fed by the pressure roll and the feed roll at an increased preselected linear speed to decrease the web tension. The tension sensing roll responds to a decrease in tension by rotating in counterclockwise direction with the tension arms. The eccentrically supported shaft also revolves in counterclockwise direction to release the web material from frictional engagement between the feed roll and the pressure roll restoring the web material to the slower preselected linear speed as provided by the envelope machine drive.

11 Claims, 4 Drawing Figures



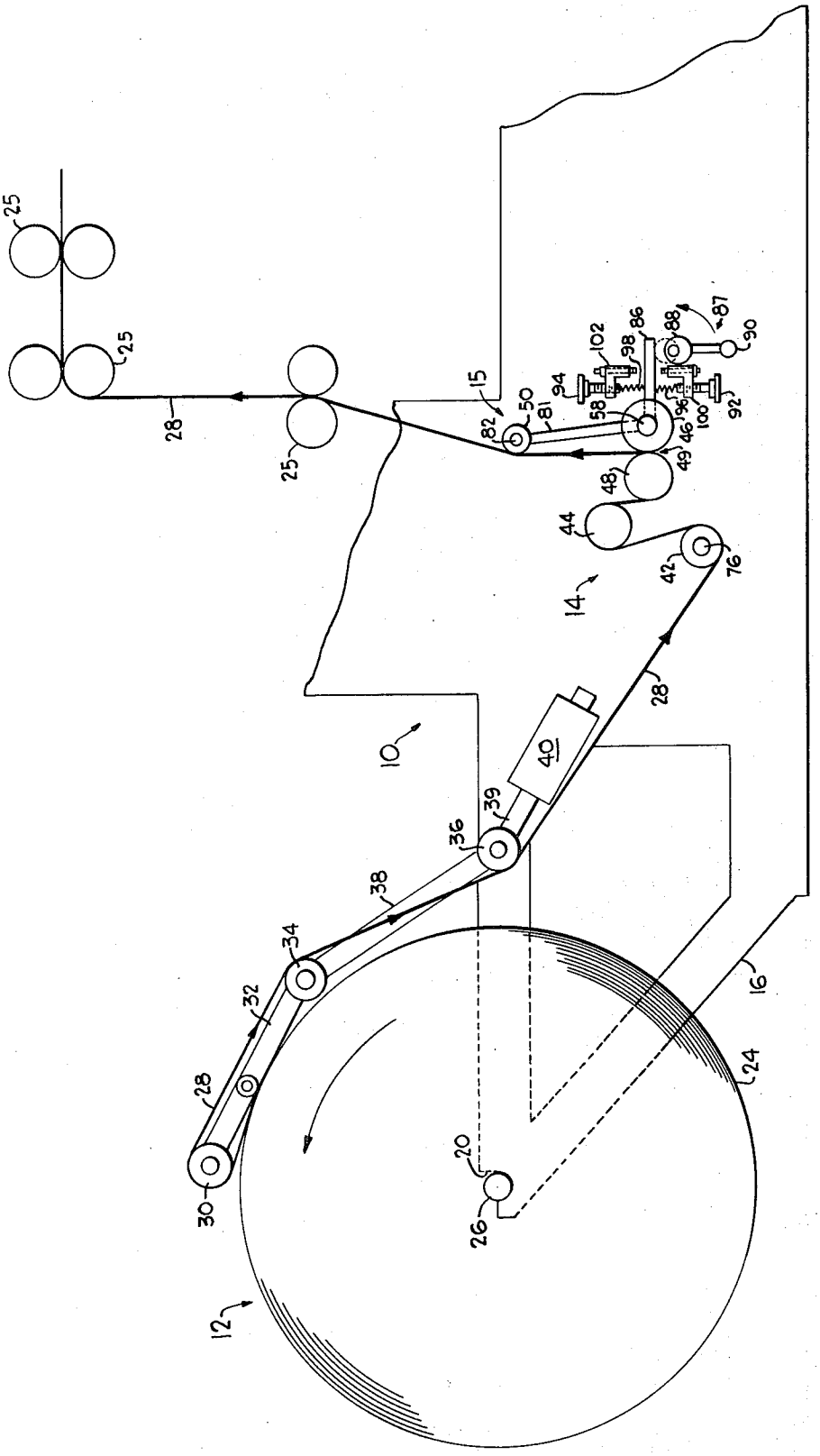
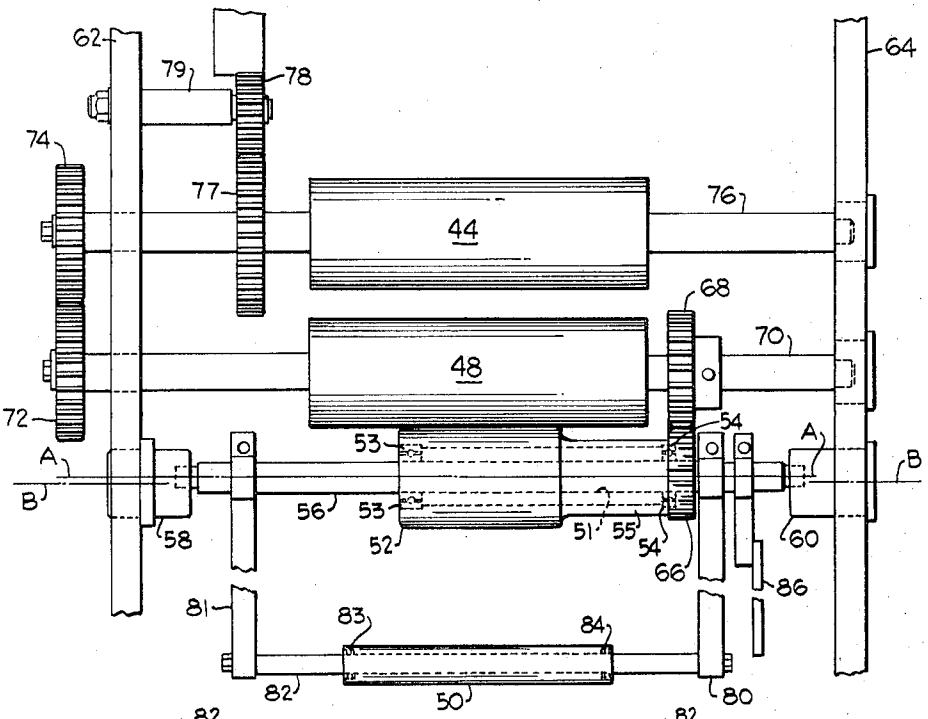

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Fig. 1.

Fig. 2.



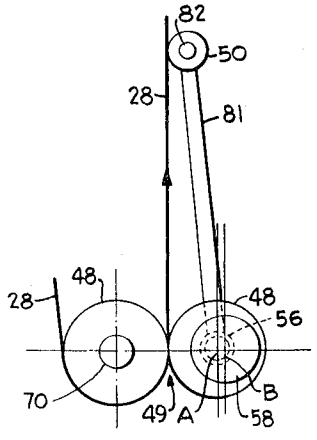


Fig. 3.

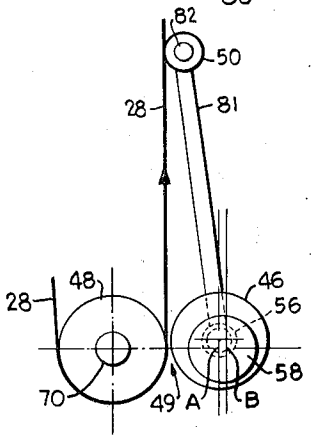


Fig. 4.

APPARATUS FOR CONTROLLING THE TENSION ON WEB MATERIAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to apparatus for controlling the tension of web material and more particularly to apparatus for maintaining a preselected tension on web material suitable for use in an envelope machine.

2. Description of the Prior Art

The manufacture of envelopes from a continuous web and operations in other areas where it is necessary to continuously feed paper or other web material from a revolving reel requires uniform tension throughout the unwinding process to remove slack in the material associated with a lack of tension or prevent breakage of material resulting from excessive tension. Devices for controlling the tension of the web by monitoring the feed rate of the web are well known in the art.

U.S. Pat. No. 3,386,635 describes a web tensioning method and apparatus for applying tension to a moving web of sheet material. A movable shoe is held in contact with the moving web material by fluid applied at a pressure sufficient to remove web flutter attributed to a decrease in web tension. Fluid pressure is applied to the shoe so that the surface thereof, in contact with the web, exerts pressure on the web. Sufficient fluid pressure is maintained to eliminate flutter in the unsupported section of the web material across the shoe. A shoe mounting means is provided to permit movement of the shoe towards and away from the moving web so that the shoe may exert a variable pressure on the web for removing local looseness in the web.

British Pat. No. 1,272,817 discloses a web tension control system for use with a web unwind stand having a tension sensing roll engaged with an unwinding web of a mill roll. The tension sensing roll actuates pneumatic brakes through suitable gearing to apply braking torque to the shaft supporting the mill roll. The tension sensing roll operably actuates an air regulator to supply air to the pneumatic brakes which apply the torque and thereby control the tension of the web material unwinding from the mill roll.

U.S. Pat. No. **3,385,535** provides a web take-up reel controller that includes a take-up reel responsive to the tension of the web. The take-up reel continuously winds the web until the tension becomes too great and deflects an arm to disengage the drive and stop the rotation of the reel. A dancer arm responsive to changes in the tape tension is provided to effect engagement and release of a spring clutch drive means drivingly connected to the take-up reel. Whenever the input tape drags across the take-up reel or is stopped, the spring clutch drive means will terminate the unwinding process and automatically restart the process when sufficient slack is restored in the tape. There is need for apparatus which is sensitive to variations which occur in tension on web material and capable of instantaneously responding to such variations by increasing or decreasing web tension to the desired level.

SUMMARY OF THE INVENTION

In accordance with the present invention there is provided apparatus for controlling the tension on web material which includes a roll of web material rotatably supported to permit continuous unwinding of the web material from the roll. The web material is supplied from the roll to an unwind unit which includes a feed roll and a pressure roll. At least one of the rolls is driven at a preselected linear speed to intermittently feed the web material frictionally engaged between the feed roll and the pressure roll to a machine for further processing the web material, such as an envelope forming machine. A tension sensing mechanism positioned adjacent the unwind unit is arranged in abutting relation with the web material whereby the web material exerts a continuously opposing force upon the tension sensing mechanism. The pressure roll is mechanically connected to the tension sensing mechanism for moving the pressure roll toward and away from the feed roll to frictionally engage the web material therebetween so that the web material is fed at a higher linear speed to the envelope machine. Thus, a uniform tension is maintained in a segment of the web material between the unwind unit and the envelope machine.

The tension sensing mechanism includes a tension sensing roll rotatably supported on a shaft which is suitably connected at one end between a pair of tension arms. The tension arms are connected at the other end for rotation with a shaft eccentrically supported in a pair of bushings for rotation relative thereto. The pressure roll is rotatably supported on the eccentrically supported shaft by a pair of bearings. The tension sensing roll is operably arranged to maintain a preselected force upon the web material. Therefore, a variation in the applied force associated with an increase or decrease in the web tension will actuate the tension arms and the tension sensing roll to rotate on the eccentrically supported shaft to thereby maintain the preselected pressure upon the web material.

When the tension on the segment of the web material between the unwind unit and the envelope machine increases from the desired tension, the tension sensing roll and tension arms rotate in clockwise direction about the eccentrically supported shaft. Clockwise rotation imparted to the eccentrically supported shaft moves the pressure roll toward the feed roll to frictionally engage the web material therebetween. Because the speed of the feed roll is higher than the speed of the envelope machine drive, the unwind unit supplies web material to the envelope machine faster than it is capable of receiving the web material resulting in a decrease in the web tension on the segment between the unwind unit and the envelope machine.

When too much slack develops in the web material, the accompanying decrease in web tension actuates the tension sensing roll and tension arms to rotate in counterclockwise direction on the eccentrically supported shaft. Counterclockwise rotation of the eccentrically supported shaft moves the pressure roll supported thereon away from the feed roll and out of frictional engagement with the web material. Thus, the unwind unit no longer feeds web material to the machine at the higher linear speed. The web material is drawn by the envelope machine drive at a lower linear speed to increase the web tension. With this arrangement the tension sensing roll constantly oscillates about the eccentrically supported shaft to maintain a uniform tension on the web material.

Accordingly, the principal object of this invention is to provide apparatus for controlling tension on web material by constantly sensing the tension on the web

material and thereby increase or decrease the tension to maintain a desired tension on the web material.

Another object of this invention is to maintain a uniform tension on web material drawn into an envelope forming machine or a printing press for the completion of further operations.

Still another object of this invention is to provide a web tension control apparatus that continuously responds to variations in tension on web material and increases the feed rate to a machine in order to adjust the web tension to the desired level.

These and other objects of this invention will be more completely disclosed and described in the following specification, the accompanying drawings and the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in side elevation of the apparatus for controlling the tension on web material.

FIG. 2 is a top plan fragmentary view illustrating the tension control apparatus according to the invention.

FIG. 3 is a diagrammatic view illustrating the relative positions of the feed roll and pressure roll for decreasing the web tension according to the invention.

FIG. 4 is a diagrammatic view illustrating the relative positions of the feed roll and pressure roll for increasing the web tension according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, there is illustrated web tension control apparatus for controlling the tension on web material generally designated by the numeral **10.** It should be understood that the hereinafter described web tension control apparatus **10** may be associated with any production process requiring uniform movement of the web material having a preselected tension as, for example, through an envelope forming machine, a printing press, and the like. For exemplary purposes only, the illustrated and described invention is associated with a machine for forming envelope blanks from a web. The envelope machine is not shown, and only those parts of the envelope machine which are essential for a complete understanding of the invention are diagrammatically illustrated in FIG. **1.**

The web tension control apparatus **10** includes a web supply unit **12** and a web unwind unit **14** having a tension sensing mechanism **15** connected thereto. The web supply unit **12** comprises a rearwardly extending portion **16** of the machine support frame **18.** The rearwardly extending portion **16** has an annular recess **20** arranged to receive a roll of web material **24** mounted on a web roll shaft **26.**

The web material **28** is unwound from the roll **24** in the direction indicated by the arrow and extends around an idler roll **30** which is rotatably supported to one end of idler arm **32** that is maintained in frictional engagement with the roll **24.** The web material **28** passing around the idler roll **30** is directed over the idler roll **34** rotatably secured to the other end of the idler arm **32.** The web material **28** is fed over the idler roll **34** and directed therefrom into abutting relation with the idler roll **36** rotatably mounted to one end of link **38.** The other end of link **38** is connected for rotation with the idler roll **34** which, in turn, links the idler arm **32** to the link **38.** A support shaft **39** is secured at one end to idler roll **36** and at the other end is connected to a cylindrical counterweight **40.**

As the roll **24** unwinds and grows smaller, the counterweight **40** acts to transmit a downwardly exerting force upon the idler arm **32** and thereby maintain the arm **32** in frictional engagement with the roll **24.** By applying a continuously downwardly exerting force upon the roll **24,** the idler arm **32** retards the roll **24** peripheral velocity which increases as the roll **24** unwinds. With this arrangement, the roll **24** is arranged to continuously supply web material **28** to the pairs of overlying pressure rolls **25,** as illustrated in FIG. **1,** of the envelope machine for further processing. Although the web supply unit **12** is illustrated, it is not essential to the invention for maintaining the tension on the web **28** uniform.

The web material **28** passing around pick-up roll **42** advances upwardly into contact with a wraparound roll **44** and therefrom through the nip **49** formed between a pressure roll **46** and the feed roll **48.** The web material **28** in abutting relation with the feed roll **48** passes through the nip **49** and follows a substantially vertical path upwardly into contact with the tension sensing roll **50** of the tension sensing mechanism **15.** Thereafter, the web material **28** is fed between the overlying pressure rolls **25** which are arranged to rotate and convey the web material **28** toward the envelope machine at preselected linear velocity.

Referring to FIG. **2,** there is illustrated the pressure roll **46** having a control bore **51** which passes through the enlarged diameter end portion **52** and small diameter end portion **55.** The pressure roll **46** is rotatably supported in the bore **51** by pairs of bearings **53** and **54** which are secured to shaft **56** for rotation therewith. The shaft **56** is eccentrically supported by bushings **58** and **60** for rotation about an eccentric axis A displaced from the common central axis B of the bushings **58** and **60.** The bushings **58** and **60** are suitably journaled in the side frames **62** and **64,** respectively. With this arrangement, the eccentric relation between the shaft **56** and the bushings **58** and **60** provide for the rotation of the axis A around the axis B.

The pressure roll **46** has a gear **66** secured to the end of the small diameter end portion **55** for rotation therewith. The gear **66** is in meshing relation with a gear **68** secured to the shaft **70** of feed roll **48.** The shaft **70** is suitably journaled at one end in the side frame **64,** and the other end extends through side frame **62** for axial connection outboard thereof to gear **72.** The gear **72,** in turn, is connected in meshing relation with gear **74** also positioned on the outboard side of the frame **62.** The gear **74** is supported for rotation on shaft **76** journaled at the other end in the side frame **64.** A gear **77** is secured to the shaft **76** for rotation therewith and meshes with gear **78** rotatably supported by the shaft **79** which is bolted to the side frame **62.** A suitable drive motor (not shown) drivingly connected to gear **78** transmits rotation to the shafts **76, 70** and **56** through the gear train provided by meshing gear pairs **78** and **77, 74** and **72** and **68** and **66** at a preselected speed higher than the speed provided by the envelope machine drive which draws the web material **28** through the pressure rolls **25.**

As illustrated in FIGS. **1, 2** and **3,** a pair of spaced parallel tension arms **80** and **81** are supported on the shaft **56** for rotation therewith and extend substantially vertically upwardly therefrom. A shaft **82** connects the

tension arm **80** to the tension arm **81** passing through aligned bores therein. The shaft **82** extends through the axial bore **85** of roll **50** and is nonrotatably supported therein by a pair of bearings **83** and **84** which support the tension sensing roll **50** on the shaft **82** for rotation relative thereto.

A lever arm **86** is nonrotatably supported on the shaft **56** and extends horizontally outwardly therefrom. A crank **87** as illustrated in FIG. **1**, having a handle portion **90** and a cylindrical end portion **88** is positioned adjacent the lever arm **86** in underlying relation thereto. By rotation of handle **90**, the cylindrical end portion **88** is urged toward and away from the lever arm **86** as indicated by the phantom lines illustrated in FIG. **1**. The force exerted upwardly by the crank **87** against the lever arm **86** is transmitted therefrom to the shaft **56** which then rotates on axis A in a counterclockwise direction about axis B. Rotation of shaft **56** moves the pressure roll enlarged diameter portion **52** laterally into and out of frictional engagement with the surface of the web material **28** so that the web **28** is threaded over wraparound roll **44** and engaged in abutting relation with the feed roll **48**.

A pair of adjusting bolts **92** and **94** are threadably secured to the envelope machine side frame above and below the lever arm **86**. Compression springs **96** and **98** are connected at one end to the adjusting bolts **92** and **94**, respectively, and at the other end to the lever arm **86**. By adjusting the bolts **92** and **94**, the compression in the springs **96** and **98** may be increased or decreased to maintain the lever arm **86** in a substantially horizontal position. By limiting the displacement of lever arm **86** from the horizontal position relative to the shaft **56**, a preselected resistance to rotation about shaft **56** is applied to the tension bars **80** and **81** thereby centering arms **80** and **81** above rolls **46** and **48**. In addition, a pair of stop members **100** and **102** are axially supported on the bolts **92** and **94** respectively to maintain the lever arm **86** in a substantially horizontal position.

In operation, the envelope machine drive feeds the web material **28** from the roll **24** at a preselected linear speed required for completion of the envelope forming operations in timed relation to each other. The web material **28** is drawn between the rolls **46** and **48** of the web unwind unit **14** and upwardly therefrom into contact with the tension sensing roll **50**. The tension sensing roll **50** is retained in abutting relation with the web material **28** which continuously exerts pressure against the web material **28**. Consequently, the tension sensing roll **50**, responsive to variations which occur in the tension on the web material fed into and through the envelope machine, pivots about the shaft **56** to thereby maintain a uniform tension in the web material **28**.

When the tension on the segment of web material between the rolls **46** and **48** and the pressure rolls **25** increases above the desired tension, the tension sensing roll **50** and tension arms **80** and **81** operably respond to the increase in pressure exerted by the web material **28** upon the roll **50** by rotating in a clockwise direction about shaft **56**. The clockwise rotation imparted to shaft **56** by the tension arms **80** and **81** rotates the shaft **56** about the eccentric axis A which, in turn, revolves about axis B. The clockwise rotation of the shaft **56** moves the pressure roll **46** laterally thereby urging the web material **28** into frictional engagement between rolls **48** and **46**, as illustrated in FIG. **3**. Thus, when feed roll **48** is driven at a speed 1.05 times greater than the speed of the envelope machine drive, the web material **28** is tightly engaged between the nip **49** of rolls **48** and **46** and advances at a feed rate greater than the feed rate provided by the envelope machine drive. Accordingly, an increase in speed of the web material **28** fed to the envelope machine decreases the web tension in the segment between the rolls **46** and **48** and the pressure rolls **25**.

The rolls **46** and **48** of the unwind unit **14** continue to feed the web at a greater speed until the tension sensing roll **50** responds to the decrease in pressure exerted by the web material **28** associated with a decrease in web tension by rotating in a counterclockwise direction. Counterclockwise rotation of tension arms **80** and **81** revolves axis A of shaft **56** also in a counterclockwise direction around axis B to thereby move the pressure roll **46** laterally and out of frictional engagement with the web material **28**. Once the web material **28** is freed from frictional engagement between the rolls **46** and **48**, as illustrated in FIG. **4**, the rolls **46** and **48** no longer feed the web material to the pressure rolls **50** at a greater linear speed. The segment of the web material **28** between the unwind unit **14** and the pressure rolls **25** is then drawn by the envelope machine drive at a slower preselected speed. Once the 1.05 overfeed effect is terminated, tension is restored on the web material **28** and the pressure exerted thereby against the tension sensing roll **50** is increased. With the above apparatus, it is now apparent that the tension sensing roll **50** constantly oscillates in a back and forth motion with the tension arms **80** and **81** responding to variations in pressure exerted by the web material **28** as a result of changes in the tension of the web material being fed into the envelope machine. In this manner, a uniform web tension is maintained on the web material **28** being drawn into the envelope machine.

According to the provisions of the patent statutes, I have explained the principle, preferred construction and mode of operation of my invention and have illustrated and described what I now consider to represent its best embodiment. However, it should be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically illustrated and described.

I claim:

1. Apparatus for controlling the tension on web material comprising,

a roll of web material rotatably supported to permit continuous unwinding of the web material from said roll,

apparatus for further processing the web material in which the web material is arranged to move at a first preselected linear speed,

an unwind means for intermittently feeding the web material at a second preselected linear speed to said apparatus for further processing the web material, said unwind means positioned adjacent said roll of web material so that the web material is supplied to said unwind means,

said second preselected linear speed being higher than said first preselected linear speed,

said unwind means includes a feed roll and a pressure roll positioned adjacent thereto, at least one of said rolls being driven at said second preselected linear speed,

a tension sensing means for sensing the tension in a segment of the web material between said unwind means and said apparatus for further processing the web material,

said tension sensing means positioned adjacent said pressure roll and operably connected thereto for moving the pressure roll toward and away from said feed roll so that said web material is frictionally engaged between said feed roll and said pressure roll so that said web material is fed to said apparatus for further processing the web material at said second preselected linear speed thereby maintaining desired tension in a segment of the web material between said unwind means and said apparatus for further processing the web material.

2. Apparatus for controlling the tension on web material as set forth in claim **1** in which,

said tension sensing means positioned in abutting relation with said web material between said unwind means and said apparatus for further processing the web material so that said web material continuously exerts an opposing force upon said tension sensing means.

3. Apparatus for controlling the tension on web material as set forth in claim **1** in which said tension sensing means includes,

a tension sensing roll having a central bore therethrough and positioned in abutting relation with said web material between said unwind means and said apparatus for further processing the web material so that said web material continuously exerts a predetermined opposing force upon said tension sensing roll,

said tension sensing roll is mechanically connected to said pressure roll for rotational movement about the longitudinal axis of said pressure roll so that upon rotation of said tension sensing roll said pressure roll moves toward and away from said feed roll.

4. Apparatus for controlling the tension on web material as set forth in claim **1** in which said tension sensing means includes,

a tension sensing roll mechanically connected to said feed roll for rotational movement about the longitudinal axis of said feed roll so that upon rotation of said tension sensing roll said feed roll moves toward and away from said pressure roll.

5. Apparatus for controlling the tension on web material as set forth in claim **1** which includes,

a pair of bushings nonrotatably mounted in a frame portion adjacent said unwind means and below said tension sensing roll, said bushings coaxially aligned on a common central axis passing therethrough,

a first shaft member rotatably supported by said bushings,

said first shaft member having an axis of rotation in said bushings eccentrically displaced from the common central axis of said bushings so that the axis of rotation of said first shaft member revolves about the common central axis of said bushings upon rotation of said first shaft member,

a second shaft member positioned in the central bore of said tension sensing roll to permit rotation of said tension sensing roll relative to said second shaft member,

a pair of tension arms nonrotatably secured at one end in spaced parallel relation to the ends of said second shaft member and extending substantially vertically downwardly therefrom for connection at said tension arms other end to the ends of said first shaft member for rotation therewith.

6. Apparatus for controlling the tension on web material as set forth in claim **5** wherein,

said tension sensing roll positioned to continuously apply a predetermined pressure upon said web material and operable to rotate with said tension arms in clockwise and counterclockwise direction for maintaining a predetermined pressure upon said web material as the tension thereon increases and decreases.

7. Apparatus for controlling the tension on web material as set forth in claim **1** in which,

said pressure roll is supported for relative rotation upon said first shaft member and positioned thereon between said pair of tension arms,

said feed roll rotatably supported in said frame portion adjacent said pressure roll and positioned in abutting relation with the web material,

means for rotating said first shaft member to thereby urge said pressure roll into abutting relation with the web material so that the web material is frictionally engaged between said pressure roll and said feed roll.

8. Apparatus for controlling the tension on web material as set forth in claim **1** in which,

said tension sensing roll rotates with said tension arms in clockwise direction about said first shaft member in response to an increase in tension on a segment of the web material between the unwind means and the apparatus for further processing the web material to thereby urge said pressure roll toward said feed roll into abutting relation with the web material so that the web material is thereby frictionally engaged between the feed roll and the pressure roll and is fed to the apparatus for further processing the web material at said second preselected linear speed.

9. Apparatus for controlling the tension on web material as set forth in claim **1** in which,

said tension sensing roll rotates with said tension arms in counterclockwise direction about said first shaft member in response to a decrease in tension on a segment of the web material between the unwind means and the apparatus for further processing the web material to thereby urge said pressure roll away from said feed roll out of abutting relation with the web material so that the web material is pulled through the apparatus for further processing the web material at said first preselected linear speed.

10. Apparatus for controlling the tension on web material as set forth in claim **1** in which,

said second preselected linear speed is higher than said first preselected linear speed by a factor of 1.05.

11. Apparatus for controlling the tension on web material as set forth in claim **1** which includes,

a wraparound roll rotatably supported in said frame portion adjacent said feed roll, said wraparound roll positioned in abutting relation with said web material,

means drivingly connecting said wraparound roll to said feed roll to said pressure roll for transmitting rotation from said wraparound roll to said feed roll so that the web material passing between said feed roll and said pressure roll if fed upwardly therefrom into abutting relation with said tension sensing roll at said second preselected linear speed.

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