United States Patent

Saunders

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[45] **Mar. 21, 1972**

[54] CONTROLLED TENSION WEB WINDING APPARATUS

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[73] Assignee: **Egan Machinery Company**

[22] Filed: **May 7, 1970**

[21] Appl. No.: **35,326**

[52] **U.S. Cl.**.....**242/75.3**, 242/75.5, 242/75.51, 242/75.53

[51] **Int. Cl.**.....**B65h 59/38**

[58] **Field of Search**.....242/75.3, 75.5, 75.53, 75.51, 242/75, 75.45, 75.47; 226/195

[56] **References Cited**

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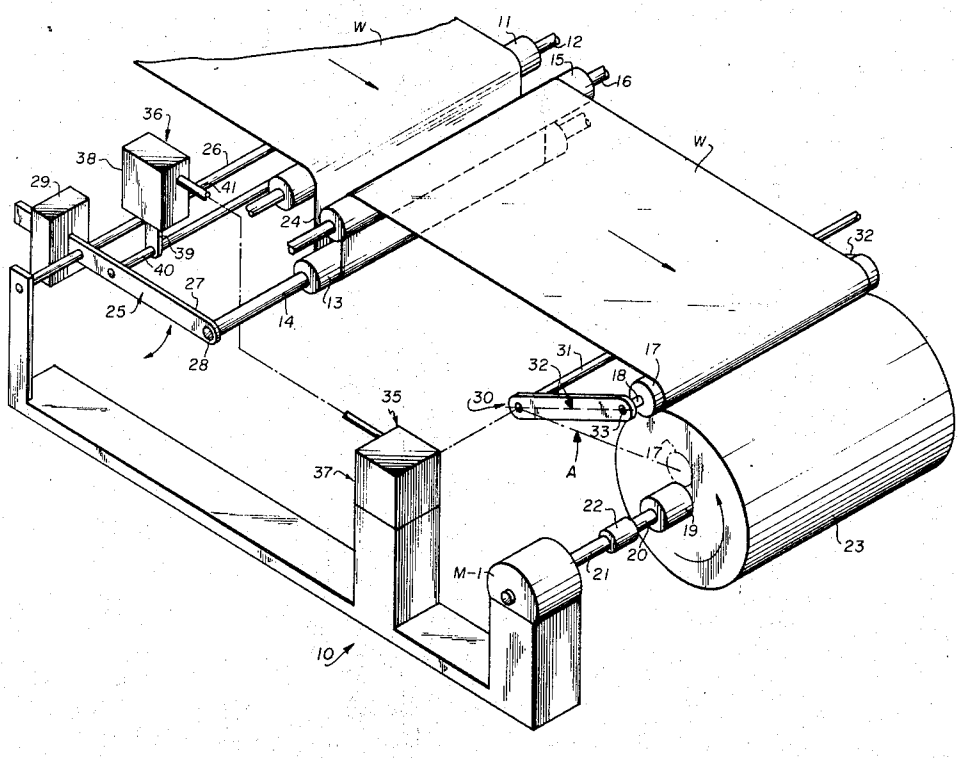
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Primary Examiner—Stanley N. Gilreath
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[57] **ABSTRACT**

Web winding apparatus in which a web of flexible material is adapted to successively pass over a first idler roll, under a dancer roll, over a second idler roll, over a lay-on roll and then be wound on a wind-up roll. The dancer roll is movable bodily through the medium of a first pair of arms which are pivotal about a first axis and the lay-on roll is movable bodily through the medium of a second pair of arms which are pivotal about a second axis. A mechanism, including a cam and a variable fluid pressure system, is connected to both pairs of arms and is so constructed and arranged as to effect application of programmed tension to the web by the dancer roll in response to bodily movement of the lay-on roll about the second axis during winding of the web on the wind-up roll.

12 Claims, 3 Drawing Figures



PATENTED MAR 21 1972

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SHEET 1 OF 2

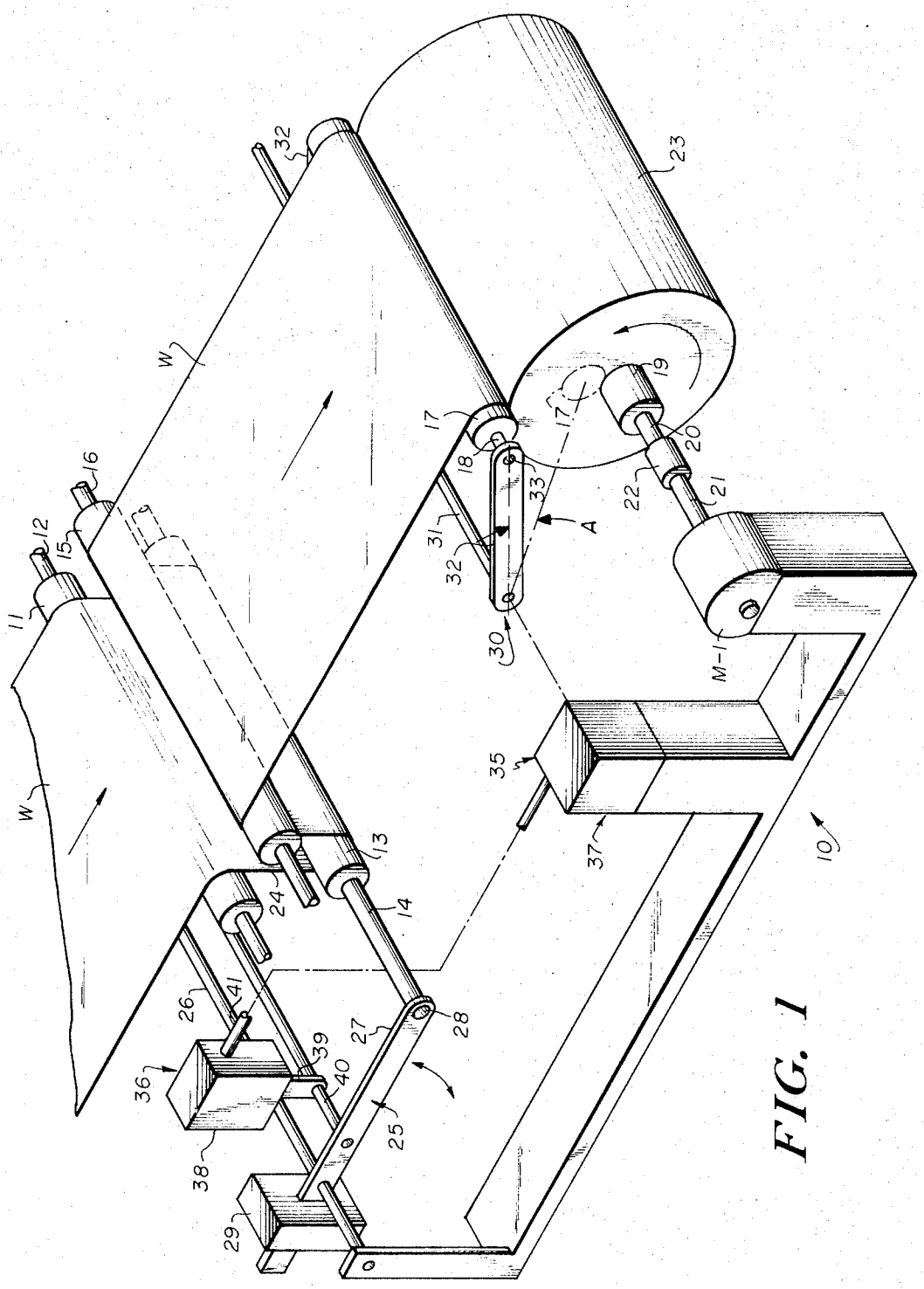


FIG. 1

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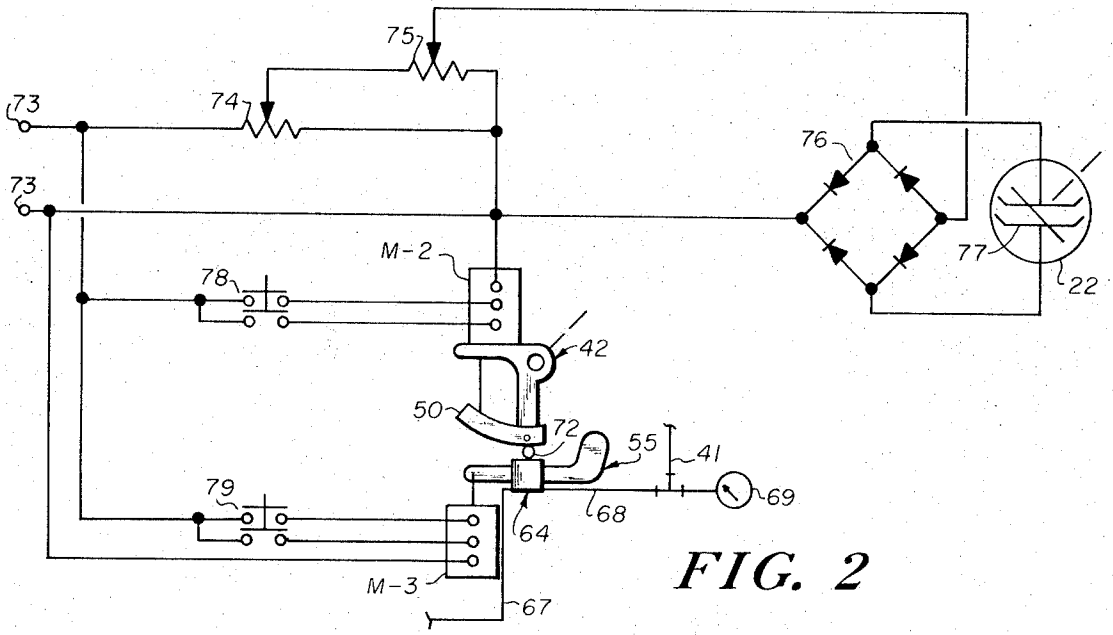


FIG. 2

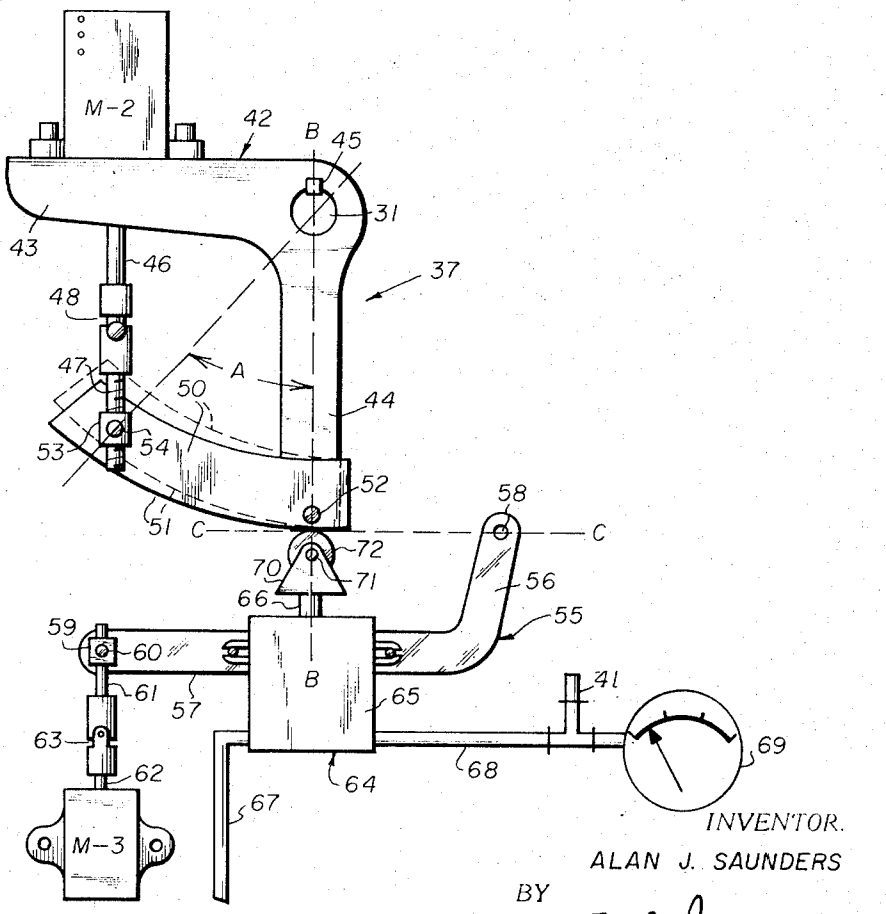


FIG. 3

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CONTROLLED TENSION WEB WINDING APPARATUS

BACKGROUND OF THE INVENTION

In the course of winding a web of a flexible material, such as paper, plastic film or the like, onto a windup roll, it is important to control the tension of the web. The reason for this is that, as the diameter of the wound web material on the windup roll increases, the peripheral speed increases at constant rotational speed, thereby progressively and objectionably increasing the tension in the web.

It is well known in the art that web winding may be accomplished by various types of winder drives, including drives which provide constant tension in the web throughout the winding cycle, drives which provide constant torque to the winder shaft and the web tension decreases in proportion to the increase in diameter of the windup roll, and drives which provide for a gradual decrease in web tension, commonly referred to as "taper tension," somewhere between those of the first two types of drives.

One category of present day winder drives is that known as the dancer roll controlled system in which a dancer roll applies a force upon a loop of a running web and creates tension in the web which is proportional to such force. By utilizing the position of the dancer roll to actuate a transducer device, the winder drive can be controlled to obtain a windup roll rotational speed which will maintain the position of the dancer roll within a selected range of travel between stops. The indicated arrangement provides constant web tension throughout the winding cycle. With the view of modifying this system to effect decreasing tension in a running web, a number of developments have been made over the years. Such developments are exemplified by Hill U.S. Pat. No. 2,886,257, Haley U.S. Pat. No. 3,189,295 and Hank U.S. Pat. No. 3,317,156. The Hill tension control device utilizes a container having a supply of liquid and carried by a dancer roll assembly. The container is so arranged that, as the dancer roll changes position, the liquid shifts from one end of the container to the other end thereby changing the loading on the dancer roller. The Haley tension winding apparatus contemplates changing the loading on a dancer roll because of changes in the path of movement of the web, as the winding roll builds up, due to the geometry of the system. The tension control device of the Hank patent relies on liquid transfer from one container to another to correspondingly change the loading on a dancer roll.

SUMMARY OF THE INVENTION

This invention relates to novel and useful web winding apparatus having improved operating characteristics. The invention pertains, in one of its specific aspects, to web winding apparatus having its parts so constructed and arranged as to effectively control web tension, as desired, from initiation of winding on an empty windup roll to completion of a full roll.

The web winding apparatus of this invention comprises a support, a pair of idler rolls, a dancer roll, a lay-on roll, and windup roll, and a drive for imparting rotation to the windup roll. The several rolls are carried by the support, are spaced apart and are rotatable about corresponding parallel axes. A web of a flexible material is adapted to successively engage and pass over one of the idler rolls, under the dancer roll, over the other idler roll and partly around the lay-on roll and then engage and be wound on the windup roll. The apparatus also comprises first means connecting the dancer roll to the support and permitting bodily movement of that roll relative to and parallel to the windup roll, second means connecting the lay-on roll to the support and permitting bodily movement of that roll relative to and parallel to the windup roll, and a mechanism connected to and coacting with the first and second means for effecting programmed tension in the web during winding thereof on the windup roll. The mechanism includes variable fluid pressure means for applying corresponding force to the dancer roll through the first means and camming means for controlling operation of the fluid pressure means in response to bodily movement of the lay-on roll.

It is the primary object of this invention to provide web winding apparatus having improved structural features and operating characteristics.

Another object of this invention is to provide web winding apparatus including a dancer roll, a lay-on roll, a windup roll and a mechanism operatively associated with the dancer and lay-on rolls for programmed tensioning of a running web as the windup roll with wound web material increases in diameter.

Another object of this invention is to provide web winding apparatus for applying desired preset programmed tension in a web.

A further object of this invention is to provide apparatus of the character stated in the preceding object in which the programmed tension may be easily and quickly preset by the operator, as required.

This invention has for a still further object the provision of apparatus of the character indicated which is sturdy and durable in construction; which is reasonable in manufacturing, installation and maintenance costs; which is adapted to be made in a wide range of sizes and adequately handle a variety of web materials; and which is capable of performing its intended functions in an entirely satisfactory manner over extended time periods.

The enumerated objects and additional objects, together with the advantages of the invention, will be readily apparent to persons trained in the art from the following detailed description and the accompanying drawings which describe and illustrate a preferred arrangement of web winding apparatus embodying the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings wherein like reference characters denote corresponding parts in the several views:

FIG. 1 is a partly isometric and partly schematic view of a portion of the web winding apparatus;

FIG. 2 is a schematic view of certain parts of the web winding apparatus and associated electrical circuits; and

FIG. 3 is an enlarged elevation view of a tension control mechanism incorporated in and constituting part of the web winding apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring initially to FIG. 1 of the drawings, the therein illustrated web winding apparatus comprises support means including a pair of spaced side frames **10**, only one of which is shown in part. These frames carry a plurality of rolls, namely a first idler roll **11** having a shaft **12**, a dancer roll **13** having a shaft **14**, a second idler roll **15** having a shaft **16**, a lay-on roll **17** having a shaft **18** and a windup or core roll **19** having a shaft **20**. The axes of the several shafts are parallel and spaced apart. Shafts **12**, **16** and **20** are mounted for rotation on the support means and their axes are stationary. Shafts **14** and **18** are mounted, as will be described, to permit bodily movement thereof and of the corresponding rolls.

Windup roll **19** is driven by an electric motor M–1. This motor has a rotary shaft **21** which is coaxial with and coupled to shaft **20** by a magnetic clutch **22**.

A web of flexible material W is adapted to travel as indicated by the arrows in FIG. **1** and engage and pass over idler roll **11**, under dancer roll **13**, over idler roll **15**, over lay-on roll **17** and finally around windup roll **19** on which it forms a wound roll **23** of the material. The dancer roll rides in a loop **24** of the web. The height of this loop is variable depending on the force exerted by the dancer roll and the resulting tension applied to the web, as will be explained further along herein.

Dancer roll **13** is pivotal bodily relative to the support means through the medium of a first means **25** which will now be described. Means **25** includes a pivot shaft **26** which is parallel to dancer roll shaft **14** and is supported for rotation by frames **10**. Secured to and pivotal with shaft **26** is a pair of spaced parallel arms **27**. Shaft **14** is mounted for free rotation

at an end of each arm **27**, as indicated at **28**. The portion of each arm to the side of shaft **26** remote from shaft **14** is equipped with a counterweight **29** for balancing the weight of the dancer roll.

Similarly, lay-on roll **17** is pivotal bodily relative to the support means and windup roll **19** through the medium of a second means **30**. This means includes a pivot shaft **31** which is parallel to lay-on roll shaft **18** and is supported for rotation by frames **10**. Each of a pair of spaced parallel arms **32** is secured at one end to shaft **31** and is rotatable therewith. Shaft **18** is mounted for free rotation at the other ends of arms **32**, as indicated at **33**. In the course of winding web W onto windup roll **19**, lay-on roll **17** moves bodily upwardly through angle A (FIG. **1**) from its broken line position, when the windup roll is empty, to its full line position, when wound roll **23** attains its required diameter.

The apparatus also comprises a mechanism, generally denoted by numeral **35**, which is connected to and cooperates with first means **25** and second means **30**, for effecting programmed tension in web W in the course of winding the web on windup roll **19**. Mechanism **35** includes a third means **36** for exerting a variable force on arms **27** and, therefore, on dancer roll **13**, and a fourth means **37** for controlling the operation of the third means in response to bodily movement of lay-on roll **17** about the axis of shaft **31**.

Third means **36** comprises a variable fluid pressure unit including a cylinder **38** mounted on the support means and a plunger **39** which is slidable through the lower end of the cylinder. The free end of plunger **39** is connected to a rod **40** which extends between and is secured to arms **27**. The fluid pressure unit is preferably pneumatic. Air under predetermined pressure is admitted into the upper end of cylinder **38** by way of a conduit **41** and exerts a downward force to plunger **39**. This causes clockwise pivotal movement of means **25** about the axis of shaft **26**, as viewed in FIG. **1**, and the application of corresponding force on dancer roll **13**, thereby creating corresponding tension in web W.

The force exerted by the fluid pressure unit and the resultant force applied to the dancer roll and the tension created in web W is controlled by fourth means **37**, which will now be described. This means includes an L-shaped lever **42** having a lateral arm **43** and a vertical arm **44**. As is best shown in FIG. **3**, lever **42** is mounted on and affixed to shaft **31** by a key **45** for rotation therewith. Lever arm **43** carries a reversible electric motor M–**2** having a rotary shaft **46** which is connected to a threaded rod **47** by a universal coupling **48**. A cam member **50**, having an arcuate lower camming surface **51**, is pivotally connected at one end to the lower end of arm **44** by a pivot pin **52**. A block **53** is pivotally connected to the other end of cam member **50**, as indicated at **54**. Block **53** has a through tap for engagement with threaded rod **47**. It will be evident from an examination of FIG. **3** that Motor M–**2** adjusts the effective length of threaded rod **47** and correspondingly adjusts or varies the position of cam member **50** relative to lever arm **44** about the axis of pin **52**.

A generally L-shaped lever **55** is positioned substantially wholly below lever **42** and consists of an upstanding arm **56** and a lateral arm **57**. The free end of arm **56** is pivotally connected to a side frame **10** by a pin **58**. A block **59** is pivotally connected to the free end of arm **57**, as indicated at **60**. This block has a through tap for engagement with a threaded rod **61**. A second reversible electric motor M–**3** is mounted on a support frame and has a rotary shaft **62** which is connected to threaded rod **61** by a universal coupling **63**. Motor M–**3** adjusts the effective length of threaded rod **61** and, therefore, the angular position of lever **55** about the axis of pin **58**.

Attached to lever arm **56** is an air control valve **64** which includes a casing **65** and a reciprocable valve stem **66** that extends through and beyond the upper end of the casing. High pressure air from a convenient source of supply (not shown) is admitted to the inlet of valve **64** by a conduit **67** and is discharged and then transmitted from the outlet of the valve by a conduit **68** to conduit **41** and thence into the upper end of cylinder **38**. Conduit **68** is equipped with a pressure gauge **69**. Valve **64** is in the nature of a pressure regulating valve and may be of any suitable known construction wherein the pressure of the air discharged therefrom is dependent on the position of valve stem **66**. A bracket **70** is affixed to the upper end of valve stem **66** and carries a pin **71** that is parallel to pin **52** and shaft **31**. Mounted for rotation on pin **71** is a roller **72** which bears against camming surface **51**.

When lay-on roll **17** is at its broken line position (FIG. **1**), i.e., against empty windup roll **19**, it is important that the angular position of lever **42** be such that the axes of shaft **31**, pivot pin **52** and pivot pin **71** intersect a straight line which is denoted B—B in FIG. **3**. Also, for best results during operation, the axis of pivot pin **52** should be as close as practical to the periphery of roller **72** and the axis of pivot pin **58** should intersect a line C—C which is normal to line B—B and passes through the line of contact between camming surface **51** and roller **72**.

Reference is now had to FIG. **2** for an understanding of the electrical circuitry that is incorporated in the present invention. The circuitry includes a pair of terminals **73** for connection to a suitable source of alternating current supply (not shown), a pair of potentiometers **74** and **75** for controlling the line voltage to a rectifier **76** which supplies direct current to the coil **77** of magnetic clutch **22**. The clutch is a slip type and the voltage applied to its coil controls the amount of torque transmitted by drive motor M–**1** to winding shaft **20**, thereby controlling the rotational speed of windup roll **19**. A pair of selector switches **78** and **79** control the operation of adjusting motors M–**2** and M–**3**, respectively.

In describing the operation of the illustrated embodiment of the invention, it is assumed initially that cam **50** is so adjusted that it does not affect the position of roller **72** and, therefore, valve stem **66** as lever arm **44** pivots in a counterclockwise direction through the angle A (FIG. **3**) in the course of winding the web from empty windup roll condition to full wound roll **23**. Accordingly, constant pressure is applied to dancer roll **13** by fluid pressure means **36** throughout the winding cycle. The dancer roll controls the torque delivered by clutch **22** through the medium of potentiometer **74** which is actuated by shaft **26**. As the diameter of the material being wound on the windup roll increases, its rotational speed will decrease to slightly less than the linear speed of web W entering over idler roll **11**. This decrease in rotational speed is caused by insufficient delivered torque by the clutch since the winding torque requirement has increased due to increase in the torque arm radius of the web winding on the roll. The decrease in web speed will result in a downward movement of the dancer roll which results in an increase in excitation to the clutch to provide increased transmitted torque and a restoration of the correct web speed. These changes occur continuously and smoothly. Inasmuch as the web tension and, therefore, winding tension is directly proportional to the effective weight of the dancer roll, it will be observed that the foregoing will result in constant tension winding.

In order to obtain a taper tension, cam **50** is adjusted by motor M–**2** to the position indicated by the broken lines in FIG. **3**. Consequently and as the winding roll builds up in diameter with the web material and as lever arm **44** rotates through angle A, roller **72** and valve stem **66** move upwardly and gradually decrease the pressure of the air transmitted by valve **64** and conduits **68** and **41** to cylinder **38**. This causes a corresponding decrease in the force exerted by plunger **39** upon means **25**, thereby gradually decreasing the effective force exerted by the dancer roll on the web and correspondingly gradually decreasing the tension in the web as the winding roll increases in size.

One of the important advantages of this invention is the ease and simplicity of making adjustments for the initial winding tension and the amount of taper tension desired. The initial tension is obtained or adjusted by first lowering lay-on roll **17** to rest on empty windup roll **19**, as indicated by the dotted line position of roll **17** (FIG. **1**). At this time, cam **50** is in the full

line position shown in FIG. 3. Switch 79 is closed and motor M–3 is energized, thereby actuating valve stem 66 and roller 72 to the illustrated position and adjusting the air pressure that is delivered by conduits 68 and 41 to cylinder 38. This air pressure is read on gauge 69 which, if desired, may be calibrated to indicate tension directly and this reading will be the initial winding tension on the windup roll 19.

The apparatus is then set for final tension in the web by raising lay-on roll 17 to its full line position which corresponds to its position for a full wound roll 23. Lever 42 and cam 50 will now have rotated in a counterclockwise direction through angle A (FIG. 3). The cam is then raised or lowered, as required, by closing switch 78 and operating motor M–2 until the desired final tension is indicated on gauge 69.

It will be observed that, due to the straight line construction described earlier herein and the proximity of the axis of shaft pin 52 to the line of contact between cam surface 51 and roller 72, the setting of the initial tension will not be affected by any adjustment of the final tension, thereby obviating any need for the operator to make further adjustments.

It has been found that a camming surface 51 having the configuration of a circular arc affords a satisfactory tension taper program in most instances. It should be borne in mind, however, that other camming surface configurations may be employed advantageously to obtain desired tension programming.

While a magnetic clutch 22 is preferred for coupling drive shaft 21 to windup roll shaft 20, any other suitable type of controllable slip clutch may be substituted therefor. In fact, the clutch may be eliminated by utilizing a variable speed drive motor which is controlled by the position of dancer roll 13.

As illustrated and described, first means 25 and second means 30, respectively, carry and permit bodily movement of dancer roll 13 and lay-on roll 17 about the axes of corresponding shaft 26 and 31. While this arrangement is preferred, it should be borne in mind that it is within the purview of this invention to permit requisite bodily movement of such rolls by utilizing means other than the indicated pivot shafts. For example, the dancer roll may be arranged for vertical sliding movement by using constructions of the character disclosed in Haley U.S. Pat. No. 2,847,210 and Sherman U.S. Pat. No. 3,218,219.

Based on the foregoing, it is believed that the construction, operation, objects and advantages of my present invention will be readily comprehended by persons skilled in the art, without further description. It is to be clearly understood, however, that various changes in the construction described above and illustrated in the drawings may be made without departing from the scope of the invention, it being intended that all matter contained in the description or shown in the drawings shall be interpreted as illustrative only and not in a limiting sense.

I claim:

1. Web winding apparatus comprising a support, a dancer roll, a lay-on roll, a wind-up roll, a drive for imparting rotation to the wind-up roll, said rolls being carried by the support, spaced apart and rotatable about corresponding parallel axes, a web of a flexible material being adapted to successively engage the dancer roll and the lay-on roll and then engage and be wound on the wind-up roll, first means connecting the dancer roll to the support and permitting bodily movement of the dancer roll while maintaining its axis parallel to the axes of the other rolls, second means connecting the lay-on roll to the support and permitting bodily movement of the lay-on roll relative to the wind-up roll while maintaining its axis parallel to the axes of the other rolls, and a mechanism connected to and coacting with the first and second means for effecting programmed tension in the web during winding thereof on the wind-up roll, said mechanism comprising variable fluid pressure third means for applying corresponding force to the dancer roll through the first means.

2. Web winding apparatus according to claim 1 additionally comprising camming fourth means for controlling the force applied by the third means in response to bodily movement of the lay-on roll.

3. Web winding apparatus according to claim 1 wherein the third means comprises a cylinder for receiving fluid under pressure and a plunger extending through an end of the cylinder and connected to the first means, said plunger being slidable relative to the cylinder in response to variations in the pressure of the fluid.

4. Web winding apparatus according to claim 2 wherein the fourth means comprises a first lever connected to and movable with the second means about a first pivotal axis, a cam carried by the lever, a pressure regulating valve having an inlet for connection to a source of high pressure fluid and an outlet communicating with the third means, said valve including a stem that is operatively associated with the cam for controlling the pressure of the fluid discharged from the valve in response to movement of the cam.

5. Web winding apparatus according to claim 2 wherein the third means comprises a cylinder for receiving fluid under pressure and a plunger extending through an end of the cylinder and connected to the first means, said plunger being slidable relative to the cylinder in response to variations in the pressure of the fluid, and wherein the fourth means comprises a first lever connected to and movable with the second means, a cam carried by the lever, a pressure regulating valve having an inlet for connection to a source of high pressure fluid and an outlet communicating with the cylinder, said valve including a reciprocable stem device that is operatively associated with the cam for controlling the pressure of the fluid discharged from the valve in response to movement of the cam.

6. Web winding apparatus according to claim 5 wherein the cam is connected and movable relative to the first lever about a second pivotal axis, means being provided to adjust the position of the cam relative to the first lever about said second pivotal axis.

7. Web winding apparatus according to claim 6 wherein the fourth means also comprises a second lever connected to and movable relative to the support about a third pivotal axis, said pressure regulating valve being mounted on the second lever, and means for adjusting the position of the lever relative to the support about said third pivotal axis.

8. Web winding apparatus according to claim 7 wherein the first and second axes intersect a substantially rectilinear line that is coincident with the longitudinal axis of the valve stem device when the parts are in such a relative position that the lay-on roll is disposed directly against the wind-up roll.

9. Web winding apparatus according to claim 8 wherein a straight line passing through the third axis and the region of engagement between the cam and the valve stem device is substantially normal to said rectilinear line.

10. Web winding apparatus according to claim 9 wherein the valve stem device includes a roller rotatable about a fourth axis that is parallel to and closely adjacent said second pivotal axis, said roller engaging the cam.

11. Web winding apparatus according to claim 10 wherein said first, second and fourth axes intersect a substantially rectilinear line when the parts are in such a relative position that the lay-on roll is disposed directly against the wind-up roll.

12. Web winding apparatus according to claim 11 wherein a straight line passing through said third pivotal axis and region of engagement between the cam and the roller is substantially normal to said rectilinear line.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,650,490 Dated March 21, 1972

Inventor(s) Alan J. Saunders

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 36, i.e. claim 6, line 1, cancel "5" and substitute --- 4 --- .

Signed and sealed this 1st day of August 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334