July 4, 1961 J. V. KEITH 2,990,603

APPARATUS FOR DRAW-STRETCHING AND WINDING YARN

Filed April 23, 1958 2 Sheets-Sheet 1

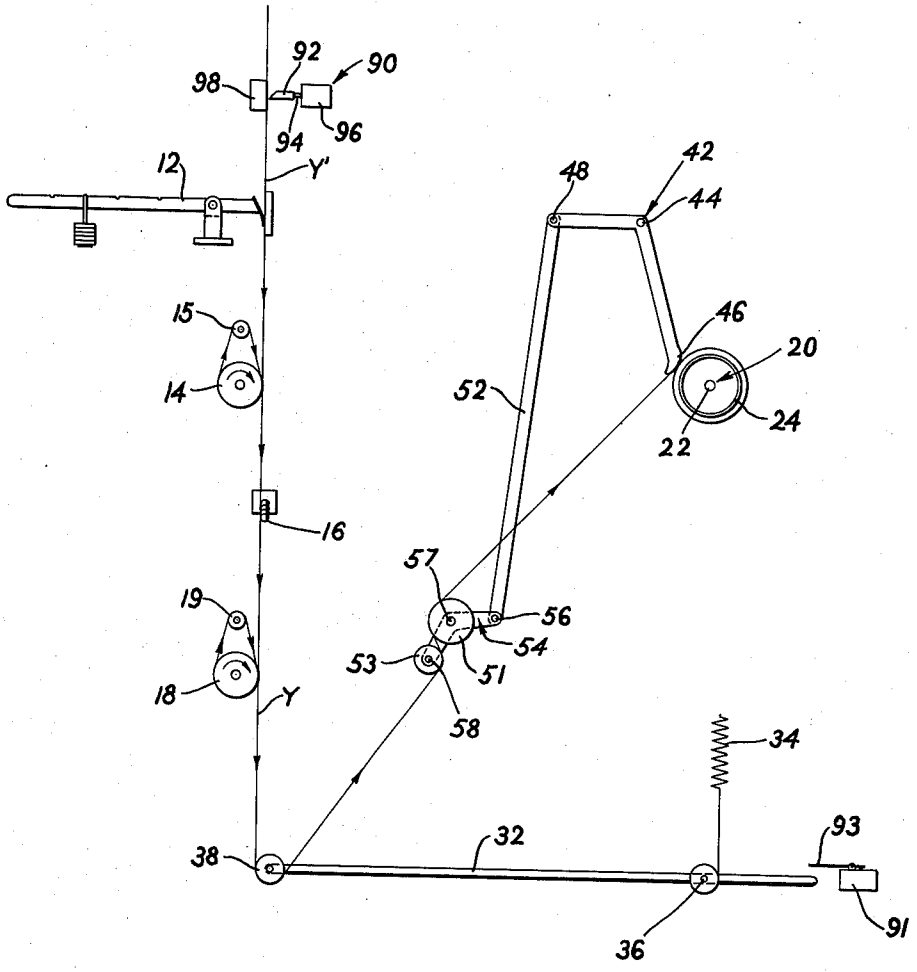


Fig. 1

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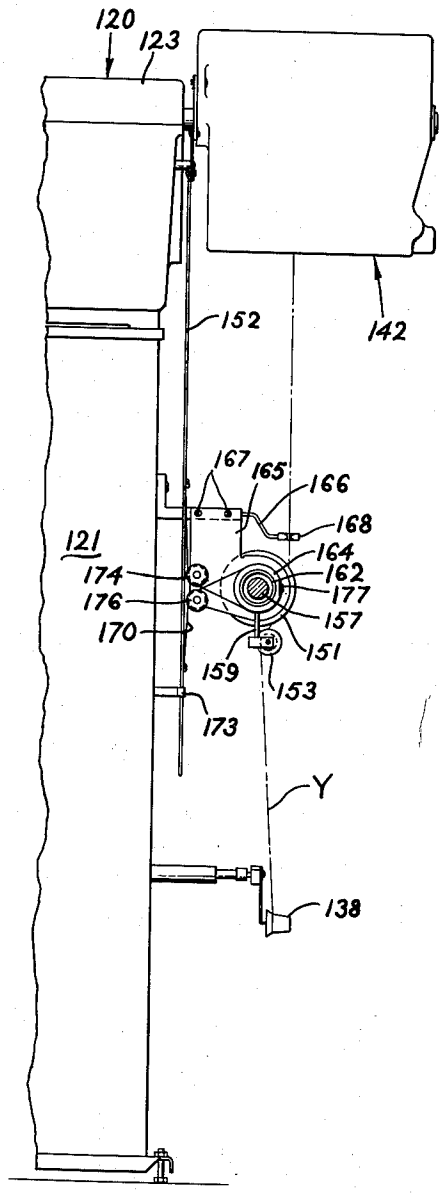


Fig. 3

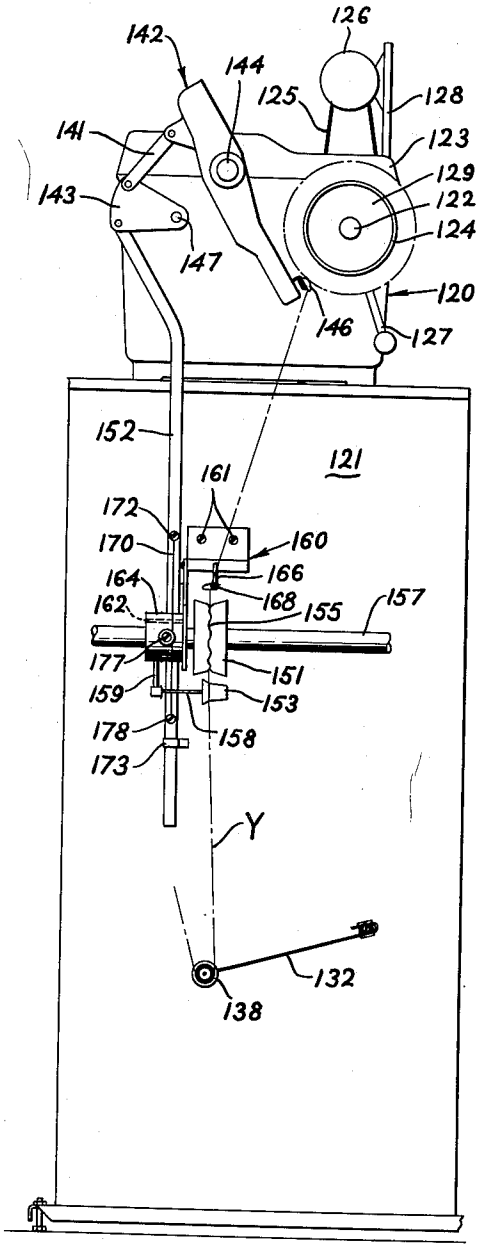


Fig. 2

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APPARATUS FOR DRAW-STRETCHING AND WINDING YARN

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Filed Apr. 23, 1958, Ser. No. 730,450
31 Claims. (Cl. 28—71.3)

The present invention relates to an apparatus, including suitable tension controlling means, for draw-stretching and winding a strand of yarn.

In the following specification and claims the term yarn is employed in a general sense to apply to all kinds of strand material, either textile or otherwise, and the designation package is intended to mean the product of a winding machine whatever its form.

It is frequently desirable in the manufacture of textiles to draw-stretch synthetic yarns and to wind the product into yarn packages. In winding the output from a draw-stretch machine of the type employed to draw-stretch synthetic linear polyamides and other synthetic yarns, the yarn must be wound at the same speed it is advanced by the draw-stretch machine. If the winder operates at a lower speed a loop of slack yarn is formed causing the yarn to tangle and break; if at a higher speed, yarn tension increases until the yarn breaks. At the same time it is essential to maintain a uniform tension in the strand of yarn emerging from the drawing apparatus. Otherwise slippage of the yarn on the drawing rolls is non-uniform.

However, in winding self-supporting packages of the cross-wound type it is highly desirable to wind the yarn at a differential tension, i.e. wherein the tension in the winding strand decreases as the winding package increases in diameter. Because of the foregoing tension requirements it has heretofore been impracticable to wind the output of a draw-stretch operation into a cross-wound package.

Prior to the present invention the output of draw-stretch machines has been wound, or taken up, by ring twisters, cap twisters, and similar devices. The packages formed by such prior art take-ups are often unsuitable for shipping purposes or subsequent operations and the yarn must be rewound. Furthermore, such winding inserts a certain amount of twist into the strand of yarn which is often objectionable.

One object of the present invention is to provide means for draw-stretching and winding a continuously advancing strand of yarn, maintaining a uniform tension therein from the output of a draw-stretch operation to the input stage of a winding operation while winding said strand at a differential tension.

Another object of the present invention is to provide means for draw-stretching and winding a strand of yarn, maintaining a uniform tension therein from the output of a draw-stretch operation to the input stage of a winding operation while winding said strand at a differential tension and means for stopping the supply of undrawn yarn in the event of strand breakage.

Another object of the present invention is to provide means for feeding and winding a strand of yarn and maintaining a uniform tension therein up to the input stage of a winding machine while varying the tension in said strand as it is wound.

Another object of the present invention is to provide means for using a winding machine as the take-up device for the product of a draw-stretch operation.

Another object of the present invention is to provide a winding machine capable of winding a continually advancing strand of yarn at a differential tension.

Another object of the present invention is to provide means for controlling the tension in a strand of yarn.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the apparatus possessing the construction, combination of elements and arrangement of parts which are exemplified in the following detailed disclosure and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

FIGURE 1 is a diagrammatic side elevation of an apparatus embodying the present invention comprising a draw-stretch unit, a winding unit, a tension controlling unit and a yarn cutter;

FIGURE 2 is a front elevation of a winding machine incorporating the tension controlling means of the present invention; and

FIGURE 3 is a fragmentary side elevation of the winding machine shown in FIGURE 2.

The present invention comprises a draw-stretch unit, a winding unit capable of winding the output strand of said draw-stretch unit into a self-supporting package and means for controlling the tension in said strand so as to wind said package at a differential tension and also to maintain a constant predetermined tension on the winding strand emerging from the draw-stretch apparatus. Means are also provided for stopping the supply of undrawn yarn to the draw-stretch apparatus in the event the strand breaks during processing.

Said tension controlling means comprises a furnishing wheel, a linkage and a compensator arm. The furnishing wheel is rotated at a constant peripheral speed in excess of the speed at which the strand of yarn is advanced, and so positioned as to be engaged by the continuously advancing strand of yarn as it passes from the draw-stretch apparatus to the winding machine. The linkage, controlled by the winding package diameter, regulates the amount of contact between said strand and furnishing wheel to thereby control the tension differential applied by said wheel to said strand. The yarn-engaging compensator arm provides means to regulate the speed of the winding spindle to maintain the peripheral speed of the winding package substantially the same as the output speed of the draw-stretch operation.

Referring now to FIGURE 1 of the drawings wherein is disclosed in diagrammatic form the apparatus of the present invention comprising a draw-stretch unit, a winding machine **20**, a yarn cutter **90** and a tension control unit. The draw-stretch unit, for example that disclosed in U.S. Patent No. 2,289,232, issued July 7, 1942 to D. F. Babcock, includes tensioning device **12**, upper feed roller **14**, upper separating roller **15**, snubbing pin **16**, lower feed roller **18** and lower separating roller **19**.

The operation of this draw-stretch unit is described in detail in said Patent No. 2,289,232 but essentially consists in the following. An undrawn strand of synthetic yarn Y′ is pulled from a supply thereof (not shown) through tensioning device **12** by upper feed roller **14**. The yarn emerging from roller **14** is pulled around snubbing pin **16** by lower feed roller **18**. Lower feed roller **18** is rotated at a higher peripheral speed than upper feed roller **14** so that said strand Y′ is drawn or stretched between said rollers, and more particularly the stretching occurs at pin **16**. The strand emerges from lower roller **18** as drawn yarn Y suitable for various textile uses.

Because slippage occurs between the strand of yarn wrapped around roller **18** and said roller, the rate at which yarn Y emerges from roller **18** depends upon the rotational speed of said roller and the tension in said emerging yarn. For a given yarn feed rate at a fixed roller speed, a particular tension is required. Increasing

the yarn tension above this particular value decreases the slippage between roller **18** and the strand of yarn and causes the yarn to feed faster from said roller; decreasing tension increases slippage and causes the yarn to feed more slowly. Snubbing pin **16** makes the feed rate of roller **14** relatively insensitive to tension in strand Y. Therefore, fluctuations in the emerging strand tension, by varying the slippage between roller **18** and the yarn thereon, change the amount of stretch occurring at pin **16**. Hence, a constant predetermined tension must be maintained in strand Y to prevent uneven stretching of yarn.

The winding unit **20** employed to wind strand Y comprises a rotatable spindle **22** having a core **24** mounted thereon and adapted to wind a self supporting package thereon. Compensator arm **32** pivotally mounted on shaft **36** has yarn engaging roller **38** rotatably journaled at one end thereof. Compensator arm **32** is loaded by spring **34** which tends to rotate said arm in a counterclockwise direction, as viewed in FIGURE 1. Arm **32** has roller **38** engaged in a bight of the running strand Y. The spring loading of arm **32** is such that tension in strand Y in excess of a predetermined amount lifts said arm, and tension less than said predetermined amount permits said arm to move downwardly. Arm **32** is connected to suitable means (not shown) as, for example, the mechanism and circuitry disclosed in U.S. Patent No. 2,752,105, issued June 26, 1956 to J. V. Keith for a "Winding Machine," to decrease the speed of spindle **22** when said arm lifts and to increase said speed when said arm lowers.

The tension controlling means further comprises a bell-crank lever **42** pivotally mounted on shaft **44** and having a yarn feeler **46**, which also functions as a yarn guide, fixed to the end of one arm and contacting the winding package. The second arm of bell-crank lever **42** is pivotally connected at **48** to rod **52**.

Furnishing wheel **51** is driven clockwise, as viewed in FIGURE 1, by any suitable means (not shown) at a constant peripheral speed in excess of the speed of strand of yarn Y. A bell-crank lever **54** is pivotally mounted on shaft **57** adjacent wheel **51** and axially aligned with said wheel. Yarn-engaging roller **53** is rotatably mounted at **58** on the end of one arm of bell-crank **54** so as to be radially disposed from wheel **51** and movable thereabout. Rod **52** is pivotally connected at **56** to the end of the other arm of bell-crank **54**.

Yarn cutter **90** is positioned to engage the undrawn strand of yarn Y′ between the supply of undrawn yarn and tensioning device **12**, and comprises knife **92** mounted on the armature **94** of solenoid **96** and adapted to be pressed against anvil **98** upon actuation of said solenoid. The strand of undrawn yarn Y′ passes between knife **92** and anvil **98** as it is drawn into the draw-stretch unit and will be severed by said knife when said solenoid is actuated. Solenoid **96** is controlled by switch **91** having actuating arm **93** positioned adjacent and actuated by compensator arm **32** when said arm rotates counterclockwise, as viewed in FIGURE 1, through a predetermined angle. Switch **91** is connected to a source of power and solenoid **96** by suitable wiring (not shown) so that said solenoid will be actuated whenever strand Y is broken and compensator arm **32** falls.

The apparatus of the present invention disclosed diagrammatically in FIGURE 1 operates in the following manner. The undrawn strand of yarn Y′ is processed in the draw-stretch unit as hereinbefore described. Yarn strand Y emerging from draw-stretch roller **18** passes downwardly around roller **38** and thence upwardly and between roller **53** and furnishing wheel **51**. Strand Y then passes upwardly around wheel **51** and proceeds to spindle **22** where it is wound into a package.

Slippage occurs between wheel **51** and the portion of strand Y in contact therewith. Furnishing wheel **51** does not positively feed strand Y to spindle **22** but rather urges said strand towards said spindle by frictional and other drag forces developed between the portions of said strand and said wheel in mutual contact. The degree of angular contact between wheel **51** and the yarn is varied by changing the position of roller **53**. A greater degree of angular contact between strand Y and wheel **51** increases the magnitude of these aforesaid forces so that a greater drag or pull is exerted on said strand and the tension in the portion thereof between wheel **51** and spindle **22** is reduced. Less angular contact decreases the drag or pulling forces and increases tension between said wheel and spindle.

As the winding package increases in diameter the peripheral speed of yarn thereon increases causing an increase of tension in strand Y. Increased tension in strand Y lifts compensator arm **32** to thereby reduce the speed of spindle **22**.

At the same time, growth of the winding package pivots bell crank lever **42** about shaft **44** in a clockwise direction, as viewed in FIGURE 1. Such pivotal movement of bell crank lever **42** lifts rod **52** which, in turn, rotates bell crank lever **54** in a counterclockwise direction changing the position of roller **53** so as to increase the wrap of strand Y around wheel **51**. This increases the angular contact between strand Y and wheel **51** thus increasing the drag therebetween. Because the drag exerted on strand Y by furnishing wheel **51** is increased, the tension in said strand between said wheel and feed roller **18** is maintained constant.

The process described above takes place continually and at a slow rate so that adjustments are gradual and continuous and no appreciable fluctuations in tension occur between wheel **51** and roller **18** while the desired differential tension is maintained between said wheel and spindle **22**.

Referring now to FIGURES 2 and 3 of the drawings which disclose a winding machine incorporating the tension controlling means of the present invention. Winding mechanism **120** is mounted on a pedestal or base **121** and is of the type known in the art as a "precision winder" wherein the number of rotations of spindle **122** to each reciprocation of yarn guide **146** is fixed from the start of the winding operation until the package being wound is completed.

The winding mechanism shown comprises a spindle **122** rotatably journaled in a casing **123**. Yarn guide **146** is mounted for reciprocation on traverse frame **142** which, in turn, is mounted for pivotal movement intermediate its ends on shaft **144** to permit said yarn guide **146** to move away from spindle **122** as the package being wound thereon increases in diameter. Yarn guide **146** is connected to and reciprocated by a cam, (not shown) located inside of casing **123**. Spindle **122** is provided with core holder **129** for releasably mounting a package core **124** on said spindle. Operating handle **127** is provided for contracting holder **129** to remove a full package from spindle **122** and for expanding said holder after a new core **124** is in place. All of the above described structure is old and well known in the art and need not be described further herein.

Winding mechanism **120** is driven by an electric motor **126** which is mounted on bracket **128** secured to casing **123** and is connected to said winding mechanism by any suitable means as, for example, belt **125**. Motor **126** is such that it has variable speed characteristics, i.e. the speed of said motor increases or decreases as the electrical current supplied thereto. Spring loaded compensator arm **132** having yarn engaging roller **138** thereon is connected to suitable current regulating means, as for example, the mechanism and circuitry disclosed in aforesaid Patent No. 2,752,105 and regulates the current supplied to motor **126**. Said arm **132** is capable of operating switching means within base **121** which in turn operate a yarn cutter (not shown) as hereinbefore described.

The upper end of frame 142 is connected to rod 152 by means of link 141 and segment 143, said segment being pivotally mounted on pin 147 which is fixed to casing 123. Rod 152 is guided at its lower end by bushing 173 which is fixed to pedestal 121. The linkage comprising frame 142, link 141, segment 143 and rod 152 is such that clockwise rotation of frame 142 in response to growth of a yarn package on core 124 is translated into substantially vertical upward motion of rod 152.

Furnishing wheel 151 is securely mounted on shaft 157 which is suitably journaled and driven at a substantially constant speed. Wheel 151 has a yarn engaging groove 155 in its periphery, said groove being aligned centrally in the wheel face, and engages the strand of yarn Y to feed it by frictional contact. A yarn engaging roller 153 provides means for controlling the wrap of strand Y about wheel 151 and thus the angular contact between said wheel and strand.

A substantially rigid bracket 160 is secured to pedestal 121 by screws 161 and projects forwardly therefrom. Arm 166 fastened to bracket 160 mounts yarn guide 168 above yarn groove 155. Plate 165 is attached to bracket 160 by screws 167 and depends therefrom in a plane substantially perpendicular to the axis of shaft 157, said shaft passing through an opening in said plate. Plate 165 is fitted on one side with a tubular hub 162 concentric about shaft 157. The openings through hub 162 and plate 165 are of sufficient size to allow shaft 157 to rotate freely therein. Sleeve 164 is rotatably mounted on hub 162 and arm 166 is fixed to and extends from said sleeve and supports shaft 158. Roller 153 is rotatably mounted on shaft 158 and aligned with yarn groove 155. Pulleys 174 and 176 are rotatably mounted on plate 165 intermediate sleeve 164 and rod 152 and adjacent said rod.

One end of cable 170 is fixed to rod 152 near the center thereof and above shaft 157 by screw 172. Said cable passes around pulley 174 and sleeve 164. Screw and washer 177 fix cable 170 to sleeve 164 as it passes therearound. Said cable then crosses past itself and passes around pulley 176. The other end of cable 170 is fixed to rod 152 near the lower end thereof and below shaft 157 by screws 178.

The tension controlling unit disclosed in FIGURES 2 and 3 operates in the following manner. A strand of yarn Y leads from a source (not shown, but for example, a draw-stretch machine) and passes downwardly around roller 138 and thence upwardly to roller 153. Said strand then passes between roller 153 and furnishing wheel 151, wrapping around the rear portion of said roller and the front portion of said wheel. Strand Y passes upwardly from wheel 151 through yarn guides 168 and 146 and onto the winding package.

Furnishing wheel 151, having a constant peripheral speed in excess of the speed of the continually advancing strand of yarn, exerts a drag urging said strand towards spindle 122. The magnitude of this drag and the tension differential between the portions of strand Y on either side of wheel 151 depends on the angular contact between said strand and said wheel as hereinbefore described.

As the winding package increases in diameter the peripheral speed of yarn thereon increases thus increasing the tension in strand Y. Increased tension in strand Y lifts compensator arm 132 which reduces the speed of spindle 122. This lessens the tension in strand Y.

At the same time growth of the winding package rotates frame 142 about shaft 144 in a clockwise direction, as viewed in FIGURE 2. Rotation of frame 142 pulls link 141 in an upward direction pivoting segment 143 about pin 147. Such pivotal movement of segment 143 lifts rod 152 and pulls cable 170 upwardly. Said upward motion of cable 170 causes clockwise rotation of sleeve 164, as viewed in FIGURE 3, which displaces arm 159, moving roller 153 towards pedestal 121 and thereby

increasing the wrap of strand Y around wheel 151. This increases the degree of angular contact between strand Y and wheel 151 thus increasing the drag therebetween. Because the drag exerted on strand Y by wheel 151 is increased, the tension in said strand between said wheel and spindle 122 is decreased while the tension in said strand between the source thereof and said wheel is maintained constant.

Another embodiment of the present invention is an apparatus similar to the aforedescribed apparatus of FIGURES 2 and 3 wherein the tension differential in the winding strand of yarn is obtained by varying the speed of furnishing wheel 151 instead of the angular wrap of said strand therearound. For example, roller 153 could be fixedly mounted relative to wheel 151, and rod 152 could connect to a potentiometer for regulating the speed of an electric motor driving shaft 157, increasing the speed thereof in response to growth of the winding package to thereby obtain the desired tension differential. Similarly, rod 152 or any other element in the linkage actuated by frame 142 could be used to actuate a variable speed transmission to control the speed of shaft 157.

Since certain other changes may be made in the above apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description (or shown in the accompanying drawings) shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. Apparatus for draw-stretching and winding yarn comprising means for drawing a strand of unstretched yarn from a supply thereof and for draw-stretching said strand, a rotatable spindle for winding the drawn strand leaving said draw-stretching means, means for traversing said drawn strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said drawn strand, a rotatable furnishing wheel, means for rotating said furnishing wheel, means for guiding said drawn strand into contact with said furnishing wheel as it passes from said draw-stretching means to said spindle, and means to increase the force exerted on said drawn strand by said furnishing wheel as said package increases in diameter to maintain a substantially constant tension in said drawn strand as it leaves said draw-stretching means and to maintain a decreasing tension in said drawn strand as it is wound on said package.

2. Apparatus for draw-stretching and winding yarn comprising means for drawing a strand of unstretched yarn from a supply thereof and for draw-stretching said strand, a rotatable spindle for winding the drawn strand leaving said draw-stretching means, means for traversing said drawn strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said drawn strand, a rotatable furnishing wheel, means for rotating said furnishing wheel, means for guiding said drawn strand into contact with said furnishing wheel as it passes from said draw-stretching means to said spindle, means to increase the force exerted on said drawn strand by said furnishing wheel as said package increases in diameter to maintain a substantially constant tension in said drawn strand as it leaves said draw-stretching means and to maintain a decreasing tension in said drawn strand as it is wound on said package, and a yarn cutter for severing said strand intermediate said supply and said draw-stretching means in response to breakage or failure of said drawn strand.

3. Apparatus for draw-stretching and winding yarn comprising means for drawing a strand of unstretched yarn from a supply thereof and for draw-stretching said strand, a rotatable spindle for winding the drawn strand leaving said draw-stretching means, means for traversing said drawn strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the periph-

eral speed of the winding package substantially equal to the speed of said drawn strand, a rotatable furnishing wheel, means for rotating said furnishing wheel, and means for guiding said drawn strand into contact with said furnishing wheel as it passes from said draw-stretching means to said spindle and for increasing the angular contact between said drawn strand and said furnishing wheel as said package increases in diameter to maintain a substantially constant tension in said drawn strand as it leaves said draw-stretching means and to maintain a decreasing tension in said drawn strand as it is wound on said package.

4. Apparatus for draw-stretching and winding yarn comprising means for drawing a strand of unstretched yarn from a supply thereof and for draw-stretching said strand, a rotatable spindle for winding the drawn strand leaving said draw-stretching means, means for traversing said drawn strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said drawn strand, a rotatable furnishing wheel positioned to be engaged by said drawn strand as it passes from said draw-stretching means to said spindle, means for rotating said furnishing wheel at a speed in excess of the speed of said drawn strand, a drawn strand engaging roller radially disposed from said furnishing wheel and movable thereabout, and means for moving said roller about said furnishing wheel to thereby increase the angular contact between said drawn strand and said furnishing wheel as said package increases in diameter to maintain a substanitally constant tension in said drawn strand as it leaves said draw-stretching means and to maintain a decreasing tension in said drawn strand as it is wound on said package.

5. Apparatus for draw-stretching and winding yarn comprising means for drawing a strand of unstretched yarn from a supply thereof and for draw-stretching said strand, a rotatable spindle for winding the drawn strand leaving said draw-stretching means, means for traversing said drawn strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said drawn strand, a rotatable furnishing wheel positioned to be engaged by said drawn strand as it passes from said draw-stretching means to said spindle, means for rotating said furnishing wheel, a sleeve rotatably journaled adjacent said furnishing wheel, a roller adapted to engage said drawn strand rotatably mounted on said sleeve and radially disposed from said furnishing wheel, and means for rotating said sleeve as said package increases in diameter to thereby increase the angular contact between said drawn strand and said furnishing wheel as the winding package increases in diameter to maintain a substantially constant tension in said drawn strand as it leaves said draw-stretching means and to maintain a decreasing tension in said drawn strand as it is wound on said package.

6. Apparatus for draw-stretching and winding yarn comprising means for drawing a strand of unstretched yarn from a supply thereof and for draw-stretching said strand, a rotatable spindle for winding the drawn strand leaving said draw-stretching means, means including a pivoted frame for traversing said drawn strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said drawn strand, a rotatable furnishing wheel positioned to be engaged by said drawn strand as it passes from said draw-stretching means to said spindle, means for rotating said furnishing wheel at a substantially constant speed in excess of the speed of said drawn strand, a sleeve rotatably journaled adjacent said furnishing wheel, a roller adapted to engage said drawn strand rotatably mounted on said sleeve and radially disposed from said furnishing wheel, and a linkage connecting said frame to said sleeve to rotate said sleeve in response to growth of said package to thereby increase the angular contact between said drawn strand and said furnishing wheel as said package increases in diameter to maintain a substantially constant tension in said drawn strand as it leaves said draw-stretching means and to maintain a decreasing tension in said drawn strand as it is wound on said package.

7. Apparatus for draw-stretching and winding yarn comprising a first roller for drawing a strand of unstretched yarn from a supply thereof, a second roller adapted to rotate at a higher peripheral speed than said first roller to thereby draw-stretch said strand, a rotatable spindle for winding the drawn strand leaving said second roller, means including a pivoted frame for traversing said drawn strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said drawn strand, a rotatable furnishing wheel positioned to be engaged by said drawn strand as it passes from said second roller to said spindle, means for rotating said furnishing wheel at a substantially constant speed in excess of the speed of said drawn strand, a sleeve rotatably journaled adjacent said furnishing wheel, a third roller adapted to engage said drawn strand rotatably mounted on said sleeve and radially disposed from said furnishing wheel, and a linkage including a flexible member connecting said frame to said sleeve to rotate said sleeve in response to growth of said package to thereby increase the angular contact between said drawn strand and said furnishing wheel as said package increases in diameter to maintain a substantially constant tension in said drawn strand as it leaves said second roller and to maintain a decreasing tension in said drawn strand as it is wound on said package.

8. Apparatus for draw-stretching and winding yarn comprising means for drawing a strand of unstretched yarn from a supply thereof and for draw-stretching said strand, a rotatable spindle for winding the drawn strand leaving said draw-stretching means, means for traversing said drawn strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said drawn strand, and a yarn cutter for severing said strand intermediate said supply and said draw-stretching means in response to breakage or failure of said drawn strand.

9. Apparatus for draw-stretching and winding yarn comprising means for drawing a strand of unstretched yarn from a supply thereof and for draw-stretching said strand, a rotatable spindle for winding the drawn strand leaving said draw-stretching means, means for traversing said drawn strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said drawn strand, a rotatable furnishing wheel, means for guiding said drawn strand into contact with said furnishing wheel as it passes from said draw-stretching means to said spindle, and means for increasing the speed of said furnishing wheel as said package increases in diameter to maintain a substantially constant tension in said drawn strand as it leaves said draw-stretching means and to maintain a decreasing tension in said drawn strand as it is wound on said package.

10. A winding machine for winding a continually advancing strand of yarn comprising a rotatable spindle for winding said strand, means for traversing said strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said strand, a rotatable furnishing wheel, means for rotating said furnishing wheel, means for guiding said strand into contact with said furnishing wheel as it passes to said spindle, and means to increase the force exerted on said strand by said furnishing wheel as said package increases in diameter to maintain a substantially constant tension

in said strand as it approaches said furnishing wheel and to maintain a decreasing tension in said strand as it is wound on said package.

11. A winding machine for winding a continually advancing strand of yarn comprising a rotatable spindle for winding said strand, means for traversing said strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said strand, a rotatable furnishing wheel, means for rotating said furnishing wheel, and means for guiding said strand into contact with said furnishing wheel as it passes to said spindle and for increasing the angular contact between said strand and said furnishing wheel as said package increases in diameter to maintain a substantially constant tension in said strand as it approaches said furnishing wheel and to maintain a decreasing tension in said strand as it is wound on said package.

12. A winding machine for winding a continually advancing strand of yarn comprising a rotatable spindle for winding said strand, means for traversing said strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said strand, a rotatable furnishing wheel positioned to be engaged by said strand as it passes to said spindle, means for rotating said furnishing wheel at a speed in excess of the speed of said strand, a strand engaging roller radially disposed from said furnishing wheel and movable thereabout, and means for moving said roller about said furnishing wheel to thereby increase the angular contact between said strand and said furnishing wheel as said package increases in diameter to maintain a substantially constant tension in said strand as it approaches said furnishing wheel and to maintain a decreasing tension in said strand as it is wound on said package.

13. A winding machine for winding a continually advancing strand of yarn comprising a rotatable spindle for winding said strand, means for traversing said strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said strand, a rotatable furnishing wheel positioned to be engaged by said strand as it passes to said spindle, means for rotating said furnishing wheel, a sleeve rotatably journaled adjacent said furnishing wheel, a roller adapted to engage said strand rotatably mounted on said sleeve and radially disposed from said furnishing wheel, and means for rotating said sleeve as said package increases in diameter to thereby increase the angular contact between said strand and said furnishing wheel as said package increases in diameter to maintain a substantially constant tension in said strand as it approaches said furnishing wheel and to maintain a decreasing tension in said strand as it is wound on said package.

14. A winding machine for winding a continually advancing strand of yarn comprising a rotatable spindle for winding said strand, means including a pivoted frame for traversing said strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said strand, a rotatable furnishing wheel positioned to be engaged by said strand as it passes to said spindle, means for rotating said furnishing wheel at a substantially constant speed in excess of the speed of said strand, a sleeve rotatably journaled adjacent said furnishing wheel, a roller adapted to engage said strand rotatably mounted on said sleeve and radially disposed from said furnishing wheel, and a linkage connecting said frame to said sleeve to rotate said sleeve in response to growth of said package to thereby increase the angular contact between said strand and said furnishing wheel as said package increases in diameter to maintain a substantially constant tension in said strand as it approaches said furnishing wheel and to maintain a decreasing tension in said strand as it is wound on said package.

15. A winding machine for winding a continually advancing strand of yarn comprising a rotatable spindle for winding said strand, means including a pivoted frame for traversing said strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said strand, a rotatable furnishing wheel positioned to be engaged by said strand as it passes to said spindle, means for rotating said furnishing wheel at a substantially constant speed in excess of the speed of said strand, a sleeve rotatably journaled adjacent said furnishing wheel, a roller adapted to engage said strand rotatably mounted on said sleeve and radially disposed from said furnishing wheel, and a linkage including a flexible member connecting said frame to said sleeve to rotate said sleeve in response to growth of said package to thereby increase the angular contact between said strand and said furnishing wheel as said package increases in diameter to maintain a substantially constant tension in said strand as it approaches said furnishing wheel and to maintain a decreasing tension in said strand as it is wound on said package.

16. A winding machine for winding a continually advancing strand of yarn comprising a rotatable spindle for winding said strand, means for traversing said strand longitudinally of said spindle, means for regulating the speed of said spindle to maintain the peripheral speed of the winding package substantially equal to the speed of said strand, a rotatable furnishing wheel, means for guiding said strand into contact with said furnishing wheel as it passes to said spindle, and means for increasing the speed of said furnishing wheel as said package increases in diameter to maintain a substantially constant tension in said strand as it approaches said furnishing wheel and to maintain a decreasing tension in said strand as it is wound on said package.

17. A winding machine for winding a strand of yarn comprising a rotatable spindle for winding said strand, means for traversing said strand longitudinally of said spindle, a rotatable furnishing wheel, means for rotating said furnishing wheel, means for guiding said strand into contact with said furnishing wheel as it passes to said spindle, and means to increase the force exerted on said strand by said furnishing wheel as the winding package increases in diameter to maintain a decreasing tension in said strand as it is wound on said package.

18. A winding machine for winding a strand of yarn comprising a rotatable spindle for winding said strand, means for traversing said strand longitudinally of said spindle, a rotatable furnishing wheel, means for rotating said furnishing wheel, and means for guiding said strand into contact with said furnishing wheel as it passes to said spindle and for increasing the angular contact between said strand and said furnishing wheel as the winding package increases in diameter to maintain a decreasing tension in said strand as it is wound on said package.

19. A winding machine for winding a strand of yarn comprising a rotatable spindle for winding said strand, means for traversing said strand longitudinally of said spindle, a rotatable furnishing wheel positioned to be engaged by said strand as it passes to said spindle, means for rotating said furnishing wheel, a strand engaging roller radially disposed from said furnishing wheel and movable thereabout, and means for moving said roller about said furnishing wheel to thereby increase the angular contact between said strand and said furnishing wheel as the winding package increases in diameter to maintain a decreasing tension in said drawn strand as it is wound on said package.

20. A winding machine for winding a strand of yarn comprising a rotatable spindle for winding said strand, means for traversing said strand longitudinally of said spindle, a rotatable furnishing wheel positioned to be en-

gaged by said strand as it passes to said spindle, means for rotating said furnishing wheel, a sleeve rotatably journaled adjacent said furnishing wheel, a roller adapted to engage said strand rotatably mounted on said sleeve and radially disposed from said furnishing wheel, and means for rotating said sleeve as the winding package increases in diameter to thereby increase the angular contact between said strand and said furnishing wheel as said package increases in diameter to maintain a decreasing tension in said strand as it is wound on said package.

21. A winding machine for winding a strand of yarn comprising a rotatable spindle for winding said strand, means including a pivoted frame for traversing said strand longitudinally of said spindle, a rotatable furnishing wheel positioned to be engaged by said strand as it passes to said spindle, means for rotating said furnishing wheel at a substantially constant speed, a sleeve rotatably journaled adjacent said furnishing wheel, a roller adapted to engage said strand rotatably mounted on said sleeve and radially disposed from said furnishing wheel, and a linkage connecting said frame to said sleeve to rotate said sleeve in response to growth of the winding package to thereby increase the angular contact between said strand and said furnishing wheel as said package increases in diameter to maintain a decreasing tension in said strand as it is wound on said package.

22. A winding machine for winding a strand of yarn comprising a rotatable spindle for winding said strand, means including a pivoted frame for traversing said strand longitudinally of said spindle, a rotatable furnishing wheel positioned to be engaged by said strand as it passes to said spindle, means for rotating said furnishing wheel at a substantially constant speed, a sleeve rotatably journaled adjacent said furnishing wheel, a roller adapted to engage said strand rotatably mounted on said sleeve and radially disposed from said furnishing wheel, and a linkage including a flexible member connecting said frame to said sleeve to rotate said sleeve in response to growth of the winding package to thereby increase the angular contact between said strand and said furnishing wheel as said package increases in diameter to maintain decreasing tension in said strand as it is wound on said package.

23. A winding machine for winding a strand of yarn comprising a rotatable spindle for winding said strand, means for traversing said strand longitudinally of said spindle, a rotatable furnishing wheel, means for guiding said strand into contact with said furnishing wheel as it passes to said spindle, and means for increasing the speed of said furnishing wheel as the winding package increases in diameter to maintain a decreasing tension in said strand as it is wound on said package.

24. A tension controlling device comprising a rotatable furnishing wheel positioned to be engaged by a strand of yarn, means for positively rotating said wheel, and means for progressively varying the force exerted on said strand by said wheel.

25. A tension controlling device comprising a rotatable furnishing wheel, means for positively rotating said wheel, and means for guiding a strand of yarn into contact with said furnishing wheel and for continuously varying the angular contact between said strand and said wheel.

26. A tension controlling device comprising a rotatable furnishing wheel, means for positively rotating said wheel, a yarn engaging guide radially disposed from said wheel and movable thereabout for guiding a strand of yarn into contact with said wheel, and means for moving said guide about said wheel to thereby vary the angular contact between said wheel and said strand.

27. A tension controlling device comprising a rotatable furnishing wheel, means for positively rotating said wheel, a sleeve rotatably journaled adjacent said wheel, a strand engaging guide mounted on said sleeve and radially disposed from said wheel for guiding a strand of yarn into contact with said wheel, and means for rotating said sleeve to thereby vary the angular contact between said strand and said wheel.

28. A tension controlling device comprising a rotatable furnishing wheel positioned to be engaged by a strand of yarn, means for positively rotating said wheel, a lever pivotally mounted adjacent said wheel, a strand engaging guide mounted on said lever and radially disposed from said wheel for guiding a strand of yarn into contact with said wheel, and means for pivoting said lever to thereby vary the angular contact between said strand and said furnishing wheel.

29. In a winding machine adapted to wind yarn upon a rotatable spindle, a tension controlling device comprising a rotatable furnishing wheel adapted to contact the yarn in advance of said spindle, means for rotating said furnishing wheel, and means for progressively varying the force exerted on the yarn by said wheel as the yarn is wound upon said spindle.

30. A tension controlling device comprising a positively driven, constantly rotating furnishing wheel adapted to be engaged by a strand of yarn and means for varying the frictional force between the wheel and yarn.

31. A device as set forth in claim 30 wherein said wheel is rotating at a constant peripheral speed.

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