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Heinig et al.

[11] **3,745,793**

[45] **July 17, 1973**

[54] **APPARATUS FOR FEEDING ELASTIC YARN TO CIRCULAR KNITTING MACHINES**

[75] Inventors: **Richard H. Heinig; Omer Bowen,** both of Fayetteville, Ark.

[73] Assignee: **Bear Brand Hosiery Co.,** Chicago, Ill.

[22] Filed: **Dec. 11, 1970**

[21] Appl. No.: **97,152**

[52] **U.S. Cl.** ..... **66/146,** 66/132 R, 66/163

[51] **Int. Cl.** **D04b 15/46,** D04b 35/12

[58] **Field of Search** ..... 66/132 R, 146, 140 S; 242/155 M

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Primary Examiner—Robert R. Mackey

Attorney—Prangley, Clayton, Mullin, Dithmar & Vogel

[57] **ABSTRACT**

There is disclosed an apparatus for feeding an elastic yarn from a supply package to a knitting station under uniform controlled tension, utilizing a mechanism for pulling the elastic yarn from the supply package at a rate greater than that required by the knitting station to deliver the elastic yarn to a wheel on a hysteresis brake under essentially zero tension, the hysteresis brake applying a constant braking force of predetermined value to place the elastic yarn under a uniform controlled tension as it is fed to the knitting station, a yarn clamp at the knitting station for holding the elastic yarn when there is no demand therefor at the knitting station, and an electrical control to detect the presence of the elastic yarn to shut down the knitting machine in the absence thereof.

4 Claims, 11 Drawing Figures

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Heinig et al. [45] **July 17, 1973**

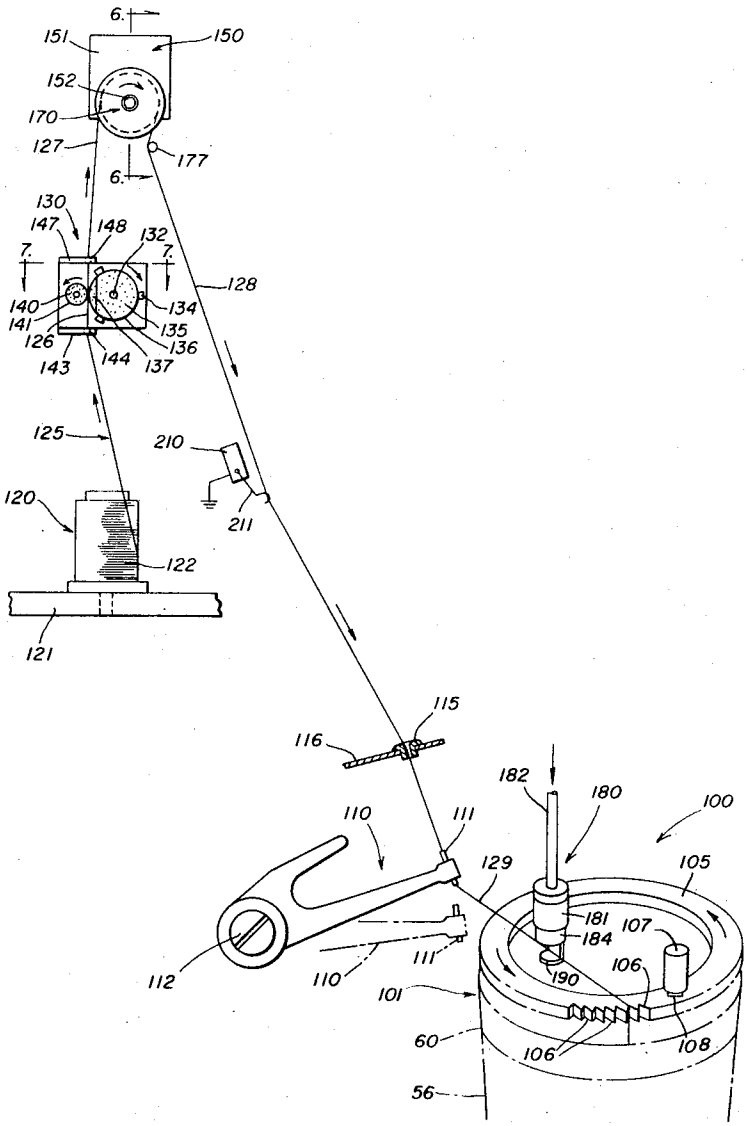


FIG. 1

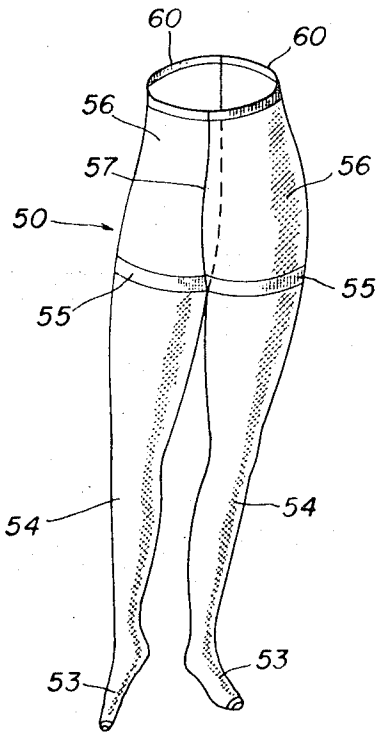


FIG. 2

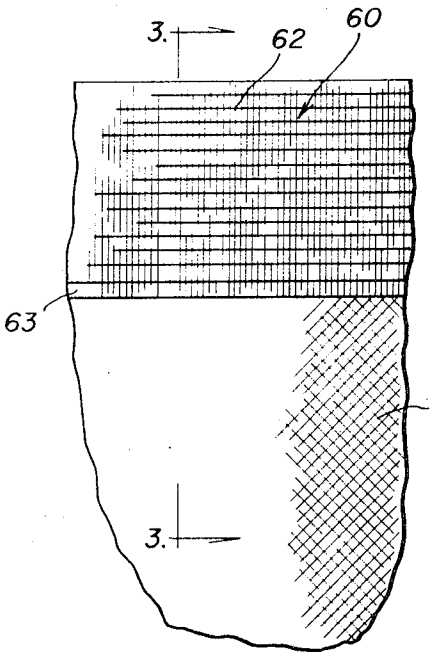
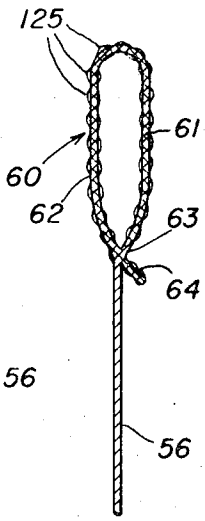


FIG. 3



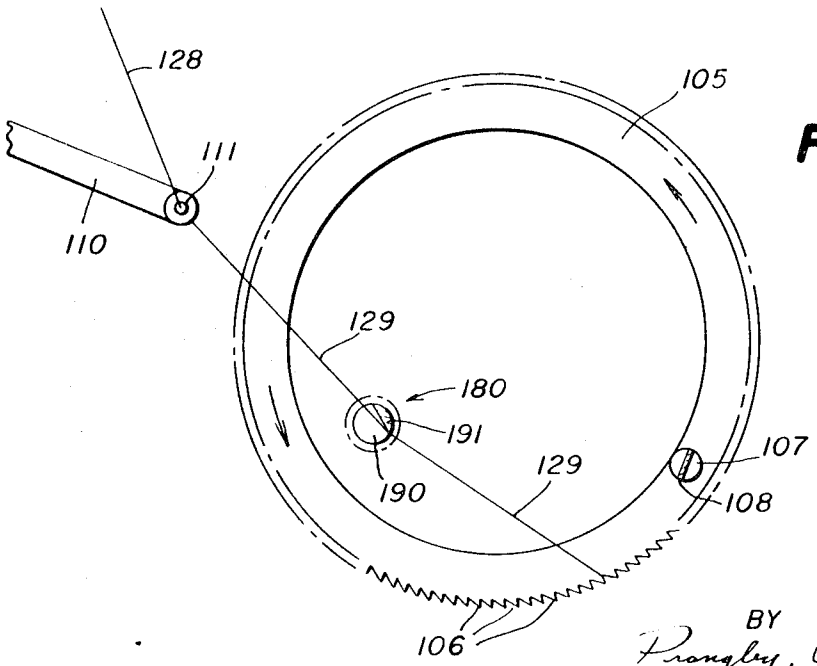


FIG. 5

INVENTORS
RICHARD H. HEINIG
OMER BOWEN

BY
Pringley, Clayton, Mullin,
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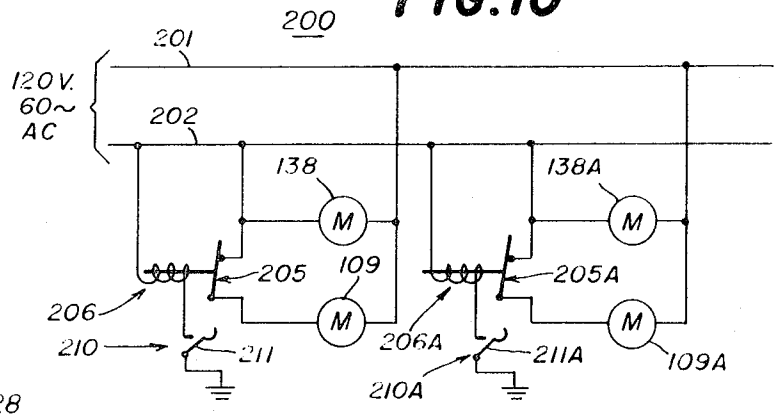
FIG. 10



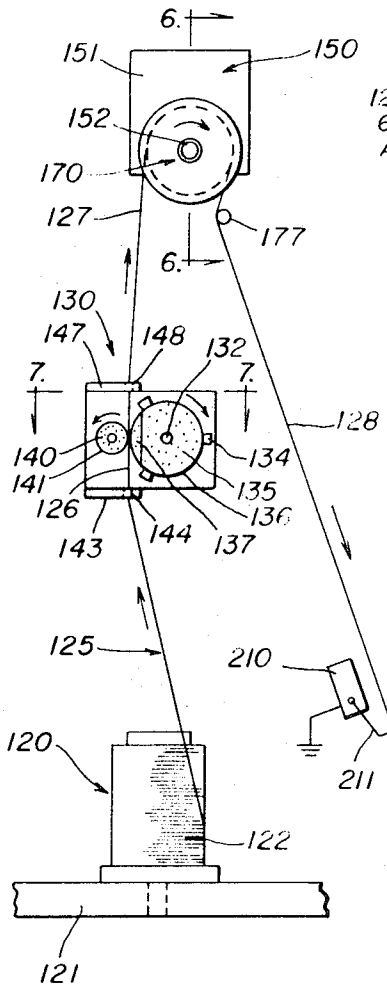


FIG. 11

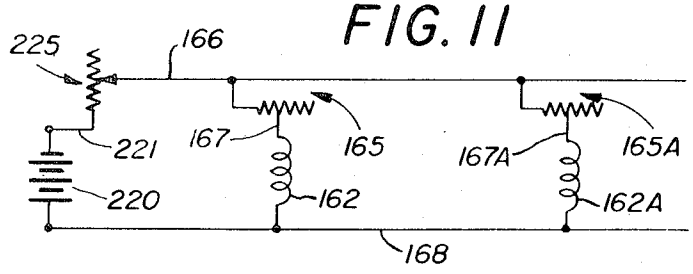


FIG. 4

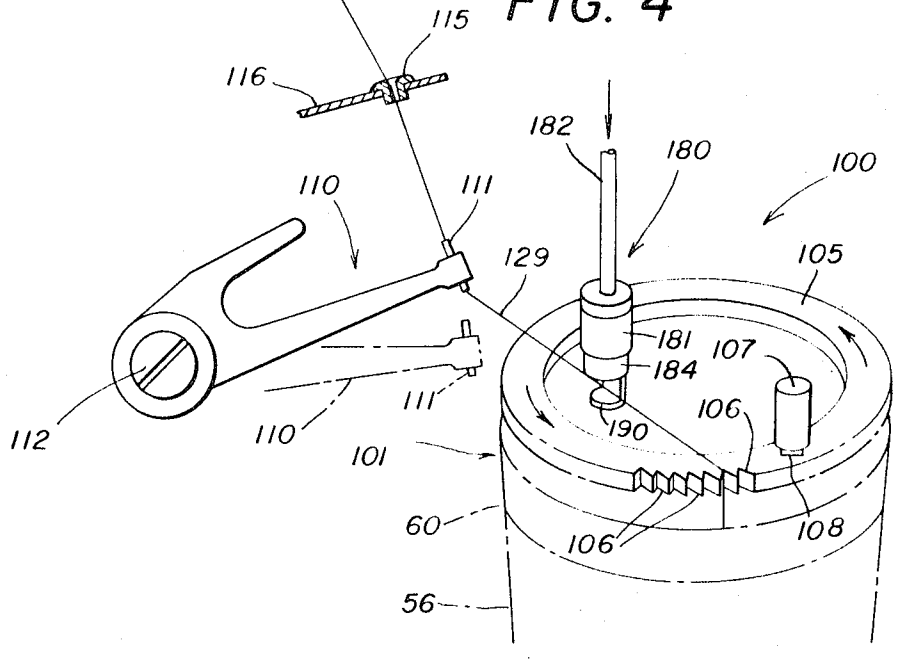


FIG. 6

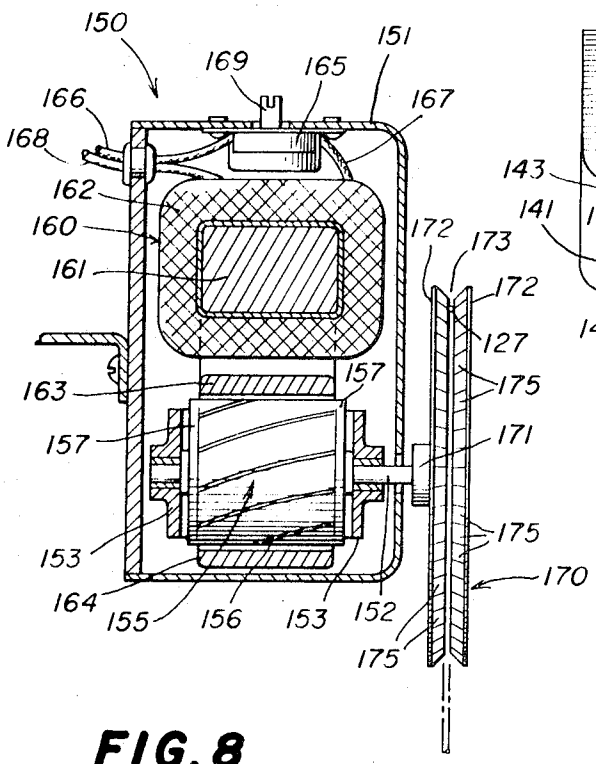


FIG. 7

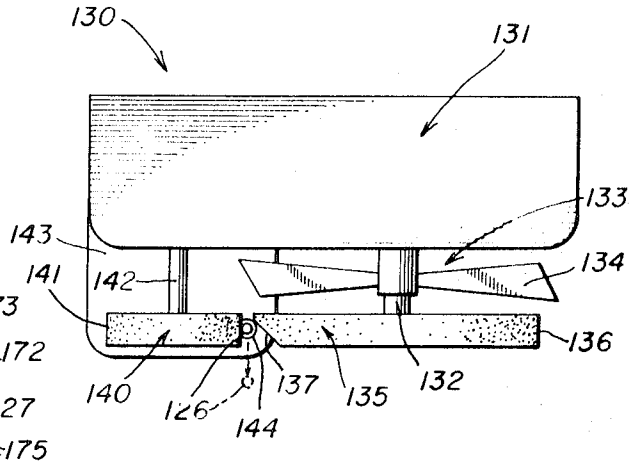


FIG. 8

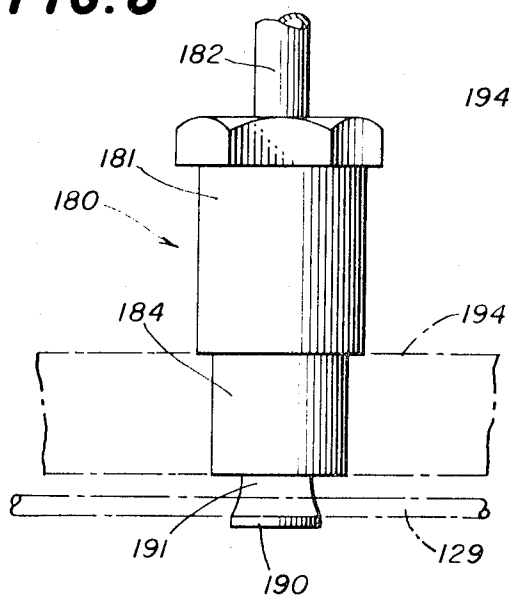
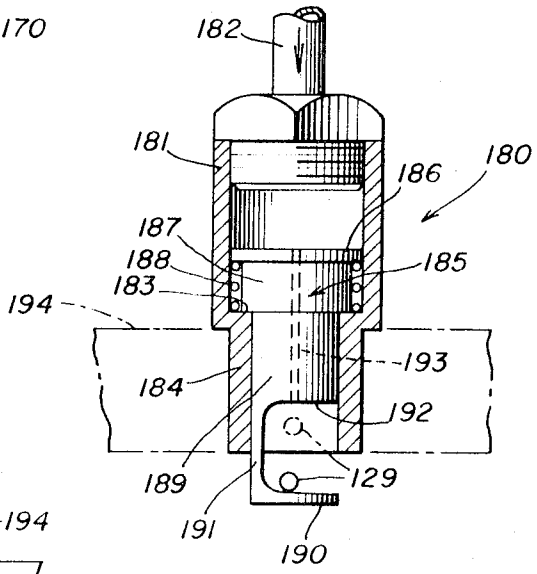


FIG. 9



APPARATUS FOR FEEDING ELASTIC YARN TO CIRCULAR KNITTING MACHINES

The present invention relates to apparatus and method for feeding elastic yarns to circular knitting machines, and to articles produced thereby.

It is an important object of the present invention to provide an improved apparatus for feeding elastic yarn from a supply package thereof to a knitting station in a knitting machine under uniform controlled tension, the apparatus comprising mechanism engaging the length of the elastic yarn disposed between the supply package and the knitting station for pulling the elastic yarn from the supply package, and a brake engaging the length of the elastic yarn disposed between the pulling mechanism and the knitting station for applying a substantially constant braking force to the elastic yarn ahead of the knitting station, the pulling mechanism serving to overfeed the elastic yarn from the supply package thereof to the brake thus to deliver the elastic yarn to the brake under essentially zero tension, the brake placing the length of elastic yarn between the brake and the knitting station under a predetermined controlled tension that is independent of the speed of travel thereof, whereby to supply the elastic yarn to the knitting station under a predetermined controlled tension that is independent of the speed of travel thereof and that is constant during the feeding of the elastic yarn to the knitting station.

Another object of the invention is to provide an elastic yarn feeding apparatus of the type set forth and further including an elastic yarn clamp for engaging the length of the elastic yarn disposed between a feed finger therefor and a knife adjacent to the knitting station for severing the elastic yarn upon the completion of the knitting of the elastic band therewith.

Another object of the invention is to provide an apparatus for feeding yarn of the type set forth wherein the brake is spaced at least 18 inches from the knitting station so as to assure that any irregularities in the feeding of the elastic yarn are smoothed out before the elastic yarn reaches the knitting station.

Another object of the invention is to provide apparatus for feeding elastic yarn of the type set forth and further including a switch for controlling the electrical drive for the knitting machine and including an actuator engaging the length of the elastic yarn disposed between the brake and the knitting station and movable between an operating position and a stopping position, the switch actuator being held in the operating position by the elastic yarn under the predetermined tension and the switch actuator being in the stopping position thereof when there is no tension in the elastic yarn, thus to stop the knitting machine.

Yet another object of the invention is to provide an improved method of feeding elastic yarn from a supply package thereof to a knitting station in a knitting machine under uniform controlled tension, comprising the steps of providing a wheel about which the elastic yarn passes in traveling from the supply package to the knitting station, pulling the elastic yarn from the supply package at a rate greater than that required by the knitting station to deliver the elastic yarn to the wheel under essentially zero tension, applying a substantially constant braking force to the wheel independently of the speed of rotation of said wheel thereby stretching the elastic yarn and producing and maintaining a substantially uniform and predetermined controlled tension in the elastic yarn as it reaches the knitting station.

In connection with the foregoing object, it is another object of the invention to provide a method of feeding elastic yarn of the type set forth wherein there is further provided a clamp adjacent to the knitting station for holding the elastic yarn when there is no demand therefor at the knitting station, and a control circuit for stopping the knitting machine when the supply of elastic yarn is lost at the knitting station.

Further features of the invention pertain to the particular arrangement of the parts of the yarn feeding mechanism and the particular steps of the method of feeding yarn, whereby the above-outlined and additional operating features thereof are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which:

FIG. 1 is a front perspective view of a panty hose made in accordance with the present invention and utilizing the yarn feeding mechanism and method thereof;

FIG. 2 is an enlarged fragmentary plan view of a section of the waistband of the panty hose of FIG. 1 together with a portion of the pant section associated therewith;

FIG. 3 is a view in section along the line 3—3 of FIG. 2;

FIG. 4 is a diagrammatic illustration of the yarn feeding mechanism made in accordance with and embodying the principles of the present invention;

FIG. 5 is a plan view of the portions of the knitting machine illustrated in FIG. 4;

FIG. 6 is an enlarged view in vertical section through the hysteresis brake of FIG. 4;

FIG. 7 is an enlarged section along the line 7—7 of FIG. 4 and further illustrating the yarn pulling mechanism;

FIG. 8 is an enlarged side elevational view of the yarn clamp of FIG. 4;

FIG. 9 is a view in vertical section through the yarn clamp of FIG. 8;

FIG. 10 is a schematic electrical diagram for a portion of the yarn feeding mechanism of the present invention; and

FIG. 11 is a schematic electrical diagram for the other portion of the yarn feeding mechanism of the present invention.

Referring first to FIGS. 1–3 of the drawings, there is illustrated a panty hose **50** which has a construction of the type wherein two identical stocking blanks have been knit on a circular knitting machine, after which the stocking blanks have been slit and then seamed together utilizing a U-seam **57** to provide the completed panty hose. The panty hose **50** includes a pair of foot sections **53** integral with boot sections **54** which terminate at the upper ends thereof in runguard areas **55** which in turn are integral with pant sections **56**. The two pant sections **56** are joined by the U-seam **57** as described above to provide a unified pant section for the panty hose **50**. Finally there is an integral knit-in waistband **60** at the upper end of the pant section **56**.

Referring to FIGS. 2 and 3, further details of the knit-in waistband are there illustrated wherein it will be seen that the adjacent area of the pant section **56** is knit integral with the waistband **60**, the waistband **60** having a plurality of strands of elastic yarn **125** knit therein to

impart a uniform controlled elastic character thereto, all as will be explained more fully hereinafter.

The waistband 60 more particularly includes an inner portion 60 integral at the upper end thereof with an outer portion 62, the lower ends of the portion 61 and 62 being joined at a joint 63 adjacent to the pant section 56, a free end 64 of waistband material extending from the knit joint 63.

Referring to FIG. 4 of the drawings, there is illustrated an elastic yarn feeding mechanism made in accordance with and embodying the principles of the present invention and shown feeding elastic yarn to a circular knitting machine diagrammatically illustrated as at 100. More specifically, the knitting machine 100 is of the circular type and includes a knitting station 101 whereat are disposed knitting needles (not shown) which are useful in knitting relatively non-elastic yarn and elastic yarn together to form the waistband 60. The usual ring 105 is provided normally rotating in a counterclockwise direction as indicated by the arrows and having around the periphery thereof a plurality of teeth of serrations 106. Disposed above the ring 105 is a holder 107 carrying a knife blade 108 which cooperates with the serrations 106 to sever any yarn carried by the serrations 106.

Also mounted adjacent to the ring 105 is a yarn feed finder 110 which includes the usual yarn guide 111 and is pivotal about a pivot axis 112 between a feeding position (illustrated in dashed lines) wherein the yarn fed thereby is directed into the knitting needles for incorporation into the garment being knit, and a holding or non-knitting position (illustrated by solid lines) wherein the yarn fed thereby is lifted out of position to be engaged by the needles at the knitting station 101.

Cooperating with the yarn feed finger is a fixed yarn guide in the form of a eyelet 115 mounted upon a stationary support 116, the eyelet 115 directing yarn therethrough into the yarn guide 111 of the feed finger 110.

In accordance with the present invention, elastic yarn is fed from a yarn supply generally designated by the numeral 120 and including a fixed support 121 on which is mounted a yarn package 122 consisting of a plurality of tightly wound turns of elastic yarn generally designated by the numeral 125. In order to feed the yarn 125 to the knitting machine 100, the yarn pulling mechanism 130 pulls the elastic yarn 125 from the package 122 and draws the yarn 125 under essentially zero tension to a star wheel 170 mounted on a hysteresis brake 150 disposed above the yarn pulling mechanism 130. The yarn is fed under a predetermined controlled and uniform tension from the hysteresis brake 150 through the eyelet 115 and by the yarn finger 110 to the knitting station 101.

The apparatus and method of the present invention are particularly useful in feeding so-called "raw" elastic yarns, i.e., elastic yarns which have no non-elastic fibers associated therewith. A specific example of such an elastic yarn useful in the present invention is that sold under the trademark Spandex, this being a synthetic polyurethane plastic yarn. Other elastic yarns having high stretch characteristics similar to those of Spandex yarn are also advantageously fed using the apparatus and method of the present invention. Spandex elastic yarn is a ribbon type fiber, i.e., the fibers are not perfectly round and are not uniform in cross section. As a consequence it is not possible to wind such elastic yarn on a cone or any package without some underwinding thereof. Accordingly, in feeding the elastic off the package thereof, such as the package 120 in FIG. 4, there will be a tendency of the yarn to cling and to catch so that it is not possible to withdraw the elastic yarn at a constant rate and under uniform tension. Should the elastic yarn be fed to the knitting station at a non-uniform rate and under varying tension, the resultant waistband will be knotty and non-uniform in appearance and in the elastic characteristics thereof.

In accordance with the present invention, the pulling mechanism 130 removes the elastic yarn 125 from the package 120 and feeds the elastic yarn to the hysteresis brake 150 under essentially zero tension. Referring to FIG. 7, the construction and operation of the pulling mechanism 130 will be further described, the pulling mechanism 130 including a housing 131 in which is disposed an electric motor 138 (see FIG. 10) from which extends a motor shaft 132. Fixedly mounted on the motor shaft 132 and adjacent to the housing 131 is a fan 133 having a plurality of blades 134 (3 being illustrated). The outer end of the motor shaft 132 carries a roller 135 formed of a compressible material, the preferred material being cork. The roller 135 has a peripheral surface 136 and carries on the face thereof a bevel 137 which intersects the surface 136 (see FIG. 4 also). Mounted adjacent to the roller 135 is a roller 140 having a peripheral surface 141 cooperating with the peripheral surface 136, the roller 140 being mounted on a shaft 142 and also preferably being formed of a resilient material such as cork. Disposed on the lower side of the housing 131 is a lower bracket 143 carrying a guide eyelet 144 and disposed on the upper portion of the housing 131 is an upper bracket 147 carrying a second guide eyelet 148.

Yarn 125 from the supply 120 passes upwardly through the eyelet 144 and between the rollers 135 and 140 and then through the eyelet 148 to the hysteresis brake 150. In the operation of the yarn pulling mechanism 130 the motor 138 driving the shaft 132 operates continually and rotates in a clockwise direction to drive the roller 135 in a clockwise direction which in turn drives the roller 140 in a counterclockwise direction, all as indicated by the arrows in FIG. 4. A section 126 of the elastic yarn 125 is disposed between the eyelets 144 and 148, the eyelets 144 and 148 being aligned so as normally to place the yarn section 126 between the adjacent peripheral surfaces 136 and 141 on the rollers 135 and 140. So long as there is a demand for yarn at the knitting station 101, the yarn section 126 will be held between the rollers 135 and 140 as illustrated by solid lines in FIG. 7 so as to cause the elastic yarn to be fed upwardly by the yarn pulling mechanism 130. The yarn pulling mechanism 130 is designed to operate normally at a speed substantially in excess of that required to supply the yarn required by the knitting station 101, i.e., the yarn pulling mechanism 130 is operated to overfeed the yarn 125 from the package 120. As soon as there is an overfeeding of the yarn to the hysteresis brake 150, there will be insufficient tension in the yarn section 126, thus to permit the fan blades 134 to blow the yarn section 126 outwardly from the solid line position illustrated in FIG. 7 to the dashed line position illustrated therein. As a result, there will be an interruption in the pulling and feeding of yarn by the mechanism 130 until there is a further demand from the knitting station 101, at which time the yarn section 126 will

again be pulled to the solid line position in FIG. 7, thus to resume pulling and feeding of the yarn 125 by the mechanism 130.

The net result of the operation of the yarn pulling mechanism 130 is to ensure a constant over-end take-up of elastic yarn 125 from the supply 120 and the supplying thereof under zero tension to the hysteresis brake 150. Further details of construction and additional explanation of the operation of the yarn pulling mechanism 130 can be had by reference to U.S. Pat. No. 2,952,393 granted Sept. 13, 1960 to Charles G. Newton for Yarn Tension Compensator.

The hysteresis brake 150 serves to apply to the elastic yarn a predetermined controlled tension under which the elastic yarn is fed to the knitting station 101. Details of the hysteresis brake 150 and the star wheel 170 forming a part thereof can best be seen from FIG. 6, wherein it will be observed that the hysteresis brake 150 includes a housing 151 within which is mounted a shaft 152 by means of a pair of bearing 153. The shaft 152 within the housing 151 carries a conductive rotor 155 of the squirrel-cage type having bars 156 of copper or other good conductive metal embedded in the rotor 155 which is typically formed of iron, the bars 156 extending between the end discs 157.

Also mounted within the housing 151 is an electromagnet 160 including a magnetic core 161 around which is an electrical coil 162. The core 161 carries a pair of spaced-apart magnetic poles 163 and 164 disposed about the rotor 155. Also disposed within the housing 151 is a rheostat 165 disposed in series with the coil 162 for adjusting the current thereto, a first conductor 166 connecting to one terminal of the rheostat 165, a second conductor 167 connecting to the other terminal of the rheostat 165 to the coil 162 and a third conductor 168 connecting to the other terminal of the coil 162. The contact in the rheostat 165 can be adjusted through the member 169.

Mounted on the end of the shaft 152 extending out of the housing 151 is the star wheel 170, the star wheel 170 including a hub 171 fixedly secured to the shaft 152. The periphery of the star wheel 170 includes a pair of spaced-apart rim portions 172 between which is defined a groove 173, a plurality of resilient grippers 175 integral with the rim portions 172 extending into the groove 173 to clamp the elastic yarn therein such as the yarn section 127 illustrated.

The yarn section 127 preferably engages about the star wheel for at least about 180° of the circumference thereof, the grippers 175 gripping the elastic yarn at closely spaced points so that there is essentially no stretching of the elastic yarn as it passes about the star wheel 170. In order to maintain contact between the yarn section 127 and the star wheel 170 around at least about 180° of the circumference thereof, a guide 177 is provided adjacent to the star wheel 170 at a point where the yarn section 127 leaves the star wheel 170. Rotation of the star wheel 170 is retarded by the action of the hysteresis brake 150, and more specifically by the torque imparted thereto by the rotor 155 rotating in the magnetic field produced by the magnet 160. The greater the field produced by the magnet 160, the greater the torque applied to the star wheel 170 and therefore the greater the tension applied to the elastic yarn fed therefrom. The amount of torque developed by the hysteresis brake 150 can be adjusted by adjusting the amount of current delivered by the conductors 166 and 168 and also by the setting of the rheostat 165. Accordingly, the braking effect of the magnetic drag induced within the rotor 155 can be controlled and adjusted precisely, thus precisely to adjust the tension imparted to the elastic yarn leaving the star wheel 170. One of the important characteristics inherent in a hysteresis brake 150 is that the braking torque or braking force applied to the star wheel 170 is substantially constant at all speeds of the star wheel 170, and therefore, at all speeds of feeding of the elastic yarn. Further details of construction and additional explanation of the operation of the hysteresis brake 150 can be had by reference to U.S. Pat. No. 3,489,368 granted Jan. 13, 1970 to Edmund A. Rehwald, for Tension Regulator For Stretch Core Thread.

There is accordingly fed from the hysteresis brake 150 an elastic yarn section 128 extending downwardly to the feed finger 110 which has imparted thereto a predetermined controlled tension as needed to knit a waist band, such as the waist band 60 described above. More specifically, the elastic yarn section 128 extends from the star wheel 170 through the guide 177 and through the guide 115 to the feed finger 110, and specifically the yarn guide 111 carried thereby.

When the feed finger 110 is in the feeding position illustrated by dashed lines in FIG. 4, the elastic yarn under the precise controlled tension is fed into the knitting needles to be incorporated by knitting into the waistband 60 diagrammatically illustrated in FIG. 4, the knitting proceeding in the usual manner.

From FIG. 3, it will be seen that after the waist band 60 has been knitted, it is turned in the same manner as a standard welt on a seamless knitting machine, thereby to provide the finished waist band 60, as illustrated in FIGS. 2 and 3.

The knitting of the elastic yarn into the waist band 60 having been completed, the feed finger 110 then is lifted to the non-knitting position illustrated by solid lines in FIG. 4, which movement of the feed finger 110 lifts the elastic yarn out of position to be engaged by the knitting needles and over the ring 105 in position to be engaged by one of the serrations 106 thereon, i.e., a section 129 of the elastic yarn is now disposed between the feed finger 110 and a serration 106 on the ring 105, the elastic yarn section 129 being disposed above the ring 105. As a consequence, as soon as the serration 106 carrying the elastic section 129 reaches the knife 108, the elastic yarn section 129 will be cut, thus to release the elastic yarn section 129. Inasmuch as the elastic yarn is under a predetermined controlled tension, cutting of the elastic yarn would permit contraction thereof, and the contraction would be sufficient in many instances to withdraw the elastic yarn from the feed finger 110. In order to prevent this from occuring, the yarn clamp 180 has been provided.

The details of the construction and operation of the yarn clamp 180 can best be seen by reference to FIGS. 8 and 9 of the drawings, wherein it will be seen that there is provided a pneumatic cylinder 181 having an inlet tube 182 therefor to supply compressed air or other suitable fluid thereto. The lower end of the cylinder 181 has provided therein a shoulder 183 from which extends a guide sleeve 184 which has been shown mounted in a suitable support 194. Disposed within the cylinder 181 is a piston 185 including a head 186 at the upper end thereof carried by a body portion 187 which in turn carries a guide portion 189 of re-

duced diameter. A spring 188 is disposed between the shoulder 183 and the head 186 normally to hold the piston 185 in the upper portion thereof, the parts in FIGS. 8 and 9 being shown in the fully extended positions thereof. The guide portion 189 carries a clamp finger 190 mounted on an arm 191, the upper surface of the clamp finger 190 being spaced from the lower surface 192 of the guide portion 189 to provide a recess for receiving the elastic yarn section 129. There also is provided in the piston 185 an air passage 193 extending from the upper surface of the head 186 through to the lower surface 192, all for a purpose to be described more fully hereinafter.

Referring to FIG. 4, the manner of operation of the yarn clamp 180 will be described further. Before the serration 106 engaging the elastic yarn section 129 reaches the point illustrated in FIG. 4, compressed air is applied to the inlet tube 182 to move the piston 185 and the clamp finger 190 carried thereby to the lower or open position illustrated in FIG. 4, 8 and 9 whereby further rotation of the ring 105 will carry the elastic yarn section 129 to the position illustrated in FIGS. 4, 8 and 9, i.e., between the yarn finger 190 and the surface 192. Prior to the time that the serration 106 carrying the elastic yarn section 129 reaches the knife 108, the air pressure in the inlet tube 182 is released, thus to permit the spring 182 to move the piston 185 to the upper portion thereof, i.e., to move the clamp finger 190 into the sleeve 184 and move the yarn section 129 from the solid line position illustrated in FIG. 9 to the dashed line illustrated therein. The elastic yarn section 129 is now firmly held by the clamp 180, whereby the elastic yarn will be firmly held after severing thereof between the ring 105 and the knife 108.

When it is again desired to feed elastic yarn to the knitting station 101, the feed finger 110 is shifted to the dashed line position thereof, and as soon as several knitting needles have engaged the elastic yarn, air pressure is provided in the inlet tube 182 to open the yarn clamp 180 and thus to release the end of the elastic yarn held thereby. At this time, a jet of air also will be blown through the passage 193 and against the elastic yarn section 129 to assist in removing the elastic yarn section 129 from the clamp finger 190.

Referring particularly to FIG. 10, the control circuit 200 for the knitting machine 100 will be described. As illustrated, a 120 volt, 60 cycle, AC source is provided on a pair of conductors 201 and 202. The motor 138 of the yarn pulling mechanism 130 is connected across the conductors 201 and 202 for operation so long as the knitting machine 100 is energized, and the main drive motor 109 for the knitting machine 100 is likewise connected across the conductors 201 and 202 via a control switch 205 that is actuated by means of a relay solenoid 206. One terminal of the solenoid for the relay 206 is connected to the conductor 202 and the other end is connected to a normally open switch 210 that has the other terminal thereof grounded. Referring to FIG. 4, it will be seen that the switch 210 includes an actuator 211 that is engaged by the length 128 of the elastic yarn 125 so as to hold the switch 210 in the normally open position so long as tension is applied to the resilient yarn in the length 128. Whenever the tension is lost in the elastic yarn in the length 128, the actuator 211 is free to move to the closed position thereof, closure of the switch 210 energizing the solenoid 206 to open the switch 205 and thus to de-energize the main drive motor 109. De-energization of the main drive motor 109 stops the knitting machine 100, and the parts will remain in this position until tension is again restored in the length 128 of elastic yarn so as to open the switch 210 and thus permit the switch 205 to close.

There also is illustrated in FIG. 11 the circuit for controlling the tension imparted to the elastic yarn by the hysteresis brake 150. There has been provided a DC source of electrical potential, such as the battery 220, one terminal of which is connected via a conductor 221 to a rheostat 225, and the other terminal being connected to the conductor 168. The movable contact on the rheostat 225 is connected to the conductor 166, so that an adjustable voltage can be provided between the conductors 166 and 168. There is connected across the conductors 166 and 168 in series the rheostat 165 and the winding 162 of the hysteresis brake 150. It will be appreciated that the current in the coil 162 can be adjusted both by means of the internal rheostat 165 and the external master rheostat 225.

The circuits in FIG. 10 and FIG. 11 also illustrate that a plurality of knitting machines can be connected to the same sources of AC and DC power, like parts for the second machine having been provided with like numbers as in the first machine but with the suffix A added. As a consequence, it will be seen that the master rheostat 225 can be used simultaneously to adjust the tension in a plurality of hysteresis brakes 150, each hysteresis brake 150 having its own internal adjustment in the form of the rheostat 165 so that the several hysteresis brakes can be calibrated with respect to each other.

In an illustrative example of the invention of the present application, the elastic yarn 125 is a Spandex yarn which is to be fed to an eight-feed circular knitting machine such as that sold under the trade designation "Zodiac 8" by G. Billi and Co. The yarn pulling mechanism 130 pulls the elastic yarn 125 from the supply 120 and delivers the elastic yarn under essentially zero tension to the hysteresis brake 150. The hysteresis brake imparts to the elastic yarn a predetermined tension in the range from about 15 grams to about 50 grams, a specific example being 42 grams of tension imparted to the elastic yarn. Such a tension reduces the cross section of the yarn to about one-half of its unstretched condition and increases the length to about twice the relaxed condition thereof. The yarn with the predetermined tension therein is fed from the hysteresis brake 150 to the feed finger at essentially the rate that the elastic yarn is required at the knitting station 101. By contrast, the yarn pulling mechanism 130 pulls the yarn from the yarn supply 120 at a rate substantially in excess of that at which yarn is required to the knitting station 101.

The length of yarn 128 between the hysteresis brake 150 and the knitting station 101 is preferably at least about 18 inches long so as to remove all effects of "plucking" caused by the tendency of the elastic yarn 125 to stick to the supply package 120. As a result, the elastic yarn is continually fed at the desired rate under a predetermined controlled tension, such as 42 grams, for example.

As a result, the waistband 60 into which the yarn is knit is uniform throughout in tension and in appearance. For example, in one preferred garment, the waistband 60 relaxes to a circumference of 7 inches and can be uniformly stretched to a circumference of 22 inches. This high ratio of expansion is made possible because

of the use of uncovered or raw Spandex elastic yarn knit into the waistband. The waistband has a softer, non-binding and more even feel. The waistband can also be less bulky and therefore more comfortable to the wearer, the waistband being flatter when worn and thus giving a better appearance under tight fitting garments.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. Apparatus for feeding elastic yarn from a supply package thereof under uniform controlled tension to a knitting station in a circular knitting machine having an electric drive motor adapted to be coupled to an associated source of electric power, said apparatus comprising electrically driven mechanism operating independently of the associated drive motor and engaging the length of the elastic yarn disposed between the supply package and the knitting station for pulling the elastic yarn from the supply package, a non-driven brake engaging the length of the elastic yarn disposed between said pulling mechanism and the knitting station for applying a substantially constant braking force to the elastic yarn ahead of said knitting station, said pulling mechanism serving to overfeed the elastic yarn from the supply package thereof to said brake thus to deliver the elastic yarn to said brake under essentially zero tension, said brake placing the length of elastic yarn between said brake and the knitting station under a predetermined controlled tension that is independent of the speed of travel thereof, a control relay having a coil connected across the associated source of electric power and having normally closed contacts connected in series with the associated drive motor, and a normally open switch connected in series with said relay coil for controlling the drive motor and including an actuator engaging the length of the elastic yarn between said brake and the knitting station and movable between an operating position and a stopping position, said switch actuator being held in the operating position thereof by the elastic yarn when the elastic yarn is under the predetermined tension due to the feeding thereof to the knitting station and said switch actuator returning to the stopping position thereof when the tension in the elastic yarn drops below said predetermined tension thus to stop the knitting machine, whereby to supply the elastic yarn to the knitting station under a predetermined controlled tension that is independent of the speed of travel thereof and that is constant during the feeding of the elastic yarn to the knitting station.

2. The apparatus set forth in claim 1, wherein said brake is adjustable to impart to the elastic yarn a tension in the range from about 15 grams to about 50 grams.

3. The apparatus set forth in claim 1, wherein said brake is spaced at least about 18 inches from the knitting station so as to assure that any irregularities in the feeding of the elastic yarn are smoothed out before the elastic yarn reaches the knitting station.

4. Apparatus for feeding elastic yarn from a supply package thereof under uniform controlled tension to a knitting station in a circular knitting machine having an electric drive motor therefor adapted to be coupled to an associated source of electric power, wherein an elastic yarn feed finger is disposed adjacent to the knitting station and is movable between a feed position for feeding the elastic yarn into the knitting station and a holding position removing the elastic yarn from the knitting station and into position to be severed by a knife adjacent to the knitting station, said apparatus comprising electrically driven mechanism operating independently of the associated drive motor and engaging the length of the elastic yarn disposed between the supply package and the knitting station for pulling the elastic yarn from the supply package, a non-driven brake engaging the length of the elastic yarn disposed between said pulling mechanism and the knitting station for applying a substantially constant braking force to the elastic yarn ahead of said knitting station, an elastic yarn clamp for engaging the length of the elastic yarn disposed between the feed finger and the knife at the knitting station, a control relay having a coil connected across the associated source of electric power and having normally closed contacts connected in series with the associated drive motor, and a normally open switch connected in series with said relay coil for controlling the drive motor and including an actuator engaging the length of the elastic yarn between said brake and the knitting station and movable between an operating position and a stopping position, said pulling mechanism serving to overfeed the elastic yarn from the supply package thereof to said brake thus to deliver the elastic yarn to said brake under essentially zero tension, said brake placing the length of elastic yarn between said brake and the knitting station under a predetermined controlled tension that is independent of the speed of travel thereof, said clamp engaging and holding the elastic yarn upon movement of the feed finger to the holding position and prior to the severing of the elastic yarn by the knife adjacent to the knitting station, said switch actuator being held in the operating position thereof by the elastic yarn when the elastic yarn is under the predetermined tension due to the feeding thereof to the knitting station and the holding thereof by said clamp and said switch actuator returning to the stopping position thereof when the tension in the elastic yarn drops below said predetermined tension thus to stop the knitting machine, whereby to supply the elastic yarn to the knitting station under a predetermined controlled tension while the elastic yarn is being fed to the knitting station and positively to hold the elastic yarn in readiness for insertion into the feed position while no elastic yarn is being fed to the knitting station, and to stop the knitting machine when the predetermined tension is lost in the length of the elastic yarn between said brake and the knitting station.

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