

Aug. 2, 1966

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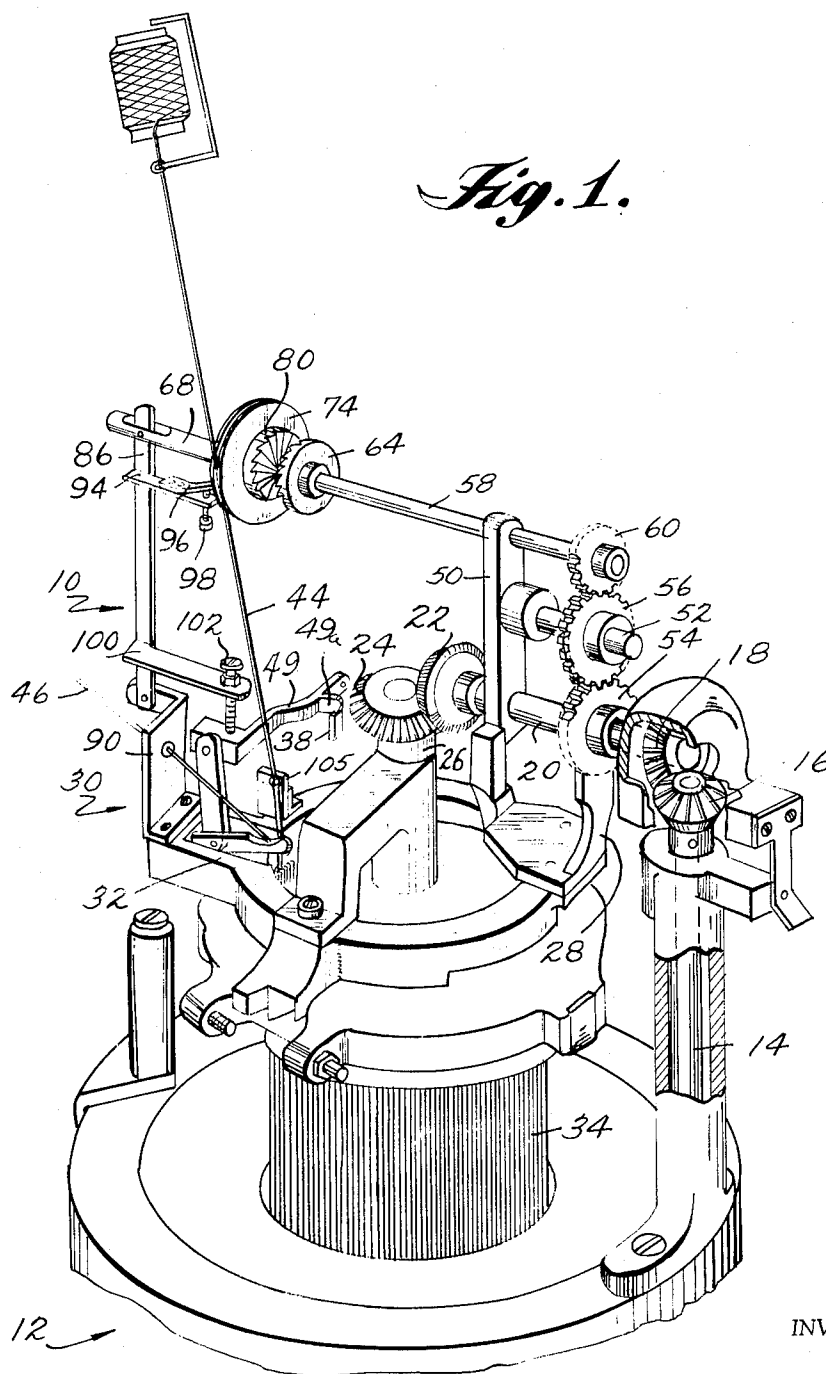
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METHOD AND APPARATUS FOR KNITTING

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Fig. 1.



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Fig. 2.

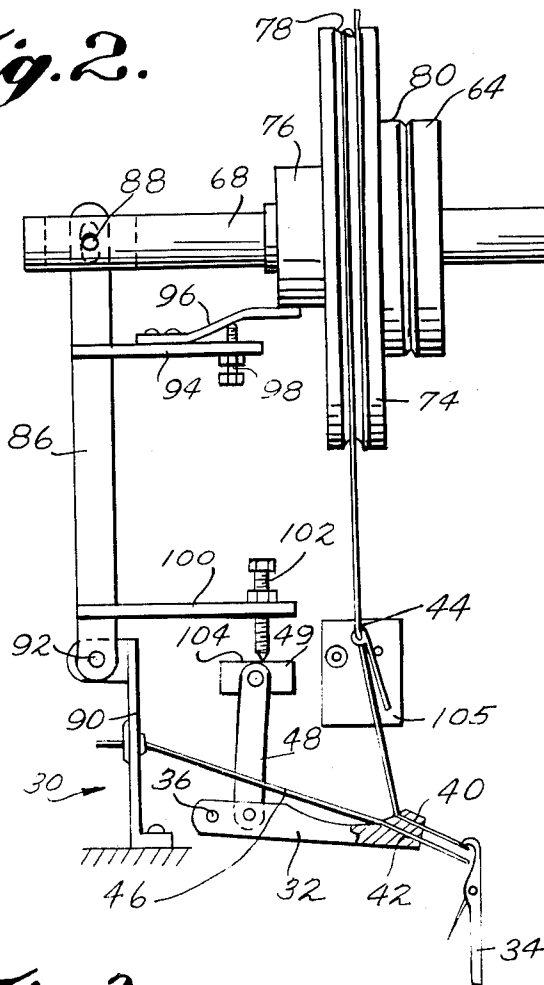


Fig. 3.

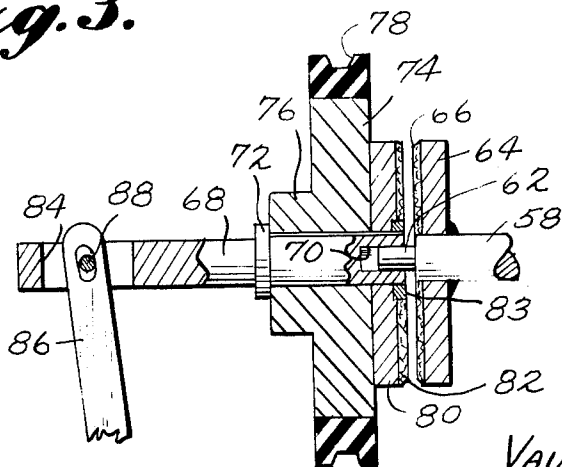


Fig. 4.

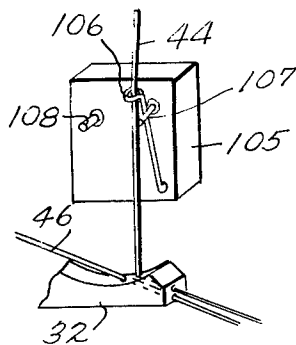
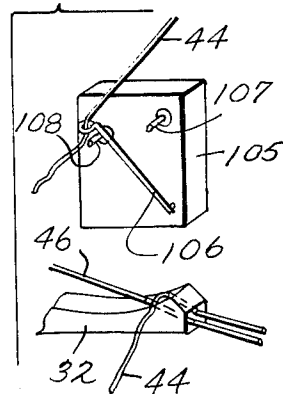


Fig. 5.



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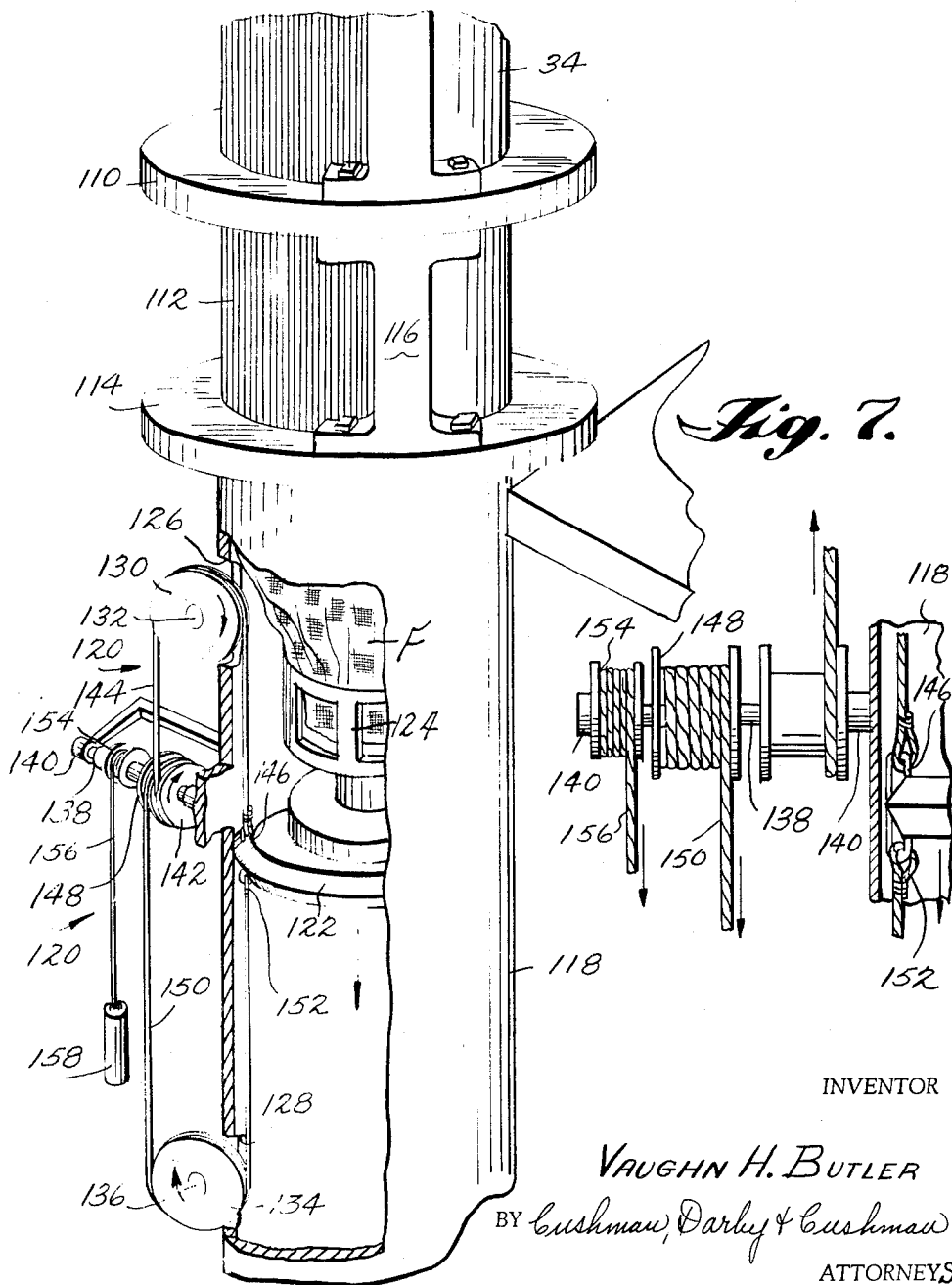
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Fig. 6.



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METHOD AND APPARATUS FOR KNITTING

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8 Claims. (Cl. 66-132)

This invention has reference to knitting compressive or support garments and in particular to circular knit ladies' compressive stockings.

The invention relates to a new and improved means for controlling the tension of bare, elastomeric polyurethane yarn which is knitted into alternate courses of fabric to provide a strong and durable compressive garment. The elastomeric polyurethane yarns utilized are non-foamed, being generally a single strand, but composed of either multi-filament or mono-filament yarns. Such yarn is commercially available, for example, from E. I. du Pont de Nemours and Company under the trade name "Fiber K" and "Lycra"; from U.S. Rubber Company as "Vyrene"; and from the Firestone Tire and Rubber Company as "Spandex."

The principal object of the present invention is to provide a method and apparatus for affording a high degree of tension control for the elastomeric polyurethane yarn which is knitted in a manner to form a compressive fabric, such as sheer ladies' compressive stockings or the like, of the type described in the pending applications of Burleson et al., Serial No. 790,912, filed February 3, 1959, now Patent No. 3,069,883, issued December 25, 1962, and Burleson et al., Serial No. 156,459, filed December 1, 1961, now Patent No. 3,098,369, issued July 23, 1963, which teachings are included herein by reference.

In these pending applications there is described a support stocking formed of elastomeric polyurethane yarn, the degree of support being controlled by the knitting operation. Since the knitted appearance of such elastomeric polyurethane yarn itself is different than that of nylon, for example, it is necessary to knit such yarn with a cover yarn, preferably of nylon, set in the same point and plaited where the nylon yarn will be on the outside of the fabric. This may be accomplished by using a yarn finger with two holes and running the elastomeric yarn in the holes nearest the needles. The knitting may be accomplished together with the knitting of the main yarn on single or multi-feed machines; however, the instant invention shall refer to a multi-feed arrangement.

In order that proper power or tension may be obtained by the elastomeric polyurethane yarn, a very close proportion must be kept between the main nylon yarn and the covering nylon yarn. For example 39½ in. per course of 40/13/7 Z nylon at the main feed and 33 in. per course of 20/7/1/2 Z nylon covering yarn, run with 70 denier elastomeric yarn at the auxiliary feed, will have a proportion between nylon yarns of 1.2 in. of main yarn to one inch of covering yarn per course. These measurements are taken from the knee area of the boot fabric and do not remain the same as the stocking is graduated into the ankle, but the proportion remains the same throughout the boot fabric. The amount of elastomeric polyurethane yarn for this combination would be 13¾ in. per course and this measurement remains the same throughout the boot fabric because the elastomeric yarn is not graduated.

The elastomeric polyurethane yarn feeding mechanism according to this invention is directly driven by circular knitting machines of conventional construction and does not change ratio at any time during the knitting cycle. The proportion and measurements described above should

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vary according to the denier and modulus of the elastomeric yarn or the denier of the nylon yarns. Since the covering nylon yarn and the elastomeric yarn are being fed simultaneously at one feed, a proper draw-down tension is provided to hold the nylon down on the needles during knitting and prevent filament breakage. The proper tension for the example above should be approximately 36 ounces, which includes the weight of the fabric clamping and take-down mechanisms.

This invention also contemplates the provision of a yarn feeding mechanism of the character described which includes a rotary feed wheel having a high coefficient of friction and a low static conductivity, there being provided clutch means for interrupting the feed of this wheel in response to movement of the yarn finger of the machine out of its knitting position. Moreover, the feeding mechanism of this invention is characterized by a high degree of reliable tension control, and simple, inexpensive construction.

These and still further objects, advantages and novel features of the present invention will become apparent in the specification and claims, taken in connection with the accompanying drawings.

In the drawings:

FIGURE 1 is a perspective view of the yarn feeding mechanism according to this invention connected to a conventional circular knitting machine;

FIGURE 2 is a partial elevational view of the feeding mechanism in the feeding position;

FIGURE 3 is a partial elevational sectional view of the feeding mechanism when the feeding has been interrupted;

FIGURES 4 and 5 are diagrammatic detail views of the stop motion;

FIGURE 6 is a perspective view, partially broken out, of the tensioning arrangement for the fabric; and

FIGURE 7 is an elevation view of the cable drum system in FIGURE 6.

Referring now to the accompanying drawings, there is shown a feeding mechanism 10 according to this invention, mounted on a multi-feed circular knitting machine 12. The machine 12 is of conventional construction and includes the usual vertical drive shaft 14 carrying a bevel gear 16 at its upper end. The bevel gear 16, in turn, is aligned in timed relationship with a mating bevel gear 18 carried on a horizontal drive shaft 20. The opposite end of the horizontal drive shaft 20 carries a bevel gear 22 in engagement with a bevel gear 24 mounted on the dial spindle 26. This mechanism is mounted on a suitable frame 28 carried on the top of the machine 12.

An auxiliary yarn feeding station 30 carries a yarn finger 32 adjacent the needles 34 of the machine 12; the yarn finger 32 being pivotally mounted thereto with a horizontal pivot pin 36. The yarn finger 32 is thereby pivotally movable into and out of the lower knitting position by a vertical push rod 38 as will become evident. The yarn finger 32 has two longitudinally spaced angular passages 40 and 42, the upper passage 40 feeding a strand of tensioned elastomeric polyurethane yarn 44, while a covering yarn 46 of nylon is fed to the needles 34 through the passage 42 therebelow.

The yarn finger 32 takes the form of a bell crank, having an upstanding link 48, which pivots downwardly toward the needles 34 when the push rod 38 drops the yarn finger 32 into the knitting position; conversely, the link 48 is pivoted upwardly when the push rod 38 raises the yarn finger 32 out of its knitting position. Connection between the link 48 of the yarn finger 32 and the push rod 38 to effect this movement is obtained by a bracket plate 49 which is joined to the bell crank at its one end and has an extending lug 49a which abuts the upper end of the push rod 38.

Reference is now made to the mechanism 10 which is operative to feed the strand of elastomeric polyurethane yarn 44 into the needles 34 under controlled tension, when the yarn finger 32 is in its lower knitting position.

A frame 50, joined to the frame 28 or to the machine 12, carries a stub shaft 52 in aligned relationship to the horizontal drive shaft 20. A feed drive gear 54 is joined to the horizontal drive shaft 20, the drive gear 54 engaging a gear 56 joined to the stub shaft 52. The frame 50 also carries a feed shaft 58 having a gear 60 fixed to its one end for receiving a drive from the gear 56. Thus, a rotary drive is transmitted to the feed shaft 58 from the gears 54, 56, and 60.

As best shown in FIGURE 3, the opposite end of the feed shaft 58 terminates in a portion 62 of reduced diameter, and carries a first clutch plate 64, as by welding. The first clutch plate 64 is positioned closely adjacent the reduced portion 62 of the feed shaft 58, its engaging face 66 facing opposite to the gear 60.

The reduced portion 62 of the feed shaft 58 engages a non-rotatable rod 68 having an end bore 70, so as to allow free rotational and longitudinal movement therebetween. This rod 68 has an intermediate peripheral shoulder 72 and carries a freely rotatable feed wheel 74 having a hub 76 which abuts the rod shoulder 72. The feed wheel 74 has a peripheral recess 78, the periphery of the feed wheel 74 being composed of a material having a high coefficient of friction and a low of static conductivity, so that a good degree of control is afforded the strand of elastomeric yarn 44 to be wrapped therearound. Undesirable slippage of the yarn strand 44 is thereby avoided.

Such material as "Micarta," manufactured by Westinghouse Electric Corp., has been found to be highly satisfactory in this regard. This material is composed of chopped pieces of fabric or paper impregnated with phenol-formaldehyde resins and compressed under heat into a permanently solid structure with high coefficient of friction and dielectric properties.

The feed wheel 74 has a second clutch plate 80 joined as by welding to its surface facing the first clutch plate 64, so that its clutch engaging surface 82 is operative for selective engagement with the adjacent surface 66 of the first clutch plate 64. The surfaces 66 and 82 may be of any appropriate configuration, e.g., a series of radial grooves, so as to provide a positive drive from the feed shaft 58 to the feed wheel 74 when the rod 68 is moved along its axis toward the first clutch plate 64. A suitable retaining ring 83 holds the feed wheel 74 and the second clutch 80 on the shaft 68, for free rotation.

The rod 68 at its end opposite to the feed wheel 74 has a vertical slot 84 which receives a slotted link 86, connected to the rod 68 with a pivot pin 88. The opposite, lower end of the link 86 is pivotally connected to a bracket plate 90 at 92, the bracket plate 90 being mounted at the auxiliary feed station 30. Accordingly, the periphery of the feed wheel 74 is positioned directly above the yarn finger 32, and the link 86 is pivotable towards and away from the needles 34.

The link 86 carries a braking arrangement for preventing undesired free rotation of the feed wheel 74 when the clutch plates 64 and 80 are disengaged. To this end, the link 86 has a plate 94 extending towards and below the hub 76 of the feed wheel 74. A leaf spring 96 is joined at its one end to the top side of the plate 94, while the opposite end of the leaf spring 96 is biased upwardly in engagement with the periphery of the hub 76, by a set screw 98 carried by the plate 94. Thus, there is a braking force on the feed wheel 74, more or less, depending on the extent to which the leaf spring 96 is biased against the feed wheel hub 76.

In order to render pivotal movement of the link 86 responsive to the knitting at the auxiliary station 30, means are provided to engage and disengage the clutch plates 64 and 80 as the push rod 38 lowers and raises the yarn

finger 32. For this purpose, the link 86 carries a lower plate 100 which is positioned over the upstanding link 48 of the yarn finger 32, the plate 100 in turn carrying a depending set screw 102. The bracket 49 joined to the link 48 has a stop 104 at its upper end in alignment with the depending set screw 102. Thus, when the yarn finger 32 is lowered to its knitting position, the link 86 is pivoted forwardly to engage the clutch plates 64 and 80 by longitudinal movement of the rod 68; when the yarn finger 32 is raised by the push rod 38, the link 86 is pivoted away from the needles, causing the rod 68 to be retracted and the clutch disengaged.

Mounted in the path of the elastomeric yarn strand 44 is a stop motion 105 (FIGURES 4 and 5), which is connected to the top of the machine 12. The stop motion 105 is of conventional construction, having a yarn guide rod 106 through which the strand 44 passes. The yarn guide rod 106 is a light, electrically conductive rod, pivoted and grounded at its opposite lower end. A stop 107 is provided at a point where tension on the yarn will hold the guide rod 106 there against the stop 107 and also in a position where, if the yarn breaks or loses tension, the rod 106 will fall freely against insulated conductor 108. This will, by means of a circuit connection to the machine's electric stop motion, stop the machine. A switch is mounted on the shipper drum (not shown) connected in series with the stop motion conductor 108. The purpose of this switch is to activate the yarn stop motion 105 at the time during the knitting of elastomeric polyurethane yarn. At other times such as knitting of the welt, heel, and toe, the switch may be cammed off by the machine to prevent unnecessary stopping of the machine if the polyurethane yarn should become slack when not knitting.

As previously stated, it is necessary that a proper draw-down tension be provided for the fabric to hold the nylon yarn down on the needles during knitting to prevent filament breakage and the like.

Reference is now made to FIGURE 6 which shows an arrangement for controlling the tension on the fabric F within precisely selected limits. There is here shown the lower portion of the knitting needles 34 positioned above the upper bed plate 110 of the circular knitting machine, there being provided a needle cylinder 112 of known construction therebelow. Likewise, a lower bed plate 114 is provided, these bed plates 110 and 114 being supported by suitable structural members 116.

Positioned below the lower bed plate 114 is a cylindrical tube 118 operative to receive the fabric F as the same is knitted on the circular knitting machine 10. In order to provide the desired tension in fabric F, a tension arrangement 120 is operatively associated with the cylindrical tube 118. To this end, a cylindrical weight 122 of suitable mass is positioned for vertical movement within the cylinder 118. The weight 122 carries at its upper end fabric gripping pawls 124 operative to engage the first-formed portion of the fabric F. Any suitable arrangement for engaging the pawls 124 to the fabric F may be provided. In this regard, the pawls may be spring-biased to their closed position or incorporate features of the fabric gripping arrangement disclosed in the patent to Butler, 2,694,304.

The cylindrical tube 118 has aligned upper and lower slots 126 and 128, respectively. A pulley wheel 130 is mounted for rotation on a shaft 132 adjacent the upper slot 126. The pulley wheel 130 is positioned so that its inner periphery extends through the slot 126 and within the cylindrical tube 118. In a like manner, the lower slot 128 receives a pulley 134 mounted for rotation on a shaft 136. A carrier shaft 138 is positioned adjacent the cylindrical tube 118 intermediate the pulleys 130 and 134. The shaft 138 is mounted on suitable bearings 140 which are joined to the frame of the knitting machine 10 by any suitable means (not shown). The shaft 138 carries a first cable drum 142, this drum carrying a cable 144 there-

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around which cable is trained over the upper pulley 130 and is joined at its opposite end to the weighted cylinder 122 by a suitable connection at 146. The cable drum 142 is joined to the shaft 138 as by a keyway connection (not shown) so as to be rotatable therewith. Another cable drum 148 is joined to the shaft 138 by a keyway connection (not shown). This latter drum carries a cable 150 wrapped therearound, the cable 150 extending downwardly where it is trained about the lower pulley 134 and then upwardly within the cylindrical tube 118 where it is joined to the underside of the weight 122 by a suitable connection 152.

In order to control the downward movement of the weight 122 and otherwise control the tension on the fabric F, the shaft 138 carries a counter weight drum 154 joined to the shaft 138 as by a keyway connection (not shown). This drum 154, in turn, carries a cable 156 on the same side of the shaft 138 as the cables 144 and 150. The cable 156 carries a counter weight 158 of predetermined weight so that the downward force of the weight 122 is determined according to the selection of the counter weight 158. Downward movement of the weight 122 within the cylindrical tube 118 is thereby controlled in an efficient manner. If the yarn should break, the weight 122 will not cause the draw down mechanism to come crashing down to the bottom of the machine 10 so as to prevent consequent damage to the machine parts. Inasmuch as the free fall of the weight 122 is controlled by the counter weight 158, tension on the cable 144 is controlled, and the cable 144 is prevented from jumping off the top of the pulley 130 during a rapid descent of the weight 122.

From the description of the structure and operation of the arrangement 120 herein, it should be apparent that the lower pulley 134 and cable 150 serve, primarily during raising of the weight 122 to ensure that such slackness does not develop in cable 144 as would allow the cable 144 to jump off the pulley 130.

In operation, the strand 44 of elastomeric polyurethane yarn is trained from the yarn package P about the feed wheel 74 where it is wrapped once around, then through the stop motion 105 and to the passage 40 of the yarn finger 32, nearest the needles 34. When the bracket 49 is lowered for knitting at the auxiliary station 30, the link 86 pivots toward the shaft 58 by gravity, so that the clutch plates 64 and 80 are engaged. The feed wheel 74 is then driven through the gears 54, 56, 60 and the clutch plates 64 and 80. The feed wheel 74, as a consequence, rotates on the rod 68.

Due to the composition of the material forming the peripheral recess 78 on the feed wheel 74, the strand 44 being pulled off the yarn package P is delivered to the needles 34 without varying the length or causing the strand 44 to be wrapped around the feed wheel 74. A high degree of tension control is thereby provided for the strand 44 as necessary to form the compressive stocking. In the event that the strand 44 should break and begin to wrap around the rotating feed wheel 78, the stop motion 106 is opened, as described, to thereby stop the machine 12 without wasting the excess of yarn.

As the feed wheel 74 is directly geared from the machine 12, the feed of the strand 44 will stop when the bracket 49 pivots the yarn finger 32 upwardly via the link 48, this force being transmitted to the link 86 via the set screw 102. This action pivots the link 86 against the force of gravity away from the needles 34, so that the clutch plates 64 and 80 become disengaged. In order to prevent the creeping or free wheeling of the feed wheel 74, the leaf spring 96 is biased against the hub 76 of the feed wheel 74 to obtain the desired resistance to rotation.

When the fabric is being knit, a weight 122 (FIGURE 6) is clipped to the first-formed portion of the fabric which is suspended in the central cylindrical tube 118 of the knitting machine 12. Such a weight provides the

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proper tension on the fabric by the pulley and counter-weight tensioning arrangement 120.

From the foregoing description of the various embodiments of this invention, it is evident that the objects of this invention, together with many practical advantages are successfully achieved. While preferred embodiments of my invention have been described, numerous further modifications may be made without departing from the scope of this invention.

Therefore, it is to be understood that all matters herein set forth or shown in the accompanying drawings are to be interpreted in an illustrative and not in a limiting sense.

What is claimed is:

1. Method of knitting a circular compressive stocking with a main nylon yarn strand, a bare elastomeric polyurethane yarn strand and a covering nylon yarn strand comprising the steps of feeding the covering yarn strand and the elastomeric yarn strand to the same point in the knitting station and plaiting the same to thereby position the cover yarn to the outside of the fabric while controlling the length of the elastomeric yarn strand during feeding thereof by wrapping the yarn about a rotating feed wheel interposed between a yarn supply and the knitting station, the circumferential surface of the wheel having a high coefficient of friction and a low static conductivity whereby the yarn is fed to the knitting station without substantial variations of length; the rotating feed wheel feeding the yarn to a feeding station having a yarn finger adjacent the knitting station; the yarn finger having two angular holes including an upper hole which is closer to the needles of the knitting station; the method further including running the elastomeric yarn through said upper hole.

2. Method defined in claim 1 including the step of maintaining a pre-determined proportion between the main yarn and the cover yarn.

3. In combination, a circular knitting machine having a knitting station including at least one pivotally mounted yarn finger having an upstanding link and two longitudinally spaced passages therethrough for feeding yarn to the knitting needles of said machine; a feed shaft; gear drive means operatively connected to the drive for said machine for positively driving said feed shaft in timed relationship therewith; a longitudinally movable rod operatively connected to said feed shaft; a feed wheel freely rotatably mounted on said rod; clutch means operatively positioned between said feed shaft and said feed wheel for selectively driving the latter upon longitudinal movement of said rod to engage said clutch means; a second link pivotally connected to one end of said rod for longitudinally moving the same and pivotally connected at its other end to said machine; brake means operatively carried by said link and engaging said feed wheel to selectively retard free motion thereof; and means operative in response to movement of said upstanding yarn finger link to pivot said second link when said yarn finger is moved into and out of knitting position to engage and discharge said clutch means; and wherein said knitting machine includes a tube for receiving the fabric formed at the knitting station; weighted means movable in said tube and operative to selectively grip the first-formed fabric; pulley wheels positioned above and below the path of movement of said weighted gripping means in said tube; cable drum means mounted for rotation adjacent said pulley wheels; first and second cables carried by said cable drum means, said first cable passing over said upper pulley wheel and operatively joined to said weighted gripping means, said second cable passing under said lower pulley wheel and also joined to said weighted gripping means to provide a taking up of said second cable when said first cable is paid out and vice versa, and a counterweighted cable carried by said cable drum means to retard rotation of said cable drum means as said weighted gripping means is lowered within said tube.

4. The combination defined in claim 3 wherein said tube has longitudinally spaced slots for receiving said first

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and second cables within said tube, said first and second pulleys being positioned for rotation with their peripheral surfaces within said slots.

5. The combination defined in claim 3 wherein said brake means includes a leaf spring carried by said link, said feed wheel having a hub portion adjacent said leaf spring; and means for selectively biasing said leaf spring against said hub to retard free rotation of said feed wheel.

6. Combination defined in claim 3 including a safety stop operative to stop said drive train in response to a loss of tension of elastomeric polyurethane yarn fed to said yarn finger from said feed wheel.

7. In a circular knitting machine having a needle cylinder, a tube positioned in alignment with said needles cylinder for receiving the fabric formed by said knitting machine; weighted means movable in said tube and operative to selectively grip the first-formed fabric; pulley wheels positioned above and below the path of movement of said weighted gripping means in said tube; cable drum means mounted for rotation adjacent said pulley wheels; first and second cables carried by said cable drum means, said first cable passing over said upper pulley wheel and operatively joined to said weighted gripping means, said second cable passing under said lower pulley wheel and also joined to said weighted gripping means to provide a taking up of said second cable when said first cable is paid out and vice versa, and a counterweighted cable carried by said cable drum means to retard rotation of said cable drum means at said weighted gripping means is lowered within said tube.

8. The combination defined in claim 7 wherein said tube has longitudinally spaced slots for receiving said first and second cables within said tube, said first and second pulleys being positioned for rotation with their peripheral surfaces within said slots.

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