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This invention generally relates to the art of treating normally inelastic synthetic yarns to give the same a permanent liveliness.

It is an object of the invention to provide a novel method of winding and twisting independent strands of nylon yarn in such a manner as to produce an inherent liveliness in a more simplified and economical manner than has heretofore been conceived and wherein the yarn is not subjected to heat setting before knitting, thus resulting in a yarn which is smoother and more sheer and has a permanent liveliness sufficient to cause the yarn to kink when relaxed whereby fabric formed from said yarn has stretchable characteristics.

Yarn processed according to this invention is known as elastic yarn and will be called elastic yarn herein from time to time but it is to be understood that the yarn itself is not substantially stretchable before knitting but is treated to maintain an inherent twist or liveliness and fabric formed from the yarn is highly elastic or stretchable. The yarn is given an inherent elasticity which becomes active after fabrication and other processing.

Fabrics woven or knitted from yarn processed according to this invention, such as ladies' sheer nylon hose, are more sheer and have a smoother unblemished texture than fabrics heretofore produced from the usual types of synthetic elastic yarns. As a matter-of-fact, ladies' hose produced from the improved yarn resulting from the present process have an appearance and texture approaching that produced from sheer inelastic synthetic or natural yarns.

It is another object of this invention to provide a continuous filament nylon yarn having permanent liveliness by imparting high twist to the yarn in the absence of tension and without heat setting or shrinking the yarn in such a manner as to permit the yarn to be handled in subsequent processes without back twisting upon itself.

Heretofore multifilament nylon yarns have been super twisted and heat set to give elasticity and similar processes applied to filament yarns have not been entirely satisfactory. Such yarns could not be handled satisfactorily in weaving or knitting and the application of heat adversely affected the hand and appearance of the yarns. In the present process, the yarn is not subjected to heat prior to being formed into fabric resulting in a sheer smooth unmarred yarn with a dull finish and good hand.

It is another object of this invention to provide a super-twisted continuous nylon yarn which is treated with a low viscosity fluid to facilitate further handling.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds when taken in connection with the accompanying drawings, in which—

Figure 1 is a schematic isometric view showing a preferred manner of carrying out the first winding step of the improved process or method.

Figure 2 is another schematic isometric view showing a preferred means for imparting twist to the yarn in carrying out the second step of the process;

Figure 3 is still another schematic isometric view show-

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ing the preferred manner of rewinding the yarn after twist has been imparted thereto while applying relatively heavy oil or lubricant to the yarn.

As is well known in the art, continuous filament nylon yarn is initially extruded in the desired form and wound onto pirns such as that indicated at 10 in Figure 1, in which condition the yarn is delivered to textile plants for further processing. The present method is concerned with the preparation of the continuous filament nylon yarn to produce inherent liveliness and elastic characteristics or properties therein after it has been wound on pirns. The process is particularly adapted for monofilament yarns.

The process comprises supertwisting the yarn in the absence of any appreciable tension and under carefully controlled conditions and then applying low viscosity fluid to the yarn and winding it on cones. The yarn is not subjected to heat nor is it untwisted. It may subsequently be manipulated into fabric and the fabric subjected to heat and moisture to shrink and set the same.

Briefly, the yarn is rewound from pirns onto bobbins under carefully controlled conditions in the absence of tension to form a smooth hard evenly wound body on the bobbin or spool. The yarn is then supertwisted by transferring to another bobbin, the twist being imparted by changing yarn direction and speed differential between the bobbins. After supertwisting the yarn is treated with low viscosity fluid and wound on cones.

The first step of the improved process is carried out by initially withdrawing the nylon yarn or strand while winding it onto a bobbin or spool in the absence of tension or under a minimum of tension. In order to eliminate the use of any tension devices, the yarn is deflected from its original path as it is withdrawn from the pirn 10 at an angle at approximately 90 degrees and is again deflected into a path substantially parallel to its original path as it is taken up by the first spool or bobbin.

In Figure 1, a winding machine is shown somewhat schematically including a bottom rail 11 for supporting the pirn 10, an upper rail 12 spaced above the bottom rail and having a pair of pigtail thread guides or yarn guides 13, 14 thereon, which are especially treated in a manner to be later described. The winding machine of Figure 1 also includes a driven take-up roller 15 upon which the flanged opposite ends 16 of a spool or bobbin 17 rests. Thus, the spool or bobbin 17 is driven to rotate in a clockwise direction in Figure 1 by the take-up roll 15. The winding machine shown in Figure 1 also includes a conventional driven traverse bar 20 having a traversing thread guide 21 thereon. The traversing bar 20 is so driven as to reciprocate the traversing thread guide so that smooth layers of the yarn Y are wound on the bell of the spool or bobbin 17.

The yarn Y passes upwardly from the pirn 10 and through the eye of the pigtail yarn guide 13, whereupon the yarn is deflected out of its original path of travel at an angle of approximately 90 degrees. The yarn Y then moves in a substantially horizontal path through the eye of the pigtail yarn guide 14 whereupon it is deflected out of its path of travel at an angle of approximately 90 degrees and passes upwardly in substantially parallel relation to its path of travel as it leaves the pirn 10. The yarn Y then passes through the traversing thread guide 21 and is directed on to and taken up by the spool or bobbin 17.

In order to maintain the smoothness of the yarn Y so the resultant product made therefrom may be extremely sheer, it is necessary that any of the parts of the machinery adjacent which the yarn passes, or in engagement with which the yarn passes, have specially treated surfaces. It has been found that the usual chrome plated pigtail yarn guides will, at times, cause slight imperfections or roughness in the yarn being processed. These guides are so smooth that yarns contacting the same wear

grooves in the guides which grooves subsequently scar the yarns.

Accordingly, each of the pigtail yarn guides 13 and 14 and each of the pigtail yarn guides hereinafter described are provided with a special mat surface. This is accomplished by chrome plating the surfaces at least adjacent the eye thereof, and then sand blasting them with a relatively fine sand or shot to produce a mat finish having minute irregularities or cavities in its surface which irregularities form air pockets and provide a cushion of air between the moving yarn and said surfaces. This causes the yarn, to actually ride on air as it is deflected from its path at the two pigtailed guides 13, 14 and assists in maintaining the guides 13, 14 at a relatively cool temperature so that they have no scarring effect upon the yarn. Also, since the guides 13, 14 are maintained at a cool temperature, this obviously prevents wear of the pigtailed guides. The mat finish is such that the yarn will not ride on a smooth surface thereby creating friction and tension but will move with a minimum of friction and tension.

The traversing yarn guide or thread guide 21 is also preferably made from a hard plastic material or ceramic material and has smoothly rounded mat surfaces past which the yarn Y passes. By deflecting the yarn out of its normal path or out of its original path in the manner heretofore described, the yarn Y is smoothly taken up by the spool 17 without the necessity of using tensioning devices of any description so the yarn has no appreciable tension therein, such tension ranging from zero to one gram. The pirn 10 is stationary and the bobbin 17 is preferably driven at about 300 R. P. M.'s. The yarn is not twisted at this stage.

After the yarn Y has been wound from the pirn 10 onto the bobbin or spool 17, the yarn is then twisted on a upwister or throwing machine shown schematically in Figure 2. The upwister in Figure 2 includes a spindle 25 which is driven as by a continuously moving endless belt 36, only a portion of which is shown in Figure 2, and on which spindle the bobbin or spool 17 is positioned to rotate about a substantially vertical axis. A suitable support 27 is spaced above the level of the spindle 25 and has a pigtail yarn guide 30 thereon which may be identical to the pigtail yarn guides 13, 14 heretofore described.

The eye of the pigtail guide 30 is preferably positioned in substantial axial alignment above the spindle 25 and the yarn Y passes from the spool 17, past the smoothly finished thin uppermost flange 16 thereof and, thence through the pigtailed guide 30. The yarn then continues upwardly movement and passes through a traversing yarn guide 31 which is carried by a traverse bar 32. The traverse bar 32 is driven in a conventional manner to smoothly lay the yarn Y on the barrel of an incompressible flanged bobbin or spool 33 whose opposite end flanges are designated at 34. It will be noted that the barrel of the spool 33, or the yarn wound thereon, rests upon a driven take up roll or roller 36.

The upwister shown in Figure 2 may be of a type such as is manufactured by Atwood Division of Universal Winding Company, Box 1605, Providence, Rhode Island and, accordingly, a detailed description thereof is deemed unnecessary. The bobbin or spool 33 is preferably made from aluminum which has been smoothly finished and which is of sufficient strength to insure that the flanges 34 thereof will not warp or collapse and to insure that the barrel 33 thereof will not collapse, since the twist inserted in the yarn as it passes from the vertical spool 17 to the substantially horizontal spool 33 causes the yarn to be wound tightly on the spool 33, although the yarn is maintained under a minimum of tension in its course from the first spool 17 to the second spool 33.

Of course, in order to produce the desired number of turns of twist in the yarn per inch, the spindle 25 and the take-up roll 36 are driven at varying speeds which are adjusted in the usual manner to produce the desired twist in the yarn. A high twist is imparted to the yarn

or strand Y which may vary from thirty to fifty-five turns per inch, depending upon the denier of the yarn. It has been found most satisfactory to impart from forty-eight to fifty-two turns of twist per inch to ten and twelve denier monofilament nylon; forty-three to forty-seven turns of twist per inch to a fifteen denier nonfilament yarn and thirty-eight to forty-two turns of twist per inch to a twenty denier monofilament nylon yarn, for example.

After the nylon yarn Y has been wound onto the second spool or bobbin 33, it is then again rewound onto a cone or conical bobbin or spool 40 during the course of which a film of relatively heavy lubricant or oil is applied to the yarn, this oil or lubricant being of low viscosity and substantially heavier than that generally used in the processing of nylon or other synthetic yarns.

The yarn Y is wound from the second spool or bobbin 33 onto the cone 40 preferably on a cone winding machine including a driven substantially horizontally disposed spindle 41 on which the cone 40 is positioned and adjacent which spindle a traversing thread guide or yarn guide 42 is disposed. The second spool or bobbin 33 is positioned on a substantially vertical axis and in substantially spaced relation below the take-up spindle 41 and the bobbin or spool 33 is stationary as the yarn Y is withdrawn therefrom.

The yarn passes upwardly from the spool 33 and, in order that it be maintained under practically no tension during the course of its movement and during the application of oil or lubricant thereto, the yarn passes through a series of mat-finish pigtail yarn guides 43, 44 and 45 carried by the cone winding machine. Disposed immediately above the lowermost pigtail yarn guide 43 is a continuously driven oil applying roll 50 partially immersed in relatively heavy oil or lubricant indicated at 51, carried in a trough 52.

The oil applying roll 50 is preferably of relatively large diameter so that its front portion projects beyond the vertical plane of the front edge of the trough 52 and pigtail thread guides 43, 44 are so positioned that the yarn Y is barely deflected from its normal path of travel therebetween as it engages the roll 50 and as the film of lubricant is applied thereto. The oil is substantially heavier than that usually used for coating synthetic yarns. From 2½ per cent to 3½ per cent of oil should be applied in proportion to the weight of the yarn Y, which oil is applied at room temperature of approximately 80 degrees F. and has a viscosity of from 80 to 90. An oil suitable for this purpose is a so called Nopco oil No. 1056A. The oil maintains the clearness of the yarn in subsequent processing.

The yarn thus processed has a high twist without roughness, mistiness or scars resembling twisted or rough yarns and is smoothly wound so that it may be handled in subsequent processing. It is not necessary to heat treat the yarn to hold or set the twist but rather it may be processed as set forth herein then formed into fabric which fabric may be subjected to heat and moisture as set forth in the co-pending application of Marvin H. Comer, Charles A. Miles, Ralph C. Braxton and James J. Curry, filed February 2, 1955, Serial No. 485,634, for Sheer Stretchable Nylon Fabric and Method.

Either right or left twist may be imparted to an individual yarn but each yarn is twisted in only one direction. Due to the inherent twist in the finished yarn it is necessary to balance the yarn in subsequently formed fabric by alternating right and left twist yarns in successive courses or groups of courses.

Example

One end of 15 denier monofilament nylon yarn is initially packaged on a pirn. The pirn is placed on a rail support and the yarn is threaded upwardly through two properly positioned stationary guides previously described and thence, through a traverse guide onto a take-up bobbin. This step in the process accomplishes the transfer

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of the yarn from its original package to a bobbin suitable for the twisting operation. The proper type of guide and the angle of travel of the yarn as specified with no tensioning device is essential to the proper packaging of the yarn on the take-up bobbin preparatory to the second step in the process.

The take-up bobbin is then placed on a spindle and the yarn is threaded upwardly through a properly positioned stationary guide and traverse guide to a second bobbin which is non-collapsible. The take-up bobbin is caused to rotate by means of a motor driven belt at sufficient speed to twist the yarn 45 turns per inch, the speed of the belt and the speed of the second bobbin being regulated to acquire the desired number of turns in the yarn. Again, the proper positioning of the guide and lack of tensioning devices accomplishes the packaging of the yarn at a negligible tension of 0 to 1 gram.

The second bobbin is then placed on a coning machine and the yarn is threaded upwardly through properly positioned guides and over an oil roller through a traverse guide to a 45° cone. The 45° cone is preferred for subsequent processing.

Approximately 3% oil is applied to the yarn, the oil being 80-90 viscosity at 80° temperature. Again the transfer of the yarn to the cone is accomplished with negligible tension by means of properly positioned guides without tensioning device.

The yarn thus treated has a permanent liveliness so that fabric formed therefrom and then subjected to heat to shrink and set the same will have great elasticity. By treating the yarn according to this invention, it is not necessary to heat set or shrink in the yarn stage and the yarn is not scarred or damaged and due to the particular manner in which the yarn is processed, it may be handled in subsequent processing without kinking or back twisting upon itself. This yarn is particularly adapted for knitting sheer stretchable nylon stockings.

In the drawings and specification, there has been set forth a preferred embodiment of the invention and although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

I claim:

1. That method of treating a sheer nylon monofilament yarn of up to 20 denier which comprises imparting 30 to 55 turns of twist per inch to said yarn in the absence of substantial tension, applying a low viscosity fluid thereto and rewinding it whereby the yarn will hold its high twist for subsequent processing without setting or shrinking the yarn.

2. A sheer nylon filament yarn processed according to claim 1.

3. That method of treating individual nylon monofilament yarns of from 10 to 20 denier which comprises imparting 30 to 55 turns of twist per inch to said yarn in the absence of substantial tension, then coating said yarn with a low viscosity fluid and rewinding it whereby the yarn will hold its high twist for subsequent processing without setting or shrinking the yarn.

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4. A nylon yarn processed according to claim 3.

5. That method of treating individual continuous filament nylon yarns which comprises supertwisting individual yarns in accordance with the following table:

Denier:	Turns per inch
10	48-52
12	48-52
15	43-47
20	38-42

while maintaining said yarns under minimum tension and friction during said twisting and applying a low viscosity fluid thereto whereby a permanent liveliness is imparted to said yarns, and whereby the yarn will hold its high twist for subsequent processing without setting or shrinking the yarn.

6. A nylon yarn processed according to claim 5.

7. That method of treating individual continuous filament nylon yarns which comprises supertwisting individual yarns in accordance with the following table:

Denier	Turns per inch
10	48-52
12	48-52
15	43-47
20	38-42

and maintaining said yarns under minimum tension and friction during said twisting and coating said yarns with 2-3% by yarn weight of a low viscosity fluid whereby a permanent liveliness is imparted to said yarns.

8. A nylon yarn processed according to claim 7.

9. That method of treating a continuous filament sheer nylon yarn which comprises withdrawing it from its original pirn and rewinding onto a take-up bobbin, then imparting 30 to 55 turns per inch of twist to said yarn by transferring said yarn from the take-up bobbin to a second bobbin while changing the direction of yarn travel and maintaining a speed differential between the take-up bobbin and the second bobbin, then transferring said yarn from the second bobbin to a cone and coating said yarn with a low viscosity fluid during said transfer, and maintaining said yarn under minimum tension and friction during all of said steps whereby a permanent liveliness is imparted to said yarn.

10. A nylon yarn processed according to claim 9.

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