

April 1, 1969

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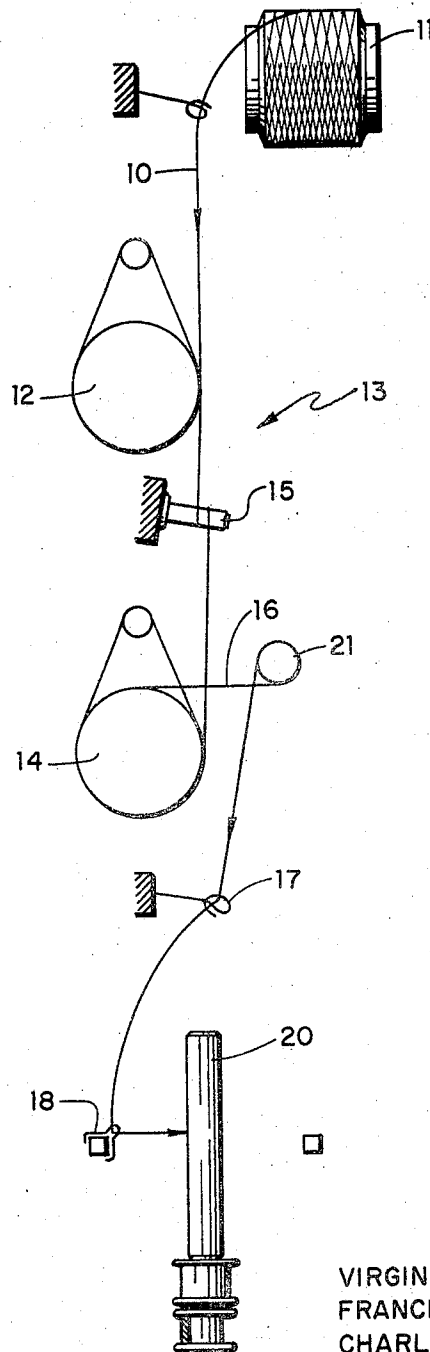
3,435,607

TORQUE YARN PROCESS

Filed Sept. 14, 1964

Sheet 1 of 2

FIG. 1



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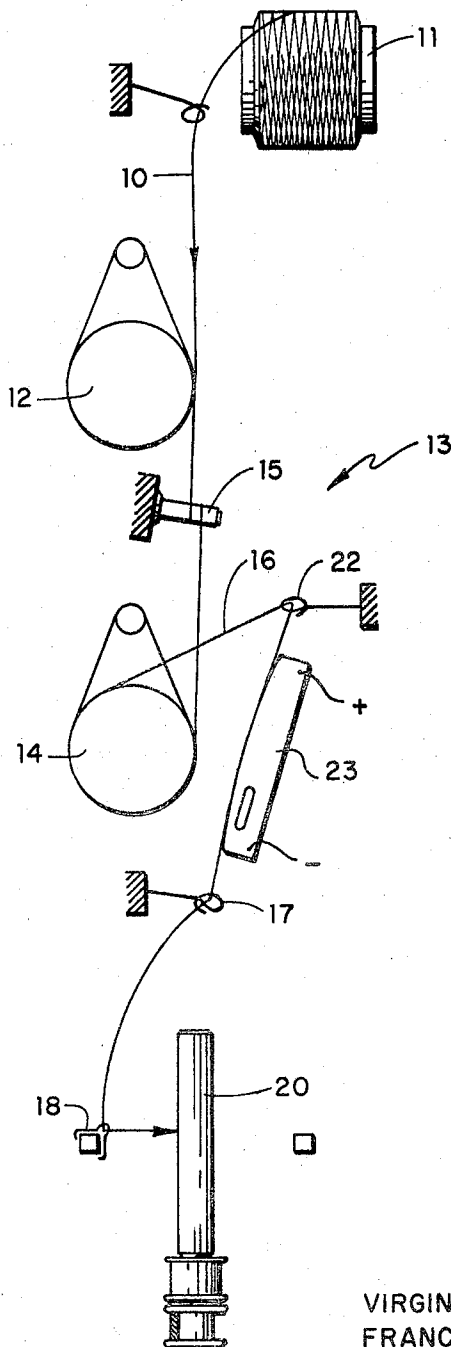
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Sheet 2 of 2

FIG. 2



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1

3,435,607

TORQUE YARN PROCESS

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U.S. Cl. 57—157

11 Claims

ABSTRACT OF THE DISCLOSURE

Production of torque yarn on a twister take-up by stripping back false twist imparted through traveller rotation and by heating yarn in the false twisted area. Stripping action produced by increasing friction between traveller and yarn.

This invention relates generally to torque yarn and more particularly to a process for manufacturing torque yarn at a faster rate although utilizing substantially conventional and commercially available textile equipment.

Torque or elastic yarn is used by the textile industry in the manufacture of hosiery for both men and women, in the production of foundation garments, support hosiery, shirts, dresses, slacks, sports goods, and for various other purposes. While therapeutic value may be attained with hosiery manufactured from high torque yarn (see for example Patent No. 2,841,971), a general overall improvement in fit and appearance can be obtained through use of yarn having somewhat less torque than utilized for support purposes.

The type of torque yarn here under consideration has been produced for a number of years by a three-step system known as the "Helanca" process which is explained fully in U.S. Patents Nos. 2,019,183, 2,019,185, 2,564,245, and 2,585,518. According to this system, as there explained, elasticity and curliness are added to synthetic yarns by (a) twisting the yarn and collecting the same in package form, (b) heat setting the twist and cooling while still in package form, and (c) untwisting the yarn.

While the torque yarn having desirable properties is produced in the manner described above, it will be apparent that considerable time as well as equipment is necessary for manufacturing a finished product. Since the number of processing steps involved has a direct bearing on the cost, it will be further apparent, and this is borne out in commerce, that the "Helanca" process results in a rather expensive torque yarn. Furthermore, the amount of time required for producing "Helanca" yarn results in an undesirably large in-process inventory.

In order to overcome some of the disadvantages inherent in the "Helanca" system, the yarn throwing industry adopted a so-called "walse twist" process of continuously and simultaneously twisting, untwisting and heat setting. This improved system is exemplified by U.S. Patent No. 2,777,276. While satisfactory torque yarn may be produced on conventional false twist equipment at considerably faster speeds than with the "Helanca" system, consumer demand for this product increased and the trade eventually progressed to even higher speed false twist systems as shown in U.S. Patent No. 2,855,750.

2

The higher speed equipment represented by the last mentioned patent increases the production of torque yarn from about 15 to 20 yards per minute to about 100 yards per minute. While this is a considerable improvement over both the original three-step torque yarn process and the initial continuously twist, heat set, untwist process, this form of texturizing synthetic yarn is still considered rather slow when compared to other types of texturizing such as stuffer box and gear crimping. Accordingly, every effort has been and now is being made to devise a torque yarn manufacturing process which is operative at speeds more comparable to other texturizing systems.

One of the objects of the present invention is to provide a process for manufacturing torque yarn not having the disadvantages mentioned above.

A further object of the present invention is to provide a process for manufacturing torque yarn at high speed.

Another object of this invention is to provide a torque yarn manufacturing process which is more economical than heretofore known systems.

Still another object of the present invention is to provide a process for manufacturing torque yarn which may be accomplished without additional textile processing steps.

An additional object of this invention is to provide for the economical and expeditious manufacture of an improved torque yarn, fabric and hosiery.

These and other objects to appear hereinafter may be accomplished in accordance with this invention by heat setting a temporary twist imparted by and impounded upstream from the yarn traveler of a conventional ring-twisting machine. Improved results are obtained by increasing the amount of twist temporarily impounded. This may be effected through modification either of the traveler, the traveler thread-up scheme and/or the yarn cross-section. Moreover, a further improvement in results may be obtained by drawing to orient the molecules in the yarn immediately prior to twist setting. Accordingly, best results are obtained by the practice of this invention on a slightly modified and commercially available drawtwister.

Upon cursory examination, it would appear the Patent No. 3,001,355 is directed to a modified embodiment of the invention set forth herein, since that patentee feeds thermoplastic yarn from a heated roller direct to a ring twister take-up. Patentee, however, apparently utilizes a different system for imparting a positive twist in a short length of yarn immediately downstream of the heater roll and states rather emphatically that he is working with real or permanent twist rather than a temporary twist, and that this twist concentrates adjacent to the downstream or outflow side of his twist arresting heater roll. The present invention, on the other hand, concerns a definite temporary twist which is set over an extended path rather than in a concentrated portion thereof.

A more detailed explanation of the foregoing will be given in connection with a description of the drawings, wherein:

FIGURE 1 illustrates in elevation a drawtwisting machine with a simplified modification for practice of this invention, and

FIGURE 2 represents a view in elevation of a drawtwisting machine requiring a more involved modification but producing more desirable results.

Synthetic yarn 10, which may be nylon, polyester, polypropylene, or other linear high polymers, is fed from yarn package 11 to the feed roller 12 of drawtwisting machine indicated generally at 13. In the system illustrated, yarn 10 has not yet been "drawn" or attenuated to orient the molecules thereof but has been collected in an undrawn condition as represented by the initial take-up package 11. While this invention may be practiced with yarn which has previously been drawn, it will be shown hereinafter that considerably improved results are obtained not only in torque properties of the yarn but also in uniformity of appearance and hand of the finished product, by simultaneously drawing and torque setting in the manner to be described.

Draw godet 14 is driven at a higher rate of speed than feed roller 12 and functions in the normal manner to stretch the yarn and thereby improve the physical properties thereof. Drawpin 15 may be used to localize the draw point if such is desired.

In a normal drawtwisting operation, drawn yarn 16 would be fed directly through pigtail guide 17 and traveler 18 onto the spindle supported pirn 20. However, in the first modification of the invention, an auxiliary heated pin 21 has been mounted in juxtaposition to draw godet 14 and receives drawn yarn 16 prior to travel through the pigtail guide 17. By experiments to be explained presently, it has been determined that yarn extending between draw godet 14 and traveler 18 on a conventional machine contains a certain amount of twist. Realization and utilization of that twist is believed to be an important aspect of this invention.

It has long been recognized that a certain amount of twist is required to protect the individual filaments of a multifilament yarn. Several methods of achieving this during package forming have been developed and are described by Truslow in his Handbook of Twisting, chapter II, published in the Textile Bulletin of January, February, April, and May of 1954. One of these is the widely used ring-twister in which yarn is fed from a pair of rolls through a guide, around a traveler, and then onto a package. The traveler moves freely in a circular path around the take-up package, guided by a smooth ring. The actual mechanism of twisting is described by Truslow, but in particular he mentions that the twist inserted can be calculated from the constants of operation, and that the twist is initially inserted in the yarn upon release by the front rolls and therefore is essentially completed by the time the yarn passes through the traveler.

It has now been discovered, however, that with certain modifications of the yarn, or the traveler, or the thread-up of the yarn through the traveler, it is possible to achieve a much higher level of twist between the traveler and the feed mechanism. This is essentially a false twist since it exists temporarily in the yarn at one stage in the yarn travel and is not found in the yarn as it is taken up on the bobbin or pirn. As an example of the level of false twist which can be obtained above the traveler, the ring-twister 13 in one experiment was set to produce a nominal twist on pirn 20 of approximately one-half turn per inch. Through use of a modified traveler 18, a twist level of 45 turns per inch above the traveler resulted.

The high level of twist in the present invention results from the frictional forces between the yarn and the traveler which resist rotation of the yarn bundle relative to the traveler as the bundle passes therethrough. The importance of this rotation of the yarn in its passage through the traveler can be understood by considering what happens if the yarn is replaced by a flat elastic ribbon. Such a ribbon running through the traveler without relative rotation is fed onto the bobbin with no twist, and each complete cycle of the traveler around the ring imparts one turn in the ribbon above the traveler. This twist is therefore confined between the feed rolls and the traveler, and as it builds up, results in rotational forces acting on that section of the ribbon passing through the

traveler. These forces will increase steadily until they reach the level at which the flat ribbon is actually turned about its own axis in the traveler, allowing one-half turn to slip past, and temporarily relieving the forces. On the next half circuit of the traveler in the ring, the forces are again raised to this threshold level and another half turn slips through; in other words, an equilibrium point has been reached with the twist of the ribbon above the traveler constant, and with the rotational forces in the yarn just sufficient to push one turn of the ribbon through the traveler for each turn put in by the movement of the traveler around the ring.

Thus, any factors that can cause the yarn bundle to react as a ribbon will result in a trapping or impounding of the twist above the traveler, hereinafter referred to generally as stripping back of twist. Such factors can be noncircular cross-section in the yarn filaments, or the use of a sharp edge on the traveler to spread the filaments out into a ribbon-like form, for example, of the manner in which the yarn is threaded through the traveler.

Having found a method of establishing a high level of false twist, it is possible without material modification of the system to heat-treat the false twisted yarn in its highly twisted state, producing a significant level of torque in the low twist yarn taken upon the pirn 20. In particular, this heat treatment may consist in passing the yarn over a heater at any point between the feed roll and the balloon of the ring-twister, shown, for example, by the heated pin 21. Here the yarn is softened in its highly twisted geometry, and the subsequent cooling that results from the high speed ballooning of the yarn still in the state of high twist sets this twist. However, as explained above, the yarn being wound up on the bobbin has a low twist, and in effect has been untwisted from the false twisted condition in which it was heat-set.

The auxiliary pin 21, which preferably is maintained at from 165 to 180° C., but which may be operated over a range of temperatures to be described subsequently, is mounted alongside the path of drawn yarn 16 prior to take-up. Twist which is impounded in the yarn 16 by frictional contact with the traveler 18 backs to and partially around the auxiliary pin 21. An equilibrium condition of twist is produced by the frictional resistance to rotation existing between the yarn and the traveler and by the extent of twist accumulated both in the ballooning yarn and in that portion of yarn extending between the guide 17 and and pin 21, as explained earlier.

As soon as the equilibrium condition is established in a given, running yarn 16, further twist will not be accumulated or impounded above traveler 18 because the torque required to impart such additional twist will overcome the frictional resistance existing between the yarn and traveler. At this point the yarn will rotate relative to the traveler and cause "spilling over" of twist past the traveler and onto pirn 20. A greater amount of twist, therefore, may be temporarily accumulated for any particular yarn only by increasing the frictional resistance or gripping force existing between the traveler and yarn. This may be accomplished in a number of ways to be described hereinafter.

In the embodiment of FIGURE 1, twist imparted by traveler 18 backs up to and even partially around the pin 21, as indicated above. The high twist occurring in drawn yarn 16 downstream of pin 21 diminishes gradually over the pin and is practically nonexistent in the portion of yarn extending between draw godet 14 and auxiliary pin 21. The twist in yarn wrapped about auxiliary pin 21 is set by the heat of this pin much in the same manner as the heat setting of false-twisted yarn. In other words, the yarn is heat softened, thereafter cooled while held in a twisted condition, and then allowed to untwist, thus creating a tendency in the yarn to return to a twisted condition and producing the torque effect desired for the purposes mentioned hereinabove.

5

A somewhat different modification to conventional draw-twisting equipment for practice of this invention is illustrated in FIGURE 2. As will appear from the examples, this system gives improved results over the apparatus of FIGURE 1, and therefore represents a preferred embodiment, insofar as concerns the product. On the other hand, the heater plate of this modification obviously requires more space and, therefore, might be less preferred for mechanical reasons. Accordingly, although the plate modification will be shown to produce better results than the pin embodiment, there are many reasons, i.e., economy, construction, etc., why either type heater might be preferred over the other.

The yarn supply, feed roller, draw godet, draw pin, and take-up are the same as that shown in FIGURE 1, and these parts accordingly are identified by correspondingly similar reference numerals. Heated auxiliary pin 21, however, has been replaced by a second pitgail guide 22 and the plate-type heater 23. A major distinction having a direct relationship on the quality of torque yarn produced has been found to exist in these two embodiments. In the apparatus of FIGURE 2, the friction of traveler 18 produces twist in drawn yarn 16 as previously described. It will be seen from the examples appearing hereinafter, however, that most of the accumulated twist backs up past the heater plate 23. Accordingly, heater plate 23 not only contacts a greater portion of twisted yarn, but also heats yarn having a uniformly higher amount of twist than does the pin 21 of the first embodiment. The longer exposure of yarn to the heated surface and the higher amount of twisting present in the yarn when heated results in a much more desirable, higher torque yarn than is available from use of a stationary heated pin such as described earlier.

Since the remainder of this specification will be devoted to examples illustrating the effect of certain variables on "torque level" (i.e., amount of torque produced in the yarn), a brief description will be devoted to the procedure used for determining torque from various samples. There are micro-balance meters commercially available for electrically determining the amount of torque in funicular structures such as synthetic yarn. For example, Cahn Instrument Company of Paramount, Calif., manufactures an Electrobalance (TM) meter which may be converted for attaching one end of torque yarn to an indicating needle and for fixing the other end of yarn against rotation. Any torque present in the yarn functions to deflect the needle from a zero or normal position. Upon application of current through a needle-associated coil, the yarn torque may be overcome and the needle returned to zero position. The amount of current required to re-zero the needle is directly proportional to the amount of torque present in the sample being tested. Since the meter or needle is balanced in each test to the same zero position, any uneven magnetic field effects about the needle axis are eliminated.

In all of the following examples, "torque level" values actually represent current readings in micro-amps. If desired, these values may be converted to torque in milligram-centimeters upon multiplication by a factor of 0.15. The figures are used, however, merely to show relative torque levels of the product of this invention and of conventional false-twisted yarn, and have not been converted to the more accurate nomenclature usually associated with torque. Each "torque level" reading reported hereinbelow was obtained by wrapping five strands or convolutions of yarn into a loop or skein form, and by then holding one portion of the loop fixed while attaching the opposite loop portion to a meter needle such as described above. Insofar as possible, all samples were prepared and tested in the same manner.

EXAMPLE I

In order to provide a guide line of comparison, 15 denier, monofilament (15/1) nylon yarn which had been

6

false-twisted in a conventional (low-speed) manner was divided into sample lots, prepared in skein form, and tested in the manner indicated above. The values obtained appear in the following tabulated form. As will be noted, tested were made on yarns which had been false-twisted in both "S" and "Z" directions.

TABLE I

Experiment	Torque level	
	"S" twist	"Z" twist
1.....	109	96
2.....	112	107
3.....	130	119
4.....	119	103
5.....	120	102
Average.....	118	105

Either one of the two false twist systems mentioned above provides a product having torque satisfactory for the desired end uses. These methods of production, however, are time consuming and therefore expensive. Accordingly, production of torque yarn at a higher or greater rate of speed has obvious economical advantages.

EXAMPLES II

As an initial experiment, a 15/1 nylon yarn similar to that which had been false-twisted by conventional methods in Example I was treated according to the invention herein set forth. The yarn was processed on a conventional drawtwisting machine modified by the addition of a heater plate maintained at about 180° C. Various samples of this yarn were collected while imparting and impounding ("twist setting") both "S" and "Z" temporary or false twist. The results obtained are as follows:

TABLE 2

Experiment	Torque Level	
	S	Z
1.....	104	96
2.....	104	91
3.....	114	105
4.....	104	99
Average.....	107	98

Each of the foregoing experiments represents the average of a number of torque level tests and the lowermost figures represent an overall average of all the tests in both S and Z directions. It will be seen that the torque level obtained with the system of this invention compares very well with the torque level of the torque yarn in Example I which was produced by the more conventional method of false twisting. Other improvements and advantages will appear from a review of the additional examples appearing hereinafter.

EXAMPLE III

A 15/3 polyester yarn was treated at various heater temperatures to illustrate the general level of torque for this type yarn relative to the conventional false-twisted nylon reported in Example I. Measurements were taken for both S and Z twisted yarn at a low temperature level and two different sets of measurements have been recorded for S twist at a higher temperature level, as represented hereinbelow.

TABLE 3

Experiment	Torque level			
	150° C.		180° C.	
	S	Z	S	S
1.....	91	67	89	92
2.....	88	66	97	88
3.....	80	68	91	90
4.....	89	69	100	80
5.....	88	76	82	85
Average.....	87	69	92	87

It is evident from these tests that the torque level of polyester yarn does not compare as favorably with that of a conventional false-twisted nylon yarn as does the nylon of Examples II. A torque is produced, however, even though to a lesser extent.

As indicated hereinabove, a distinctly different and improved product is obtained from the present invention if the twist-setting operation occurs simultaneously with or immediately after the drawing operation, as exemplified in each of the two figures attached hereto. In order to illustrate these distinctions, a number of separate comparative tests were made. In each of the following examples the discontinuous experiments were run by first drawing and collecting the yarn on a flat package take-up (without twist), by storing this yarn approximately 24 hours, and then by twist-setting. Similar or comparative yarn was treated on equipment such as that shown in the drawings without any discontinuity of process.

EXAMPLE IV

A 40 denier 8 filament (40/8) polypropylene yarn was tested in the manner indicated above. In each experiment recorded below the heater temperature was maintained at about 160° C. Results obtained are as follows:

TABLE 4

Experiment	Torque level	
	Continuous	Discontinuous
1.....	37	32
2.....	31	29
3.....	38	30
4.....	38	30
5.....	37	27
Average.....	36	30

It will be seen that the torque level for yarn processed continuously ranges about 20% higher than the level for discontinuously processed yarn. It is noted, however, that the torque level for polypropylene yarn is somewhat lower both than conventionally false-twisted nylon tabulated above and the twist-set polyester processed according to this invention, and is also lower than that of twist-set nylon, as will appear hereinafter.

EXAMPLE V

An additional amount of polypropylene 40/8 yarn was processed again at 160° C., to determine if the low torque level obtained in Example IV might be improved. These experiments were further expanded to include both S and Z twisted yarn.

TABLE 5

Experiment	Torque level			
	Continuous		Discontinuous	
	S	Z	S	Z
1.....	72	69	40	41
2.....	60	68	36	42
3.....	77	76	45	44
4.....	76	75	43	45
5.....	75	81	45	46
Average.....	72	74	42	44

In this experimental re-run, an even greater improvement is shown between the continuous and discontinuous processes. For example, the average torque level of S twisted yarn processed in a continuous manner is about 72% higher than the level of discontinuously processed yarn. The Z twisted yarn has a consistently lower torque level but still averages an improvement of about 68% in the continuous system.

EXAMPLE VI

To further illustrate the significant improvement between continuous and discontinuous drawing and torque setting, separate samples of a 40/8 nylon yarn were proc-

essed in the two systems at about 180° C., with the following results:

TABLE 6

Experiment	Torque level	
	Continuous	Discontinuous
1.....	79	45
2.....	76	45
3.....	79	43
4.....	76	41
5.....	75	41
Average.....	77	43

The torque level of this yarn approaches that of false twisted yarn reported in Example I and as will be seen from these experiments, the torque level from the continuous system is about 79% higher than the level of comparative yarn processed by the discontinuous system described above.

EXAMPLE VII

A 15/1 nylon yarn was processed at 180° C. Here again both S and Z measurements were taken with the results as tabulated below.

TABLE 7

Experiment	Torque level			
	Continuous		Discontinuous	
	S	Z	S	Z
1.....	61	70	65	63
2.....	67	69	60	62
3.....	65	69	60	59
4.....	60	54	56	60
5.....	61	64	57	60
Average.....	63	65	60	61

It will be apparent from a review of Table 7 that the improvement obtained in continuous processing also exists with monofilament yarn but not to the same degree as was obtained with multifilament yarn. For example, the S twisted yarn shows an improvement of only about 5.4%, and the Z twisted yarn a corresponding improvement of only about 7.2%. These figures do not reflect the entire advantage, however, because the average discontinuous torque levels of 60 and 61 are not reflected in lengthwise extension of fabrics knitted therefrom in comparison with the continuous torque levels. The fabric obtained from corresponding continuously processed yarn has a hand and appearance which shows much more improvement than the small percentage increase mentioned above would indicate.

EXAMPLE VIII

In order to determine the difference, if any, between products obtained by the two embodiments illustrated herein, one sample of 40/8 nylon was processed over the hot pin embodiment of FIGURE 1 and another sample of 40/8 was processed over the hot plate modification of FIGURE 2. The pin of the first sample had a diameter of 60 millimeters and the plate was 8" long. Both the pin and plate were maintained at about 180° C.

TABLE 8

Experiment	Torque level	
	Pin	Plate
1.....	51	90
2.....	56	92
3.....	57	90
4.....	52	87
5.....	51	80
6.....	49	80
7.....	53	87
8.....	50	89
9.....	49	88
10.....	45	90
11.....	42	87

It is evident that the torque level occurring in yarn processed on the plate modification of FIGURE 2 is superior to that of the pin modification of FIGURE 1 in all samples

taken. Moreover, fabric woven from this yarn is more uniform than that of yarn processed on the pin. It is believed that this improvement is due to the fact that heater plate 23 sets twist over a much longer length of yarn than does the pin 21. This, of course, is contrary to the teachings of aforesaid Patent No. 3,001,355, which specifies concentration of twist in a short zone. Tests to date, however, seem to bear out the improvement to be expected from heating over an extended length of temporarily twisted yarn.

EXAMPLE IX

It has been further demonstrated that the draw ratio affects the amount of torque to be produced in any particular type of yarn. A 40/8 nylon yarn was processed with the continuous system mentioned hereinabove and at a variety of draw ratios between feed roller 12 and draw godet 14. Each of the ratios listed in Table 9 hereinbelow has a reference to a base of 1, and each of the torque level figures recorded represents an average of five separate experiments.

TABLE 9

Draw ratio: (to 1)	Torque level	
	S	Z
2.80-----	86	88
2.90-----	87	99
3.00-----	85	86
3.10-----	79	83
3.15-----	75	79
3.20-----	74	76
3.30-----	69	72
3.40-----	69	67

Although this is more clearly shown in a graph, it will be seen from the tabulated form appearing hereinabove that the torque level of both S and Z twisted yarn drops off appreciably with an increase in the draw ratio from about 2.90 to 1 to about 3.30 to 1. The best results were obtained in each of the two directions of twist at a draw ratio of 2.90 to 1. It is noted, however, that this represents the most normal draw ratio for this particular type of yarn, and best results would be expected in that range.

EXAMPLE X

It has also been found that a variation in the twist setting temperatures has an influence on the amount of torque produced by the processes of this invention. A number of tests have been conducted with both 40/8 and 15/1 nylon with variation in the temperatures of plate 23 over a large range. Both S and Z twist yarns were produced and each of the torque levels reported in the following Table 10 represent measurements taken from at least six different operating positions of a modified drawtwisting machine.

TABLE 10

Temperature (° C.)	Torque level			
	40/8 nylon		15/1 nylon	
	S	Z	S	Z
150-----	50	79	60	60
155-----	74	78	71	74
160-----	81	93	76	85
165-----	82	92	79	86
170-----	94	91	82	87
175-----	73	89	84	88
180-----	80	82	70	81
185-----	86	94	86	78
190-----	76	96	81	80

Except for isolated instances, which undoubtedly were caused by freak situations, it appears that a higher torque is obtained in either type yarn and either type twist in the range between 165 and 175° C. This, of course, applies to both monofilament and multifilament as indicated by this table. It has been further determined that yarn produced at the range of temperatures giving the best torque level also results in a better fitting and nicer appearing hosiery.

EXAMPLE XI

By experimentation with 40/8 nylon yarn, it has been determined that the size or weight of the ring traveler used in the practice of this invention affects torque level to some extent, although not as great as other variations noted earlier herein. Three different weights of commercially available steel travelers were tested to determine the torque level appearing in Table 11 below. The level obtained on No. 18 traveler is an average of 24 separate tests having measurements ranging from 49 to 73. The level produced by No. 20 traveler represents an average of 11 tests varying from 61 to 70, and five different tests with the No. 24 traveler ranged from 66 to 70 in producing the average shown.

TABLE II

Traveler No.	Torque level	Weight (milligrams)	Diameter (microns)
18-----	63	100	850
20-----	66	80	700
24-----	68	40	560

It appears from the foregoing that twist or torque level may be adjusted by varying the traveler. Better results may be obtained, as indicated, through use of a higher traveler number.

EXAMPLE XII

It was felt that the lower weight of traveler No. 24 in the preceding example had less effect upon the improved result than the smaller diameter associated with this element, since the amount of torque produced or twist imparted depends upon the degree of frictional resistance existing between the thread and traveler, as mentioned supra. The smaller diameter traveler of course presents a more sharply curved surface and the yarn will inherently cling more to this surface than to the relatively blunt or dull surface presented by larger travelers.

To test the foregoing theory, 40/8 nylon was processed in the manner described hereinabove through a No. 20 traveler weighing 0.1353 gram, and at a heater temperature of 190° C. The weight of this same traveler was reduced to 0.1044 gram by filing away portions not in contact with yarn, after which the experiment was repeated. The results appear as follows:

Experiment	Torque level	
	Normal traveler	Modified traveler
1-----	98.8	96.3
2-----	95.0	100.0
3-----	98.8	93.8
4-----	96.3	92.5
5-----	93.8	97.5
Average-----	96.3	96.3

It will be seen that the average torque level using a normal traveler was identical to that of a traveler modified as to weight but not as to surface contacting area. Any change in tension of the ballooning yarn due to increase or decrease in weight of the traveler, therefore, clearly appears to be offset by the concurrent change in traveler size.

EXAMPLE XIII

Utilizing some of the travelers described in Example XI, the threading scheme for yarn passing therethrough and onto the take-up pin was varied to determine possible effect on torque level. The figures appearing in Table 13 represent an average from a considerable number of measurements after processing 40/8 nylon. The normal thread up scheme entails passing yarn through the traveler in the same direction of motion as the pin. In other words, if the pin rotates counterclockwise, the traveler also rotates counterclockwise and the yarn normally is threaded from the guide 17 in a counterclockwise direction through traveler 18. In the modified or "reverse" thread up, assuming that the pin continues to rotate

counterclockwise, thus producing counterclockwise rotation in the traveler, the yarn is again fed from the pigtail guide 17 in a counterclockwise direction through the traveler but then back around itself prior to passage onto the pirn, thus changing the extent of yarn wrap about the traveler.

TABLE 13

Traveler No.	Torque level	
	Normal threadup	Reverse threadup
20	98	130
22	100	142

As will appear from these data, the change in thread up produces a considerable increase in torque level, about 30% for the #20 traveler and about 42% for the #22. It is believed evident that these improved results occur because of the increased friction between the yarn and traveler.

EXAMPLE XIV

Various tests have been run to determine exactly where the greatest amount of false or temporary twist occurs in the two modifications disclosed herein. Each of the samples was produced with 40/8 nylon yarn heat set at approximately 180° C. As will appear from Table 14, two different size pins were used along with the plate embodiment of FIGURE 2. The continuous and discontinuous columns again refer to simultaneous drawing/twist setting, and intermediate collection and storage, respectively, as discussed in earlier examples.

TABLE 14

Location of measurement	Turns per inch	
	Continuous	Discontinuous
(a) 60 mm. pin:		
Above heater.....	0	0
Below heater.....	24	30
(b) 30 mm. pin:		
Above heater.....	1	2
Below heater.....	24	28
(c) Plate:		
Above heater.....	24	16
Below heater.....	48	36

From the foregoing, and particularly when compared with figures obtained in Example VIII, it becomes apparent that the stationary hot pin 21 permits some twist to back up and does not, therefore, abruptly end the temporary twist produced by the traveler 18. It has already been shown from aforesaid Example VIII that better results are obtained if a major portion of the twist is permitted to extend back past the heating means. This is evidenced by the torque level obtained through use of heater plate 23 and the amount of twist present in yarn extending between heater plate 23 and the pig tail guide 22. It is believed that use of a stationary pin 21 results in a better product than would be produced from a rotating pin, however, since the relative motion between the yarn and stationary pin permits the twist to back up farther around the pin than would be the case if the pin were rotating.

There are other ways in which resistance to rotation between yarn 16 and traveler 18 may be increased to thereby improve the torque level. For example, round monofilament or multifilament yarn may be modified to present a more flat surface for gripping the traveler. Such a flat sided yarn may be produced by extrusion through a noncircular orifice or by scraping with a hard surface prior to passage through the traveler, or by deforming in some other manner, such as cooperating pressure rolls. Furthermore, the traveler may be modified to increase friction by, for example, decreasing the radius of yarn contacting surface or a thread up modification, such as multiple yarn wraps, may be used.

EXAMPLE XV

In addition to the modifications mentioned above, the frictional grip between traveler 18 and yarn 16 may be improved considerably by grinding the traveler in such a manner as to present a sharp edge or sharp surface to the yarn passing therethrough. Separate yarn samples were tested with different weight travelers modified in this manner to produce results which appear as follows.

TABLE 15

Traveler No.	Modified traveler,			Normal traveler,		
	torque level balloon tension			torque level balloon tension		
	S	Z	Grams	S	Z	Grams
40/8 nylon:						
18.....	66	63	55	57	61	75
20.....	92	82	30	87	86	50
15/1 nylon:						
23.....	114	105	11	88	85	19
24.....	104	99	14	97	94	22

As indicated in Example XII, the lower weight travelers (higher traveler numbers) have been found to produce higher torque levels. Moreover, in each of the experiments tabulated above, the traveler which had been modified by grinding to a sharp surface produced an increased torque level. This further substantiates the previous conclusion that the smaller diameter of the traveler has more effect on improving torque level than the reduced weight. Also, as indicated earlier herein, the yarn tension while ballooning varies considerably upon variation in traveler size and weight.

The process described above and illustrated by the various examples has been found to produce a yarn having torque comparable to that produced by more conventional systems such as false twist. Moreover, the elongation and elasticity of the yarn, as well as the hand and appearance of hosiery or fabric produced with this yarn, compares favorably with that of known systems. Hosiery produced with this yarn, for example, have sufficient resiliency to insure a snug and comfortable fitting and a pleasing appearance. All of these advantages are obtained with the present invention by the mere addition of an auxiliary heater and by slight traveler modification on a conventional draw twisting machine. This invention requires a nominal expenditure when compared to the cost of false twisting spindles as well as the additional operating step previously required and is even more economical because of the multifold increase in operating speeds.

What is claimed is:

1. A process for manufacturing torque yarn comprising the steps of feeding synthetic linear high polymer yarn to a ring twister take-up imparting false twist to the yarn over an extended length upstream of the traveler by the friction exerted during rotation thereof, heating the yarn while temporarily twisted, and allowing the yarn to cool prior to passage through the traveler onto the take-up.

2. A process for manufacturing torque yarn comprising the steps of creating a twist in a synthetic linear high polymer yarn by collection in package form, impounding the twist to spread the same over an extended path of yarn travel, heat setting the twist temporarily impounded over an extended area, and allowing the yarn to cool prior to release of the twist temporarily impounded therein.

3. A process for manufacturing torque yarn comprising the steps of feeding yarn through a twist setting zone of extended length into a package, collecting the yarn in package form while imparting twist, temporarily stripping back twist in said yarn and impounding the same within said twist setting zone and for an additional length downstream therefrom, setting the twist temporarily impounded, and allowing the yarn to cool in said additional length prior to release of the temporary twist.

4. A process for manufacturing torque yarn comprising the steps of temporarily twisting synthetic linear high polymer yarn while collecting the same in package form,

maintaining this twist in the yarn over an extended path immediately prior to collection, heating the yarn over this extended path to set the twist temporarily imparted, and cooling the yarn while maintaining the temporarily twisted condition.

5 5. A process for manufacturing torque comprising the steps of collecting synthetic linear high polymer yarn while imparting a temporary twist thereto, stripping back the yarn twist imparted during collection to spread the same over an extended length, heat setting the yarn over the extended length of temporary twist, and cooling the yarn 10 prior to release of the temporary twist.

15 6. A process for manufacturing torque yarn comprising the steps of feeding undrawn synthetic linear high polymer yarn to a drawing zone, molecularly orienting the yarn in the drawing zone, feeding yarn immediately from said drawing zone into a collection zone, imparting a temporary twist to said yarn during collection, impounding said temporary twist over an extended length prior to collection, heating the yarn over at least a portion of said extended length to set the twist, permitting the yarn to 20 cool before release of the twist, and collecting the yarn in package form.

25 7. A process for manufacturing torque yarn comprising the steps of feeding synthetic linear high polymer yarn to a ring twister take-up having a ring traveler through which the yarn is passed, imparting twist to the yarn by friction of the rotating traveler, stripping back and impounding the twist imparted by increasing the surface friction existing between the traveler and yarn, heating the twisted 30 yarn to set the twist, and cooling the yarn prior to removal of the false twist.

35 8. A process for manufacturing torque yarn comprising the steps of feeding synthetic linear high polymer yarn to a ring twister take-up having a ring traveler through which the yarn is passed, increasing the surface friction existing between the traveler and yarn to resist rotation of the yarn relative to the traveler, rotating the traveler to impart a twist to yarn passing therethrough, accumulating twist imparted by the traveler, heating the yarn over an extended surface of accumulated twist, and collecting 40 the yarn in package form.

9. A process as set forth in claim 8 including the additional step of deforming yarn fed to said ring twister to

produce at least one flat side and thereby increase the surface friction between the traveler and yarn.

10. A process for manufacturing torque yarn comprising the steps of feeding undrawn synthetic linear high polymer yarn to a drawing zone, molecularly orienting the yarn in the drawing zone, feeding the drawn yarn immediately into a collection zone, imparting a temporary twist to the yarn by collection, impounding said temporary twist over an extended length of yarn travel upstream of collection, heating the yarn over an extended length while twisted, cooling the yarn prior to release of twist, and collecting the yarn in package form.

11. A process for manufacturing torque yarn comprising the steps of feeding undrawn synthetic linear high polymer yarn to a drawing zone, elongating the yarn to orient the molecules therein during passage through said drawing zone, feeding said yarn immediately from said drawing zone to a ring twister take-up having a rotating ring traveler through which the yarn is passed, imparting a temporary twist in said yarn by friction of the rotating traveler, stripping back and impounding the temporary twist imparted by increasing the surface friction existing between the traveler and yarn, heating the yarn while maintaining the temporary twisted condition, releasing the twist temporarily imparted, and collecting the yarn in package form.

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57—34