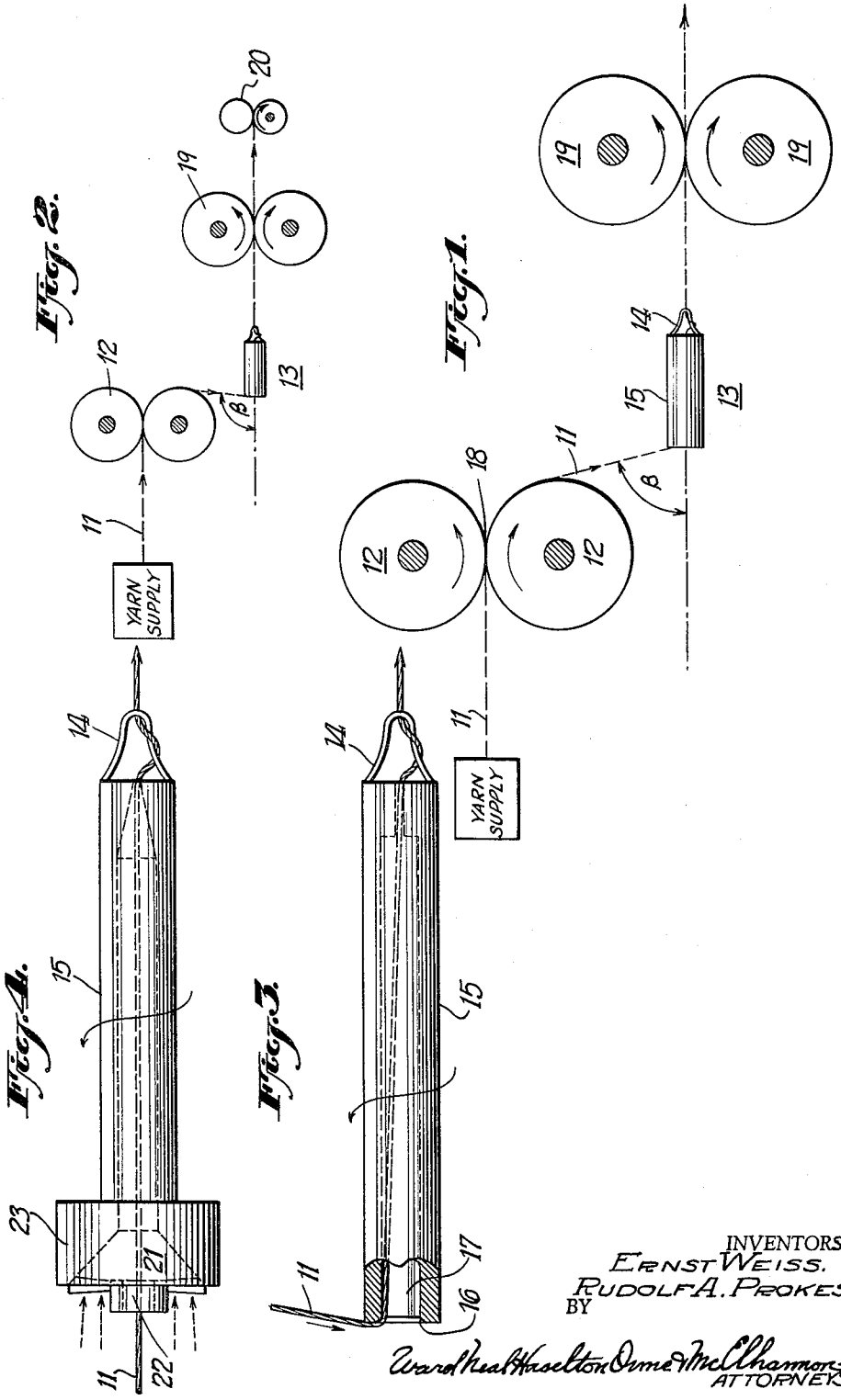
Sept. 11, 1962 E. WEISS ET AL 3,053,038

METHOD AND APPARATUS FOR TEXTURING YARNS

Filed Nov. 28, 1958 2 Sheets-Sheet 1



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Fig. 6.

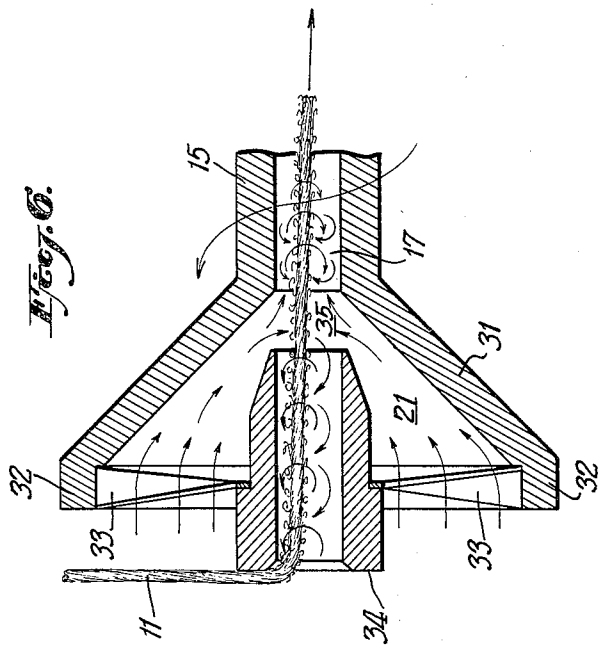


Fig. 5.

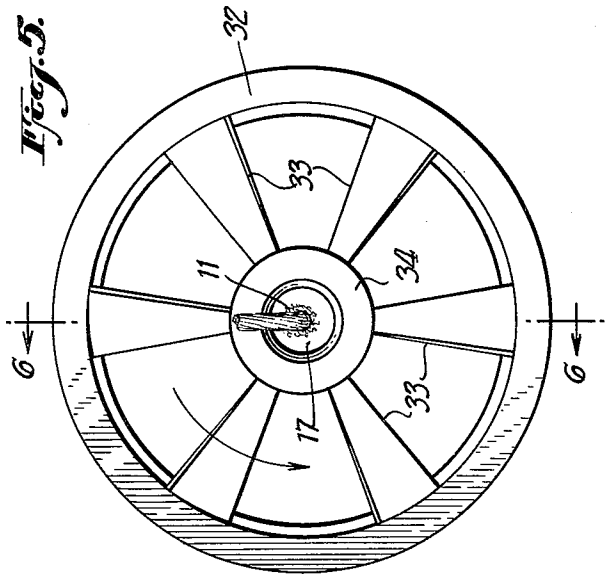


Fig. 7.



Fig. 8.



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METHOD AND APPARATUS FOR TEXTURING YARNS

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16 Claims. (Cl. 57—34)

This invention relates to a method and apparatus for texturing yarns. More specifically it relates to a method for producing a textured yarn from a pre-twisted, continuous multifilament yarn, and also to apparatus for carrying out the method.

It is known that voluminous or bulky yarns, referred to herein as textured yarns, can be produced from yarns made up of a bundle of continuous filaments by passing the yarn through a zone of turbulent air flow, specifically a jet of air under pressure, which distorts the individual filaments and forms irregular loops therein. Such a process is described in U.S. Patent Nos. 2,783,609 and 2,852,906. According to No. 2,783,609, the yarn to be textured is not pre-twisted. Rather, it is subjected to the turbulent air at zero twist or at a twist of less than about one turn per inch. Following texturing according to the prior art, the yarn is uptwisted about 6–8 turns per inch. In No. 2,852,906 it is stated that the yarn may be pre-twisted up to 5 turns per inch (200 t./m.), but it is noted that the denier increase of the finished yarn is substantially less than where the yarn to be treated had under about one turn per inch pre-twist.

While highly desired textured yarn products are produced by the process of the above patents, the method requires substantial quantities of air under relatively high pressure, which contributes appreciably to the cost of such a texturing operation. Since twist is essential to stability of the textured yarn product, uptwisting prior or subsequent to texturing is required.

The present invention provides a method for texturing an already pre-twisted continuous multifilament yarn which does not require a source of air under pressure, or the intricate apparatus which comprises the necessary air jet. The textured yarn product so produced is of substantially the same type and quality as that made by the process of the above patents, and the yarn is pre-twisted prior to texturing to as high a degree as desired.

According to the method of the present invention a pre-twisted yarn consisting of continuous, synthetic or manmade multifilaments is passed through a rotating false twisting device which temporarily back twists the yarn sufficiently to appreciably open the yarn bundle for a short interval, in which back twisted condition it is subjected to induced vortical streams of air which displace individual yarn filaments from their normally parallel relationship and form random loops therein. Following formation of the loops the initial twist is restored to the yarn. The air vortices are of relatively weak intensity as compared with the high pressure air stream of the prior art but are powerful enough to create loops and distortion in the temporarily un-twisted yarn.

As a result of rotation of the yarn during back twisting, the individual filaments are caused to oscillate and are thrown outward, being at the same time temporarily opened thus enabling a highly effective distorting action to work onto the filaments with the result that they are more easily distorted and looped than filaments which pass the vortical zone in a twisted state and without the simultaneous rotation imparted by the false twisting device. This accounts for the effectiveness of the relatively weak air vortices herein, as compared with the high pressure air streams required by other processes.

The present process does not require an external source of air under pressure. Rather, air vortices, or vortical air streams, are induced through rotation of the spindle of the false twist device. The vortical air stream may be generated adjacent the feed end of the hollow false twist spindle in at least two ways. For example, a propeller fan may be mounted on the feed end of the rotating spindle with the result that the desired air streams are created adjacent this spindle end and extend therein to. Without resorting to a propeller fan or other equivalent means, the requisite air vortices may be created simply by feeding the yarn to the rotating false-twist spindle at an angle to the spindle axis such that the moving yarn is in frictional contact with the rotating end of the spindle. Friction between the opened yarn and the rotating spindle end, the air travelling with the yarn and air currents resulting from rotation of the spindle create vortical streams adjacent the end and within the spindle which displace and loop the yarn filaments as they pass through the vortices. In addition the normal relationship of the filaments in the opened bundle is also disturbed as the yarn passes in contact with the rotating end and angles into the axial opening of the spindle. As a result of this action only weak air vortices are required to effect loop formation. In many cases the yarn may be angularly fed to a propeller fan or otherwise modified spindle, although, where the spindle is so modified the yarn may be fed axially and without contacting the spindle end.

The method of the present invention is suitable for treating yarns made of wholly synthetic material, for example polyamides, polyesters, vinyl polymers or acryl polymers. It is also applicable to yarns made of regenerated cellulose, such for example as viscose rayon or cuprammonium rayon, as well as cellulose derivative yarns, particularly acetate rayon. Also, the yarns may consist of mixed continuous filaments of the above materials.

As indicated, the yarn to which the present method applies has been pre-twisted. A favorable pre-twist is that obtained by inserting a value between 20 and 70 for C in the equation $T=C\sqrt{N}$, where T is the pre-twist in turns per meter, N is the metric yarn number and C is the metric twist constant.

Since the action of the false twist device is initially to back twist or untwist the yarn in order to temporarily open up the fiber bundle, the extent of back twist has a direct bearing upon the degree of texturing imparted to the finished yarn. Desirable results may be achieved with incomplete untwisting, for example, with only sufficient back twisting that the yarn retain about 5 to 20% of its initial twist. Theoretically it would seem that best effects would be achieved if the yarn were subjected to the air vortices at zero twist and excellent results are achieved at zero twist. However, it has been found that an equally good product can be produced where the yarn is back twisted through the point of zero twist sufficiently to impart thereto a temporary reverse twist up to about 20% of its initial or pre-twist. The yarn is preferably back twisted through the zero point to an extent of about 5 to 10% of the initial twist. These percentage figures are determined by relating the speed of rotation of the twister head to the speed of yarn travel through the false twist device.

The present invention also relates to apparatus for carrying out the above described method which consists of a yarn supply device, a false twist device including a hollow false twist spindle and a twister head, means for rotating the false twist device, means for feeding and guiding the yarn to the spindle at the desired angle, and a yarn take-up device. In one embodiment means are

mounted for rotation with the spindle for generating the air vortices.

For a further description of the method and particularly the apparatus, reference will now be made to the accompanying drawings wherein—

FIG. 1 is a schematic elevation of one embodiment of a false twisting apparatus including necessary associated devices in accordance therewith;

FIG. 2 is a view similar to FIG. 1 but illustrating a different yarn feed angle and a device to wind up the yarn;

FIG. 3 is a cutaway elevation of the false twist device shown schematically in FIG. 1;

FIG. 4 is an elevation of a false twist device having a propeller fan mounted at the feed end of the spindle, and with the yarn being fed axially of the spindle;

FIG. 5 is an enlarged end view of the apparatus of FIG. 4 illustrating the propeller fan, but with the yarn fed angularly of the spindle axis;

FIG. 6 is a sectional view taken on the line **6—6** of FIG. 5;

FIG. 7 is a greatly enlarged view showing the appearance of a length of nylon yarn product produced by the method of the present invention, and

FIG. 8 is a similar enlarged view of a length of the pre-twisted nylon yarn from which the product of FIG. 7 was produced.

Referring to FIG. 1, the pre-twisted yarn **11** is withdrawn from a conventional supply device, for example a pirn or bobbin, by a conveyor, such as feed rollers designated **12**, and fed to the false twist device indicated generally at **13**, which consists of a twister head **14** and a hollow spindle **15**. Means (not shown) are provided for rotating the false twist device. It will be noted that the yarn **11** enters the feed end of spindle **15** at a rather sharp angle beta with respect to the longitudinal axis of the spindle. The yarn passes through the hollow spindle and at the exit end thereof is turned about the twister head **14**, which preferably consists of a steel frame or loop, although other conventional twister heads may be employed.

The false twist device illustrated schematically in FIG. 1 is represented on an enlarged scale in FIG. 3, wherein is seen that the yarn contacts the feed end of the rotating spindle, which is prferably chamfered as at **16** so that the yarn is not abraded. The vortical air stream above described is created adjacent the feed end and extends into the hollow portion **17** of the spindle.

Referring again to FIG. 1, by reason of rotation of the twister head **14** the yarn between the nip **18** of feed rollers **12** and the twister head is unwound, and as it passes over the rotating twister head the initial twist is restored. The yarn is withdrawn from the twister head preferably by a pair of take-up rollers **19** and passed finally to a wind-up device (not shown). The wind-up device is conventional and may comprise simply an indirectly driven bobbin indicated as **20** in FIG. 2. In some instances the take-up rolls **19** may be omitted and only a wind-up device provided. It is to be understood that the term "take-up device" may comprise either the rollers **19** in combination with a wind-up device or simply a wind-up device.

Overfeeding or conveying the yarn at low tension is of course necessary in order that the individual filaments be sufficiently slack to permit distortion and loop formation. Accordingly the feed rollers **12** are driven at a peripheral speed greater than take-up rollers **19** and/or the wind-up device. Where take-up rollers are employed in combination with the wind-up device the effective peripheral speed of the former is preferably slightly greater than that of the latter.

Where angular yarn feed is required as with the false twist device of FIGS. 1–3, the feed rollers which serve also to guide the yarn are offset from the spindle axis as **in** FIGS. 1 and 2. The feed angle beta is preferably at least 80°, with respect to the spindle axis although in some cases lesser angles may prove satisfactory. With nylon multifilament yarn of about 80 denier an angle between about 85 and 95° is preferred. As illustrated in FIG. 2 this angle may be over 90°, although as a practical matter not more than about 100°.

Referring now to FIG. 4, the false twist device therein illustrated is the same as that of FIG. 3 except that at the feed end of the spindle a propeller fan indicated generally as **21** is provided which is capable of producing vortical air streams more powerful than those possible with angular yarn feed and the spindle of FIG. 3. The modified end of the spindle is desirably enclosed by means of a hood **23** to build up the air vortices. The yarn may be fed to this device out of contact with the spindle end i.e. axially as shown in FIG. 4 and by reason of the more powerful air vortices produced the product is comparable to that produced by angular feed with the spindle of FIG. 3.

Referring to FIGS. 5 and 6, the feed end of spindle **15** is outwardly flared as at **31** to an edge portion **32** of uniform diameter to which the outer edge of each of a plurality of propeller blades **33** is secured. The propeller blades are assembled on a hub which comprises a hollow shaft **34** positioned in-line with spindle **15**. As seen in FIG. 6 the outer end of the hollow shaft **34** constitutes the effective feed end of spindle **15**. The propeller fan assembly rotates along with spindle **15** and creates the relatively powerful air vortices. The zone of greatest air turbulence, designated **35**, is substantially between the inner end of shaft **34** and the adjacent portion of spindle **15**. Vortical streams are directed into the spindle and also into shaft **34**, as shown by the arrows in FIG. 4.

A greatly magnified length of continuous nylon multifilament yarn product as it is withdrawn from the twister head is illustrated in FIG. 7. It will be observed that the product is more voluminous than the starting yarn shown in FIG. 8, even though both are twisted to the same extent. The textured yarn product is characterized by displaced or wild filaments which are distorted into random loops along the yarn.

The following non-limiting examples further illustrate the present invention.

EXAMPLE I

An 80 denier yarn consisting of 68 continuous filaments of polyhexamethylenadipamide having a twist of 600 t./m. (twist constant $C=58$) was treated on apparatus as illustrated in FIGS. 1 and 2. The feed rollers were driven at a peripheral speed (FR) of 27.5 meters/min. and the yarn was fed to the false twist spindle at an angle of 95° with respect to the spindle axis. The spindle was driven at 19,200 r.p.m., sufficient to back-twist the yarn about 700 t./m., which untwisted the yarn through the zero point by about 100 t./m., or about 16.6% with reference to its pre-twist of 600 t./m. During the passage through the false twist device loops were formed in the individual filaments, and they were mutually distorted. The yarn was withdrawn from the twister head by a take-up roller pair driven at a peripheral speed (TR) of 26 m./min., and then wound at a wind-up speed (RU) of 25.8 m./min.

In this manner a textured yarn was obtained which was found to have increased in denier an amount equal to 6.6% of the denier of the starting yarn. Denier increase was determined by dividing the difference between feed and wind-up speeds by the wind-up speed.

The stability (i.e. the ability of the textured yarn to regain its length after a specified load has temporarily stretched the yarn) of the textured yarn was determined as follows:

A one meter length (a) of the textured yarn preloaded with 0.01 gram per textured denier was hung by one end. The length was then subjected to a tension of 0.5 gram per textured denier for 30 seconds, after

which it was subjected to 0.01 gram per denier for one minute and its length (b) measured. Stability in percent was determined by

$$\frac{(b-a)\times 100}{a}$$

to be 0.45%. A stability between 0 and 5% is satisfactory.

EXAMPLE II

The pre-twisted yarn of Example I was treated with an apparatus consisting of feed rollers, a false twist device as shown in FIGS. 4–6, and a wind-up device. The feed rollers were driven at 28.6 m./min., and so disposed that the yarn, after leaving the same, was fed along the axis of the false twist spindle (beta=0). The spindle and a propeller fan mounted thereon were driven at 19,300 r.p.m. In the false twist device the yarn underwent a temporary back twist of 675 t./m., which exceeded the zero twist point by 75 t./m. (12.5% of the pre-twist). After leaving the false twist device, the yarn was wound up at a speed of 27 m./min.

The textured yarn obtained increased in denier 5.9%, and had a stability of 0.49%.

EXAMPLE III

The pre-twisted yarn of Example I was treated as in Example II with the apparatus therein described, with the exception that the yarn was fed to the false twist device at an angle of 90° to the spindle axis with friction against the end of the hub of the propeller fan as shown in FIGS. 5 and 6. Further, the speed of the wind-up device was 25.3 m./min. A textured yarn was obtained with a denier increase of 12.1% and a stability of 0.79%.

EXAMPLE IV

The pre-twisted yarn of Example I was treated with the device of Example I and with the yarn being fed to the false twist device at an angle of 95°. The spindle was driven at 19,500 r.p.m., and the peripheral speeds of the feed rollers, take-up rollers and wind-up device were 34.2 m./min.; 33.0 m./min. and 32.8 m./min., respectively. The back twist was only about 570 t./m., and the yarn was thus not twisted through the zero point, but about 5% of the pre-twist was retained. The denier increase was 4.3% and the stability was 0.28%.

EXAMPLE V

A 70 denier yarn consisting of 34 endless threads of polyhexamethylenadipamide pre-twisted 400 t./m. (twist constant C=36) was treated with the apparatus described in Example I. The yarn was fed to the false twist device at an angle of 95°, and the spindle speed was 19,300 r.p.m. The peripheral speeds of the feed and take-up rollers and the wind-up device were 42.7 m./min., 41.5 m./min. and 41.3 m./min., respectively. The back twist was 480 t./m. exceeding the zero point by 80 t./m. or 20% of the pre-twist. The denier increase was 3.4%, and the stability 0.36%.

The following table reports the results of additional tests on both 80 denier, 68 filament nylon with 15¼ t./in. Z pre-twist and 70 denier, 34 filament nylon with 10 t./in. Z pre-twist, at various feed rates and degrees of back twist through the zero point and further illustrates the flexibility of the process. The simple spindle of FIG. 3 was employed and the yarn feed angle was 95°. "Overfeed" reported is

$$\frac{FR-TR}{TR}\times 100$$

and "net overfeed" is

$$\frac{FR-RU}{RU}\times 100$$

Table 1

Run No.	FT	FR	TR	RU	OF, percent	NO, percent	BT	D	Ten	S, percent
	Nylon 80/68/15¼ Z							83	5.5	0.30
1	19,500	34.2	33.0	32.8	3.8	4.3	14½	86	4.4	0.28
2	19,500	32.5	31.3	30.9	3.8	5.2	15¼	86	4.2	0.26
3	19,200	30.0	28.9	28.7	3.8	4.5	16¼	83	4.4	0.31
4	19,500	28.7	27.3	27.3	5.1	5.1	17¼	84	4.8	0.39
5	19,200	27.5	26.0	25.8	5.8	6.6	17¾	85	4.8	0.45
6	19,200	26.7	25.3	25.1	5.5	6.4	18¼	85	4.9	0.40
7	19,200	25.7	24.7	24.6	4.5	4.5	19	83	5.1	0.35
	Nylon 70/34/10 Z							73	5.6	0.24
8	19,200	41.7	40.9	40.7	2.0	2.5	11¾	74	5.2	0.37
9	20,500	42.7	41.5	41.3	2.9	3.4	12¼	74	4.9	0.36
10	19,500	39.0	38.0	37.8	2.6	3.2	12¾	74	5.5	0.30

NOTE.—FT=Spindle speed (r.p.m.). FR=Feed roll speed (m./min.). TR=Take-up roll speed (m./min.). RU=Wind-up speed (m./min.). OF=Overfeed. NO=Net overfeed. BT=Back twist (t./m. S). D=Textured denier. Ten=Tensile strength (g./den.). S=Stability.

Table 2 reports the results of further tests conducted without take-up rollers and with a false twist device mounting a propeller fan. In runs 2 and 3 the yarn feed angle was 0. In run 1 the feed angle was 90°.

Table 2

Run No.	FT	FR	RU	NO, percent	BT	D	Ten	S, percent
	Nylon 80/68/15¼ Z					83	5.5	0.30
1	19,300	28.6	25.5	12.1	17¼	86	3.3	0.79
2	19,300	28.6	25.5	12.1	17¼	86	3.1	0.78
3	19,300	28.6	27.0	5.9	17¼	86	3.6	0.49

NOTE.—For symbols see footnote at end of Table 1.

We claim:

1. A method for producing a textured yarn from a pre-twisted continuous multifilament yarn, which comprises temporarily back-twisting at least partially a moving length of the pre-twisted yarn, thereby causing the filaments to rotate and oscillate and the filament bundle to be thrown open, subjecting the yarn while back-twisted and in open condition to the action of a vortical stream of air, which vortical air stream displaces individual yarn filaments from their paralled relationship and forms random loops therein, and then restoring the initial twist to the yarn by passing the yarn through a rotating false-twist spindle, said vortical stream of air acting upon the yarn closely adjacent said false-twist spindle.

2. A method as set forth in claim 1 wherein the pre-

twisted yarn is temporarily back-twisted through the point of zero twist.

3. A method as set forth in claim 1 wherein the pre-twisted yarn is temporarily back-twisted beyond the point of zero twist up to 20% of the number of turns of the initial twist.

4. A method as set forth in claim 1 wherein the pre-twisted yarn is temporarily back-twisted to a retaining twist of between 5 and 20% of the number of turns of the initial twist.

5. A method for producing a textured yarn from a pre-twisted, continuous multifilament yarn which comprises feeding a moving length of the pre-twisted yarn, while temporarily back-twisting the same, thereby causing the filaments to rotate and oscillate and the filament bundle to be thrown open, into a rotating false twist spindle, subjecting the yarn while back-twisted and in open condition to the action of a vortical stream of air adjacent the feed end of the spindle, which stream displaces individual yarn filaments from their parallel relationship and forms random loops therein and withdrawing the thus treated yarn from the false twist spindle.

6. A method as set forth in claim 5, wherein the yarn is fed to the rotating false-twist spindle substantially in the direction of the axis of the spindle.

7. A method as set forth in claim 5, wherein the yarn is fed to the rotating false-twist spindle at a greater linear speed than it is withdrawn therefrom.

8. A method as set forth in claim 5, wherein the yarn is fed to the rotating false-twist spindle substantially normally of the axis of the spindle.

9. A method for producing a textured yarn from a pre-twisted, continuous multifilament yarn, which comprises feeding a moving length of the pre-twisted yarn, while temporarily back-twisting the same an amount such that the twist of the temporarily back-twisted yarn is between 20% of the number of turns per unit length of initial twist in the same twist direction and the same number of turns in the opposite direction, thereby causing the filaments to rotate and oscillate and the filament bundle to be thrown open into a hollow rotating false-twist spindle, subjecting the yarn while back-twisted and in open condition to the action of a vortical stream of air adjacent the feed end of the spindle, which stream displaces individual yarn filaments from their parallel relationship and forms random loops therein, and withdrawing the thus treated yarn from the spindle.

10. A method as set forth in claim 9, wherein the yarn is fed to the hollow rotating false-twist spindle at an angle between about 80° and about 100° with respect to the axis of the spindle.

11. Apparatus for texturing pre-twisted, continuous multifilament yarn, including in combination a yarn supply device, rotatable false twist device including a hollow spindle and a twister head, means associated with the spindle closely adjacent its feed end and rotatable therewith for supplying a vortical stream of air adjacent the feed end of the spindle in response to rotation of the spindle, means for continuously guiding pre-twisted yarn to the spindle, and take-up means for withdrawing yarn from the twister head.

12. Apparatus for texturing pre-twisted, continuous multifilament yarn, including in combination a yarn supply device, a rotatable false twist device including a hollow spindle and a twister head, means mounted on the spindle for supplying a vortical stream of air adjacent the feed end of the spindle in response to rotation of the spindle, means for continuously guiding pre-twisted yarn to the spindle at an angle of between about 80° and about 100° with respect to the axis of the spindle, and take-up means for withdrawing yarn from the twister head.

13. Apparatus for texturing pre-twisted, continuous multifilament yarn, including in combination a yarn supply device, a false rotatable twist device including a hollow spindle and a twister head, a propeller fan with a hollow hub axially mounted at the feed end of said spindle for rotation therewith, said propeller fan in response to rotation creating vortical streams of air adjacent the feed end of the spindle and in said hollow hub, means for continuously guiding pre-twisted yarn through the hollow hub to the spindle, and a take-up device for withdrawing yarn from the twister head.

14. Apparatus for texturing pre-twisted continuous multifilament yarns, including in combination a yarn supply device, a rotatable false-twist device including a hollow spindle and a twister head mounted thereon at the exit end of the spindle, the feed end of the spindle being so formed as to avoid abrasion and enable free rotation of yarn passing in contact therewith, means for continuously guiding pre-twisted yarn to the spindle, said means being so positioned as to guide said yarn to the feed end of the spindle at an angle between about 80° and about 100° with respect to the spindle axis and in contact with the feed end of the spindle, and a take-up device for withdrawing yarn from the twister head.

15. A method for producing a textile yarn from a pre-twisted, continuous multi-filament yarn, which comprises feeding a moving length of the pre-twisted yarn while temporarily back-twisting the same, thereby causing the filaments to rotate and oscillate and the filament bundle to be thrown open, into a hollow rotating false-twist spindle at an angle between about 80° and about 100° with respect to the axis of the spindle whereby the moving yarn contacts the effective end of the rotating spindle, the frictional contact of the moving opened yarn with the rotating spindle end together with air streams created by rotation of the spindle and movement of the feeding yarn displacing individual yarn filaments from their parallel relationship and forming random loops therein, and withdrawing the thus treated yarn from the false-twist spindle.

16. Apparatus for texturing pre-twisted, continuous multifilament yarn, including in combination a yarn supply device, a rotatable false twist device including a hollow spindle and a twister head, means for continuously guiding pre-twisted yarn to the spindle, means positioned closely adjacent the feed end of the false twist spindle for creating a vortical air stream adjacent the feed end of the spindle in response to rotation of said spindle, and a take-up device for withdrawing yarn from the twister head.

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