

Sept. 12, 1961

T. B. DAVENPORT ET AL

2,999,351

BULKY YARN

Filed July 17, 1956

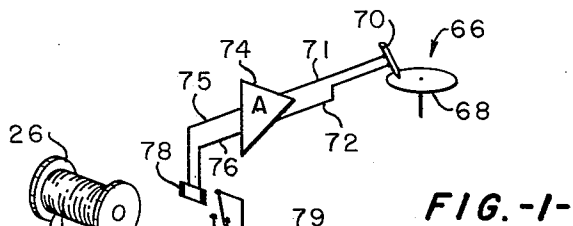


FIG. -1-

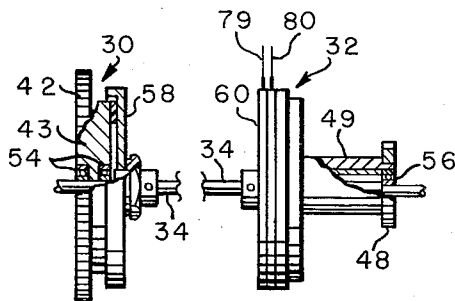


FIG. -2-

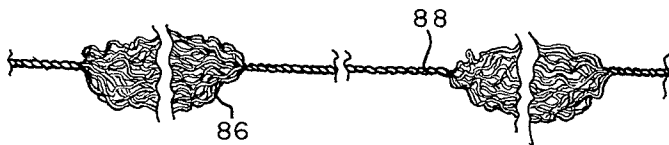


FIG. -3-

INVENTORS
T. B. DAVENPORT
ALFRED G. NEW
BY
Roger R. Jones
ATTORNEY

1

2,999,351

BULKY YARN

T B. Davenport and Alfred G. New, Greenville, S.C., assignors to Deering Milliken Research Corporation, Pendleton, S.C., a corporation of Delaware
Filed July 17, 1956, Ser. No. 593,353
7 Claims. (Cl. 57—140)

This invention relates to thick and thin filamentary yarns, and to methods and apparatus for producing the same.

Thick and thin staple fiber yarns are well known and widely employed in the textile industry for the production of novelty fabrics. Staple fiber yarns cannot, however, be readily employed for the weaving or knitting of sheer fabrics and in some instances do not have as high a strength to weight ratio as is desired. For these reasons, numerous efforts have been made to develop suitable procedures for the manufacture of thick and thin continuous filament yarns, but as yet no method has been developed which is satisfactory in all respects.

The only method for producing a thick and thin continuous filament yarn which has achieved any degree of commercial success comprises varying the rate of extrusion during the original spinning operation so that the filaments in the extruded yarn have longitudinal fluctuations in diameter. This procedure has several severe disadvantages. In the first place, use of the process is limited to the yarn manufacturer and cannot be readily performed by the yarn user. This means that the weaver or knitter must place his order for the specially extruded yarn long in advance of the time when the yarn is actually needed and that he cannot vary the length or character of the slubs to suit his own taste and needs as they arise. A further disadvantage of this prior art process is that specially extruded yarns are generally expensive and this limits their use in the commercial manufacture of many fabrics. Still another disadvantage of the variable rate extrusion process for the manufacture of thick and thin continuous filament yarns is that it is frequently impossible to obtain a slub differing sufficiently in size and texture from the thin portion of the yarn to result in the slub being as apparent as is desired in a finished fabric. This is because there is substantially no difference in the bulking characteristics of the thick and thin portions of the yarn and the difference in appearance must result entirely from the variations in diameter of the component filaments.

It is an object of this invention to provide a versatile method for producing a thick and thin continuous filament yarn that can be practiced by the textile fabricator and that permits the fabricator to readily vary the length and nature of the slubs to suit his immediate needs and desires.

It is another object of this invention to provide a thick and thin continuous filament yarn in which the slubs are of such nature that when the yarn is formed into cloth, the slubs are readily apparent regardless of the angle from which the surface of the cloth is viewed. The slubs in the novel yarns of this invention are due to an increased localized tendency of the yarn to bulk rather than to increased diameters of the yarn filament, and since the highly bulked yarn segments have an entirely different luster than the remainder of the yarn, a fabric woven of yarns according to this invention has an exceedingly novel and attractive appearance.

According to this invention there is provided a multi-filament yarn, formed from a heat-settable material, which has had imparted thereto a set tendency to twist with spaced lengths of the yarn being detwisted in opposition to this tendency and having not more than about 15 turns of twist per inch. The portions of the yarn

2

disposed between these spaced lengths remain in a relatively highly twisted condition such that they contain at least about 20 turns of twist per inch and preferably such that there is at least about 20 turns or more of twist per inch differential between the spaced lengths of substantially completely detwisted yarn and the relatively highly twisted segments. The torque tendencies set into the yarn filaments cause them to form into loops, snarls and curls at the points where the yarn is substantially completely detwisted so that the yarn at these points is highly bulked, while the high twist in the yarn segments intermediate the detwisted portions retains the highly twisted segments in a compacted condition. This differential bulking is apparent to a very pronounced extent when the yarn is formed into fabric.

Two generally similar but slightly different procedures for making the new yarns have also been discovered and it is intended that they constitute a part of the invention. The first and generally preferred procedure comprises imparting to the yarn a longitudinally uniform set tendency to twist and thereafter detwisting spaced lengths of the yarn to a much greater extent than the remaining portions of the yarn. An alternative procedure comprises twisting a multi-filament strand in such a manner that spaced lengths thereof are twisted to a less extent than segments of the yarn between the spaced lengths, setting the twist and thereafter uniformly detwisting to such an extent as to substantially untwist the spaced lengths of yarn previously containing only a low amount of twist so that the intermediate portions of the yarn remain in a highly twisted condition. It will be seen that by either procedure one obtains a yarn having alternating highly twisted portions and substantially completely detwisted segments.

It has been previously suggested that yarns be differentially twisted for the purpose of producing fabrics with novel surface effects. Such yarns are, however, generally suitable only for producing variable crepe effects and it is not possible to produce a satisfactory thick and thin yarn by a simple differential twist procedure. A first reason why this is true is that if one attempts to limit the high twist to only a short segment of the yarn, such as would be necessary in making a slubbed yarn, the twist tends to equalize during weaving so that substantially no surface effect at all is obtained. Another reason why a simple differential twist procedure is not satisfactory for producing a thick and thin yarn is that little or no differential bulking can be achieved by this procedure.

It is a surprising feature of this invention that there is substantially no tendency for twist in the yarn to equalize in winding and weaving operations conducted with the yarn after its manufacture. This is apparently because the filaments in the detwisted segments of the yarn respond individually to the torque set into the yarn and form into loops, curls and snarls. This serves to partially relax the stresses in the yarn so that there is a reduced tendency for the yarn, at the points where it is untwisted, to return to a highly twisted condition. At the same time, the formation of the filaments into loops, snarls, and the like results in the detwisted segments of the yarn becoming highly bulked and the bulked nature of the detwisted segments also serves to prevent twist from passing into these segments of the yarn as a result of twist equalization.

It is a feature of the new process that it can be employed with multi-filament yarns formed from any heat-settable material and illustrative examples of filamentary yarns which can be suitably employed in the new process include yarns made from nylon, polyester materials such as glycol terephthalate, and acrylic materials such as polymers of acrylonitrile or co-polymers of acrylonitrile with other polymerizable monomers. Nylon yarns are

preferred since cold flow in these yarns is negligible and since they are capable of taking an excellent set. The new process can be employed with almost any size of yarn and denier per filament may vary within wide limits. For example, the total denier of the yarn may vary from about 20 denier or less to about 200 denier or more and the denier per filament may vary about 1 to 20. As a general rule, each end of the yarn to be processed should be composed of at least about 5 to 7 filaments and yarns composed of at least about 10 to 15 filaments are generally preferred. This is because the degree of bulking in the detwisted segments increases with an increase in the number of filaments in the yarn.

The first twisting operation is preferably performed on an up-twister and according to a preferred procedure, the yarn is initially twisted in a uniform manner to at least about 30 and preferably to about 60 to 100 turns per inch. The greater the amount of twist inserted into the yarn at this point, the greater is the bulking effect obtained in spaced segments of the yarn when they are subsequently detwisted. According to an alternative procedure, the amount of twist inserted in the original twisting operation is varied, for example by momentarily stopping or reducing the rate of rotation of the take-up package, so that spaced lengths of the yarn are twisted to a lesser extent than the remaining portions of the yarn. However, even the portions of the yarn containing the smaller amount of twist should be highly twisted, or in other words should contain at least about 30 turns of twist per inch and should preferably contain at least about 40 to 60 turns per inch of twist. The twist differential between the highly twisted and the lesser twisted portions of the yarn should be at least about 20 to 30 turns.

The heat setting operation to set the original twist into the yarn can be conducted in a conventional manner, for example, with super heated steam. As a general rule, one should employ a heat-setting temperature of at least about 230° F. and temperatures of from about 240° F. to 280° F. are generally preferred. The time required for an adequate set is generally only 10 to 20 minutes although the yarn can be retained at a heat-setting temperature for longer periods of time if desired.

The detwisting operation is also preferably performed on an up-twister machine. If the original twisting operation was uniform in nature, the detwisting operation must be irregular to provide the sections of yarn of lower and higher twist. This can readily be achieved by periodically varying the rate of take-up. If the original twisting operation was irregular in nature, the detwisting operation can be conducted in a uniform manner since the yarn is already provided with sections of lower and higher twist. The detwisting operation should be conducted to an extent such that spaced lengths of the yarn have not more than about 15 and preferably not more than about 10 turns per inch of twist so that these portions of the yarn are free to bulk to a near maximum extent. As a general rule the smaller the amount of twist in these portions of the yarn, the greater is the slub effect obtained. The remaining portions of the yarn should contain at least about 20 turns of twist to hold the yarn in a highly compacted condition at points intermediate the substantially completely detwisted segments, and for best results there should be about 20 and preferably at least about 40 turns of twist per inch differential between the substantially completely detwisted segments and the more highly twisted portions of the yarn.

The invention will now be described with reference to the accompanying drawings in which:

FIGURE 1 is a schematic view in perspective of one form of apparatus suitable for manufacturing the yarns of the invention;

FIGURE 2 is an enlarged front plan view, partially

in section, of a portion of the apparatus schematically illustrated in FIGURE 1;

FIGURE 3 is a fragmentary plan view of a novel yarn according to this invention.

With reference to FIGURES 1 and 2 in greater detail, there is illustrated a conventional up-twister spindle 10 journaled in a twister frame, not illustrated, and provided with a whorl portion 12. Conventional means are provided for rapidly rotating the spindle 10 and may, for example, comprise a belt 14 running about a plurality of pulleys, one of which is illustrated at 16, and contacting the whorl portion 12 of spindle 10.

Carried by spindle 10 is a conventional spool or bobbin 18 containing a supply of yarn 20 and journaled about the upper extremity of spindle 10 immediately above the upper head of bobbin 18 is flyer 22 which may be conventional in form. The flyer 22 operates in a well known manner to guide an end of yarn 23 from bobbin 18 to an apex guide 24 positioned on the extended axis of rotation of the spindle 10.

The reference numeral 26 designates a conventional takeup spool which may be driven by any suitable means, for example, by means of a surface contact roll 28. Roll 28 is illustrated as being driven from pulley 16 through a slip clutch, generally indicated by the reference numeral 30, or through an electromagnetic clutch, generally indicated by the reference numeral 32. Both slip clutch 30 and electromagnetic clutch 32, which may, in each instance, be of conventional design, are carried by a single shaft 34 and are driven from a single shaft 36. The slip clutch 30 is driven by means of a first gear 38, carried by shaft 36, a chain 40, and a gear 42 carried by the driving element 43 of the clutch 30, while the electromagnetic clutch 32 is driven by means of a gear 44, carried by shaft 36, a chain 46, and a gear 48 carried by the driving element 49 of the electromagnetic clutch. The shaft 36 is illustrated as being driven through bevel gears 50 and 51 and a shaft 52 but may be driven in timed relationship to the spindle 10 by any suitable means.

The driving element 43 of slip clutch 30 is journaled for free rotation about shaft 34 by means of antifriction bearings such as ball bearings 54 (FIGURE 2) and the driving element 49 of electromagnetic clutch 32 is likewise journaled for free rotation about shaft 34 by means of antifriction bearings, one of which is shown at 56. The driven element of slip clutch 30, indicated by the reference numeral 58, and the driven element of electromagnetic clutch 32, indicated by the reference numeral 60, are, in each instance, keyed to shaft 34 and rotate in fixed relationship therewith. The gear 42 is relatively large as compared to gear 38, so that when the electromagnetic clutch 32 is disengaged, the shaft 34 is driven at a relatively low speed through slip clutch 30. The gear 48 is relatively small as compared to gear 44 so that when the electromagnetic clutch 32 is engaged, it overpowers slip clutch 30 and the shaft 34 is rotated at a relatively high rate of speed. The shaft 34 drives roll 28 by means of gears 62, 63, and 64 and a shaft 65, so that the yarn take-up rate is proportional to the rate of rotation of shaft 34.

The reference numeral 66 generally indicates a source of electrical impulses which is here schematically illustrated as comprising a conventional phonograph record player. The record player 66 is provided with a record 68 transcribed with a series of high frequency signal impulses which are preferably of constant duration but which may suitably be either of random or patterned occurrence. The transcribed signals on record 68 are used to produce a high frequency alternating electric current by means of play-back head 70 and the electric current is transmitted through leads 71 and 72 to a conventional amplifier schematically illustrated at 74. The amplified signal is fed through leads 75 and 76 to an electromagnetic relay 78 which controls a flow of direct

current from any suitable source, not illustrated, to clutch 32 through a pair of leads 79 and 80. A selector switch 82 is preferably provided so that activation of relay 78 can either interrupt or initiate the flow of direct current to clutch 32 and thereby deactivate or activate clutch 32 as desired.

The reference numeral 84 generally indicates a pair of nip rolls which are here illustrated as being freely rotatable but which may be driven in timed relationship to the roll 28 if desired. The rolls 84 serve to prevent the twist inserted in yarn end 23 by spindle 10 from running along the yarn to the take-up package 26, when short length slubs are desired, and result in a more effective localization of the twist in the differentially twisted portions of the yarn. Means, not illustrated, are preferably provided for changing the position of rolls 84 relative to the take-up roll 26 and for removing the rolls 74 from operative position when long slubs are desired.

In operation, an end of yarn from package 18 is threaded through flyer 22, guide 24 and passed between rolls 84 to take-up package 26. If it is desired that the yarn be uniformly twisted, amplifier 74 is simply disconnected and selector switch 82 is set to prevent a flow of current to clutch 32. The take-up spool 26 is then driven at all times through slip clutch 30. If it is desired that the yarn be intermittently twisted, amplifier 74 is energized, record player 66 is placed in operation, and selector switch 82 is set so that relay 78 intermittently supplies direct current to clutch 32. When the clutch 32 is supplied with a flow of direct current, the clutch becomes engaged, the rate of rotation of shaft 34 increases and the yarn end 23 between rolls 84 and flyer 22 is twisted to a less extent than would be the case if take-up roll 26 were being rotated at its normal rate.

According to the preferred procedure outlined above, the first twisting operation is preferably conducted with record player 66 inoperative and with clutch 32 disengaged. A gear ratio is then selected to provide for a rate of rotation of roll 28 relative to the rate of rotation of spindle 10 such that from about, for example, 50 to 100 turns per inch of twist are inserted into the yarn end 23. When the supply of yarn originally on spool 18 is uniformly twisted and collected on spool 26, the twisted yarn is heat-set and the spool of heat-set yarn is placed upon the spindle 10. The direction of rotation of spindle 10 is then reversed, the record player 66 is placed in operation and selector switch 82 is preferably set so that the flow of direct current to clutch 32 is interrupted when a signal is produced by the play-back head 70 and so that clutch 32 is normally engaged. Gears 44 and 48 are selected of such size that when clutch 32 is engaged, the rate of take-up is such that the yarn end 23 is only partially detwisted. For example, the ratio of the rate of rotation of spindle 10 to the rate of rotation of roll 28 can suitably be such that only about 5 to 15 turns per inch of twist are removed from the yarn when the take-up device is in normal operation with clutch 32 engaged. Gears 38 and 42 are selected of such size that when clutch 32 is disengaged, a length of the yarn end 23, corresponding to the length of the slub desired, is substantially completely detwisted. The length of the detwisted segments is controlled by the length of the signal fed to relay 78 and can be varied by the use of records having, relative to each other, signal impulses of different durations or more satisfactorily by the use of a conventional electronic time delay-relay mechanism to vary the duration of the control impulses.

In some instances slubs of a length equal to only the distance from flyer 22 to spool 26, or even less, may be desired. Slubs of a length equal to the distance from flyer 22 to spool 26 can readily be formed by moving rolls 84 to an inoperative position and removing chain 40 so that the take-up of yarn stops when clutch 32 is de-energized. Shorter length slubs can be formed by removing chain 40 and spacing rolls 84 from flyer 22 a

distance equal to the length of the slub desired. It will be understood that in such instances, the length of the signal impulse fed to relay 78 and the rate of rotation of spindle 10 must be so correlated that a length of the yarn, equal to the length of the slub desired, is substantially completely detwisted.

According to the alternative procedure outlined above, the first twisting operation is conducted with record player 66 and amplifier 74 in full operation and preferably with the selector switch 82 set so that clutch 32 is normally disengaged and so that the clutch becomes engaged when a signal is being received by relay 78. Gears are selected such that from about, for example, 50 to 100 turns per inch of twist are inserted into the yarn when clutch 32 is disengaged and such that about 20 to 70 turns per inch of twist are inserted when clutch 32 is engaged. When the yarn from spool 18 has been twisted and collected upon spool 26, the twist in the yarn is heat-set as above and the heat-set yarn is placed on spindle 10. The direction of rotation of the spindle is then reversed and the record player is disconnected so that the clutch 32 remains continuously engaged or disengaged as desired depending upon the position of selector switch 82. A gear ratio is then selected which results in the portions of the yarn which received the lower degree of twist in the original twisting operation being substantially completely detwisted but leaves sufficient twist in the more highly twisted portions of the yarn to prevent bulking thereof.

With specific reference to FIGURE 3 of the drawings, there is illustrated a short length of yarn approximately as it would appear when prepared by either one of the above two procedures. It will be seen that at 86, where the yarn is substantially completely detwisted, the filaments form into curls, kinks and snarls and a noticeable bulking of the yarn is achieved. It will also be seen that portions of the yarn, for example, at 88 remain in a twisted condition and are highly compacted as a result of the twist therein. A thick and thin continuous filament yarn is thus produced without any substantial change in the diameter of the component filaments.

Having thus described our invention, what we desire to claim and secure by Letters Patent is:

1. A multi-filament thick and thin yarn formed from a heat-settable material, said yarn having imparted thereto a set tendency to twist, spaced lengths of said yarn being twisted sufficiently in conformity with said tendency to prevent any substantial degree of bulking, and said yarn having segments, disposed between said spaced lengths, with a relatively lower degree of twist, the individual filaments of the yarn within said segments containing loops and kinks which impart a lofty nature to the portions of said yarn within said segments.

2. A multi-filament yarn formed from a heat-settable material said yarn having imparted thereto a set tendency to twist to the extent of a least about 20 turns per inch, spaced lengths of said yarn having not more than about 15 turns of twist per inch, and said yarn having segments, disposed between said spaced lengths, which are more highly twisted in conformity with said tendency and contain at least about 20 turns of twist per inch.

3. A multi-filament yarn as in claim 2 wherein the twist differential between said spaced lengths and said more highly twisted segments is at least about 20 turns of twist per inch.

4. A multi-filament yarn according to claim 3 wherein the yarn contains at least about 10 filaments per end and is nylon.

5. A multi-filament nylon yarn containing at least about 10 filaments per end and having imparted thereto a set tendency to twist to the extent of at least about 40 turns per inch, spaced lengths of said yarn having not more than about 10 turns of twist per inch, and said yarn having segments, disposed between said spaced lengths, which are more highly twisted in conformity with said tendency so that there is at least about 40 turns of twist

7

per inch differential between said spaced lengths and said highly twisted segments.

6. A yarn according to claim 5 wherein said spaced lengths are of substantially uniform length but are randomly distributed along the length of said yarn.

7. Intermittently bulked continuous multi-filament yarn having alternately spaced bulked and unbulked segments, there being substantially the same filament quantity in number of filaments and in filament diameter, in both the bulked and unbulked segments, the filament portions in said bulked segments being in a relaxed self-straining and self-kinking deformed state and forming substantially larger air-filled interstices therebetween than the filament portions of said unbulked segments, the filament portions in said bulked segments having substantial unbalanced internal stresses along their length which tend to self-establish a non-linearly deformed configuration for said filament portions when in a relaxed state, said filament portions in said bulked segments being torsionally heat-stressed and tending to assume a mechanically self-deformed kinky configuration.

8

References Cited in the file of this patent

UNITED STATES PATENTS

2,061,614	Dickie et al.	Nov. 24, 1936
2,084,975	Katz	June 22, 1937
2,089,193	Dreyfus	Aug. 10, 1937
2,104,810	O'Dowd	Jan. 11, 1938
2,293,003	Hunter	Aug. 11, 1942
2,703,439	Dole et al.	Mar. 8, 1955
2,711,627	Leath et al.	June 28, 1955
2,751,747	Burleson	June 26, 1956
2,783,609	Breen	Mar. 5, 1957

OTHER REFERENCES

- 15 Stretch and Bulk Yarns, Textile World, June 1955, pp. 94-97 (p. 94, column 3, lines 19-21 pertinent).
 Crepe, Crimp and Crinkled Yarn, pp. 398-404, Journal of the Textile Institute, vol. 46, No. 7, July 1955 (p. 402, last six lines pertinent).
 20