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AMENDED SPECIFICATION

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PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

A process for the manufacture of improved False-Twist-Crimped Bulked Filament Yarn

We, IMPERIAL CHEMICAL INDUSTRIES LIMITED of Imperial Chemical House, Millbank, London, S.W.1, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a process for the manufacture of improved bulked filament yarn.

Bulked filament yarn may be made in many ways. For example, it is known to make bulked filament yarn by twisting a filament yarn, setting the twist in the filaments, e.g. by heating, and then untwisting the yarn. By this process the individual filaments which are originally substantially straight become deformed and this imparts the bulk to the yarn. Such yarns are hereinafter described as "twist crimped bulked yarns". Commercially the twisting and untwisting is now most commonly done by false twisting and yarns made using a false twisting step are hereinafter described as "false twist crimped bulked yarns".

In comparison with wool and cotton yarns, false twist crimped bulked yarns shrink to an excessive degree when subjected to hot wet conditions, e.g. hot water or steam. When making garments or fabrics from these bulked yarns it is common practice to knit or weave them to much larger dimensions and with much looser stitches than are required in the finished article. The garment or article is then caused to shrink e.g. by scouring at 60°C. This shrinkage of the bulked yarn is necessary to obtain the degree of bulk required to give to the garment or fabric good textile

characteristics. To obtain a shrunken garment or fabric in which the yarn has the optimum textile characteristics and which has the correct final dimensions needs considerable care. If the garment or fabric is shrunk insufficiently the necessary bulk will not be obtained in the yarn while if it is over shrunk a garment or fabric with a harsh consolidated handle will be obtained. Thus the process is one which must be controlled carefully. After the scouring process the garment or fabric is usually heat set by means of a heat treatment to confer on it dimensional stability during subsequent use.

When making garments or fabrics from cotton or wool the process is much simpler and less liable to error. As the garments or fabrics do not shrink greatly, e.g. 5% they are knitted or woven to a size very near to the final size required. They are usually given a scouring treatment to ensure that all parts of the garment or fabric are subjected to uniform conditions and shrunk evenly. A heat setting process is not usually required.

Most of the machinery used for knitting and weaving was originally intended for use with wool and cotton yarns. While it is possible with some machinery to make the large allowances needed when knitting or weaving garments or fabrics from false twist crimped bulked yarns, it is an added complication in the manufacturing process and one which can easily lead to errors. Furthermore, when using circular knitting machines some restriction is placed on the type of product which can be made, because the size of garment or fabric which can be knitted is limited by the size of the

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machine. With false twist crimped bulked yarn the knitted product may not be big enough to allow for the high shrinkage which takes place in the scouring process and still arrive at the required finished dimensions.

A disadvantage of bulked yarn made by the false twist process is that singles yarn is not free from torque and tends to snarl and twist which results in difficulty in processing and leads to objectionable characteristics in fabrics produced from them. Because of this bulked yarns are commonly used only in the form of doubled yarn. A further disadvantage of these yarns is that when quite low tensions are applied to them, e.g. by extending them by hand, the strains imposed during the false twisting and heating steps used in their manufacture seem to be released and they contract as much as 50% of their original length.

In this condition the yarn has a high degree of elasticity and as such is very sensitive to tension variations, such as may occur either in knitting or weaving operations and this clearly makes the production of regular and even knitted and woven structures very difficult. Such yarns can be said to have a high degree of yarn crimp elongation. The effect which is produced by applying a tension to the false twist yarn can be achieved by steaming the yarn under conditions such that free shrinkage can take place and the extension of the steamed yarn under a standard load is used throughout the specification to compare the yarn crimp elongation of various yarns.

According to our invention we provide a new and improved false-twist-crimped bulked filamentary yarn characterised in that it has excellent bulk properties combined with low yarn crimp elongation, namely less than 15%, a shrinkage in hot water or steam of less than 10%, and is free from torque in the singles state.

We also provide a process for making a bulked filament yarn as above, which comprises the steps of false-twisting filamentary yarn, partially heat setting the yarn by a treatment which is not so severe as to render the crimp permanent, winding the false-twist-crimped yarn on to a package by feeding the yarn to the package at a speed higher than the wind-up speed such as only partially to relax the yarn and then subjecting the yarn to a setting treatment using a hot fluid or gas. It is preferred that this treatment should take place while the yarn is on the package because of simplicity and because the loosely wound yarn is in an ideal condition for a hot gaseous treatment.

The process of this invention can be operated simply by crimping the yarn using a false twisting technique, on a slightly modified up-twisting false twist machine, i.e. a machine wherein the yarn is fed from feed rolls or through some other tension stabilising device to a false twisting device, via a hot setting

zone and then from the false twisting device to a second set of rolls which forward the false-twist-crimped yarn to a wind-up device, preferably a side wind-up device, the linear wind-up speed being less than the linear speed of the second set of rolls; the yarn on the package from the wind-up device may then be set in a hot oven, preferably a steam oven. When the false twist crimped yarn is wound on to the package the wind-up speed, which is less than the rate of feed to the wind-up mechanism, is preferably 10 to 30% less so as only partially to relax the yarn. By "side wind-up device" is meant a winding device wherein the yarn is laid on the package by a traverse mechanism, acting along a line substantially parallel to the axis of the package and the package is driven by frictional contact with a driven spindle, usually horizontal.

The heat treatment applied during the false twisting is not sufficiently severe to render the crimp imparted by the false twist permanent. This can easily be tested in a somewhat rough and ready manner by extending the false twist bulked yarn a number of times by hand. When a permanent heat setting treatment has been applied the yarn will ~~lose its bulk as the~~ the extending force is withdrawn. When only a temporary heat setting treatment has been applied the yarn will lose its bulk as the filaments lose their crimp, after a number of extensions. Because of the lack of permanence in the crimp, these yarns if made into fabrics without further treatment, would not develop their bulk characteristics to anything like their full extent.

In the setting of the false twist in the heating zone the degree of permanence obtained depends on a combination of the temperature in the zone and the time the yarn spends in the zone, i.e. the rate of feed of the yarn. It is also dependent upon the thickness of the yarn, as a heavy denier yarn requires more heat to attain a suitable uniform temperature than does a lighter low denier yarn. It is appreciated that the degree of permanence of crimp is a difficult matter to test exactly. However, the important practical point arising from this somewhat theoretical consideration is that when making bulked yarn by the process of this invention the amount of heat set and the degree of permanence which must be imparted to the yarn during the false twisting stage is far less than that required for a yarn of the same denier when making the known type of false twist bulked yarn. This is because in the process of our invention the crimp is set by the final hot fluid or gaseous treatment when the yarn is substantially in the form in which it will be used and it is indeed unnecessary for the heating in the hot setting zone to be such as to render the original false twist crimp permanent. Moreover less twist may be used to attain the desired crimp.

The fact that in the process of our inven-

continue to contract once

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tion less heat need be imparted to the yarn in the heating zone makes the successful operation of a commercial process much easier because the rate of feed of the yarn may be much higher, in relation to a particular temperature of the heating zone than it can be in the case of the ordinary false twist process. This is particularly useful in the case of heavy denier yarns. For example, using the

same false twisting and heating equipment we have found that with the temperatures given below in Table 1 the rates of feed which can be used successfully to make satisfactory false twist bulked yarn (column 2) for "Terylene" (Registered Trade Mark) polyester fibre are lower than the speeds which can be used in the process of our invention, (column 3), to produce a crimp of 35 turns per inch.

TABLE 1

Yarn Denier	Temperature	Rate of Feed (metres per minute)	
		(2)	(3)
150	200°C	30	80
75	180°C	20—24	36

This table indicates the practical consequence of the statement that the crimp imparted by false twisting need not be permanent.

Conditions of operation of the process according to the present invention vary according to the type of yarn being treated, e.g. polyester yarn, such as "Terylene" (Registered Trade Mark) polyester yarn, nylon or "Perlon" (Registered Trade Mark) polyacrylonitrile or polypropylene, and on the type of product required. For example, using "Terylene" yarn of 75 denier we have found that a soft but lively yarn is produced using a feed speed and take-up speed of 12 to 18 metres per minute through the false twister, which produces a crimp of 55 to 80 turns per inch, a hot setting zone temperature of 100 to 140°C, followed by setting in a steam oven at a pressure of 20 to 40 lb. per square inch for from 15 to 45 minutes. When high speed false twisting machines are used the feed speed may be as high as 80 metres per minute and for "Terylene" polyester fibre, the hot setting zone may be as high as 215°C. In the process of the present invention the hot setting zone temperature is maintained at a temperature such that for the yarn speed being used, the thermoplastic filaments do not become sufficiently hot to become plastic, i.e. readily deformable by small forces. As stated previously, in the process of our invention it is only necessary for the set imparted at this stage to be of a temporary character.

During the false twisting operation the twist is preferably set by contact with a hot metal surface for convenience, but any other means of twist setting, such as passage through hot fluids or infra-red heating, may be used. If a hot surface is used it may be heated by electric

heating coils, by a direct current flowing through a metal plate or by means of hot liquids or fluids circulating within the heated surface. Any suitable shape of hot surface may be used, e.g. a simple hot plate preferably with a convex surface or a hot tube or part of a tube.

Any suitable high speed false twisting means may be used in making the bulked filament yarns of our invention. False twisting ranging from 10 to 170 turns per inch may be used depending upon the yarn being treated.

The feed mechanism and the take-up mechanism from the false-twister may be any of those known in the art. Although the feed rate may be slightly higher or lower than the take-up rate from the false twister, we prefer that the two rates should be substantially the same.

A typical apparatus for making the bulked yarn of our invention is illustrated diagrammatically in the drawing. This apparatus is described and claimed in copending application number 1247/57 (Serial No. 881729) and comprises means for subjecting the yarn to a hot fluid or gaseous treatment (not shown).

Referring to the drawing, filament yarn (1) is fed from a package (not shown) through a heater (2) and a false twister (3) by feed roll system (4), where the yarn makes a number of turns round the larger roll, and take-up roll system (5). Roll system (5) feeds the yarn via a guide (6) to a traverse mechanism (7) which lays it on the package (8) driven by the roller (9) at a lower surface speed than that of the roll system (5).

The take-up roll system (5) comprises a pair of rubber covered pinch rolls (11) and (12), a guide (13) and a driven roll (14). The yarn from the false twister enters the nip of

the rolls (11) and (12) and then is wrapped in a number of turns round the roll (12) and the guide (13). It leaves the nip at a point almost vertically below the traverse mechanism (6). The fact that the yarn enters the rolls (11) and (12) at the nip gives excellent control of the yarn during the false twisting operation and the fact that it leaves at the nip, when over-feeding to the package, reduces problems arising as a result of over-feeding, e.g. it allows long continuous runs without any lapping of the rolls.

The following Examples illustrate but do not limit our invention.

15 All Examples were carried out on an apparatus of the type illustrated in the drawing.

EXAMPLE 1

20 A two fold 150 denier "Terylene" polyester filament yarn was passed at 20 metres per minute through the false twister operating at 50

t.p.i., the feed and take-up rates being the same and the heating zone temperatures being as specified in Table 2. From the take-up rolls the yarn was fed at 20% overfeed to the yarn package. The yarn on the package was heated in a steam oven at 27 lb. pressure for twenty minutes. Table 2 shows the temperature of the heating zone, the % shrinkage of the yarn when exposed to atmospheric steam for 15 minutes and the yarn crimp elongation of the steam treated yarn. This is measured by first applying a very light load of 0.0033 gm. per denier, i.e. just sufficient to straighten the yarn so that its original crimped length can be measured and then adding a load of 0.04 gm. per denier which is sufficient to extend the yarn and take out the crimp. The difference between the two measurements is used throughout the examples to compare the yarn crimp elongation of the yarns.

TABLE 2

Temperature	Shrinkage %	Yarn Crimp Elongation %
170	0.68	8.8
180	1.75	9.2
190	2.4	10.1
200	3.0	10.9
210	4.6	12.6

45 From Table 2 it can be seen that a bulked yarn can be obtained with a low shrinkage and low yarn crimp elongation, and that by selecting suitable conditions very low figures for both shrinkage and yarn crimp elongation can obviously be obtained. The bulked yarns produced were soft and regular and could be

knitted into fabrics and garments without difficulty.

By way of comparison Table 3 lists the shrinkage and yarn crimp elongation figures obtained under comparative circumstances for bulked yarn of this invention and other bulked and natural yarns.

TABLE 3

	Shrinkage %	Yarn Crimp Elongation %
Yarn of this invention	8%	6.9
False twist bulked yarn	58%	72.0
Stuffer box crimped yarn	36.6%	34.0
Wool	5%	1.5
Cotton	3%	1.0

It can be seen that for the yarns of this invention the shrinkage and extension are of a different order to those encountered with known bulked yarns and are much nearer to those of cotton and wool.

EXAMPLE 2

Yarns of different denier made of "Terylene" polyester fibre were passed through the

apparatus under conditions as in Example 1, but the temperatures of the heating zone and the twists imparted were varied as set out in Table 4. Figures for the % shrinkage of the yarn after being exposed to atmospheric steam for 15 minutes and the yarn crimp elongation of the steam treated yarn are also set out in Table 4.

TABLE 4

Denier	Temp.	False Twist t.p.i.	Shrinkage %	Yarn Crimp Elongation %
40	160	100	4.2	9.1
75	160	70	5.1	8.2
100	180	60	1.1	12.0
250	190	40	0.25	10.7
1000	210	20	4.0	8.1

In all cases bulked yarn of good handle and appearance was obtained.

This example illustrates that the process of our invention can be applied to yarns over a wide range of deniers, to give useful products. In general, with a fixed yarn speed, the lower denier yarns do not need such a high temperature on the hot plate.

EXAMPLE 3

A 150 denier "Terylene" polyester yarn was passed through the false twister operating at 40 t.p.i. at a speed of 25 metres per minute, the feed and take up rates being the same. The hot plate temperature was 170°C and the overfeed to the wind up package was 20%. Steaming was carried out at different pressures and for different times. The results are set out in Table 5.

TABLE 5

Steaming		Shrinkage %	Yarn Crimp Elongation %
Pressure	Time		
20 lb.	15 min.	1.2	13.1
20 lb.	45 min.	2.1	11.8
40 lb.	15 min.	2.2	10.6

In all cases a bulked yarn of good appearance and handle was obtained.

EXAMPLE 4

A 100 denier "Terylene" polyester yarn was passed through the false twister operating at 60 t.p.i. at a speed of 37.5 metres per minute, the speed and take up rates being the same. The hot plate temperature was 195°C, the overfeed to the wind up was 20% and

steaming was carried out at 27 lb. for 20 minutes. A bulk yarn of good appearance and bulk was obtained with a yarn crimp elongation of 8.6% and a shrinkage of 2.9%.

It was found necessary to use a temperature of 195°C for the higher speed of 37.5 metres per minute as compared with the temperature of 180°C at 20 metres per minute shown in Table 4.

EXAMPLE 5

Using the apparatus illustrated and the operating conditions specified in Example 1

bulkied yarns of nylon, polypropylene and polyacrylonitrile were produced with the properties set out in Table 6.

TABLE 6

Yarn	Denier	False Twist t.p.i.	Plate Temp.	Shrinkage %	Yarn Crimp Elongation %
Nylon	150	50	140	5.6	0.5
	150		170	5.7	0.5
Polypropylene	120	40	120	8.8	5.0
Polyacrylonitrile	100	48	120	7.4	4.8

In all cases a torque free bulkied yarn of good appearance and handle was obtained.

In the examples, for the sake of illustration, yarns having a wide variation of yarn crimp elongation and shrinkage were made. In practice yarns having a yarn crimp elongation of 8-10% and a shrinkage of about 5% would probably be most acceptable commercially.

The foregoing examples illustrate the fact that the process of this invention can be applied to synthetic yarns of all types and sizes with equal success. They also show that conditions are not critical, to obtain a bulkied yarn with the desired properties. This is of great importance with regard to commercial production as it allows the plant to be constructed more cheaply and operated more easily. On the other hand by selecting the yarn used as starting material, and adjusting the treating conditions to suit the selected yarn, bulkied yarns which do not only have good appearance and handle but which also resemble wool and cotton with regard to shrinkage and extension can be produced.

In the examples the final treatment was carried out in a steam oven. This was primarily for convenience, but also because steam ovens are readily available in the textile trade. This final treatment can take place in other gaseous or fluid media. If desired this treatment may be part of the dyeing treatment, i.e. after being wound up onto the package, the yarn can be dyed instead of steamed. It is, however, preferred that the yarn should be steamed first and dyed afterwards.

To compare the bulkied yarns produced using the process of this invention with those of the prior art, plain fabrics were knitted on a 21 gauge fully-fashioned knitting machine from "Terylene" polyester bulkied yarns, 150 denier, made by this invention (A) and by the stuffer box crimping technique (B). The con-

ditions selected were such as gave the best results with the yarns being knitted. As an indication of the bulk or covering power of the two yarns, fabrics of similar cover and fullness of handle were compared by weight per square yard.

A = 4.4 oz. per square yard
B = 5.3 oz. per square yard

A further comparison was made between a 300 denier bulkied yarn made by the process of this invention (C), a conventional false twist bulkied yarn (D) and a stuffer box bulkied yarn (E). The fabric was produced on a 10 gauge flat-bed knitting machine.

C = 4.20 oz. per square yard
D = 4.80 oz. per square yard
E = 5.60 oz. per square yard

The yarn of this invention because of its excellent bulking character, gave light-weight fabrics of excellent handle and appearance and with as good a covering power and fullness of handle as heavier fabrics produced from other bulkied yarns.

The bulkied yarns of our invention are superior to those of the prior art in relation to dyeing. In general bulkied yarns made by the processes of the prior art develop a high degree of shrinkage when relaxed by atmospheric steaming or boiling water. When dyeing these yarns it is necessary to shrink them before dyeing. This involves winding onto a reel of large circumference to form a hank shrinking in steam, and then dyeing. With the yarns of this invention, it is possible to dye them on the package from the bulking process. Commercially this saves time and money and an excellent product can be obtained. This advantage is particularly significant with poly-

ester yarns, the dyeing of which has provided some difficulty. The polyester bulked yarns of our invention can be subjected to pressure dyeing direct from the bulking process.

- 5 As the bulked yarns of the prior art are fully relaxed during dyeing and pre-steaming, the fabrics and garments made from them tend to have a harsh handle. To overcome this it is common to dye garments or fabrics after they have been knitted or woven. This is not necessary using the bulked yarns of our invention which can be dyed without difficulty to give dyed singles yarn of excellent handle and appearance or, if desired, dyed in garment or fabric form to give excellent results.

- 10 This invention may be used in connection with all thermoplastic synthetic yarn, e.g. nplon, polyacrylonitrile, polypropylene. It is particularly suitable for use with polyester yarns such as "Terylene" (Registered Trade Mark) polyester yarns.

WHAT WE CLAIM IS:—

1. An improved false-twist-crimped bulked synthetic filamentary yarn characterised in that it has excellent bulk properties combined with low yarn crimp elongation, namely less than 15%, a shrinkage per unit length in hot water or steam of less than 10%, and freedom from torque in the singles state.
2. A false-twist-crimped bulked yarn according to claim 1 containing polyamide, polyester, polyacrylonitrile or polypropylene filaments.
3. A process for making the new and improved bulked filamentary yarn according

to either of the preceding claims comprising the steps of false-twisting filamentary yarn, partially heat-setting the yarn by a treatment which is not so severe as to render the crimp permanent, winding the false-twist-crimped yarn on to a package at a speed higher than the wind-up speed such as only partially to relax the yarn and then subjecting the yarn to a setting treatment using a hot fluid or gas.

4. A process according to claim 3, wherein the wind-up speed is 10% to 30% less than the rate of feed to the wind-up device.

5. A process according to claim 3 or claim 4, wherein the setting treatment with hot fluid or gas takes place while the yarn is still on the wind-up package.

6. A process according to any one of claims 3, 4, or 5, wherein the hot fluid or gas is steam.

7. A process according to claim 6, wherein the setting treatment is carried out for 15—45 minutes.

8. A process according to any one of claims 3 to 5, wherein the setting treatment with hot fluid or gas is part of a dyeing process.

9. A process for making new and improved bulked filamentary yarn according to claim 1, substantially as hereinbefore described and illustrated in the attached drawing.

10. Process for making bulked yarn substantially as hereinbefore described and illustrated in the attached drawing.

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- 5 As the bulked yarns of the prior art are fully relaxed during dyeing and pre-steaming, the fabrics and garments made from them tend to have a harsh handle. To overcome this it is common to dye garments or fabrics after they have been knitted or woven. This is not necessary using the bulked yarns of our invention which can be dyed without difficulty to give dyed singles yarn of excellent handle and appearance or, if desired, dyed in garment or fabric form to give excellent results.

- 10 This invention may be used in connection with all thermoplastic synthetic yarn, e.g. nylon, polyacrylonitrile, polypropylene. It is particularly suitable for use with polyester yarns such as "Terylene" (Registered Trade Mark) polyester yarns.

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2. A false-twist-crimped bulked yarn according to claim 1 containing polyamide, polyester, polyacrylonitrile or polypropylene filaments.
3. A process for making the new and improved bulked filamentary yarn according

to either of the preceding claims comprising the steps of false-twisting filamentary yarn, partially heat-setting the yarn by a treatment which is not so severe as to render the crimp permanent, winding the false-twist-crimped yarn on to a package at a speed higher than the wind-up speed such as only partially to relax the yarn and then subjecting the yarn to a setting treatment using a hot fluid or gas.

4. A process according to claim 3, wherein the wind-up speed is 10% to 30% less than the rate of feed to the wind-up device.

5. A process according to claim 3 or claim 4, wherein the setting treatment with hot fluid or gas takes place while the yarn is still on the wind-up package.

6. A process according to any one of claims 3, 4, or 5, wherein the hot fluid or gas is steam.

7. A process according to claim 6, wherein the setting treatment is carried out for 15—45 minutes.

8. A process according to any one of claims 3 to 5, wherein the setting treatment with hot fluid or gas is part of a dyeing process.

9. A process for making new and improved bulked filamentary yarn according to claim 1, substantially as hereinbefore described and illustrated in the attached drawing.

10. Process for making bulked yarn substantially as hereinbefore described and illustrated in the attached drawing.

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