

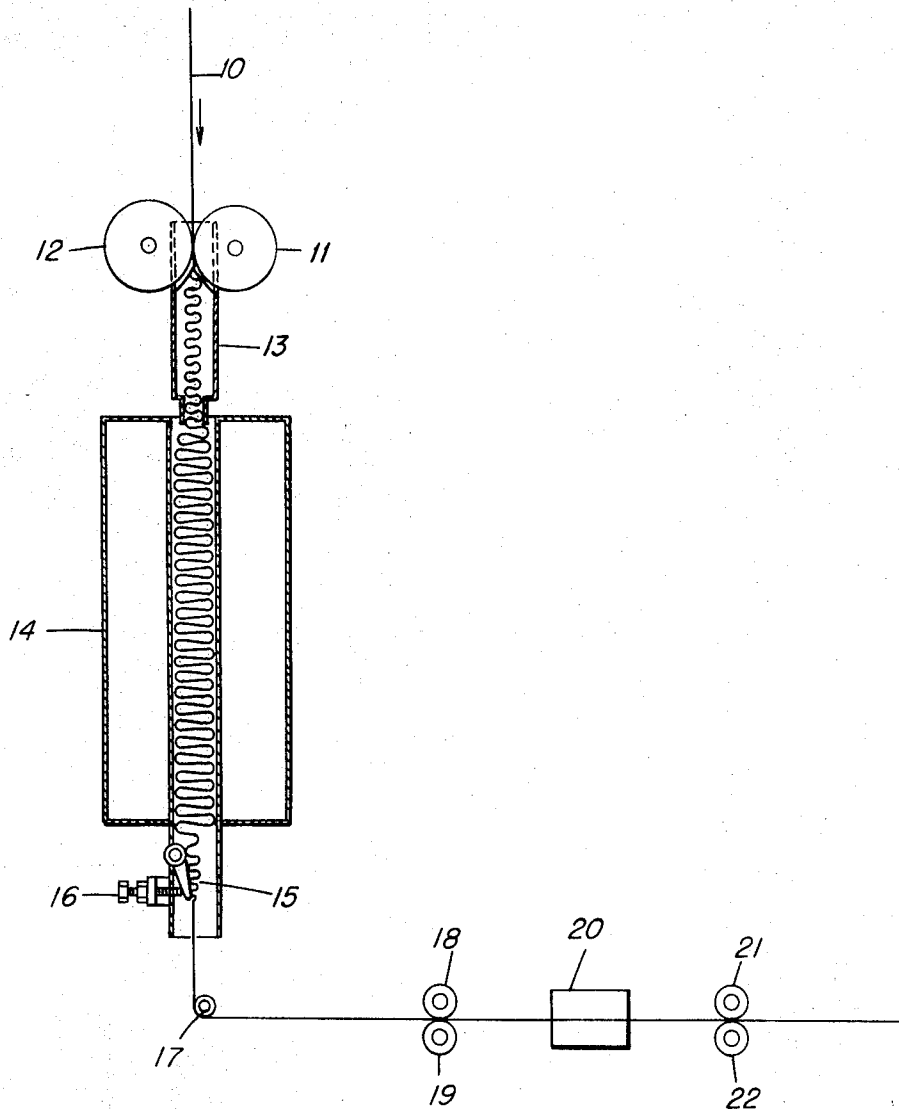
Sept. 29, 1970

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3,530,660

MANUFACTURING A MECHANICALLY CRIMPED YARN AND PRODUCTS THEREOF

Filed July 12, 1965



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3,530,660
**MANUFACTURING A MECHANICALLY CRIMPED
YARN AND PRODUCTS THEREOF**

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Filed July 12, 1965, Ser. No. 471,318

Int. Cl. D02g 1/20, 3/24

U.S. Cl. 57—140

10 Claims

ABSTRACT OF THE DISCLOSURE

A bulked yarn is produced by first mechanically crimping the yarn and thereafter air entangling the crimped yarn.

This invention relates to an improvement for the manufacture of a mechanically crimped yarn and to the products obtained therefrom. More particularly, the invention is directed to the product and method for producing a substantially no twist, entangled, bulked yarn having deregistered crimp characteristics suitable for use in various textile operations and especially suitable for needle tufting into chenilles and rugs.

In the development of bulked yarns, various techniques have been suggested to provide yarns which will provide more cover and less weight. This type of bulked yarn is highly desirable in the use of textile yarn in the production of light-weight fabrics, and is also sought after in the production of rugs utilizing higher total denier continuous filament yarns. In the prior art, continuous filament yarns have been treated by a so-called texturizing or bulking process which substantially increases the bulk or volume of the yarn by pneumatic or mechanical means.

After the filament yarns have been bulked or texturized, it is generally a requirement, especially for heavy-denier yarns, to subject the filament yarns through an additional twisting step in order for the yarns to be more easily processed in the manufacture of fabrics and through carpet yarn tufting machines. The twist placed in the yarn inhibits bulk development, but the twist, although disadvantageous, is considered essential for the processing requirements. By this invention, a process has been discovered whereby the twisting of mechanically bulked filament yarn can be substantially eliminated and the filament yarn products can be readily utilized in various textile operations and especially for needle tufting into chenilles and rugs.

The method contemplated herein utilizes a permanently crimped filament yarn produced by mechanical means, such as stuffing box crimping, gear crimping and the like, by passing the filament yarn through a gas jet under conditions to provide a substantially no-twist entangled bulk filament yarn having deregistered crimp characteristics. This processing technique provides a cohesive bulked filament yarn which does not require additional twisting for various uses and, therefore, allows full bulk development. An additional advantage of the product of this process is apparent in the deregistering of the mechanical crimp which places the substantially uniform crimp in a non-uniform manner, thereby increasing bulk and provide a better hand in the finished fabrics. Furthermore, this process tends to mask bright or dull sections in the fabric or rug product which are defects of the type caused by absence of or variation in the crimp in the filament yarn that will cause the rays of light to show up the undesirable defect. These significant improvements now permit the efficient use of mechanically crimped filament yarns which heretofore required complicated and expensive processing methods to provide a desirable filament yarn product. The process of this invention is carried out by

initially mechanically crimping filament yarns by use of techniques used in the art to provide bulk, such as stuffing box or gear crimping, or the like. The initial crimps which are placed in the filament yarn, especially synthetic filaments, are required to be heat set or by other means to provide a permanent crinkled effect, otherwise the crimps can be readily removed by placing them under tension. It is highly desirable for purposes of this invention to provide a uniform crimp throughout the filament yarn to avoid considerable variability from filament to filament which could produce known undesirable effects in the finished fabric or product. The amount of crimp placed in the filaments can range from about 3 to about 100 crimps per inch, preferably from 5 to 50 crimps per inch. After the crimp has been permanently set, the filament yarn is passed to a nip roll, through a gas jet and through a second nip roll. The purpose of the two sets of nip rolls is to provide a sufficient tension to provide intermingling of the crimped filaments so that the yarn bundle is held together by frictional constraint between the intermingled filaments. This provides a cohesive yarn equivalent to at least a $\frac{3}{4}$ twist per inch, preferably greater than 1 to 2 turns per inch to as high as 15 turns per inch but yet the yarn bundle is substantially free of true twist and false twist. The yarn bundle product obtained from the action of the gas jet, has a bulkiness in excess of 15 percent of the non-crimped yarn which is used as the starting yarn in the mechanical crimping. A further desired property of the yarn product obtained from the action of the gas jet relates to the deregistering of the crimp characteristics, i.e., causing the individual crimped portion of the yarn bundle to separate so that the individual crimps of the filaments which are identified with the crimped bundle are out of phase with one another. The deregistering technique provides bulk and better hand in the fabric produced from the filament yarn.

The process of the invention will be better understood from the following description, taken in connection with the accompanying drawing, in which a specific embodiment has been set forth for purposes of illustration. In the accompanying drawing, the filaments 10 are passed from a supply point (not shown) at a controlled rate through paired conveyor rolls 11 and 12 into a crimping or stuffer chamber 13 wherein the initial folds of the filaments 10 occur. The folded filaments 10 pass from the crimping or stuffer chamber into a setting chamber 14 which is provided with heating means for purposes of setting the crimp of the filaments. At the base of the setting chamber 14 is a constriction 15 which can be fixed or variable, depending on the requirements to obtain a uniform crimp. Attached to the constriction 15 is an adjustable screw 16 to provide the necessary constriction pressure to the filaments 10 in the setting chamber 14. After the filaments 10 have been crimped and heat set, they are withdrawn from the setting chamber 14 around an idler roll 17 and passed through a pair of nip rolls 18 and 19, through an air jet 20 and through a second pair of nip rolls 21 and 22 to a package not shown for winding and collection. Another method of crimping the filament yarn is passing the yarn through a gear crimper and heat setting the crimp, heating the yarn and then passing the yarn through the gear crimper or by passing the yarn over a gear crimper which is heated to simultaneously place and permanently set the crimp in the filaments.

The unique feature of the process of this invention is the treatment under controlled positive tension of the permanently crimped filament yarn by passing the yarn into a gas jet containing a yarn passageway in combination with one or more gas conduits positioned to direct a stream of high velocity gas toward the yarn axis. The stream of gas may be directed perpendicular to the yarn axis at the point of contact, or it may be angled forward

or backward along the yarn axis. The purpose of the gas jet treatment of the yarn is to separate the individual crimped filaments of the yarn bundle, and by the use of the controlled tension permit the crimped filaments to entangle with adjacent filaments along the yarn to maintain the unity of the yarn by frictional constraint between filaments thereby providing a cohesive bulk filament yarn free of bundle twist and false twist. The tension of the yarn can be maintained in the range from about 0.05 to 0.4 gram per denier depending on the yarn composition, gas pressure in jet, amount of entanglement desired, among other variables. The resulting yarn has sufficient cohesiveness so that in the use of the yarn in needle tufting into rugs, no additional twisting is required. Additionally, the treatment of the yarn further causes the individual bundle crimps to be deregistered so that the individual filaments of the crimped bundle are placed out of phase with one another to provide additional bulk but yet the desired cohesiveness.

The gas jets which can be used to provide the product of this invention are of similar construction as those described in U.S. Pats. 2,924,868, 2,985,995, 3,115,691 and others. These jets have the advantage that the gases may be impinged against the surface of the yarn going through the yarn passageway of the jet to separate the crimped yarn bundle into multiple groups of one or more filaments, and permit reassembly of the filaments in a manner to intermingle the filaments. The treatment of the yarn can be accomplished by utilizing a gas jet having gas conduits disposed at intervals along the yarn passageway, having gas conduits alternately disposed at intervals along opposite sides of the yarn passageway or preferably having the gas conduits in diametrically opposed pairs along the length of the yarn passageway in a manner to provide an equalized flow of gas on the yarn. This type of jet construction permits the gas to act upon the yarn in a manner that the permanently crimped yarn has a plurality of filaments intermingled because of frictional constraint between adjacent filaments to provide a unity even when there is no bundle twist present i.e., non-twisted interlaced yarn or yarn which has been twisted to remove any bundle twist. The term "bundle twist" is used in reference to conventional true twist or alternating twist to distinguish from the interfilament twist introduced by intermingling.

The positive controlled tension on the filaments during the treatment is maintained so that the filaments and groups of filaments which are separated and revolved randomly in different directions by the action of the gas will permit intermingling of the filaments as they are reassembled. This tension varies with jet design, gas velocity, etc., but is readily determined under any particular operating condition. In general a tension in the range of 0.01 to 0.65 gram per denier is suitable. The supply of gas to the jets can range from about 5 to about 175 pounds per square inch depending on the jet design process variables but it is preferred that a range from about 30 to about 125 pounds per square inch be utilized. Any gas such as air, nitrogen, carbon dioxide and the like which is inert to the yarn may be employed in the process of the invention and air is preferred.

The passage of the yarn through the gas jet under a positive tension is controlled under such conditions that the mechanical overfeed of the yarn to the jet in relationship to the take up of the treated yarn ranges from about 0 to 5%. It is preferred to run the yarn at 0% overfeed. Higher overfeeds than 5% produce ring-like, crunodal or other loops in the yarn which are not considered desirable. Although loops are generally desired in producing bulk yarns, these loops tend to snag adjacent yarns and cause considerable difficulties in handling. The product of this invention, however, provides the bulk in the mechanical crimp and on treatment through the gas jet maintains its bulk but also provides a cohesive yarn substantially free of loops which avoids the difficulties of the loop containing bulked yarns.

The products of this invention can be prepared from any natural or synthetic filamentary material which can be permanently crimped by mechanical means. Typical materials include polyamides e.g., poly (epsilon caproamide) and poly (hexamethylene adipamide); cellulose esters, e.g. cellulose acetate and cellulose triacetate; polyesters e.g. poly (ethylene terephthalate), poly (hexahydro-p-xylylene terephthalate) and the like; polyolefins, e.g. polyethylene, linear polypropylene and the like; polyvinyls and polyacrylics, e.g. polyacrylonitrile, as well as copolymers of acrylonitrile and other copolymerizable monomers can be used. Yarns useful in this process include those having Y, circular, bell-shaped, trilobal, cruciform or otherwise modified cross sections. Natural fibers in the form of filaments can be used such as wool, cotton, silk and the like.

The following examples serve to illustrate the process and products of the invention without limiting the same:

EXAMPLE 1

Undrawn untwisted 10,800 denier 204 filament nylon (polyhexamethylene adipamide) yarn which has been stretched 3.67 times its original length and heat relaxed 6% is passed into a stuffing box crimper as shown in the accompanying drawing through conveyor rolls to initiate the folding of the yarn. The folded yarn is passed into a setting chamber maintained at 75° C. and the folded yarn is placed under pressure and heat set to form the permanent crimps ranging from about 9 to 15 crimps per inch measured in an untensioned condition. The crimped yarn which is non-coherent and highly registered i.e. the individual crimps are aligned across the yarn bundle, passes through a pair of nip rolls through an entanglement jet and through a second pair of nip rolls. The preferred entanglement jet consists of a body with a cylindrical duct and an air passage to intersect the cylindrical duct at the mid point of the cylindrical duct such that the axis of the air passage intersects the axis of the cylindrical duct. A cylindrical insert fitted into the cylindrical duct of the housing has a cylindrical yarn duct bored co-axially with the cylindrical insert. A plenum groove is machined in the circumference of the insert at the midpoint of the insert such that the walls of the plenum groove and the wall of the cylindrical duct form an annular plenum when the insert is housed in the body. Two rubber O rings, one at each end of the insert, in two additional circumferential grooves protrude above the circumferential surface of the insert to bear against the wall of the cylindrical duct when the insert is housed, thus sealing the insert in the duct. Two diametrically opposed air passages are bored from the bottom of the plenum groove in the insert to the yarn duct. Entrance and exit alignment guides are mounted from the entanglement jet body to be co-axial with the yarn duct through the insert. The tension of the yarn through the entanglement jet is controlled by fixing the ratio at one to one the speeds of the first and second pairs of nip rolls. The plenum of the entanglement jet is supplied with compressed air at 100 pounds per square inch gauge in such that the yarn, during passage through the entanglement jet, is impinged by an equalized flow of air from the diametrically opposed air passages which intersect the yarn duct. The yarn is whipped about in the highly turbulent exhaust of compressed air such that the filament of the yarn are first splayed apart and then intermingled with one another such that the crimp is deregistered and frictional constraint of the entangled filaments hold the yarn in a coherent bundle having an equivalent coherency of approximately 2/3 turn per inch and bulked in excess of about 15 volume per cent of the starting non-crimped yarn. The crimped, deregistered and cohesive yarn which is free of loops and substantially free of bundle twist is then taken up on a package.

EXAMPLE 2

A nylon 66 yarn (polyhexamethylene adipamide) having a total denier of 192 (34 filaments) was passed over rollers rotating at 500 feet per minute and thence passed over a draw pin heated to 190° C. The yarn is then passed to a draw roll rotating at 1350 feet per minute via the nip between two gear wheels of 3-inch diameter having 38 teeth per inch. These gear wheels were machined so that the teeth intermeshed to a degree of about 11 thousandths of an inch and were rotated by a separately driven motor at about 950 r.p.m.

On leaving the drawroll, the yarn was fed into a gas jet of the type described in claim 1 and utilizing the same reaction conditions therein. The yarn is passed onto a second roll, the speed of which was adjusted to maintain a tension of 7 to 10 grams on the yarn between the last two rolls. The resulting yarn contains intermingled filaments to provide a coherent yarn having an equivalent coherency of approximately 1 turn per inch and bulked in excess of about 15 volume percent of the starting non-crimped yarn. The crimped deregistered and cohesive yarn which is free of loops and substantially free of bundle twist is then wound on a bobbin.

In a similar manner as the above example a gear crimped yarn was produced eliminating the entanglement of the yarn in the air jet. The yarns treated in the air jet gave a considerable improvement in cover, bulk and handle of knitted fabrics when compared to those yarns which were not treated in an air jet.

It is to be understood that the foregoing description is merely illustrative of preferred embodiments of the invention of which many variations may be made by those skilled in the art within the scope of the following claims without departing from the spirit thereof.

What is claimed is:

1. In the production of a bulked continuous multifilament yarn utilizing a mechanical crimping apparatus, the improvement comprising passing a permanently crimped multifilament yarn bundle through a gas jet under a yarn tension sufficient to prevent looping of the filament wherein the gas separates the crimped yarn bundle into multiple groups of one or more filaments thus causing the separated groups to intermingle and entangle the filaments, said intermingling being sufficient to be equivalent to at least $\frac{1}{2}$ twist per inch, and with drawing the entangled, crimped filaments from the gas jet under tension as a bulked yarn bundle substantially free of bundle twist and having said crimps deregistered from one another, the filaments of said yarn being intermingled with adjacent filaments and groups of filaments along the yarn to maintain the unity of the yarn by frictional constraint between filaments.

2. In the production of a bulked continuous multifilament yarn utilizing a mechanical crimping apparatus, the improvement comprising passing a permanently crimped multifilament yarn bundle through a gas jet under a yarn tension sufficient to prevent looping of the filaments wherein the gas impinges the surface of said yarn through at least a pair of diametrically opposed conduits along the length of the yarn passageway in a manner to provide an equalized flow of gas on said yarn and separates the crimped yarn bundle into multiple groups of one or more filaments causing the separated groups to intermingle the filaments, said intermingling being sufficient to be equivalent to at least $\frac{1}{2}$ twist per inch, and withdrawing the filaments from the gas jet under tension as a bulked yarn bundle being substantially free of bundle twist and having deregistered crimp characteristics, the

filaments of said yarn being intermingled with adjacent filaments and groups of filaments along the yarn to maintain the unity of the yarn by frictional constraint between filaments.

3. The process of claim 2 wherein the crimped multifilament yarn passed through the gas jet is crimped utilizing a stuffer box crimper.

4. The process of claim 2 wherein the crimped multifilament yarn passed through the gas jet is crimped utilizing a gear crimper.

5. A bulked multi-filament mechanically crimped yarn having deregistered crimps and substantially free of bundle twist wherein the crimped filaments are intermingled with adjacent filaments along the yarn to maintain the unity of the yarn by frictional constraint between filaments, said intermingling being equivalent to at least $\frac{1}{2}$ twist per inch and said yarn having a bulk in excess of 15 volume per cent of the noncrimped yarn which is used as the starting yarn in the initial mechanical crimping.

6. The product of claim 5 wherein the crimps per inch of each of the filaments range from about 3 to about 100.

7. The bulked, multifilament mechanically crimped yarn of claim 5 wherein the yarn is poly(hexamethylene adipamide) wherein the individual filaments contain from 5 to 50 crimps per inch and wherein the intermingling with adjacent filaments along the yarn is equivalent to at least $\frac{2}{3}$ twist per inch.

8. A process for the manufacture of bulked, multifilament yarn comprising forwarding a multifilament yarn to a means for mechanically crimping the yarn, mechanically crimping the yarn so as to produce crimps therein subjecting the crimped yarn to the action of a gas jet under a yarn tension of 0.01 to 0.65 gram per denier at a gas pressure of 5 to 175 pounds per square inch in said gas jet, whereby the crimps in the crimped yarn are deregistered with respect to one another and the filaments in the yarn are entangled with one another, said intermingling being sufficient to be equivalent to at least $\frac{1}{2}$ twist per inch, thereby forming a bulked yarn having a bulkiness in excess of 15 volume percent of the starting non-crimped yarn.

9. Process according to claim 8 wherein the crimp in the mechanically crimped yarn is set prior to subjecting the crimped yarn to the action of the gas jet.

10. Process according to claim 9 wherein the yarn subjected to the action of the gas jet is overfed during such action in the range of from about 0 to 5%.

References Cited

UNITED STATES PATENTS

3,126,095	3/1964	Caines et al.	28—1
2,972,798	2/1961	Stanley et al.	28—72
3,099,064	7/1963	Haynes	28—1
3,099,594	7/1963	Caines et al.	28—72 X
3,110,151	11/1963	Bunting et al.	57—157
3,157,022	11/1964	Haynes	57—140
3,309,855	3/1967	Stoll et al.	57—34

FOREIGN PATENTS

231,468	12/1960	Australia.
658,465	5/1965	Belgium.
1,064,765	4/1967	Great Britain.

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U.S. Cl. X.R.

28—1.3, 72.11; 57—34, 157