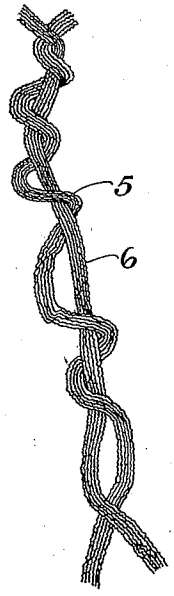
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YARN AND METHOD OF PRODUCING SAME

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YARN AND METHOD OF PRODUCING SAME

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This invention relates to the production of a novel, wool-like yarn containing artificial filaments. More particularly, the invention relates to the production of a wool-like yarn containing crimped artificial filaments, which yarn may be woven or knitted without removal of the crimp to an objectionable degree. The invention also relates to an improved process of producing such novel wool-like yarns by the use of spontaneously crimpable synthetic linear condensation polymers.

This invention is a continuation-in-part of the copending application of Hardy and Miles, Serial No. 183,922, filed January 7, 1938.

Many methods for the production of crimped wool-like artificial filaments have been proposed heretofore. Threads or yarns composed of such crimped artificial filaments have, in a great many instances, resembled threads or yarns of wool. Upon constructing fabrics from these yarns, however, the wool-like crimp has been largely removed from the filaments due to the tensile forces used in the fabric construction. The resulting fabric consequently does not exhibit the desired loft or fullness.

It is therefore an object of the present invention to produce a wool-like yarn comprising crimped artificial filaments, which yarn can be woven or knitted into fabrics without objectionably destroying the wool-like character of the yarn.

It is another object of this invention to provide a method for the production of a yarn comprising crimped artificial filaments, said yarn containing crimped filaments having different lengths when straightened out.

Another object of the invention is to produce a composite yarn composed of crimped filaments and spontaneously crimpable artificial filaments, which upon causing the latter filaments to crimp, will result in the production of a yarn having crimped filaments of different straight lengths.

Other objects of the invention will appear hereinafter.

The objects of the invention can be accomplished, in general, by combining two or more strands of filaments, at least one strand of which comprises synthetic linear condensation polymer filaments capable of crimping spontaneously on drying in the relaxed condition, and preferably at least one other strand of which possesses crimp, and drying the resultant yarn under low tension to permit crimping and shrinking of the drying filaments, whereby to produce a composite yarn containing crimped filaments of different straight lengths. By "filaments of different straight lengths" is meant filaments which, upon being pulled straight to remove the crimps therefrom, without stretching, will have different lengths.

By a "spontaneously crimpable thread" is meant a thread which, when wet and allowed to dry in the relaxed condition, crimps automatically to such a pronounced degree that at least four crimps per inch are introduced and the length of the crimped thread is less than 75 per cent of its straightened length.

The resultant composite yarn composed of crimped threads having filaments of different straight lengths is illustrated in the accompanying drawing. The composite yarn illustrated comprises two threads or strands 5 and 6 which have different straight lengths. The strand 5 was crimped before combining the same with strand 6. The strand 6 was composed of straight, spontaneously crimpable filaments at the time it was combined with strand 5 and subsequently the spontaneously crimpable filaments were caused to crimp.

The present invention can be carried out by the use of synthetic linear condensation polymers of the type described in U. S. Patents Nos. 2,071,250 to 2,071,253 inclusive. These patents describe a new class of artificial filament-forming materials known as "synthetic linear condensation polymers". A characteristic property of these filaments, as indicated in the above-mentioned patents, is that they can be cold drawn into oriented filaments (fibers) of great utility for the manufacture of fabrics. In the above-mentioned copending application of Hardy and Miles there is described a novel method for preparing crimped or wool-like filaments from these synthetic polymers. This process, generally stated, consists in drying, under low tension, suitably prepared cold drawn wet filaments. During the drying operation the filaments crimp spontaneously to produce a product greatly resembling wool in character. The ratio of crimped length to straight length of filaments spontaneously crimped in this manner will usually be within the range of about 1:2 to 1:4. The filaments also shrink during the drying thereof so that the straight length of the crimped filaments is generally from 5% to 25% less than the straight length of the filaments before crimping. The crimps may be rendered more permanent by steam treatment.

Thus, in the case of the synthetic linear condensation polyamide, the pretreatment may take

several forms. One form consists in preparing the filaments by melt spinning a polyamide of rather low intrinsic viscosity (usually 0.6 to 1.0) at a temperature from 5 to 30° C. above its melting point and cold drawing the filaments while wet with a liquid having a mild swelling action on the filament such as water, methanol, ethanol, etc., to an extent below the maximum possible. Such filaments crimp spontaneously on drying in a relaxed condition. To increase the rate of drying the filaments may be washed with acetone or other readily volatile solvent which aids in the removal of the water or other swelling agent. Another method of pretreatment consists in heating for a short time filaments spun in any manner. The preferred method of heating consists in passing the filaments while wet with water or other mild swelling agent for the filament, e. g., an alcohol, very rapidly through a bath of hot non-solvent for the polyamide, e. g., oil, removing the non-solvent by washing or other suitable procedure, and cold drawing the wet filaments. Filaments prepared in this way crimp spontaneously on drying. To hasten the drying operation the filaments can be washed with acetone or the like prior to the drying operation under low tension. The crimp in the filaments is rendered more permanent by treating with steam or other setting agents.

With reference to the above process of spontaneous crimping, it should be stated that if a crimpable filament is allowed to dry under tension so that it cannot crimp and is then rewetted and dried in the relaxed condition, it undergoes only slight crimping. If, however, the original crimpable filament contains a hydroscopic material or a wetting agent such as a sulfonated oil, it can be dried in air under tension without destroying its crimping power on subsequent wetting and drying under low tension.

The crimps which appear in the fibers during spontaneous crimping are in the form of helixes which reverse their direction at irregular intervals along the length of the filaments. The filaments greatly resemble wool in feel and appearance and have excellent crimp retentivity in the sense that pulling the filaments, wet or dry, until the crimps are straightened out and then applying an additional 10% stretch does not permanently destroy the crimps. When the filaments are released and, if wet, allowed to dry, most of the crimps reappear. The principal defect of these filaments, as well as other artificial filaments to which a crimp has been imparted, is that when they are formed into a yarn by the usual method of doubling or plying (with or without twisting) a yarn is obtained, in which all the filaments have substantially the same straight length. This means that when the yarn is subjected to sufficient tension, all the crimps straighten out at about the same time. Forces approaching or exceeding this magnitude are involved in making fabrics from these yarns by the process of weaving and knitting. Consequently, the resulting fabrics are much less woolly than the original yarn, although the thread in the fabric is fully capable of regaining its crimp and would regain it except that the fabric construction is so tight as to prevent it.

It has now been found that the above difficulty can be largely overcome by preparing yarns according to the process of the present invention.

According to the process of the present invention wool-like yarns of superior quality are obtained by taking advantage of the remarkable property of spontaneous crimping exhibited by suitably prepared filaments of synthetic linear condensation polymers. In its preferred embodiments the process consists in plying two strands of filaments, one of which contains crimp and the other of which is capable of crimping on subsequent treatment. The latter strand is composed of wet synthetic linear condensation polymer filaments, preferably polyamide filaments, which undergo spontaneous crimping on drying. In plying the two strands it is desirable to apply some twist, e. g., 4 to 10 turns per inch. The subsequent treatment mentioned above consists in drying the resultant yarn. This step is preferably followed by steam treatment to increase the crimp retentivity of the product. It is also desirable to apply additional twist.

Since polyamide filaments undergo a large shrinkage during spontaneous crimping, often as much as 20%, and this shrinkage is much greater than that undergone by rewetting and redrying straight polyamide filaments or polyamide filaments which have already been crimped and dried, it will be apparent that the above process will give a yarn composed of filaments having different straight lengths. The filaments in the strand which underwent crimping during drying will have a shorter straight length than those in the strand crimped before the plying operation. On applying stress to this woolly yarn, therefore, only the crimp in the strands which underwent crimping after plying will pull out leaving a yarn which is still quite wool-like due to the crimp retained in the strands crimped before the plying operation.

The following illustrative examples describe the invention more specifically. It is to be understood that the invention is not limited thereto.

Example I

A sample of 30 filament, 300 denier yarn prepared from polyhexamethylene adipamide of intrinsic viscosity 0.9 was cold drawn 200% (i. e., until its length was three times that of the original yarn) and then, while it was wet with water, it was passed at a rate of 100 feet per minute through a four inch oil bath containing mineral oil at 155 C. This treatment ("conversion") gave the yarn spontaneous crimping properties. The converted yarn was thoroughly washed with soapy water followed by fresh water to remove the oil. The wet yarn was next cold drawn an additional 50% and split into two approximately equal parts. One part or strand was wound on a bobbin and placed in a container of water and the other part wound on another bobbin and placed in a container of acetone. Ends from each of the two bobbins were then plied without twisting in such a way that the strand from the acetone crimped before it reached the wind-up bobbin while the strand from the water was not crimped. The wind-up bobbin was sprayed with water during the wind-up. The plied yarn was then skeined and allowed to dry. This caused the uncrimped strand present in the yarn to crimp. This gave a yarn of excellent crimp, part of which (the strand which crimped in the skein) pulled taut much sooner than the other. The loose part (the strand which crimped before reaching the wind-up bobbin) would slip readily back and forth on the taut part. This slippage was overcome by applying approximately 8 to 10 turns per inch twist to the yarn. The yarn was treated with saturated steam to improve its crimp

retentivity. It yielded fabrics having a decided woolly appearance and hand.

Example II

Four strands of water-wet 10 filament, 80 denier polyhexamethylene adipamide yarn were "converted" without prior cold drawing by a 0.4 second oil treatment at 150° C. After washing the strands to remove the oil, they were combined into a single strand. This wet strand was then cold drawn 175%, washed with acetone, and allowed to dry in the relaxed condition whereupon spontaneous crimping occurred. The crimped strand was wound up on a motor-driven reel without tension, (using a diamond traverse) and the crimps in the filaments set by treatment with saturated steam at 20-lb. pressure for 20 minutes. A second strand of polyhexamethylene adipamide filaments (30 filament, 300 denier) was predrawn 200%, converted by means of oil at 155° C., washed, and afterdrawn 50% while wet. This strand was kept wet so that it would not crimp. These two strands, one crimped and the other uncrimped but capable of crimping on drying, or upon wetting and redrying, were then plied, under tension, on the twister at 4 turns per inch. Owing to the tension applied, the crimp in the crimped strand pulls straight during the plying. The yarn thus formed was next skeined, and dried, whereupon the uncrimped strand crimped spontaneously. The finished yarn had an excellent wooly appearance. Part of the filaments in the yarn pulled taut much sooner than the rest, but the loose part showed some tendency to slip on the taut part. This was overcome by putting in an additional aftertwist and, as in Example I, a total of approximately 8 to 10 turns per inch was required to prevent slippage. The yarn was then treated with steam to improve the crimp retentivity. It yielded excellent knitted and woven fabrics.

As additional examples of synethetic linear condensation polyamides which can be used in the peparation of the yarns of this invention may be mentioned polyhexamethylene sebacamide, polyhexamethylene beta-methyl adipamide, polydecamethylene adipamide, polydecamethylene p-phenylenediacetamide, polymerized 6-amino-caproic acid, and polymerized 11-amino-undecanoic acid. Polyamides derived from diamines of formula $NH_2CH_2RCH_2NH_2$ and dicarboxylic acids of formula $HOOCCH_2R'CH_2COOH$ or amide-forming derivatives thereof, in which R and R' are divalent hydrocarbon radicals free from aliphatic or acetylenic unsaturation and in which R has a chain length of at least two carbon atoms are particularly useful in this invention. Filaments derived from mixtures of polymers or from interpolymers may be used.

The term "linear condensation polyamide" is meant to designate polyamide compounds of the types herein disclosed and their equivalents whether or not such compounds are produced by chemical condensation or by some other process.

It is within the scope of the invention to prepare woolly yarns from filaments containing modifying agents, e. g., pigments, dyes, resins, plasticizers, antioxidants, luster modifying agents, etc.

Although the preferred embodiment of the invention comprises combining two strands of polyamide filaments, the invention also includes combining by twisting a strand of any natural or synthetic filaments, preferably crimped, with a strand of polymer filaments capable of undergoing spontaneous crimping. For example, filaments of crimped viscose or cellulose acetate rayon may be combined with polyamide filaments capable of undergoing spontaneous crimping (and shrinking) and thereafter subjecting the composite yarn to the treatment required to spontaneously crimp the polyamide filaments. Similarly, natural wool can be combined with the crimpable polyamide filaments. The precrimped filaments may consist of a mixture of different filaments. Likewise the crimpable filaments may consist of more than one kind of filament.

When crimped polyamide filaments are combined with crimpable polyamide filaments, it is not essential that the precrimped filaments employed be prepared by the spontaneous crimping above-identified process of Hardy and Miles. The crimped filaments can be prepared by passing straight filaments between intermeshing gears, by twisting-setting-back twisting, and other mechanical methods. It will be noted that the process of this invention gives an artificial wool-like yarn containing continuous filaments. Most other artificial wool-like yarns owe their wool-like character to the presence of loose ends, i. e., short or staple fibers. Although staple fibers are not essential to the preparation of the wool-like yarns of this invention, the strands of filaments used to make the yarns may contain staple fibers.

Yarns prepared according to the process of this invention can be plied with other types of yarns, e. g., cotton, wool, silk, rayon, etc.

Yarns prepared in accordance with the process of this invention are useful in making knitted and woven fabrics. The fabrics produced with these yarns are more wool-like than those made from yarns containing the same type of filaments but formed into a yarn according to usual methods. Fabrics made from the yarns of this invention can be subjected to the conventional treatments applied to wool and worsted fabrics, e. g., milling, crabbing, blowing, decatising, raising or teazling, napping, and shearing.

Since it is obvious that many changes and modifications of the above-described method and product can be made without departing from the nature and spirit of the invention, it is to be understood that the invention is not to be limited except as set forth in the appended claims.

I claim:

1. A composite yarn comprising a crimped thread and a spontaneously crimpable thread.

2. A composite yarn comprising a crimped thread and a spontaneously crimpable thread comprising synthetic linear condensation polymer filaments.

3. A composite yarn comprising a crimped thread and a spontaneously crimpable thread comprising synthetic linear condensation polyamide filaments.

4. A plied yarn comprising a strand of a spontaneously crimpable thread composed of synthetic linear condensation polymer filaments, and another thread which is not spontaneously crimpable.

5. A plied yarn comprising a strand of a spontaneously crimpable thread composed of synthetic linear condensation polyamide filaments, and another thread which is not spontaneously crimpable.

6. A composite yarn comprising a plurality of crimped threads, at least one of said threads having a straight length varying substantially

from the straight length of another of said threads.

7. A composite yarn comprising a plurality of crimped threads, at least one of said threads having a straight length varying substantially from the straight length of another of said threads, at least one of said threads comprising filaments of a synthetic linear condensation polymer.

8. A composite yarn comprising a plurality of crimped threads, at least one of said threads having a straight length varying substantially from the straight length of another of said threads, said threads twisted together.

9. The process of making yarn which comprises combining, with twisting, a crimped thread and a spontaneously crimpable thread, causing said crimpable thread to crimp, and twisting said threads together.

10. The process of making yarn which comprises combining a crimped thread with a spontaneously crimpable thread, causing said crimpable thread to crimp, and twisting said threads together.

11. The process of making yarn which comprises combining a crimped thread with a spontaneously crimpable thread, causing said crimpable thread to crimp, and twisting said threads together.

12. The process of making yarn which comprises combining a crimped thread with a spontaneously crimpable thread, composed of a synthetic linear condensation polyamide, causing said crimpable thread to crimp, and twisting said threads together.

13. The process of making yarn which comprises combining a crimped thread composed of a synthetic linear condensation polymer with a spontaneously crimpable thread composed of a synthetic linear condensation polymer, causing said crimpable thread to crimp, and twisting said threads together.

14. The process of making yarn which comprises combining, with twisting, a crimped thread with a spontaneously crimpable thread composed of a synthetic linear condensation polymer, causing said crimpable thread to crimp, and twisting said threads together.

15. The process of making yarn which comprises combining a crimped thread with a spontaneously crimpable thread composed of a synthetic linear condensation polymer and causing said crimpable thread to crimp.

16. The process of making yarn which comprises combining a crimped thread with a spontaneously crimpable thread composed of a synthetic linear condensation polymer, causing said crimpable thread to crimp and twisting said threads together.

17. A process for making wool-like yarns which comprises plying a crimped thread with a wet synthetic linear condensation polyamide thread which crimps on drying in the relaxed condition, and then drying the yarn under low tension.

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