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METHOD OF PRODUCING REGENERATED CELLULOSE TEXTILE MATERIAL

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This invention relates to yarns, and to woven, knitted and pile fabrics produced therefrom. More specifically, it relates to yarns and fabrics comprising regenerated cellulose filaments.

The present invention is a continuation-in-part of our copending application Serial No. 180,976, filed December 21, 1937, now issued as U. S. Patent No. 2,249,745, dated July 22, 1941.

In the production of some fabrics from regenerated cellulose yarn, it is required that the yarn be comprised of crimped filaments in order to impart to the fabric a satisfactory loft, depth, and fullness. Regenerated cellulose yarns comprising crimpy filaments are difficult to handle in weaving or knitting operations. Such yarns tend to bind in the heddles in a weaving operation, or tend to catch on the needles in a knitting process. In addition, such yarns are bulky which makes it necessary to put less yarn on a cop or bobbin. The art has long desired a regenerated cellulose yarn which may be woven or knitted with the ease of handling of a straight-filament yarn, but which will have the bulking capacity in a fabric of a crimped-filament yarn.

It is, therefore, an object of this invention to produce a regenerated cellulose yarn which may be woven or knitted with the ease of handling of straight-filament regenerated cellulose yarn but which will have a bulking capacity in a fabric of crimped-filament regenerated cellulose yarn.

It is another object of this invention to produce a fabric, such as a woven, knitted or pile fabric, comprising a straight-filament regenerated cellulose yarn, the filaments of said yarn having a spontaneous crimp-forming capacity.

It is another object of this invention to provide a process for making an improved woven, knitted or pile fabric comprising substantially permanently crimped regenerated cellulose filaments, the crimp in the filaments having been formed, in situ, in the fabric.

It is still another object of this invention to produce a fabric of great bulk and depth comprising regenerated cellulose filaments which are spontaneously crimped, in situ, in the fabric.

Other objects of the invention will appear hereinafter.

The objects of this invention may be accomplished, in general, by drying, under sufficient tension to remove any crimp present therein and to prevent the formation of any crimp therein, a wet yarn comprising regenerated cellulose filaments, which filaments upon wetting and drying without tension will spontaneously form a permanent crimp therein, whereby to produce a yarn

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having straight filaments which have a spontaneous crimp-forming capacity. For the production of a fabric, the resulting yarn is woven or knitted into the desired fabric structure, and the yarn filaments subjected to conditions of wetting and drying favoring the spontaneous formation of crimps.

By the term "spontaneous crimp-forming capacity" as used throughout the specification and claims is meant the capacity of filaments and yarns to spontaneously form crimps therein by subjecting the same to thorough wetting with an aqueous medium, followed by drying without substantial tension.

By "permanent crimp" or "permanently crimped filaments" as used herein is meant a crimped filament or fiber which will substantially regain its original crimp after being subjected to the following conditions: A single crimped filament, or a small bundle of such filaments, is thoroughly wet in water and thereafter stretched 10% over and above that required to just remove the crimps. The filaments are maintained in this stretched condition until completely dried. After drying, the filaments are again thoroughly wet out with water and permitted to dry while freely relaxed, i. e., without substantial tension.

Several yarns, and processes for producing the same, comprising permanently crimped regenerated cellulose filaments are known, for example, the yarn produced in accordance with our above-mentioned copending application Serial No. 180,976, now U. S. Patent No. 2,249,745, or the yarn produced in accordance with the copending applications of William D. Nicoll, Serial No. 318,326 and Serial No. 318,327, filed February 10, 1940, and the copending application of William D. Nicoll, Serial No. 465,414, filed November 13, 1942, which is a continuation-in-part of said Serial Nos. 318,326 and 318,327; Nicoll Serial No. 465,414 covers both straight and crimped regenerated cellulose filaments and yarns which will spontaneously crimp from the straight or crimp free state when immersed, free of tension, in an aqueous liquid, and also covers processes including the process of Example IV of the present application, for preparing such filaments and yarns. Yarns produced in accordance with processes outlined in the above-identified applications not only have a permanent crimp but they will retain their crimp when subjected to treatment in liquid ammonia, thus exhibiting a particularly permanent crimp. These yarns are

therefore preferred species for use in accordance with the present invention.

In order to produce straight regenerated cellulose filaments having the spontaneous crimp-forming capacity of the present invention, any dry permanently crimped filaments may be wetted and then dried under sufficient tension to remove the crimp from the filaments, or alternatively, the wet gel filaments produced in a process for making permanently crimped filaments may be dried under sufficient tension to prevent the formation of the said permanent crimps.

The tension imparted to the filaments during the drying step must, of course, be less than the tension which will stretch the filaments to their elastic limit.

The following specific examples will serve to illustrate preferred methods for carrying out the present invention. The scope of the invention is, of course, not to be limited to the details set forth in the examples. Unless otherwise stated, percentages and parts set forth in the examples shall be considered to be parts and percentages by weight.

Example I

Viscose made from regular cotton linters comprising 7% cellulose, 6% sodium hydroxide viscose, salt index 4.0–4.2 is spun into 40% ammonium sulfate bath containing 1.5% ammonium hydroxide at 45° C. using a spinneret which contains 40 holes, each hole 0.002 inch in diameter at a rate of 8.08 grams per minute (this represents a nozzle velocity of 3530 inches per minute). The crimped yarn formed in this manner is drawn away at the rate of 474 inches per minute and wound upon a bobbin (this represents a ratio of nozzle velocity to draw-off speed of 7.45). The coagulated yarn wound on a bobbin is then immersed in a bath consisting of 20% sulfuric acid, 18% sodium sulfate, and 10% glucose at room temperature for 10 minutes in order to regenerate the yarn. After regeneration, the bobbin cakes are washed acid-free with soft water and then immersed in an aqueous solution of a finish followed by drying on the bobbin at room temperature. Drying the yarn on the bobbin will prevent the formation of permanent crimps in the filaments. The dry yarn is given approximately two turns twist on a down twister. The filaments of the resulting yarn possess no crimp but they have a spontaneous crimp-forming capacity.

Example II

A yarn is spun according to the process in Example I with the exception that it is reeled to skeins and dried in a relaxed form. A yarn having permanently crimped filaments results. This yarn is then wet with water and dried while holding the skein under a slight tension. The resulting yarn is straight but the filaments have a spontaneous crimp-forming capacity.

Example III

The yarn of either Example I or II is woven into a fabric using a plain weave wherein the warp consists of 10/1 spun viscose rayon yarn made from 5.5-denier, 2-inch dull viscose staple plus 15% 64's wool with about 34 warp threads per inch. The filling yarn consists of approximately 600-denier, 40-filament yarn produced by the above spinning operation using 26 picks per inch. This fabric is boiled off in the manner common to textile finish procedures for rayon followed by drying in an "Air-lay" drier, which permits shrinkage of the fabrics resulting in a finished fabric consisting of approximately 42 warp threads per inch and 32 filling threads per inch. The finish treatment and drying of the fabric while relaxed spontaneously forms a crimp in the filaments of a filling yarn.

A second fabric is prepared using the same warp as the above and a filling yarn identical with the warp, also using a pick count of 26 per inch. This fabric is finished in the identical manner with the above fabric. Upon comparing the finished fabrics, it is observed that the fabric containing the yarn having spontaneously crimped filaments, produced by the above method, possesses more loft or bulk than the one made up solely from the spun rayon yarn, because of the greater covering power of that yarn which develops a crimp during the finishing operation.

Example IV

A commercial type of viscose made from cotton linters and containing 7% cellulose and 6% alkali is spun at a sodium chloride index of 4.0 using a precious metal spinneret and an aqueous regenerating bath comprising 8.0% sulfuric acid, 19% sodium sulfate and 1.5% zinc sulfate at a temperature of 55° C. The yarn formed in this manner is made to pass around roller guides in the spinning bath to develop tension and the bath travel used is approximately 130 inches at a spinning speed of approximately 2500 inches per minute. The tension on the yarn at the point of its emersion from the bath is approximately 1 gram per denier and the filaments are approximately 3.75 denier each. The yarn is wound on a bobbin, twisted (4 turns per inch) while maintained in a wet condition and afterwards relaxed in a bath of hot water in the form of loose skeins. The yarn is then dried in a relaxed condition. A permanent crimp is formed in the filaments when the yarn is relaxed in the hot water. A yarn, according to the present invention, is obtained by wetting the resulting yarn with hot water and drying while under a slight tension. The filaments of the yarn treated in this manner possess no crimp but have a spontaneous crimp-forming capacity.

Example V

The yarn having spontaneous crimp-forming capacity described in Example IV is woven into a fabric using a plain weave wherein the warp consists of 100-denier, 60-filament continuous filament viscose yarn with a twist of 3 turns per inch. The filling yarn consists of the yarn made according to the above procedure and is 150-denier, 40-filament yarn with a twist of 3 turns per inch. The fabric as it is woven contains 82 warp yarns per inch and 60 filling yarns per inch at a reed width of 43 inches. This fabric is boiled off in the manner common to textile finishing procedures for rayon and returned to a finished width of 40 inches and dried.

A second fabric is prepared using the same warp as in Example V, and a filling yarn consisting of a standard, continuous filament viscose rayon yarn having a denier of 150, a filament count of 40 and a twist of 3 turns per inch. The filaments, therefore, did not have a spontaneous crimp-forming capacity. This fabric is finished in an identical manner with the above fabric. Upon comparing the finished fabrics, it is observed that the fabric containing the yarn having spontaneously crimped filaments possesses more loft or bulk than the one made up solely

from the standard continuous filament viscose yarn because of the greater covering power of that yarn which develops a crimp during the finishing operation.

In the production of pile fabrics, yarn comprising filaments having a spontaneous crimp-forming capacity such as described above may be used as the pile yarn. On development of the crimp a full dense pile results. The yarns of the present invention are further applicable to pile fabrics such as are produced by adhesively uniting flock or very short fibers to a backing. The flocks may contain fibers up to ¼ inch or more in length which fibers are made to stand out from the backing. The flocks may be composed of regenerated cellulose fibers having a spontaneous crimp-forming capacity, which after being attached to the backing will be subjected to wetting and drying conditions to spontaneously form a crimp therein.

Any yarn in which the filaments have the "permanent crimp" characteristics, as above defined, may be used in accordance with the present invention. As above stated, yarns having permanently crimped filaments may be produced by any of the processes set forth in the following copending applications: Serial No. 180,976 (now U. S. Patent No. 2,249,745), Serial No. 318,326, Serial No. 318,327 and Serial No. 465,414. The invention further includes staple fibers and yarns and fabrics containing these yarns and fibers where such staple fibers have a spontaneous crimp-forming capacity, and are made to spontaneously crimp, in situ, in the fabric.

There are a number of wetting and drying procedures by which the crimp may be spontaneously formed in the filaments of these yarns, after incorporation into a fabric and it is evident that this invention is not limited to any one method. The following procedures illustrate several alternative methods whereby crimps may be spontaneously formed in the filaments of regenerated cellulose yarns prepared in accordance with the present invention:

1. The fabric may be boiled off, or simply wet out, in water or preferably a finish solution, followed by drying without substantial tension, i. e., under a tension substantially less than that necessary to prevent crimp formation.

2. The fabric may be soaked in an aqueous solution containing approximately 3% sodium hydroxide at room temperature for about 30 minutes followed by washing the fabric free from any alkali, and drying without substantial tension.

3. The fabric may be steamed with moist steam, followed by drying without substantial tension.

4. The fabric may be soaked in liquid aqueous ammonia, followed by drying without substantial tension.

The present invention may be applied to fabrics, both woven and knitted wherein said fabrics may consist wholly or partially of the potentially crimpable yarn. The process of this invention may be applied to either continuous filaments or staple fibers with equal facility. Furthermore, the yarns may comprise both straight filaments which do not have a spontaneous crimp-forming capacity and straight filaments which do have a spontaneous crimp-forming capacity.

The invention is further not limited to any particular weave used in the manufacture of fabrics.

While the effect caused by the spontaneous crimp formation in the filaments is noticeable in

all fabrics, such as described above, the effect is more pronounced in the more loosely woven or knitted fabrics. In pile fabrics in which the pile comprises filaments which have been spontaneously crimped, in situ, in the fabric, the crimp will be highly developed.

Yarn comprising straight regenerated cellulose filaments having a spontaneous crimp-forming capacity has advantages over previously known regenerated cellulose yarn both in the manufacture of the fabric and in the fabrics which result. The yarns, since they do not contain a crimp, are easily handled on textile twisting and packaging equipment such as coners or spoolers; and since they are considerably less bulky than the crimped variety, about twice the poundage can be placed in the same size package. This straight fiber is easier to handle in the weaving operation since it has less tendency to bind in the heddles and also a greater yardage can be placed on the cop. This straight yarn can also be handled under higher tensions during textile and weaving operations without injuring the yarn, which ability considerably facilitates these operations. In the knitting operation, the straight yarn more easily passes through the knitting needles and the knitting tension may be more accurately and uniformly applied.

The spontaneous crimp formation in the filaments of the yarn which makes up the woven or knitted fabrics improves the general properties of said fabrics. Improvements are obtained in the loft and the hand. The fullness of the fabric and the covering power of the yarns in the fabrics are increased. Fabrics of this type are somewhat wool-like and have increased heat insulation properties.

Surface effects and embossed effects may be obtained in pile fabrics by using, along with the potentially spontaneously crimpable regenerated cellulose yarn in the pile, a standard straight filament regenerated cellulose yarn in which the filaments do not have a spontaneous crimp-forming capacity. Predetermined effects are obtained by forming a pattern of one type of yarn, which pattern will show up when the crimp is developed in the potentially spontaneously crimpable yarns because of the greater decrease in length of said yarns.

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

We claim:

1. The process which comprises wetting, with an aqueous medium, a yarn comprising regenerated cellulose filaments having a permanent crimp therein, drying said yarn under sufficient tension to remove the crimp and to prevent the formation of crimp in said filaments whereby to produce a yarn having straight filaments which have a spontaneous crimp-forming capacity.

2. The process which comprises wetting, with water, a yarn comprising regenerated cellulose filaments having a permanent crimp therein, drying said yarn under sufficient tension to remove the crimp and to prevent the formation of crimp in said filaments whereby to produce a yarn having straight filaments which have a spontaneous crimp-forming capacity.

3. The process which comprises wetting, with an aqueous alkaline medium, a yarn comprising

regenerated cellulose filaments having a permanent crimp therein, drying said yarn under sufficient tension to remove the crimp and to prevent the formation of crimp in said filaments whereby to produce a yarn having straight filaments which have a spontaneous crimp-forming capacity.

4. The process which comprises wetting, with an aqueous medium, a yarn comprising regenerated cellulose filaments having a permanent crimp therein, drying said yarn under sufficient tension to remove the crimp and to prevent the formation of crimp in said filaments whereby to produce a yarn having straight filaments which have a spontaneous crimp-forming capacity, constructing a fabric with said yarn and causing said yarn filaments to crimp spontaneously, in situ, in

the fabric by wetting said fabric and drying the same without substantial tension.

5. The process which comprises wetting, with water, a yarn comprising regenerated cellulose filaments having a permanent crimp therein, drying said yarn under sufficient tension to remove the crimp and to prevent the formation of crimp in said filaments whereby to produce a yarn having straight filaments which have a spontaneous crimp-forming capacity, constructing a fabric with said yarn and causing said yarn filaments to crimp spontaneously, in situ, in the fabric by wetting said fabric and drying the same without substantial tension.

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