METHOD OF MAKING STRETCH YARNS AND FABRICS

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FIG. 1

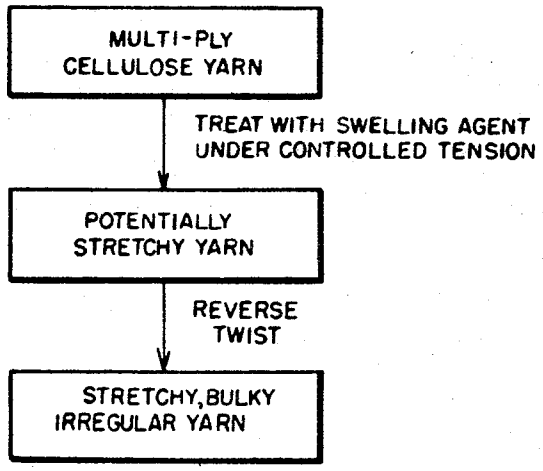

FIG. 2

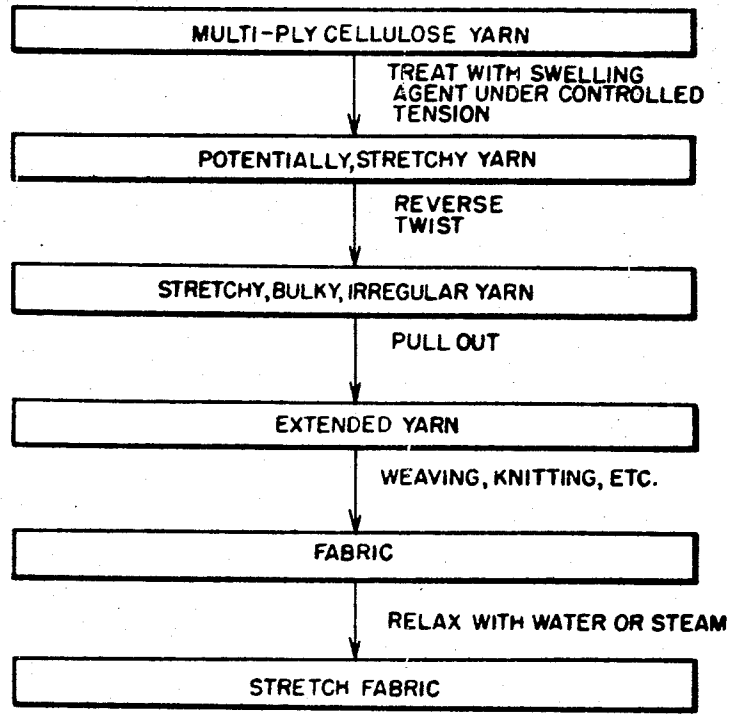

FIG. 3

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3,365,769

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This invention relates to a method for making stretch yarns and fabrics from cellulose filaments.

The use of stretchy yarns to make fabrics which have stretch properties has become increasingly widespread. Most of such yarns contain an elastomeric material, either as a component fiber or as an impregnant. The use of elastomers has drawbacks because in many instances they impart an undesirable hand or feel to the fabric and because they add to the cost of the fabric. Moreover, if stretch is imparted to the yarn before it is made into fabric, it becomes difficult to handle the yarn on conventional textile machinery.

There is therefore a need for an inexpensive yarn which will have stretch properties, and which can be processed on conventional textile machinery.

In our copending application Ser. No. 363,248, filed Apr. 28, 1964, there is described a process in which stretch yarns and fabrics can be made from cellulosic filamentary material. In this prior process a multi-ply yarn is treated with a swelling agent for cellulose in the substantial absence of tension and then reverse twisted.

The yarns obtained under the conditions described in said prior application have excellent properties, but because the process described requires treatment in the absence of tension, it cannot conveniently be practiced in many types of conventional textile apparatus which inherently require that the yarn be subjected to tension during processing.

It has now been found that a satisfactory yarn having good stretch properties can be made when the yarn is treated under tension, provided that the amount of tension applied is restricted to that which will maintain the yarn at from about 50 to 100% of its original, untreated length; or stated another way, which will give a yield, in terms of yarn length, of 50 to 100%.

The invention therefore includes a method for making a stretchy yarn which comprises contacting a cellulose yarn having at least two plies with a cellulose swelling agent equivalent to an aqueous solution containing 5 to 40% sodium hydroxide and capable of shrinking said yarn, maintaining said yarn during contact with said swelling agent under tension sufficient to maintain said yarn at at least 50% of its original length and subsequently reverse twisting the treated yarn.

Yarn made in accordance with the invention has an irregular appearance, as will be described more fully below. It may be drawn out and if retained in an extended position for a period of time, will lose its stretchy characteristics. In this condition it may be used on textile machinery like any non-stretch yarn, to make woven or knitted fabrics. Such fabrics upon being wetted out or steamed, without tension, will develop the stretch characteristics originally present in the yarn.

In another aspect the invention therefore includes a method for making a stretch fabric which comprises treating a multi-ply yarn consisting essentially of cellulose filaments with a swelling agent for cellulose, equivalent to an aqueous solution containing between about

5% and about 40% NaOH and capable of shrinking said yarn, under a tension sufficient to maintain said yarn at at least 50% its original length, drying the yarn, releasing said tension, reverse twisting the yarn to produce a coiled yarn having an irregular, three-dimensional series of helical sections, pulling out the yarn to form a substantially straight yarn, converting the straight yarn to fabric and relaxing the fabric in an aqueous fluid.

In the drawings:

FIG. 1 is a flow diagram, illustrating the manufacture of stretch yarn in accordance with the invention.

FIG. 2 is a flow diagram illustrating the manufacture of stretch fabric in accordance with the invention.

FIG. 3 is a view in elevation of reverse twisted yarn made according to the invention.

Referring first to FIG. 1, yarn in accordance with the invention is made by treating a multi-ply yarn consisting essentially of cellulose fibers with a swelling agent for cellulose.

The multi-ply yarn used in the invention has at least two plies and may have up to say 6 plies. The individual filaments making up the singles yarns may be staple filaments, or continuous filaments. The filaments may be made from natural cellulose, e.g. cotton, ramie, jute and linen; or they may be synthetic filaments, i.e., rayon whether made by the viscose, cuprammonium or nitrate processes, or by the saponification of organic esters of cellulose such as cellulose acetate. Best results have been obtained with so-called "high wet modulus" or "polynosique" viscose rayon. This is a relatively new type of rayon made by extruding unripened viscose into a coagulating bath having little regenerative power and stretching the resulting filaments to a high degree while they are still substantially unregenerated. Such processes are described in the United States patents to Tackikawa, 2,732,279, and, Cox, 2,937,070.

Fiber made in this way has a fine and stable microfibrillar structure, a smooth, non-crenulated skin, a generally circular cross-section and no apparent skin-core structure. It will have a minimum wet strength of 2.2 grams per denier and a wet modulus of above 1 gram per denier at 5% extension. The wet modulus is the stress in grams per denier required to attain a given extension of fiber saturated with water.

Rayons other than polynosique rayon are preferably not used in the present process except in blends with at least 65% natural cellulose or polynosique rayon fibers. When treated with 5 to 40% NaOH, conventional rayons tend to be gelatinized, so that when the yarn contains more than about 35% of such fiber the final product is stiff, boardy and unmerchantable.

Yarns employed in the present invention may also include a minor proportion of non-cellulosic fibers, provided, however, that such fibers do not affect the basic nature of the blend.

The singles yarns used in the plied yarn may be of any desired weight or construction varying from about 1 denier to about 15 denier. They may be twisted in either direction, and to any desired extent. The twist in the component singles yarns, should, however, be opposite in direction to the ply twist. Normally the singles yarns will have 10 to 40 turns per inch and the ply 5 to 40 turns per inch in the opposite direction.

The swelling agent used is an aqueous solution equivalent in swelling power to solutions containing 5 to 40% by weight NaOH. Preferably the solution will in fact be a solution of 5 to 40% NaOH and most preferably

5 to 25% NaOH. Other swelling agents may be used, if desired, including other alkali metal hydroxidees such as KOH and such materials as zinc chloride and sodium zincate.

The temperature at which the swelling agent is applied may be varied considerably. In accordance with well known principles, lower temperatures tend to cause a more vigorous swelling action. Conveniently, the treatment is carried out at room temperature (20° C., more or less) but may be carried out at any temperature between the freezing and boiling points of the solution.

The time of treatment will vary depending on the nature and concentration of the swelling agent and on the nature of the fiber, on the mechanical construction of the yarn and on mechanical details of the treating apparatus. Broadly, it may range from say .1 to 120 minutes.

The physical arrangements for treating the yarn may vary widely. In commercial practice a conventional warp mercerizing machine may be employed. In laboratory or small scale operations, the yarn may be wrapped on a form or bobbin of suitable size and shape, the yarn being wrapped in such a manner that when it undergoes shrinkage during treatment, it will conform to the outline of the form or bobbin and thus reach the desired proportion of its original length and so be subjected to the appropriate tension. The treating liquor may be applied by dipping, spraying or in any other convenient way.

Following contact with the swelling agent the yarn is washed, neutralized with a weak acid such as acetic acid, and dried. These steps are carried out with the yarn under tension.

In accordance with the invention, the yarn is then reverse twisted, i.e., it is given a twist in a direction opposite to that in which it was plied. While the degree of reverse twist may vary, preferably it is between about 135 and 160% of the initial ply twist. The result is shown clearly in FIG. 3. As can be seen from that figure, the yarn is now an irregular three dimensional sequence of helical sections, the helix angle of succeeding sections varying in an arbitrary and random manner. The yarn is stretchy and when extended and released will recover its original length to a high degree.

It is difficult to process stretch yarn, as such, on looms and knitting machines, precisely because it *is* stretch yarn. However, this is not a problem with the present yarn because when the yarn is wound on a spool, preparatory to being converted into fabric, the tension incident to winding pulls the stretch out. If maintained under tension in the extended position for more than about 30 minutes, the yarn loses its recovery ability substantially entirely. Normally, the yarn stays wound on a spool for at least 24 hours before it is used and in this time the yarn loses its apparent stretchability. It can thus be woven or knitted just as though it had never had stretch characteristics. When, however, the resulting fabric is wetted, or steamed, under zero tension, the stretch characteristics redevelop and the result is a stretch fabric made of 100% cellulose.

The invention is illustrated in the following examples.

Example I

Samples of a 24/2 (5.5 t.p.m.) "high wet modulus" rayon yarn having a wet modulus of 2 grams per denier at 5% extension are wrapped on plastic forms in such a way that when shrunk to conform to the forms they have lengths 70, 80, 90, 95 and 100% of the original length. They are then treated with 16% aqueous NaOH for 2 minutes. All samples shrink to fit closely over the forms. The samples are washed with water, neutralized with 5% acetic acid, washed with water and dried on the forms. They are then removed from the forms and reverse twisted to 31.8 turns per inch. Samples of the reverse twisted yarn are then relaxed in water for five minutes at 65° C. and dried. Recovery values are determined by stretching the yarns along a calibrated scale to maximum usable stretch, keeping the yarns at that point for five minutes and then relaxing for one minute before noting the return length. The results are as follows:

TABLE

Sample	Length of sample After Treatment (percent of original length)	Maximum Usable Stretch (percent)	Percent Recovery
A	70	200	61.0
B	80	173	55.8
C	90	187	53.5
D	95	178	49.4
E	100	143	47.5

In these results, percent recovery is calculated as follows:

$$\text{Percent recovery}=\frac{\text{percent stretch}-\text{percent growth}}{\text{percent stretch}}\times 100$$

where

$$\text{Percent growth}=\frac{\text{length after stretch and release}-\text{original length}}{\text{original length}}\times 100$$

and

$$\text{Percent stretch}=\frac{\text{stretched length}-\text{original length}}{\text{original length}}\times 100$$

Example II

The procedure of Example I is followed using a 30/2 cotton yarn and 25% NaOH. Like results are obtained.

Example III

The yarn made according to Example I (Sample A) is wound on spools. In this procedure substantially all stretch is removed from the yarn, though this can easily be redeveloped by wetting or steaming. Several days after winding, the yarn is knitted into a fabric which is relaxed in water at 60° C. for five minutes. It has excellent stretch and recovery characteristics.

What is claimed is:

1. A method for making a stretchy yarn which comprises contacting a cellulosse yarn having at least 2 plies with a cellulose swelling agent equivalent to an aqueous solution containing 5 to 40% sodium hydroxide and capable of shrinking said yarn, maintaining said yarn during contact with said swelling agent under a tension sufficient to maintain said yarn at least 50% of its original length and subsequently reverse twisting the treated yarn in a direction opposite to the initial ply twist and to a degree greater than the initial ply twist.

2. The method claimed in claim 1 wherein the cellulose yarn comprises filaments selected from the group consisting of cotton, and rayon having a wet modulus greater than about 1 gram per denier at 5% extension.

3. A method for making a stretch yarn which comprises treating a plied yarn consisting essentially of filaments selected from the group consisting of cotton, and rayon having a wet modulus greater than about 1 gram per denier tt 5% extension, with an aqueous solution containing 5 to 40% by weight NaOH at a temperature between about 0 and about 80° C., for between about 0.1 and about 120 minutes, and maintaining said yarn during contact with said solution at a length between 50% and 100% of its original length, and subsequently reverse twisting the treated yarn in a direction opposite to the initial ply twist and to a degree greater than the initial ply twist.

4. A method for making a stretch fabric which comprises treating a multi-ply yarn consisting essentially of cellulose filaments with a swelling agent for cellulose equivalent to an aqueous solution containing between about 5 and about 40% NaOH, under a tension sufficient to maintain said yarn at not less than 50% of its untreated length, reverse twisting the yarn in a direction opposite to the initial ply twist and to a degree greater

than the initial ply twist, converting the yarn to a fabric and relaxing the fabric in an aqueous fluid.

5. The method claimed in claim 4 wherein the cellulose is natural cellulose.

6. The method claimed in claim 4 wherein the cellulose is rayon having a wet modulus greater than about 1 gram per denier at 5% extension.

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LOUIS K. RIMRODT, *Primary Examiner.*