Jan. 30, 1968 J. E. BROWN ETAL 3,365,767

METHOD FOR MAKING STRETCH YARNS AND FABRICS

Filed April 28, 1964

FIG. 1

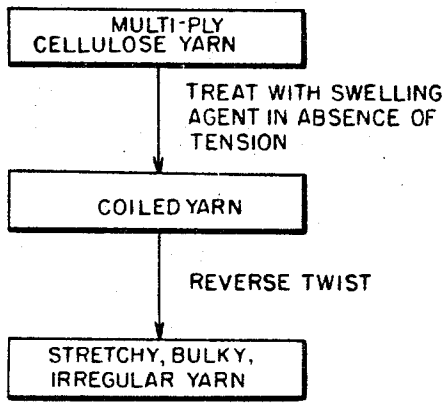


FIG. 2

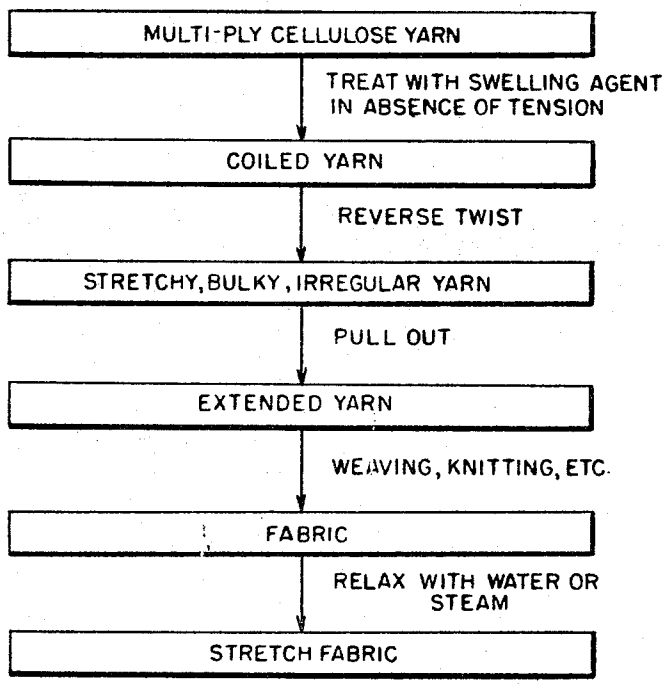


FIG. 3

FIG. 4

Inventors
James E. Brown
William Frank Taylor
By their attorneys
Howson and Howson.

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METHOD FOR MAKING STRETCH YARNS AND FABRICS

James E. Brown, Axis, and William Frank Taylor, Mobile, Ala., assignors to Courtaulds North America Inc., New York, N.Y., a corporation of Alabama

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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 accordance with the invention, such yarns are made by 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% by weight NaOH, said yarn being treated in the substantial absence of tension, and then applying a reverse twist to the 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 redevelop the stretch characteristics originally present in the yarn.

The invention therefore further includes a method for making a stretch fabric which comprises treating a multi-ply cellulose yarn with a swelling agent for cellulose equivalent to an aqueous solution containing between about 5% and about 40% by weight NaOH, in the substantial absence of tension, to form a coiled yarn, reverse twisting the coiled yarn, extending the coiled, reverse twisted yarn to pull out the coils, converting the pulled out yarn to a fabric and relaxing the fabric in an aqueous fluid to develop stretch.

In its product aspects, the invention comprises a multi-ply stretchy yarn consisting essentially of cellulose filaments, having an irregular, three-dimensional sequence of helical sections, helical coils and the helix angle of succeeding sections varying in an arbitrary and random manner.

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 yarn which has been treated with swelling agent prior to reverse twisting.

FIG. 4 is a view in elevation of reverse twisted yarn made in accordance with 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 single 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 Tachikawa 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 [1] of above 1 gram per denier at 5% extension.

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 then about 35% of such fiber the final product is still, 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 hydroxides 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 be any of those customarily used, provided that the yarn is maintained under substantially zero tension. The yarn may be passed through a bath of the swelling agent in the form of a catenary, or it may be laid down in a plaited pattern and passed through a bath, or sprayed, in that form. Alternatively, hanks or skeins may be passed through a bath or sprayed.

Following contact with the swelling agent, the yarn is

[1] Wet modulus is the stress in grams per denier required to attain a given extension of fiber saturated with water.

washed, neutralized with acetic acid or some other relatively weak acid, and dried. All of these steps are carried out with the yarn under substantially zero tension.

At this stage the yarn is as shown in FIG. 3. It is composed of a helical series of regular coils, the coils being substantially contiguous with one another and having a helix angle approaching 90° (say more than 45°).

In accordance with the invention, the yarn is now 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. 4. 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

A 24/2 yarn was spun from 1.5 denier, 1¼", high wet modulus rayon staple fiber with 32 twists per inch in the Z direction in the singles yarns and 22.5 twists per inch in the S direction in the ply. A 120-yard skein of this yarn was treated without tension for one minute with an aqueous solution containing 16% NaOH. The skein was then washed for three minutes at 66° C., neutralized in 1% acetic acid for three minutes, extracted and dried for five minutes at 121° C. It was then reverse twisted to 31.8 turns per inch.

Maximum stretch and recovery values were obtained by placing a ten inch reference mark on the yarn, stretching it to the maximum extent along a calibrated scale and releasing after ten seconds. Percent recovery was calculated as follows:

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

where

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

and

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

At a stretch of 170% there was 27% growth, giving a recovery of 84% after 25 stretches.

EXAMPLE II

The procedure of Example I was repeated using a 30/2 cotton yarn and 25% NaOH. At a maximum stretch of 178%, 32% growth and 82% recovery were obtained.

EXAMPLE III

A sample of a 30/2 high wet modulus rayon yarn made as in Example I but without reverse twisting was cross-linked by impregnating it to 100% pickup with an aqueous solution containing 3% $MgCl_2.6H_2O$, 3% HCHO (pH 7.0), drying at 121° C. for five minutes and curing at 160° C. for five minutes. This yarn had a maximum stretch of 77%, 14% growth and 82% recovery after one stretch.

EXAMPLE IV

A 30/2 yarn made according to Example I was wound on spools. In this procedure substantially all stretch was removed from the yarn, though this could easily be redeveloped by wetting or steaming. Several days after winding, the yarn was knit into stockings on an 18-gauge circular knitting machine. The stockings were then placed in water at 65° C. for five minutes.

One inch strips were then cut from the stockings. Five-inch reference marks were placed on the strips. One sample was stretched along a calibrated scale to determine maximum stretch. A maximum of 210% was observed.

What is claimed is:

1. A method of making a stretchy yarn which comprises contacting a cellulose yarn having at least 2 plies with a cellulose swelling agent equivalent to an aqueous solution of 5 to 40% sodium hydroxide, in the absence of tension, and then twisting the yarn in the direction opposite to its ply beyond the point of no twist in the original plied yarn.

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 of 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 at 5% extension, with an aqueous solution containing 5 to 40% NaOH at temperature between about 0 and about 80° C., for between about .1 and about 120 minutes, at substantially zero tension, drying the yarn and twisting the yarn in the direction opposite to its ply beyond the point of no twist in the original plied yarn.

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, at substantially zero tension, to form a coiled yarn, twisting said yarn in a direction opposite to its ply beyond the point of no twist in the original plied yarn, pulling out the coiled, reverse twisted yarn to form a substantially straight yarn, converting the straight yarn to 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.

7. A stretchy, multi-ply yarn produced according to the method of claim 1.

8. A stretch fabric produced according to the method of claim 4.

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JOHN PETRAKES, *Primary Examiner.*

FRANK J. COHEN, *Examiner.*