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PROCESS OF PRODUCING CREPEABLE YARN

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This invention relates to the manufacture of a textile yarn capable of producing novelty effects when made into fabrics. More particularly, the invention relates to spun yarns which, when woven into fabrics and suitably processed, produce puckered, pebbled or creped effects.

Continuous filament yarns of widely different shrinkage characteristics have been plied and doubled together heretofore to produce a crepe yarn, as described in U. S. Patents 1,976,201 and 2,328,074. However, heretofore, no one has successfully produced a spun yarn, i. e., a yarn comprised of relatively short length fibers, which exhibits any tendency to crepe or pucker after it has been incorporated in a woven fabric without the use of high (crepe) twist. Even though fibers having widely different shrinkage characteristics are blended and combined to form a spun yarn by any of the methods commonly used heretofore, the resulting spun yarn shows no creping tendency. In other words, the great difference in shrinkage characteristics of fibers has led to no advantage when such fiber mixtures are blended and worked together to form a spun yarn. This is true even if the two types of fiber were originally in the form of continuous filament tow and are brought together and broken or otherwise severed to form a top or sliver in the manner described in the Perry and Lohrke Patent No. 1,883,384 (Perlok process), and then subsequently blended, drawn and twisted to form a spun yarn.

It is, therefore, an object of this invention to provide a spun yarn of regenerated cellulose fibers having creping properties. A further object of the invention is to provide a process for the production of a spun yarn of regenerated cellulose capable of becoming rippled, puckered, pebbled or creped when incorporated in a woven fabric and suitably processed. A further object of the invention is to provide a crepeable spun yarn comprised of two different fibers. Other objects of the invention will appear hereinafter.

The objectives of this invention are accomplished by combining two different regenerated cellulose yarns on the direct spinner. To produce a crepeable yarn, the yarns must have certain different physical properties and must be used in certain ratios. One of the combining yarns must be highly oriented and highly crystalline and have a low percentage shrinkage even when dry stretched just short of the breaking point. This low percentage of shrinkage of the dry-stretched yarn should be no more than 4%, and preferably no more than 2.5%. The other yarn

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must be a high tenacity regenerated cellulose yarn, such as tire cord or a normal "textile" yarn of regenerated cellulose. Such yarns are less crystalline and, therefore, shrink considerably more after being dry stretched to 90% of the breaking elongation, for example, from about 10% to 15%. Shrinkage is the shortening in length in a yarn or filament when it is subjected to aqueous treatment in the relaxed state.

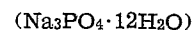
The direct conversion of a plurality of continuous filament yarns or tow into a spun yarn is accomplished on the direct spinner. This comprises a rotating set of front rollers and a rotating set of back rollers. The yarns pass through the nip of the back set and through the nip of the front set, and from there to a twister bobbin. The front rollers are traveling from 5 to 100 or more times the speed of the back rollers. In this direct process the continuous filaments are broken and twisted to form a spun yarn.

The two or more continuous filament yarns (or tows) used in the process of this invention initially may have substantially the same shrinkage characteristics but must differ in other properties so that upon being stretched to break on the direct spinner filaments result having different shrinkages. These are combined on the direct spinner and twisted to a single end. The resultant spun yarn has a predominance of one type of filament on one side and a predominance of the other type on the other side. Upon shrinking the spun yarn or a fabric containing it, creping occurs due to this differential.

In the experiments tabulated below, Fiber Y is a continuous filament rayon yarn made by extruding viscose into a bath maintained under such conditions as to precipitate the cellulose xanthate rapidly without substantially converting it to regenerated cellulose, stretching the unregenerated structure to a very marked degree, then converting the cellulose xanthate to regenerated cellulose by the use of any suitable treatment, purifying the product and subjecting it to the action of a drying medium while it is preferably free from substantial tension. Procedures which may be used are described in Cramer, U. S. Patent No. 2,412,969, issued December 24, 1946, and copending application of Hare and Signaigo, Serial No. 104,613, filed July 14, 1949, now U. S. Patent No. 2,516,316. Yarns thus prepared have residual shrinkages of about 0.5% to 2.0%. Fiber Z is a high tenacity tire cord yarn such as "Cordura" yarn ("Cordura" is a registered trademark for a high tenacity regenerated cellulose

yarn) which, in the continuous filament form, has about the same shrinkage, or perhaps a little more, say in the range from about 1% to 5%. However, when a spun yarn is made from each of these continuous filament yarns on the direct spinner, the shrinkage of the Fiber Y spun yarn will be about the same as the continuous filament yarn from which it was made, whereas the shrinkage of the Fiber Z will increase several fold to as much as 12% or even 15%. It is believed

In Table II, the composite spun yarn was used in making fabric as shown. The fabric samples were heated in a water solution of 0.18% olive oil soap flakes and 0.22% sodium phosphate



for one hour at 95° C. and thoroughly rinsed in 50° C. water, dried without tension and ironed prior to examination. The fabrics were then rated as to extent of crepe.

TABLE II

Yarn preparation and fabric construction

Warp: 150 denier, dull viscose rayon, reeded 90 ends per inch and 40 inches wide

Item No.	Filling--				Per cent Shrinkage Fillingwise of Fabric After Boil-Off	Crepe Effect
	Yarn Count	Picks Per Inch	Per Cent Fiber Y	Per Cent Fiber Z		
I.....	50/1	54	0	100	15.0	None.
II.....	50/1	54	25	75	12.5	Good.
III.....	50/1	54	33	67	12.5	Do.
IV.....	50/1	54	42	58	13.1	Excellent.
V.....	50/1	54	50	50	10.6	Do.
VI.....	50/1	54	67	33	8.1	Fair.
VII.....	50/1	54	75	25	8.1	Do.
VIII.....	50/1	54	100	0	0.6	None.
Conventional Spun Rayon Yarn.....	50/1	54	0	0	4.4	Do.

¹ Textile Yarn.

that this difference in shrinkage in the spun yarn is due to certain inherent characteristics of the continuous filament yarn coupled with this specific method of conversion into the spun yarn. Peculiarly, creping cannot be obtained by mixing prepared staple of filaments of the two types and converting the mixture to yarn; nor can creping be obtained by use of the Perlok process or processes similar to it.

Shrinkage is determined by measuring length differences upon immersing the filament in aqueous 1.35% sodium hydroxide substantially free of tension. If a 100 centimeter length of yarn is suspended in aqueous 1.35% sodium hydroxide substantially free of tension to eventually attain a length of 98 centimeters, it has a shrinkage of 2%.

In Table I below, the two continuous filament tows were spun simultaneously, that is, fed together, side by side, on a direct spinner using the conditions given. The yarns or tows were fed separately to the direct spinner and the combining occurs thereafter. In this table, the draft ratio is the ratio of the front roll speed to the back roll speed, the spindle speed is the speed of the twister bobbin and the ratch distance is the distance between the front and back rolls.

Table I
(Direct spinner settings)

	I	II	III	IV	V	VI	VII	VIII
Ends of 1100 denier—Fiber Y.....	2	3	2	11	1	1	1	2
Ends of 1100 denier—Fiber Z.....		1	1	1	1	2	3	
Nominal Count.....	50/1	50/1	50/1	50/1	50/1	50/1	50/1	50/1
Nominal Twist T. P. I.....	19.40	19.40	19.40	19.40	19.40	19.40	19.40	19.40
Twist Factor.....	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75
Draft Ratio.....	21.80	42.50	31.40	23.80	21.80	31.40	42.50	21.80
Back Roll Speed I. P. M.....	14.55	7.45	10.20	13.30	14.55	10.20	7.45	14.55
Front Roll Speed I. P. M.....	317	317	317	317	317	317	317	317
Spindle Speed R. P. M.....	6,150	6,150	6,150	6,150	6,150	6,150	6,150	6,150
Traveller Size.....	#16/0	#16/0	#16/0	#16/0	#16/0	#16/0	#16/0	#16/0
Ratch Distance.....	12	12	12	12	12	12	12	12

¹ 1 end 1500 denier textile yarn.

As can be seen from the above results, shrinkage of the fabric generally decreased as the percentage of Fiber Y, the high tenacity yarn, increased. The pebbled effect, puckering or crepe effect, increased and then decreased as the amount of Fiber Y increased. While crepe effects are produced with amounts of the Fiber Y as low as 10% and as high as 85%, the greatest effect occurs using from 25% to 50% of this with 75% to 50% of Fiber Z.

This invention has been illustrated using two specific yarns, Fiber Y and Fiber Z, having the properties listed below in Table III. The X-ray parameters are usually measured photometrically from flat diffraction patterns with nickel-filtered copper radiation, 5 cm. specimen-to-film distance. The orientation parameter is the ratio of the equatorial to polar intensity of the 101 interference minus one. On this scale, zero indicates no orientation and increasing numbers indicate increasing orientations. This parameter measures orientation of the hydroxyl-rich planes of the cellulose (101) and/or orientation of the long chain axes.

The lateral order parameters are calculated from the relation

$$\frac{(I_l - I_m)}{I_l} 100$$

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where I_1 equals intensity of the 101 interference and I_m is the minimum intensity between the 100 and 101 interferences. This parameter is a measure of the relative perfection of the lateral diffracting planes of cellulose and may be taken as a measure of crystallinity. The higher the lateral order, the greater is the crystallinity.

TABLE III

	Fiber Y	Fiber Z	
		Slasher Dried	Relaxed Dried
Dry Tenacity g. p. d.	5.3	4.2	3.4
Dry Elongation per cent.	6.0	6.9	15.0
Wet Tenacity g. p. d.	3.7	2.5	2.1
Wet Elongation per cent.	6.8	20.2	20.9
Per cent Shrinkage:			
Relaxed Dried	0.2		2.7
Slasher Dried	0.6	13.8	
Dry stretched to break, per cent.	2.3	14.2	
X-ray Parameters:			
Orientation	6.5	2.5	
Lateral Order	62.7	26.0	

The invention is, however, not limited to the use of these particular yarns. Instead of Fiber Y, one may use other highly crystalline, low elongation yarns exhibiting low percentage shrinkage after dry stretching to 90% of the breaking elongation. Such yarns are the high acid bath yarns produced according to Lilienfeld U. S. Reissue 18,170, and regenerated cellulose yarn made from cellulose acetate yarn by heat or solvent stretching and then saponifying the stretched yarn. Similarly, normal "textile" yarn may be used as Fiber Z. For instance, spun yarns can be made up of Lilienfeld and regular textile rayon by combining on a direct spinner as above mentioned and in the range of amounts just previously mentioned to give similar cockled or pebbled fabrics. Also, similar spun yarns can be made with the low elongation regenerated cellulose produced from cellulose acetate threads again combined with any relatively high elongation, regenerated cellulose threads; such as tire cord yarn or normal textile yarn.

In choosing a fiber of the type Y, the orientations may vary from 3.5 to 7.0, and the lateral orders may be from 35 to 75. In the Fiber Z types the orientations vary from 0 to 3, and the lateral orders from 10 to 40. The greater the difference in these values in the two types, the greater is the creping effect. However, the two fibers may have close values in one direction, say lateral order, and still be useful together in the process of this invention if they differ markedly in the other, say orientation. For a tow of type Y, it is preferred to use a yarn having an orientation of from 4.0 to 6.5 and a lateral order of from 55 to 75. For type Z, it is preferred that the orientation be from 0 to 2.5 and the lateral order from 10 to 30.

While this invention has been described in terms of regenerated cellulose yarns, the essential idea of the invention may be applied to other type yarns, such as nylon polymer yarns or other synthetic or natural polymer yarns. Such yarns may be modified to alter crystallinity, molecular orientation, etc., for instance, by heat treatment, so that two or more combining yarns attain widely different shrinking properties when extended to the breaking point as on a direct spinner. The spun yarn thus formed, or fabric containing the same, may then be shrunk by heating or by treating in a swelling medium or otherwise treated to give a similar effect as the boil-off treatment of

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fabrics containing the spun rayon yarns previously discussed.

Peculiarly, the objects of this invention can not be attained by independently cutting Fiber Y and Fiber Z into staple length and spinning the resultant combined staple by the usual method on the cotton system. Similarly, if a blended yarn is made by combining Fibers Y and Z in a single yarn, the resulting products will exhibit properties intermediate the properties of the two spun yarns. Similarly, if the continuous filament yarns are subjected to a breaking treatment by the "Perlok" process and the sliver or top formed is further drawn, blended and twisted into a yarn, this yarn will also exhibit properties substantially the same as the spun yarn made on the cotton systems.

It is indeed surprising that spun yarns produced on the direct spinner exhibit properties widely different from the properties of the continuous filament yarns from which they were made. It is even more surprising that two relatively high tenacity yarns, both having relatively low elongation and nearly the same shrinkage characteristics in the continuous filament yarn if dried while in a relaxed state, should attain such a great difference in shrinkage characteristics when converted on the direct spinner into spun yarn. As a result of this finding, combinations of two different yarns in varying proportions were converted on the direct spinner into the novelty yarns of this invention which are useful in making a crepe fabric, that is, a lightweight fabric characterized by a crinkled surface.

By the process of this invention, it is possible to produce crepe effects directly using low twist yarns. Heretofore, crepe effects could be produced only by using high twist yarns containing about 60 to 80 turns per inch or higher. Through this invention twists in the order of 20 turns per inch need only be used. Considerable saving is effected by avoiding expensive, time consuming high twist operations.

Any departure from the above description which conforms to the present invention is intended to be included within the scope of the claims.

I claim:

1. A process for the production of a regenerated cellulose spun yarn having creping properties which comprises simultaneously spinning and combining to a single spun yarn on a direct spinner a plurality of continuous filament yarns, at least one yarn of which has high orientation and high crystallinity and low percentage shrinkage and at least one of which has low orientation and low crystallinity and higher percentage shrinkage.

2. A process for the production of a regenerated cellulose spun yarn having creping properties which comprises simultaneously spinning and combining to a single spun yarn on a direct spinner a tow comprising a yarn of high orientation and high crystallinity and low percentage shrinkage and a tow comprising a yarn of low orientation and low crystallinity and higher percentage shrinkage, said spinning and combining being conducted so that the resultant spun yarn contains from 10% to 85% of filaments derived from the said yarn of high orientation and high crystallinity.

3. A process in accordance with claim 2 in which said resultant spun yarn contains 25% to 50% of filaments derived from the said yarn of high orientation and high crystallinity,

4. A process for the production of a regenerated cellulose spun yarn having creping properties which comprises simultaneously spinning and combining on a direct spinner, a tow comprising a yarn of high orientation and high crystallinity and low percentage shrinkage and a tow comprising a yarn of low orientation and low crystallinity and higher percentage shrinkage, said tows being stretched to break on said spinner.

5. A process for the production of a regenerated cellulose spun yarn having creping properties which comprises simultaneously spinning and combining on a direct spinner a tow comprising a yarn having an orientation of from 3.5 to 7.0 and a lateral order of from 35 to 75 and a tow comprising a yarn having an orientation of from 0 to 3 and a lateral order of from 10 to 40, the said tows having different percentages of shrinkage.

6. A process for the production of a crepe fabric which comprises simultaneously spinning and combining on a direct spinner a tow comprising a regenerated cellulose yarn of high orientation and high crystallinity and low percentage shrinkage and a tow comprising a regenerated cellulose yarn of low orientation and low crystallinity and higher percentage shrinkage; incorporating the resultant spun yarn in a fabric; and shrinking the resultant fabric.

7. A process for the production of a crepe fabric which comprises simultaneously spinning and combining on a direct spinner a tow comprising a regenerated cellulose yarn of high orientation and high crystallinity and low percentage shrinkage and a tow of low orientation and low crystallinity and higher percentage shrinkage, said combining of said tows on said spinner yielding a spun yarn that contains from 10% to 85% of filaments derived from said yarn of high orientation and high crystallinity; incorporating the resultant spun yarn in a fabric; and wetting the resultant fabric to allow shrinkage to occur.

8. A process for the production of a regenerated cellulose spun yarn having creping properties which comprises producing on a direct spinner at least two yarns of different shrink-

age by stretching to break a yarn of high orientation and high crystallinity and a yarn of low orientation and low crystallinity; and combining the resultant stretched, broken filaments on the direct spinner to a single spun yarn.

9. A process for the production of a regenerated cellulose spun yarn having creping properties which comprises stretching to break on a direct spinner at least two yarns differing in original properties so that the resultant stretched, broken filaments have different shrinkage; and combining on the direct spinner the resultant stretched, broken filaments of different shrinkage to a single spun yarn.

10. A process for the production of a regenerated cellulose spun yarn having creping properties which comprises producing on a direct spinner at least two yarns of different shrinkage by stretching to break a yarn of high orientation and high crystallinity to produce thereby filaments having a percentage of shrinkage less than 4% and a yarn of low orientation and low crystallinity to produce thereby filaments having a percentage of shrinkage from about 10% to about 15%; and combining the resultant stretched, broken filaments on the direct spinner to a single spun yarn.

11. A process in accordance with claim 10 in which the filaments produced from said yarn of high orientation and high crystallinity has a percentage of shrinkage of no more than 2.5%.

12. A process in accordance with claim 5 in which the first tow has an orientation of 4.0 to 6.5 and a lateral order of 55 to 75 and the second tow has an orientation of 0 to 2.5 and a lateral order of 10 to 30.

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REFERENCES CITED

The following references are of record in the file of this patent:

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