Aug. 15, 1939. J. G. McNALLY 2,169,270

MANUFACTURE OF CELLULOSE ORGANIC ACID ESTER CREPE YARNS

Filed Jan. 21, 1937

FIG. 1.

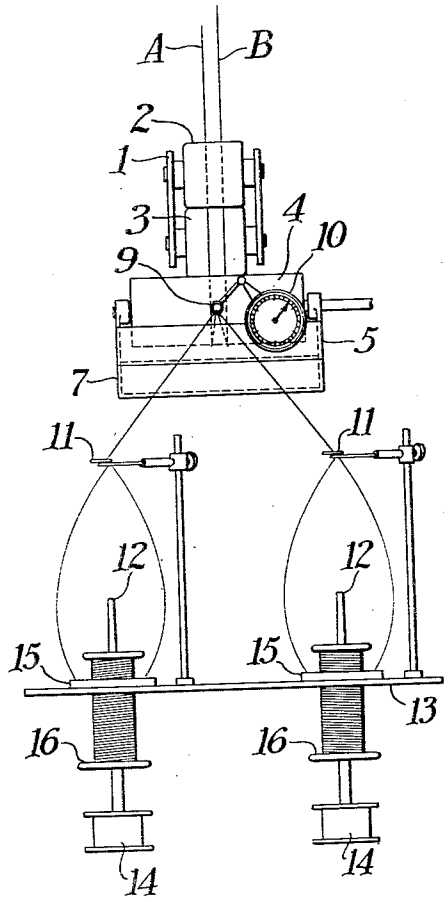
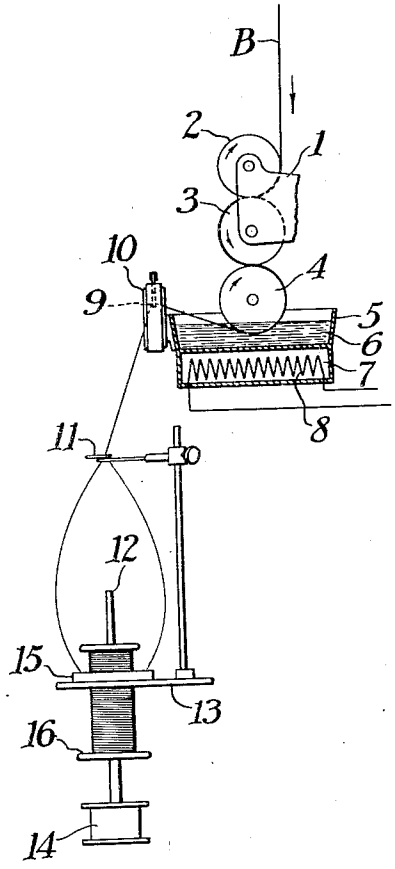


FIG. 2.



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Patented Aug. 15, 1939 2,169,270

UNITED STATES PATENT OFFICE

2,169,270

MANUFACTURE OF CELLULOSE ORGANIC ACID ESTER CREPE YARNS

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Application January 21, 1937, Serial No. 121,555

8 Claims. (Cl. 57—140)

This invention relates to crepe yarns and crepe fabrics and their production, and more particularly to crepe yarns and fabrics made of organic acid esters of cellulose, such as cellulose acetate, cellulose propionate, cellulose butyrate, cellulose acetate-propionate, cellulose acetate-butyrate and the like.

This application is in part a continuation of my copending application Serial No. 62,007, filed February 1, 1936.

It is customary in the art to employ for the manufacture of crepe fabrics, highly twisted yarns, comprising cotton, natural silk, wool, or the regenerated cellulose type of synthetic yarn, usually referred to as rayon and referred to herein as rayon, the highly twisted yarn being referred to as crepe yarn. Cloth constructions are very well known wherein crepe yarns are used either in warp or filling or both, but the crepe filling type is the more popular, which condition is largely due to the lower cost of production of the crepe filling fabric. The present discussion is, therefore, more particularly directed to fabrics employing crepe filling yarns, although it is understood that the remarks herein may relate to warp crepes as well, with modifications such as are obvious to a textile technician.

For certain novelty effects crepe yarns are used which comprise a mixture of materials such as cotton-natural silk, natural silk-rayon, natural silk-cellulose acetate yarn, or rayon-cellulose acetate yarn. These mixtures are employed either as separate threads or two threads may be twisted together before weaving for the purpose usually of decreasing the cost of production of the fabric or of producing cross-dye or other novelty effects. It may be pointed out, however, that in crepe constructions where cellulose acetate yarn is used in the filling it is used in conjunction with a crepe filling yarn of some other material and has no active part in producing the crepe effect.

Cellulose acetate yarns have found extensive use as warp yarns for crepe fabrics because of the highly desirable properties of fabrics made with these warps. The filling yarns usually used in these popular constructions is rayon or natural silk crepe yarn and the presence of two types of yarn, i. e., cellulose acetate and rayon or silk, leads to dyeing difficulties in finishing the goods owing to the fact that cellulose acetate yarn is, in general, unaffected by dyes for rayon or natural silk and, similarly, dyes suitable for coloring cellulose acetate yarn are not suitable for the other materials. It, therefore, becomes necessary to use separate dyes for coloring the constituent yarns of these fabrics, which is an inconvenience and added expense. Aside from the desirability of eliminating this dyeing difficulty with acetate warp crepes, it has been found that crepe fabrics made entirely of cellulose acetate yarns (both warp and filling) show to an enhanced degree the desirable properties of durability, non-creasability, and excellent hand and draping properties which are obtained by using cellulose acetate yarns in the warp alone.

In order that the novel features of the instant invention may be clearly apparent, a brief description of the way crepe fabrics are at present made, using rayon or natural silk crepe filling, is here given, the essential features of such present processes being the following:

(1) Low turn rayon or natural silk yarn is soaked in a solution of size the excess solution removed and the yarn dried.

(2) The sized yarn is twisted, usually on an up draft twister, to form 30 to 60 turns per inch, depending upon the denier of the yarn and the use to which it is to be put.

(3) After the operation (2) the yarn has a tendency to untwist. To overcome this difficulty, the yarn is steamed while wound on spools to set the twist of the yarn.

(4) The filling yarn is wound on cops and used in the customary looms in crepe fabric constructions.

(5) The greige goods from the loom are subjected to a boil off treatment in hot soap solution to remove the size from the yarn; the fabric shrinks widthwise preferentially and develops a pebbled appearance characteristic of crepe fabrics.

(6) The fabric is dyed on a winch machine, dried on a slack dryer and framed out to the desired width on a tentering frame.

The finished crepe fabric has two outstanding characteristics:

(1) A pebble or rough surface which varies in appearance depending on the type of crepe produced.

(2) Extensibility and elasticity which differentiate the cloth from tightly woven constructions such as taffetas or satins.

A popular construction for producing a rayon filled Canton crepe is as follows:

Warp.—112 ends per inch, 120 denier dull cellulose yarn, 40 filaments, 4 turns per inch.

Filling.—52 picks per inch of 150 denier rayon twisted to 50 turns per inch, the filling construction being two picks of right yarn alternating with two picks of left twist yarn.

The greige goods are woven 50 inches wide in the loom.

When this fabric is woven, as indicated, into greige goods and boiled off it shrinks widthwise from 50 inches to 28–30 inches and develops a bumpy, finely pebbled surface. On framing in the tentering machine, the cloth is brought back to 39–40 inches in width and this represents the

finished dimension. The cloth shrinks longitudinally about 10–15 per cent.

I am aware that the prior art reports many attempts to produce a cellulose acetate crepe yarn. It was first proposed in the art to produce cellulose acetate crepes by substantially imitating the method of producing crepe from natural silk, involving sizing, twisting, setting weaving and boiling off. Since that time it has been variously proposed to subject the yarn to shrinking treatments before weaving, to treat fabrics woven from cellulose acetate crepe yarns with baths capable of swelling cellulose acetate, to partially saponify the cellulose acetate yarn before twisting, to incorporate water-soluble materials in the cellulose acetate crepe yarn, or to combine cellulose acetate yarns having different degrees of twist, using a relatively low twist in the doubling operation. It has further been proposed to produce cloths of cellulose acetate having a puckered or crepe-like appearance by subjecting cloths woven at least partly of cellulose acetate yarn to treatments calculated to cause differential shrinking of the various yarns contained in the fabric. It may be said, however, that these processes result in such very slight effects as to be scarcely perceptible (widthwise contraction or shrinkage, due to creping, produced in the boil-off, not exceeding 10–15%) and are of no commercial importance, as the resulting fabrics have none of the properties exhibited by the rayon-filled Canton crepe.

In addition to the above-mentioned methods of producing cellulose acetate crepe yarns and fabrics, numerous other expedients have been suggested. For example, it has been proposed to produce acetate crepe yarn by treating the yarn with hot (95–100° C.) water during the insertion of at least the last part of the crepe twist, it apparently being the theory of the proponent of this procedure that the creping ability of the yarn results from the simultaneous application of stretching and twisting forces to the material while in a softened condition and that the yarn must be stretched at such temperatures as render it plastic and ductile. The type of crepe yarn resulting from such a process is characterized by the fact that it is stretched from 5% to 30% of its original length, has a denier of 95–115% of that of the original yarn before twisting, and has a specific gravity of 85–90% of the actual specific gravity of the original filaments. It is also characterized by the fact that the surface of the threads are smooth and cylindrical as opposed to the rough feel of a viscose crepe yarn or of a cellulose acetate yarn which has been crepe twisted by the method hereinafter described.

I am further aware that it has also been proposed to use various modifications of the process referred to in the preceding paragraph, using dry steam, wet steam, organic liquids, etc., as the yarn treating medium. When using either one of the methods last referred to, when sufficient tension is employed to induce the necessary degree of stretch in the yarn, the product is characterized by a smooth appearance and is, as stated, free from kinks.

I have now discovered that a commercially successful cellulose acetate crepe yarn can be made by a departure from the prior art wherein, following my invention, the crepe twist is inserted in the yarn while it is swollen with water but under such mechanical conditions that the yarn experiences a minimum of longitudinal extension during the twisting process. The temperature of the water used to soften the yarn prior to or during the twisting operation is of importance only inasmuch as this factor is one of several that determine the longitudinal extension given to the yarn. The other factors are the chemical composition and dynamometric properties of the yarn used, the length of time of soaking and the longitudinal tension on the yarn during the twisting process. When using cellulose acetate yarn of the type commercially available under the name "Eastman acetate yarn" and when twisting on the type of ring twister hereinafter described, I find that the longitudinal tension should not exceed 0.15 gram per denier when twisting the yarn wet with water at approximately 60° C. as at higher tensions at this temperature the yarn is given excessive longitudinal extension resulting in an inferior quality of crepe yarn. If the mechanical conditions of twisting can be so arranged to provide for sufficiently low tensions to prevent longitudinal extension, somewhat higher temperatures may be employed for example as high as 85° C. with a tension of approximately 0.1 gram per denier. Correspondingly, at lower temperatures, somewhat higher tensions are permissible, for example at 20° C. I may employ tensions amounting to 0.20 gram per denier.

Opposed to the teachings of the prior art, I have found that in the production of true crepe fabrics from cellulose organic acid ester yarns the yarn need not be sized before, during, or after twisting, but need merely be softened before twisting, preferably without sizing; the twisted yarn should not be given any treatment which thermoplastically molds the yarn, such as hot water treatment, or treatment with hot steam or other hot liquids or vapors; and the woven fabric should be sufficiently softened in the boil-off bath to permit the crepe action in the twisted yarn to assert itself. Furthermore, opposed to the results obtained by the prior art in attempting to produce cellulose acetate crepes I have found that it is possible to produce a cellulose acetate crepe by my invention which has a widthwise contraction or shrinkage of approximately 40–60%, a condition which is necessary in the production of true crepe effects in the fabric.

One feature of the product of my invention wherein it differs from cellulose acetate crepe yarns made by stretching the yarn prior to, after or simultaneously with the twisting process is that my crepe yarn has good breaking strength and good extensibility at break whereas these desirable features are lacking in the stretched yarns. In order to weave successfully on the type of power looms universally used for weaving crepe fabrics, an acetate crepe yarn must be able to stretch considerably without breaking and although the requisite extensibility of the yarn will vary somewhat depending on exact weaving conditions, I have found that a cellulose acetate crepe yarn having an extensibility of under 15% breaks so frequently in the loom as to render its use uneconomical. Yarn made by the process herein described and claimed has an extensibility before breaking ranging from 15–26% and operates with high efficiency in modern rayon or silk type automatic looms. I have found that the stretch-twisting process of twisting gives acetate crepe yarns having extensibilities well below this lower limit of 15%. They are usually in the range of 8–10% and I have further determined that such yarns cannot be employed in the operation of an automatic loom with any degree of efficiency such as would render their use economi-

cally possible even if they could produce a desirable crepe fabric.

This invention has as its principal object to produce from cellulose organic acid ester yarns a crepe yarn which is useful as filling or warp or both in the production of fabrics produced exclusively or partially from such yarns. A further object is to produce a crepe yarn without the necessity of employing a sizing bath, without using liquids or vapors heated to a high temperature or any other agency which thermoplastically molds the yarn. Another object is to produce a true crepe fabric composed either exclusively or partially of cellulose organic acid ester yarns. Other objects will appear hereinafter.

These objects are accomplished by the following invention which, in its broader aspects, comprises the treatment of the yarn with a hot aqueous liquid such as water or a weak aqueous solution of soap, or similar agent which has a moderate softening action on the cellulose organic acid ester material of the yarn, at temperatures ranging up to about 85° C., then giving the yarn a high degree of twist while in a softened condition and under such tensions as at the temperatures employed will result in a permanent elongation of the filaments of less than 5%.

As indicated, for the purpose of softening the yarn, I have successfully employed water alone, but I may employ mixtures of water and other softening agents, aqueous emulsions of vegetable, animal or mineral oils, solutions of soaps or other wetting or dispersing agents and solutions of colloidal film-forming materials, which solutions have a softening action such as gelatin, starch, water-soluble polyvinyl resins. The application of this size in no way accounts for the creping power of the crepe yarn produced by following this invention as I obtained as good creping results when using a softening bath which contains no film forming or colloidal material. The function of the size, when used, is to form a protective coating on the yarn which binds the filaments together thereby protecting them from mechanical abrasion during weaving and the presence of the size on the crepe yarn is of no consequence in the production of the crepe effect by a suitable aqueous boil off treatment of the woven greige cloth.

In order to produce cellulose organic acid ester crepe yarn with the desired creping ability and strength characteristics I have found it necessary to twist the yarn in the water or other aqueous creping bath at the particular temperature and under a minimum tension as indicated above. For the twisting operation, a down draft twister may be most conveniently used, hence a trough containing the creping bath may be conveniently mounted below the lower feed roll of such a device. The feed roll may be partly immersed in the liquid and the yarn may be passed completely under the feed roll and out of the trough to the guide, or if the feed roll rotation be reversed, the yarn may come directly from the point of contact of the feed roll and its idler roll. In the latter case, the wetting of the yarn is accomplished by contact with the rolls, whose surfaces are wet as a result of the lower one being in contact with the water or aqueous solution. However, up draft twisters may be employed if provision is made for having the yarn wet during the act of twisting.

A convenient apparatus of the type first-mentioned is illustrated in the accompanying drawing in which,

Fig. 1 is a diagrammatic elevation of one form of such a device and,

Fig. 2 is also a diagrammatic elevational view in partial section of the device of Fig. 1, illustrating the manner in which the yarn is submerged in the creping bath.

Referring specifically to the drawing, the letters A and B represent cellulose acetate yarns of, for example, 100 denier or other desired size which is supplied from a suitable source (not shown). The numeral 1 designates an assembly of rolls by means of which the yarn is caused to be submerged in the creping bath. Rolls 2 and 3 are idler rolls over which the yarn passes to the applicator roll 4 which is positioned with respect to the trough 5, in such manner that the roll carries the yarn beneath the surface of the creping liquid 6 contained in trough 5.

Trough 5 is conveniently heated by an electrical resistance unit 7 or other appropriate heating means positioned in chamber 8 forming a part of the trough 5.

Numeral 9 designates a circular yarn guide which is connected to tension indicator 10 mounted in convenient proximity to trough 5. The yarn passing from the guide 9 passes through a guide 11 adjustably positioned as shown over the center of spindle 12 of the ring spinner 13. The spindle 12 is driven by means of pulley 14, operated by a source of power (not shown). Numeral 15 designates a conventional type of ring provided with a traveler (not shown).

In Fig. 1 I have shown two ring spinning devices of identical construction which may be operated in such manner that one gives the yarn the so-called "Z-twist" while the other gives the yarn the "S-twist". The type of twist, as is well-known, depends merely upon the direction in which the spindles are rotated.

The operation of the twisting device is well known in the art and will be readily apparent from the drawing. Yarn passes around idle rolls 2 and 3 as shown, and finally around applicator roll 4, whereby it is submerged in the creping bath 6. Yarn then is passed to guides 9 and 11 to the spool 16, which is driven at a high speed by means of pulley 14 to insert a high twist in the yarn. As the yarn passes to the spool, it is ballooned out in the manner indicated and twisted to the desired degree. The tension on the yarn is dependent not only upon the speed at which the spindle is operated, but also upon the drag produced by the traveler, and other factors, this tension being measured by means of the tension indicator 11, of a conventional type. Although the temperature may be varied widely, depending upon the type of product being produced and the creping properties desired, I have found that a creping bath temperature of about 60–65° C. gives highly satisfactory results with yarns of about 150 denier using a twist of 50 turns per inch and a tension of 10 grams. As indicated, the composition of the aqueous creping bath may vary rather widely, but I have found that especially good results may be obtained by employing an aqueous dispersion of certain oils such as olive oil, sulfonated oil, mineral oil and mixtures thereof. The amount of oil may conveniently be 5–20% of the weight of the water. When using temperatures in excess of 30° C. emulsions are not stable over long periods of time and hence, I prefer to use water to which a small amount of soap or other wetting agent has been added. Excellent results are obtained by treat-

ing the yarn with 1–10% of the above-mentioned oils and twisting with water.

As previously stated, it is necessary to assign much more definite limits to the amount of tension employed than is the case in the ordinary crepe twisting of silk and rayon. I have found that the control of tension is very necessary if the finished yarn is to have the strength and extensibility necessary to produce a finished commercially useful fabric. Broadly speaking, I find that the best crepe yarn is prepared under conditions of minimum tension during twisting. The line of demarkation between good and poor crepe yarn is by its very nature somewhat vague, but, in general, it may be said that it is necessary to maintain the tension below the point where a given yarn shows a permanent stretch of more than 5% of its original length. I have found that especially good results are obtained by adjusting the tension so that the stretch induced in the yarn is from 1–4%.

The induced percent stretch may be computed as follows: for example, 10 inches of crepe yarn previously twisted at a tension of 0.1 gram per denier may serve as a basis of illustration. The take-up of this yarn, that is, the difference between the length of the twisted crepe yarn and the length of the crepe yarn after untwisting may be represented by the symbol θ. The final denier of the crepe yarn may be represented by the symbol D_f and the initial denier by the symbol D_i. The denier which the crepe yarn has after being untwisted is

$$\frac{10Df}{10+\theta}=D_u$$

where D_u symbolizes the denier of the untwisted crepe yarn. The per cent stretch given the original yarn by the process of crepe twisting is then given by:

$$\frac{100(D_i-D_u)}{D_u}=\%\text{ stretch}$$

The initial denier used in these computations should be the denier of the yarn not including the weight of any oil which may have been placed on the yarn.

It is to be noted that the above-mentioned limitation of tension during the crepe twisting operation to low values is a marked departure from and in direct contrast to the practices recommended in the prior art wherein it is proposed to stretch the yarn as much as possible, that is, to employ high tensions in twisting in order to provide for the necessary crepe shrinkage. As previously indicated, however, such practices of the prior art are unsatisfactory from the standpoint of producing a satisfactory crepe yarn or fabric, and it is only by the use of low tensions as herein described that I have found it possible to produce a commercially satisfactory crepe.

In the following examples and description I have set forth several of the preferred embodiments of my invention but they are included merely as an illustration and not as a limitation thereof.

Example I.—The twisting bath is made up of distilled water and ½% of oleate soap, and is maintained at 10° C. by a cooling coil. 150 denier cellulose actate yarn is twisted in one operation to 65 turns per inch, at a spindle speed of 7000 R. P. M., under a tension so adjusted that the take-up of a 10-inch sample of the twisted yarn is 2.7 inches. To attain this tension—about 12 gm.—a No. 26 traveler on a 3-inch ring, with a balloon height of 16 cm. is suitable. However, it has been observed that the actual tensions attained with different travellers of the same number are somewhat different, for although the travelers are identical in weight, there are small differences in shape and smoothness which result in different tensions. Therefore, the traveler size and balloon height should be changed until the yarn shows the desired physical properties. The final denier of the yarn twisted according to the above directions will be about 185–190 and the stretch of the original yarn, were it untwisted, is about 3%. The yarn had a breaking load of 0.80 gram per denier and stretch at break of 20%. This yarn is woven in a matelassé construction and the fabric is boiled off in water at 95° C. The resulting product is a true crepe fabric of excellent quality.

Example II.—The twisting bath is made up of water, ½% of oleate soap, and an appropriate fugitive tint to distinguish S and Z twists, the temperature being allowed to assume room temperature. 100 denier cellulose acetate yarn, initially half turn, is twisted in one operation to 63 turns per inch under tension resulting in a takeup of 1.8 inches in 10 inches of the twisted yarn, a final denier of about 117, and a stretch of 1% based on the original yarn. To attain this tension—6 to 8 gm.—a No. 30 traveler is used, with a balloon height of 15 cm. The breaking load of this yarn was 0.83 gram per denier and the stretch at break 25%. The yarn is woven as filling in a 4 x 4 construction, to form a Canton crepe upon boiling off.

Example III.—A twisting bath is prepared of a 10% emulsion of olive oil prepared with triethanolamine and oleic acid and maintained at a temperature of 25° C. 200 denier half-turn cellulose acetate yarn is twisted in one operation to 50 turns per inch under a tension which produces a takeup of 1.9 inches, a final denier around 230, and a stretch based on the original yarn of 3.6%. To obtain this tension, around 12 gm. a No. 26 traveler and 15 cm. balloon height are suitable. The breaking load was 0.90 gram per denier and the stretch at break 18%. The yarn is incorporated in a matelassé fabric and boiled off in water at 98° C. As in the previous examples, a commercially satisfactory crepe fabric results.

Example IV.—A twisting bath is prepared of water, ½% of potassium oleate soap, and appropriate fugitive tint. The bath is maintained at a temperature of 75° C. with a tolerance of five degrees either way. 160 denier half-turn cellulose acetate yarn is twisted in one operation to 66 turns per inch under a tension resulting in a takeup of 2.85 inches, a final denier of 200, and a stretch based on the original yarn of 2.9%. To obtain this tension—8 gm.—a No. 30 traveler and 16 cm. balloon height are suitable. The breaking load of the yarn was 0.92 gram per denier and the extension at break 20%. This yarn is woven into a 4 x 4 Canton crepe, 52 picks per inch, and the fabric is boiled off to give a good crepe appearance.

Example V.—A twisting bath is prepared of water to which is added 0.2% of sulfonated olive oil together with an appropriate fugitive tint. The bath is maintained at a temperature of 70° C. 158 denier half-turn cellulose acetate yarn is twisted to 62 turns per inch, a final denier of 182, a stretch of 5.5% being induced. The strength of the crepe yarn is .89 gm. per denier and the extension at break is 16½%. To obtain

this tension—8 gm.—a No. 30 traveler is used with balloon height of 16 cm. The yarn is woven into a fabric and boiled off in soapy water at 90–100° C.

Example VI.—A twisting bath is prepared of water, 0.1% soap, and a tint, the bath being maintained at a temperature of 60° C. 150 denier cellulose acetate yarn is twisted to about 50 turns per inch, the traveler and balloon height being the same as in Example V. The final denier is 165, the induced stretch about 2%. The crepe yarn is then rewound to another package, in the course of rewinding being sized with a 2.5% solution of gelatin. The yarn had a breaking load of 0.83 gram per denier and stretch of 24%. This sized yarn is then woven into a fabric which is boiled off in the usual way and is then rinsed, dyed, tentered and dried in the usual way.

Example VII.—A twisting bath is prepared of water to which 0.1% of soap is added together with an appropriate fugitive tint. The bath is maintained at a temperature of 60° C. with a tolerance of five degrees in either direction. 150 denier cellulose acetate yarn which has had 10 turns per inch inserted during some previous process—for example, spinning or oiling with the oils which have been previously mentioned as being beneficial—is twisted to a total of 60 turns per inch under a tension which results in a takeup of 2.4 inches, a final denier of 180, and a stretch of the original yarn of 3.3%. To obtain this tension—about 8 gm.—a traveler size No. 30 and balloon height of 16 cm. are suitable. The breaking load of the crepe yarn was 0.85 gram per denier and it had an extensibility of 21%. This yarn is then woven into a suitable fabric and finished by a hot aqueous treatment.

Although in the above examples I have found it convenient to illustrate my invention by reference to yarns composed of cellulose acetate, the broad scope of my invention includes the manufacture of crepe yarns in accordance with the process herein described from yarns composed of or containing other cellulose organic acid esters such as cellulose propionate, cellulose butyrate, cellulose acetate propionate, cellulose acetate butyrate and the like. Likewise, although I have found it convenient to refer to certain specific deniers, temperatures, tensions, percent stretch and other factors, it will, of course, be understood that these are merely illustrative and that my invention is broadly applicable to the production of crepe-twisted yarns and fabrics produced therefrom, regardless of the composition and denier of the yarn, when produced as herein described.

The crepe yarns produced as indicated in the foregoing examples are particularly characterized by the fact that the filaments comprising the yarn strands receive practically no longitudinal extension either during the twisting or in any subsequent operation. This is in direct contradistinction to known practice and apparently accounts for the remarkable creping power of my new type of crepe yarn in comparison with the poor results heretofore obtained by the practice of the prior art.

Without limiting myself by any particular explanation of the results obtained by the practice of my invention as herein described, I have worked out a theory which appears to explain the above-stated facts and this theory is given for the purpose of providing a more complete understanding of my invention. Probably the chief reason why the previous workers in this field have failed to achieve success is the opinion consistently maintained that the creping action of a crepe yarn is associated with the ability of the yarn to contract lengthwise when the fabric is subjected to whatever influence is used to produce the desired crepe effect. I have carried out an extensive program of research on the fundamental phenomena of producing this crepe effect and as a result of these studies I have reached the conclusion that the above premise is false and misleading and that the principal requisite of a successful crepe yarn is the fact that there has been stored therein a suitable amount of energy which is released as a torsional force during the manufacturing operation wherein the creping power of the yarn asserts itself and the crepe pebble appearance appears. Commonly, this is the boil off operation. Upon the release of this torsional force, in the yarn by the boil off, the stable configuration of the crepe yarn changes from a straight line to a helical spiral and it is the formation of these spirals and not the longitudinal contraction of the yarn which is chiefly responsible for a genuine crepe effect.

Further information concerning the potential torque in yarns as well as process and apparatus for determining such torque and other related details are set forth in my copending application Serial No. 121,556 entitled "Manufacture of crepe fabrics". The potential torque in my novel yarns provides another and additional feature upon which the yarns of this invention may be further distinguished as will be set forth in more detail hereinafter. The values set forth herein have been arrived at in accordance with procedure described in my copending application, aforementioned. Briefly, this procedure includes measuring the torque exhibited by yarn (four strands) after five minutes in water at a predetermined temperature.

I am further of the opinion as a result of my work on crepe yarns and fabrics that the molecular structure of cellulose acetate and other cellulose organic acid ester filaments is capable of supporting only a limited total internal strain. Whatever part of this available energy-absorbing or storing capacity is taken up by a longitudinal strain, which upon release causes the filament to contract lengthwise, is deducted from the total amount available for the storing of energy convertible into torsional forces which distort the crepe yarn into a spiral form and give rise to a crepe effect. It is herein that my process of producing cellulose acetate crepe yarns differs from the previous unsuccessful attempts to cause highly twisted cellulose acetate yarns to crepe. The essential feature of my process is that under my preferred twisting conditions as much as possible of the energy-storing capacity of the yarn is utilized for the storing of torsional forces and as little as possible for longitudinal forces.

The cellulose acetate crepe yarns made by my process are subjected preferably to degrees of twist approximately equal to the twists now customarily inserted in regenerated cellulose crepe yarns. The degree of twist used depends upon the denier and the type of effect it is desired to produce, but in general it is sufficient to duplicate many known crepe cloths now constructed with the use of regenerated cellulose crepe yarns by substituting therefor cellulose acetate crepe yarns of the same denier and similar degree of twist. Thus, for most purposes 100 denier yarn is given a twist of 60–65

turns per inch, 150 denier yarn 55 turns per inch, and 200 denier yarns 50 turns per inch, the denier numbers referring to the untwisted yarn. This feature of my invention further serves to differentiate it from such processes as have hitherto been described which have as their object softening or otherwise conditioning the yarn to enable it to accommodate extremely high degrees of twist. Cellulose acetate crepe yarns produced in accordance with the process herein described are rather sharply distinguished from the so-called crepe yarns of the prior art. They are particularly distinguished by the following features:

(a) *Per cent stretch of the yarn during twisting.*—Low—in the order of 0–5%.

(b) *Denier of the crepe yarn.*—High in comparison with the denier of the low twist yarn—approximately 110–125% of the denier of the low twist yarn when 150 denier yarn is used.

(c) *Twist takeup.*—High—in the order of 15–25% for the 150 denier yarn.

(d) *Apparent specific gravity.*—Low—in the order of 75–80% of the specific gravity of the cellulose acetate used.

(e) *Breaking load of crepe twisted yarn.*—High—of the order of 0.8 to 0.9 gm. per denier.

(f) *Extension at break.*—High—of the order of 15–25%.

(g) *Physical appearance.*—Crepe yarn is rough and has some rough feel as is characteristic of rayon crepe yarns.

(h) *Creping power.*—High—comparable with similar rayon crepe yarns.

(i) *Potential torque.*—Varies, depending on denier—in the order of at least 500 dyne centimeters for 100 denier yarn (about 700 preferred), 1300 dyne centimeter for a 150 denier yarn (1400 preferred) and 1600 dyne centimeters for 200 denier yarn (about 1900 preferable). Values for intermediate and other denier, of an order proportional to those stated.

Of above enumerated properties and characteristics, that set forth relative to twists of about 50–65 turns per inch (depending on denier), and under headings (b), (c), (f) are believed to be the most significant.

What I claim and desire to secure by Letters Patent of the United States is:

1. A cellulose organic acid ester crepe twisted yarn having a twist in the order of from 65 turns per inch for 100 denier to 50 turns for 200 denier, said yarn after twisting having a final denier approximately 110–125% of its original denier, a twist takeup of approximately 15–25%, an extension of not over about 5% and a breaking load of the order of 0.8–0.9 gram per denier and an extension at break of the order of 15–25% of its length, and having the ability, when woven into an appropriate construction, of producing a true crepe fabric when the twist is released.

2. A cellulose organic acid ester crepe twisted yarn having a twist in the order of from 65 turns per inch for 100 denier to 50 turns for 200 denier, said yarn after twisting having a final denier approximately 110–125% of its original denier, a twist takeup of approximately 15–25%, an extension at break of the order of 15–25% of its length, and having the ability, when woven into an appropriate construction, of producing a true crepe fabric when the twist is released.

3. A cellulose organic acid ester crepe twisted yarn having a twist in the order of from 65 turns per inch for 100 denier to 50 turns for 200 denier, said yarn after twisting having a final denier approximately 110–125% of its original denier, a twist takeup of approximately 15–25%, a breaking load of the order of 0.8–0.9 gram per denier, an extension at break of the order of 15–25% of its length, and having the ability, when woven into an appropriate construction, of producing a true crepe fabric when the twist is released.

4. A cellulose organic acid ester crepe twisted yarn having a twist in the order of from 65 turns per inch for 100 denier to 50 turns for 200 denier, said yarn after twisting having a final denier approximately 110–125% of its original denier, a twist takeup of approximately 15–25%, an extension of not over about 5%, an extension at break of the order of 15–25% of its length, and having the ability, when woven into an appropriate construction, of producing a true crepe fabric when the twist is released.

5. A cellulose organic acid ester crepe twisted yarn having a twist in the order of from 65 turns per inch for 100 denier to 50 turns for 200 denier, said yarn after twisting having a final denier approximately 110–125% of its original denier, a twist takeup of approximately 15–25% and having the ability, when woven into an appropriate construction, of producing a true crepe fabric when the twist is released.

6. The product of claim 2 in which the crepe twisted yarn is composed of cellulose acetate.

7. A crepe fabric containing crepe yarns produced in accordance with claim 2.

8. A cellulose organic acid ester crepe twisted yarn having a twist in the order of from 65 turns per inch for 100 denier to 50 turns for 200 denier, said yarn having a potential torque in the order of at least 500 dyne cm. for 100 denier yarn, 1300 dyne cm. for a 150 denier yarn and 1600 dyne cm. for 200 denier yarn, and having the ability, when woven into an appropriate construction, of producing a true crepe fabric when the twist is released.

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