May 14, 1968 O. N. SEELIG ET AL 3,382,662

COVERED ELASTOMERIC YARNS

Filed July 15, 1965

FIG. 1.

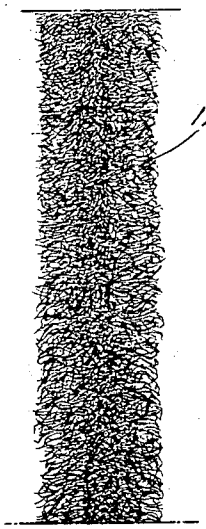


FIG. 2.

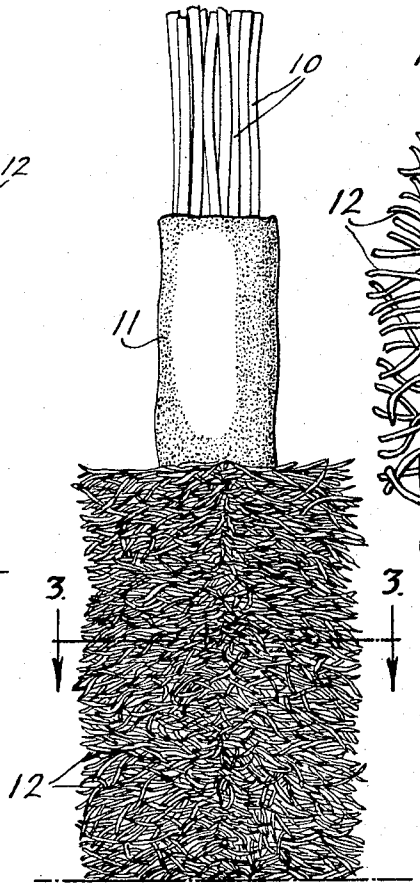
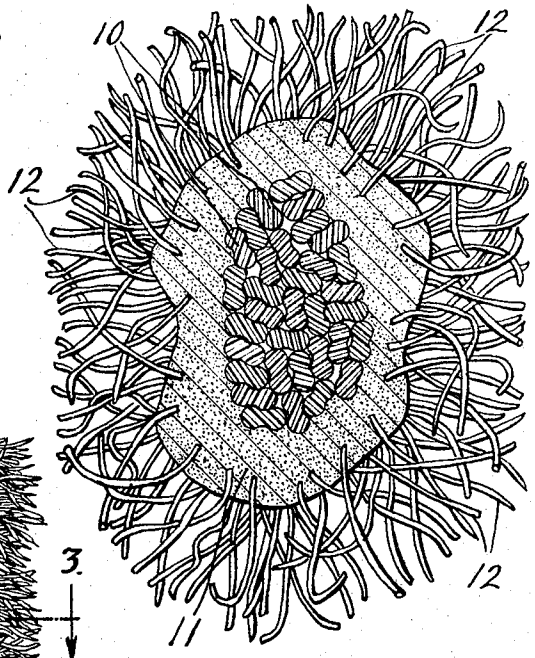


FIG. 3.



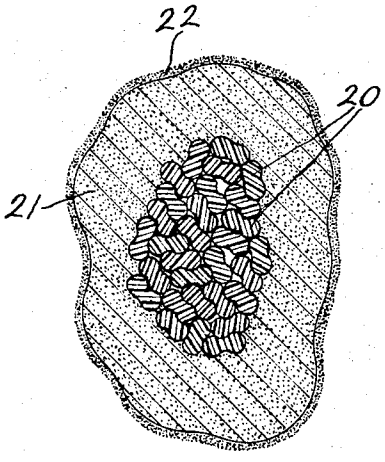


FIG. 4.

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COVERED ELASTOMERIC YARNS

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Continuation-in-part of application Ser. No. 275,383, Apr. 24, 1963. This application July 15, 1965, Ser. No. 472,230

10 Claims. (Cl. 57—153)

The application is a continuation-in-part of our application for "Covered Elastomeric Yarns," Ser. No. 275,383, filed Apr. 24, 1963, now abandoned.

The present invention relates to elastomeric yarns, and is particularly applicable to spandex and other synthetic yarns comprised of filaments whose extensibility is at least greater than 15 % and especially to synthetic elastomeric yarns having greater than 100% extensibility.

Prior to the present invention, there has been limited usage of bare elastomeric yarns such as rubber and spandex, because of the limited dyeability of the yarns, the handle of the fabrics embodying such yarns, the slipperiness of the yarn in the fabric and the resulting tendency for raveling, and the difficulties in handling the yarns during the formation of the fabrics due to their high friction, low modulus, and high elongation characteristics. Accordingly, it has been the practice to cover the elastomeric yarns by twisting or braiding with conventional textile yarns. The covering operation limits the elasticity or modulus of the elastomeric core yarn, but it has been found difficult to precisely control the modulus of the covered yarn strand. As a result, there is nonuniformity along the length of the strand, and in fabrics using multiple strands of covered yarn, there is an inherent non-uniformity among the strands so used. Furthermore, it has been found that the covering material oftentimes cuts into the elastomeric core yarn and causes a weakening of the core yarn in localized areas, and the core yarn may separate within the covering. Also the separation of the covering material upon flexing, may expose the elastomeric core yarn.

Particularly, with settable synthetic elastomeric yarns such as spandex, the use of bare yarns in fabrics has been limited by the difficulty in obtaining a modulus (i.e., the power required to effect a given elongation of the yarn), which satisfies the various requirements in various end uses of the fabric, without unduly increasing the cost of the yarn incorporated in the fabric. Furthermore, although spandex yarn is dyeable, its dyeability is limited in that the dyes must be chosen with care and it is oftentimes difficult to obtain the desired color effect. Furthermore, the characteristics of the bare yarn require extreme care in the processing of the yarn into fabric, particularly in the tensions applied to the yarns and in the selection of the stitch formation to avoid inadvertent raveling.

The use of conventionally covered spandex fibers is becoming more common; however, there are certain drawbacks to the use of conventionally covered spandex yarns. For example, the conventional covering operation is a time-consuming and expensive additional processing operation in which yarn must be covered individually. The individual processing of each conventionally-covered spandex strand creates in the finished fabric, a

degree of non-uniformity resulting from the inherent non-uniformity between separately processed packages of the conventionally covered spandex yarn. Furthermore, the covered spandex yarn embodies expensive covering materials which contribute to the high cost of such yarns and the resultant limitations in end uses to which the conventionally covered yarns may be put.

With the foregoing in mind, the present invention provides an improved elastomeric yarn having an elastomeric core of a settable synthetic yarn, an adhesive coating covering said yarn and cooperating therewith to control the properties of the yarn, and a coating of particulate material surrounding said adhesive coating.

Another object of the present invention is to provide a yarn having controlled elongation and power or modulus in accordance with the requirements of the end-use fabric.

More specifically, the present invention provides a yarn of the stated type having an outer sheath of fine particles of flock, talc or similar material adapted to impart improved dyeability to the strands and improved frictional characteristics so as to afford proper handling in the knitting, weaving, or other fabricating operation, and, in the case of flocked yarn, to enable interlocking entanglement with similarly sheathed strands in the finished fabric, thereby retarding raveling of the fabrics.

All of the objects of the invention are more fully set forth hereinafter with reference to the accompanying drawing, wherein:

FIG. 1 is a view in side elevation in a greatly enlarged scale of a yarn made in accordance with the present invention;

FIG. 2 is a further enlarged elevation showing the components of the yarn of FIG. 1;

FIG. 3 is a transverse sectional view taken on the line 3—3 of FIG. 2; and

FIG. 4 is a view similar to FIG. 3 of another yarn made in accordance with the present invention.

The present invention is directed to covered elastomeric yarns such as rubber and spandex which are characterized by extensibility due to the molecular structure of the fibers comprising the yarn rather than the stretchability due to the physical configuration or conformation of the filaments in the yarn. The present elongation or extensibility of untreated natural and synthetic non-elastomeric fibers and monofilaments is usbstantially less than 15% when the elongation is maintained below the elastic limit of the material. When synthetic yarns are texturized to impart stretch thereto, the percent elongation is increased to approximately 70%, but the filaments themselves do not elongate or extend beyond 15%, and when such yarns are incorporated into a fabric by weaving, the maximum elongation of the fabric is in the neighborhood of 35%. Covered elastomeric yarns made in accordance with the present invention, however, erhibit extensibility in a woven fabric often as high as 210% and, depending on the ultimate use to which the fabric is to be put, the normal range is between 70% and 300% elongation. The yarns themselves may exhibit elongation in the range of 140% to 390% ultimate (i.e., the maximum elongation within the elastic limit of the yarn). This is opposed to the elongation at break which may be 10% or 50% greater than ultimate.

Referring now to the drawing, the yarn illustrated in FIGS. 1–3 therein comprises a core 10 of an elastomeric yarn, in the present instance, a multi-filament yarn which is a long chain synthetic polymer comprised of at least 85% of a segmented polyurethane. The core yarn 10 is coated under longitudinal stress with an adhesive 11 which is elastomeric and which exhibits a low modulus and high elongation. The stretch of the adhesive when set or cured, is correlated to the stretch of the core yarn so as to produce in the finished yarn the properties desired, as more fully set forth hereinafter. The adhesive is controlled as to its viscosity and solids content during application to control the thickness of the coating 11 on the core yarn 10 and is sheathed by a covering of flocking material 12 which is partially embedded into the adhesive layer 11. When covering spandex as the core yarn, we have used a suitable thermosetting resin adhesive, such as polyurethane adhesives. The uniform coating of adhesive applied to the yarns not only assures uniform flocking about the circumference of the yarns, but also the compositions of the adhesive may include additives to retard the oxidation or other deterioration of the spandex yarn which may adversely affect the appearance of the yarn. The uniform application of the adhesive to the yarns also insures that when set or cured, the yarns are uniformly limited in their recovery from stretch and/or in their stretchability, so as to maintain the yarns uniformly at the desired tensile stress relative to their limit of elastic recovery.

The flocking material may be of any desired textile product, such as rayon or cotton, and is selected in accordance with the properties desired in the finished yarn. Flock having a fiber length less than 0.040 inch has been preferred. An analysis by weight of a typical yarn made in accordance with the present invention indicates the composition of the yarn includes 30% by weight of spandex, 40% by weight of coating, and 40% by weight of flock. Depending on the end to which the yarn is to be put, the range of percentages for the elastomeric core may range from 15% to 80%, the range for the adhesive coating may range from 10% to 50%, and the range for the flock may range from 0 to 55%.

In accordance with the invention, the properties of the finished yarn are controlled by the application of the adhesive coating 11 to produce the desired properties in the fabric. For example, the thickness of the adhesive coatings may be controlled by controlling the viscosity of the liquid adhesive applied to the core yarn during the processing thereof and by the percentage of solids in the adhesive. This in turn controls the tensile strength of the adhesive film which is normally expressed in pounds per square inch of strength required to effect rupture of the film. The strength of the adhesive may range from 620 p.s.i. to 9000 p.s.i. A further factor in controlling the end properties of the yarn is the elongation of the spandex during the coating operation. As pointed out in the patent referred to above, the elastomeric core yarn is coated while stretched under uniform tension in order to modify the modulus of the bare uncoated yarn by reason of the coating's ability when cured to hold the core yarn under tensile stress. The elongation of the spandex or other core yarn during treatment and curing of the yarn may range anywhere from 25% to the ultimate, in the neighborhood of 600%, the normal range being between 200% and 400%. By varying the properties of the adhesive used in the coating operation and the elongation of the spandex during the coating operation, the ratio of adhesive to spandex is modified or is controlled to produce the desired results.

As pointed out in the above-identified application, the processing of a yarn in accordance with the present invention consists of a continuous operation in which the yarn is preferably arranged in the form of a sheet of multifilament yarns disposed in spaced relation from a creel supporting a plurality of packages of the uncovered elastomeric core yarn and having individual feed means for each package. The sheet of yarns is advanced and stretched by positive feed means such as feed rolls at a uniformly constant predetermined rate of speed, preferably correlated to the creel feed means, into contact with a liquid-adhesive applying roller and thereafter through a flocking chamber in which small discrete fibers of textile materials are blown into contact with the adhesive-coated core material and thereby become embedded in the adhesive coating. The yarn, while still stretched, is passed through a curing stage, so as to at least partially cure or set the adhesive so as to eliminate tackiness. The curing or setting of the adhesive is accelerated by the application of heat, and in accordance with the present invention, the heat applied to the yarn during the curing or setting to eliminate tackiness, may range anywhere from room temperature to just under the degradation temperature of the core yarn or the adhesive coating, the degradation temperature of a typical spandex fiber being in the neighborhood of 300° F. The coated and flocked yarn which has been dried and cured sufficiently to eliminate tackiness is then wound on suitable packages, beams, or the like, for subsequent fabricating operations. The tension on the core yarn during the coating, flocking, and curing or setting operations is controlled, for example by feed rolls, to maintain the yarns elongated during these operations. During the winding operation on pacakes, the yarn may be partially relaxed, may be held extended, or may be further extended, depending upon the results desired. Complete setting or curing of the adhesive coating may be completed while the yarn is on the package or beam which may occur over several hours or days, depending upon the conditions of storage, and the type of adhesive used.

It has been found that particulate materials other than flock are also useful in providing the desired frictional, tactile, and visual properties in the yarn and fabric. For example, talc has been found to produce a sheath upon the adhesive which provides the necessary frictional properties to the yarn to enable satisfactory knitting, weaving, and other fabricating operations. A yarn of this type is shown in FIG. 4 wherein the core yarn 20 is coated with an adhesive coating 21, which in turn is covered by a sheath of talc particles 22 which are at least partially embedded in the outer skin of the adhesive coating 21.

The character of the sheath has no substantial effect upon the modulus and other stress-strain properties of the covered yarn, so long as it is of particulate material. The sheath material is selected to provide the desired frictional characteristics, tactile properties such as the "hand," and appearance.

The stretch of the fabric is controlled, not only by stretch in the flocked adhesive-coated core yarn, but also by the fabric construction. The fabric may be knitted, woven, or braided, the woven fabrics being less stretchable than the knitted or braided fabrics. Typical woven fabrics in tape form include straps and bands for lingerie, foundation garments, and the like. Straps normally require a stretch in the range of 70% to 120% and waist bands, leg bands, bottom bands, facing trims, etc., may range from 120% to 150% elongation. The yarn elongation is normally approximately 50% greater than the woven fabric elongation. By the present invention, it is possible to provide fabrics having uniform stretch characteristics which are comparable in economy and superior in performance to fabrics embodying conventionally covered rubber yarns.

Table I shows the possibility of producing various yarn properties by varying the denier of the spandex, the elongation of the spandex during processing, the adhesive/spandex ratio, and the adhesive tensile strength. Table II shows the properties of the spandex used in Table I when not coated with the adhesive.

TABLE I

[Properties of adhesive-coated spandex yarn processed to prevent tackiness at 200-250° F. for 30 seconds and cured for three days at room temperature in the extended state.]

Experiment	Denier of Spandex	Elongation During Processing, percent	Adhesive/ Spandex Ratio	Adhesive Tensile Strength in p.s.i. (film strength at rupture)	Modulus at 100% Elongation, g.	Modulus at 150% Elongation, g.	Ultimate Elongation at 220 g., percent	Elongation at Break, percent
A	420	400	1.20/1	8,105	60	----------	142	171
B	420	400	1.25/1	8,105	26	53	207	211
C	420	300	1.02/1	8,105	21	30	253	260
D	420	200	1.10/1	8,105	19	24	385	408
E	420	375	1.54/1	620	20	25	356	424
F	420	667	----------	8,105	----------	----------	47	80
G	420	130	----------	8,105	26	31	437	470
H	560	200	----------	8,105	24	33	*300	325
J	560	400	----------	8,105	35	67	*205	217
K	560	400	3.03/1	8,105	45	188	*160	188
L	560	400	3.08/1	3,156	22	25	*326	383
M	560	400	2.07/1	8,105	61	----------	*145	180
N	560	400	.91/1	8,105	28	68	*201	225

*Ultimate at 250 g.

TABLE II

[Properties of bare spandex yarn.]

Experiment	Denier of Spandex	Temperature and Time of Treatment	Elongation during Treatment, percent	Modulus at 100% Elongation, g.	Modulus at 150% Elongation, g.	Ultimate Elongation at 250 g., percent	Elongation at Break, percent
W	420	Room temp	0	16	18	638	735
X	420	220° F./30 sec	400	21	26	375	421
Y	560	Room temp	0	15	21	604	750

With reference to Tables I and II, it is apparent that the heavier denier spandex has a greater modulus and smaller ultimate elongation.

By controlling the elongation of the spandex during the processing, the regulation of the final yarn properties is obtained. For example, comparing experiments H and J in Table I wherein the other conditions are the same, it is apparent that the modulus at 150% elongation is doubled by doubling the elongation during processing. The modulus at 100% elongation is 1.5 times. The increase in the elongation during processing also results in a corresponding decrease in the ultimate elongation. It has been found that the degree of elongation during processing is limited to 25% at the lower end by the ability of the apparatus to advance the yarn at minimum tension and to 667% at the upper end by the inherent ultimate elongation of the spandex yarn. A further factor with regard to the elongation of the core during treatment is the characteristic of the adhesive with regard to its tensile strength and the thickness of its coating with its consequent ability to control the extension and retraction of the core following curing of the adhesive.

The adhesive/spandex ratio results from the thickness of the adhesive coating on the core. As pointed out above, the thickness is controlled by the viscosity and/or solids content of the liquid adhesive applied to the core. A thick coating or high adhesive/spandex ratio inhibits the core from retracting because of the increased strength of the adhesive, and as shown by experiments in M and N, the ratio controls to a substantial extent the modulus and ultimate elongation of the covered yarn. As shown in these experiments, the doubling of the adhesive/spandex ratio doubles the modulus at 100% elongation and substantially reduces the ultimate elongation.

The strength of the adhesive operates similarly to the adhesive/spandex ratio to control the retraction of the covered yarn subsequent to its processing, shown by experiments K and L.

It should be noted that the yarns listed in Table I were all processed to prevent tackiness at between 200° and 250° F. for 30 seconds. It is known that the spandex used in these experiments is settable to an appreciable extent, even without the application of adhesive. As shown in Table II, the treatment of bare spandex without application of an adhesive coating thereto, affects the modulus and elongation of the yarn, increasing the modulus and reducing the elongation. Thus, the modification of the elongation and heating of the yarn affects the modulus and elongation of the finished product. It should be noted that the yarn of Experiment X in Table II is similar or corresponds to the core yarn in Experiment A of Table I with regard to its elongation and treatment temperature and time. The differences in modulus and elongation between Experiment A and Experiment X are directly attributable to the application of the adhesive to the yarn.

A review of Table I shows the wide variety of modulus and elongation characteristics which are obtainable by varying the above-noted factors. For example, Experiments D and E show approximately corresponding results obtained by different combinations of factors using the same denier of spandex. In other words, by using a greater strength adhesive with a thinner coating on a 200% elongated spandex, a result comparable to a yarn produced by a lesser strength coating applied thicker to a greater elongated spandex is obtained. Thus, it is apparent that a wide variety of yarn characteristics may be obtained by selectively controlling the conditions of processing the yarn. These characteristics, in turn, control the properties of the textile fabrics formed with the yarn, for example by weaving, braiding, or knitting. When compared to conventionally covered yarns of similar properties, the yarn of the present invention provides a fabric which is lighter in weight, is not as bulky, and has an improved "hand," and a finer appearance.

While particular embodiments of the present invention have been described herein, it is not intended to limit the invention to such specific embodiments, but changes and modifications may be made therein and thereto within the scope of the following claims:

What is claimed is:

1. A covered elastomeric yarn comprising an elastomeric core yarn having predetermined characteristics of modulus and elongation, and a coating of an elastomeric adhesive having a stretch correlated to the stretch of said core yarn, the thickness of said coating and the tensile strength of said adhesive cooperating with the tensile stress in said core yarn to produce in the covered elastomeric yarn controlled characteristics of modulus and elongation different from said predetermined characteristics.

2. A covered elastomeric yarn according to claim 1 wherein said core yarn is a settable synthetic multifilament yarn such as spandex, and said adhesive coating holds the core yarn under tensile stress resulting from uniform elongation of said core yarn in the range of 25% to 600% during at least partial curing of said adhesive.

3. A covered elastomeric core yarn according to claim 1 wherein the spandex/adhesive ratio is uniformly correlated to said elongation of the core yarn and the tensile strength of the adhesive to produce the said controlled characteristics of modulus and elongation.

4. A covered elastomeric yarn according to claim 3 wherein the tensile strength of the adhesive is in the range of between 620 p.s.i. to 9000 p.s.i.

5. A covered elastomeric yarn according to claim 1 including a sheath of fine particles of particulate material at least partially embedded in said adhesive coating.

6. A covered elastomeric yarn according to claim 5 wherein the yarn consists of core yarn in the range of 15% to 80%, adhesive coating in the range of 10% to 50%, and particulate material in the range of 0% to 55%.

7. A yarn according to claim 5 wherein said particulate material comprises textile flock having a fiber length less than 0.040 inch.

8. A yarn according to claim 5 wherein said particulate material comprises talc.

9. A method of modifying the stretch characteristics of a synthetic elastomeric yarn comprising the steps of tensioning the yarn uniformly to a predetermined degree sufficient to stretch said yarn, uniformly coating the tensioned yarns with an elastomeric adhesive having a given

tensile strength, curing or setting said adhesive coating to eliminate tackiness thereof on said tensioned elastomeric yarn, and correlating the thickness of said adhesive coating to the degree of stretch in said tensioned yarn and the tensile strength of said adhesive to produce the desired modification in the stretch characteristics of said elastomeric yarn.

10. A method according to claim 9 including the step of applying particulate material to said adhesive coating prior to curing thereof to at least partially embed said material in the outer skin of said coating so as to form a sheath on said adhesive coating.

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