April 30, 1968 R. S. MARTIN 3,380,244

CORE-SPUN ELASTIC YARN PRODUCT AND PROCESS

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FIG. 1

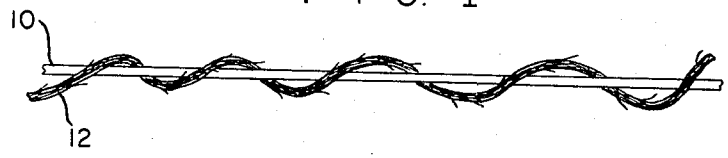
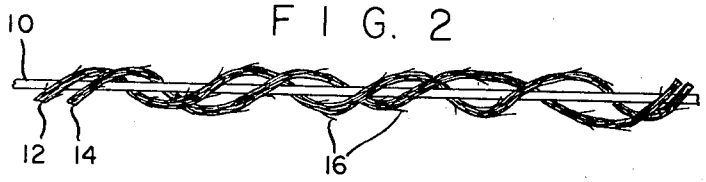


FIG. 2



INVENTOR

ROBERT S. MARTIN

BY Frank R Ortolani

ATTORNEY

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CORE-SPUN ELASTIC YARN PRODUCT AND PROCESS

Robert S. Martin, Charlotte, N.C., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

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ABSTRACT OF THE DISCLOSURE

A method for preparing an elastic yarn comprising core-spinning uncrimped, stretched continuous filaments of a segmented elastomer with a sheath of two types of inelastic staple fibers (self-crimpable fibers and low strength non-crimpable fibers) heat setting the resulting core-spun yarn under tension, and plying the heat-set core-spurn yarn with a second core-spun yarn of the same type of inelastic staple fibers.

The high-bulk elastic composite yarn comprises a core-spun yarn having an initially stretched elastic core (as described above) which is helically surrounded by a sheath of two types of elastic staple fibers (as described above), the sheath being in engagement with the core, but free of adhesion thereto. This first core-spun yarn is plied with a second core-spun yarn of the same type of inelastic staple fiber. The yarns of this invention are characterized by good bulk, cover, stretch, and pill-resistance.

This invention relates generally to the spinning of yarn and, more particularly, is concerned with elastic yarns core-spun from continuous filaments of elastic fibers and from inelastic staple fibers including self-crimpable staple fibers.

Elastic yarns have previously been wrapped or core-spun with inelastic fibers including staple fibers. The wrapped yarns and the highly twisted core-spun yarns have been highly satisfactory for support garments such as girdles and hose, and for swim suits. However, such yarns have been unsatisfactory for outerwear garments, such as sweaters and suits, because of high stretch-modulus and low covering power. Core-spun fibers have also been made from elastic filaments and staple fibers using low twist multipliers in order to obtain more cover or bulk in the fabrics. Fabrics from such yarns pill so badly that no commercial success has been realized with such yarns. In such yarns there is also a tendency for the core fibers to become exposed when the fabrics are stretched and this gives a mottled effect in the fabric, especially if the core yarn does not dye to the same shade as the sheath fibers. Typical disclosures of the known core-spinning of elastic and non-elastic fibers include U.S. Patent 3,009,311 to Wang and U.S. Patents 3,017,740 and 3,038,295 to Humphreys.

In accordance with the present invention, there is provided core-spun yarn comprising a continuous filament elastic core having a sheath of inelastic staple fibers consisting of a blend of self-crimpable staple fibers and low strength, substantially non-self-crimpable staple fibers. This core-spun yarn is plied, with twist, with yarn spun from the same inelastic staple fibers to provide the novel composite yarn. The elastic filament is under tension while being core-spun and plied. Upon release of the tension, the elastic filament contracts and the sheath fibers bulk. Fabrics made from these yarns and finished in a manner to crimp the crimpable fibers are characterized by good bulk, good stretch and good pill resistance. Upon being subjected to boil-off or similar procedure, the crimpable filaments crimp to the characteristic helical form, while the low strength fibers essentially remain as

the surface fiber in the yarn. Hence the crimpable fibers provide bulk and the weak surface fibers impart pill resistance to the fabric.

The core-spun yarns of this invention are spun on conventional spinning equipment and typical equipment and spinning technology are described in U.S. Patents 3,009,311 to Wang and 3,017,740 and 3,038,295 to Humphreys, to which reference may be made. For purposes of this invention, the elastic filament during spinning is stretched between 3X and 5X and preferably 3.5X to 4.5X. The resulting core-spun yarn may be fed through a ring twister to wind-up on a bobbin.

The core-spun yarn is wound on the bobbin under the tension applied to stretch the elastic yarn. While on that bobbin or after winding to another bobbin at similar tension, the core-spun yarn is heat-set in a closed container by subjecting alternately to vacuum and the steam. The heat-setting under these conditions prevents appreciable sinking of the yarn when tension is removed and also limits the stretch of the yarn. Heating time should be 10 to 60 minutes at a temperature of 110° C. to 150° C.

After heat-setting, the core-spun yarn is plied, with twist, with another yarn, preferably one spun from the same roving as that used in the core-spun yarn. Plying serves to lower stretch-modulus and improve the aesthetics of fabrics knit or woven from the yarn as well as to increase the bulk and aid in keeping the elastic core fibers well covered.

The twist in the core-spun yarn may vary from about 10 to 15 turns per inch. The twist in the inelastic yarn should be in about the same range. Lower twist will result in weak yarns with excessive fuzzing in the fabric while higher twist will decrease bulk and fabric cover. The ply twist should be in the range of 5 to 8 turns per inch.

The twist in the core-spun yarn and in the inelastic yarn may be in the same direction and the ply twist in the opposite direction. This is the conventional method. However, some advantage, especially in the stability of the cover on the elastic core, has been found for spinning the core-spun yarn and the inelastic yarns in opposite directions and then twisting the plied yarn in the same direction as the core-spun yarn. This keeps the sheath fibers of the core-spun yarn tightly twisted about the elastic filaments making up the core. This will necessitate starting with less twist in the core-spun singles yarn to allow for the added twist in the ply.

Yarn according to this invention is shown in the attached drawing in which:

FIGURE 1 shows a yarn of inelastic sheath fibers and elastic core member; and

FIGURE 2 shows a plied yarn formed from a second yarn and the core-spun yarn of FIGURE 1.

In FIGURE 1 the elastic core member **10**, which is composed of spandex polymer, is provided with a sheath or covering **12** which is an inelastic yarn of a blend of bicomponent and low strength staple fibers. As core-spun, the yarn is under tension and is provided with twist. The novel yarn of the present invention is made with that core-spun yarn by plying it with a second yarn **14**, with twist, and is shown in FIGURE 2. The number **16** indicates the extending low strength fiber ends that contribute pill resistance in fabrics made from the present invention. Upon boil-off or similar treatment, the core member contracts while the bicomponent fibers in the yarn crimp. Since the low strength fiber, being of low draw ratio, has little to no shrinkability, it remains fixed thereby providing the surface or cover fibers **16** for the composite yarn.

As noted, yarns of the present invention are composed of a continuous elastic filament core, and inelastic staple

fibers consisting of self-crimpable staple fiber and low strength, relatively non-crimpable staple fibers. For the core component a segmented elastomer of the spandex type is employed. Spandex is the generic term for filaments composed of at least 85 percent of segmented polyurethane and is further characterized by having segments of high-melting crystalline polymer alternating with segments of low-melting amorphous polymer. Segmented elastomers of this type and processes for preparing them in filamentary form are described in U.S. Patents 2,813,775, 2,813,776, 2,929,800, 2,929,801 2,929,804, 2,953,839, 2,957,852, 3,097,192 3,077,006; in British Patent 779,054; and in French Patent 1,388,588 to which reference can be made for details.

The self-crimpable fiber employed in the blend from which the rovings are spun preferably is a bicomponent fiber. The preferred bicomponent is an acrylic fiber spun from two different polymer compositions in a side-by-side relationship along the length of the fiber. However, bicomponent polyamide or polyester fibers can likewise be used. Bicomponent fibers have spontaneous crimp, when heated or boiled off, because of a difference in shrinkage properties of the two polymer compositions distributed side-by-side along the length of the fiber. Technology for spinning such fibers is disclosed in U.S. Patents 2,931,091, 3,006,028, 3,038,235, 3,038,236, 3,038,237, 3,038,238, 3,038,239, 3,038,240, 3,039,173, 3,039,174, and 3,039,524. Crimpable fibers can also be made by the method of British Patent 760,179 to Halbig. As long as the difference in shrinkability exists, any two acrylic compositions can be employed and typical pairs of compositions that can be used are disclosed in the prior art.

The third fiber used in the present invention is a weak fiber. Homofiber acrylics are preferred and such can be obtained most conveniently by using a low draw ratio from about 1.3 to 2.5 in an otherwise conventional spinning procedure to give fibers with tenacities in the range of 0.80 to about 1.0 gram per denier (g.p.d). Polyamide fibers can be weakened chemically by means of hydrogen peroxide as taught in U.S. Patent 3,050,822 to Matray and Stine. Polyester fibers can be weakened by treatment with alkalies, glycols or by other means.

For reasons of dyeability, it is usually preferable to have the low strength fiber of the same general composition as the bicomponent fiber, but fibers of different compositions can be used to obtain cross-dyeing or tone-on-tone dyeings.

Example I

A bicomponent fiber is spun from two different polymer compositions as follows (parts by weight):

	Parts
Composition I:	
Acrylonitrile	93.6
Methyl acrylate	6.0
Sodium styrenesulfonate	0.4
Composition II:	
Acrylonitrile	96
Sodium styrenesulfonate	4

The bicomponent fiber is spun by the method disclosed in U. S. Patent 2,988,420 of Ryan and Tichenor. The resulting fibers have the two polymer compositions side-by-side along the length of the fibers. After spinning, the fibers are washed in hot water and stretched (drawn) 4.5X to orient the polymer molecules. Ribbons of fibers from several spinning machines are combined to give a tow of 470,000 denier made up of filaments of 3 denier. This tow is put through a Pacific Converted to cut the tow into 4.5 inch length staple in the form of a sliver.

A homofiber is spun from the following polymer composition in parts by weight, dissolved in dimethyl formamide.

	Parts
Acrylonitrile	93.6
Methyl acrylate	6.0
Sodium styrenesulfonate	0.4

The fibers are washed in hot water and drawn 1.35X, then passed through a stuffer-box crimper, and finally dried. A tow of this fiber of 470,000 denier and 4.1 denier per filament is likewise processed on a Pacific Converter to a sliver of 4.5 inch staple fiber.

Three slivers of this homofiber are combined with one sliver of the bicomponent fiber and the combined slivers are pin drafted to yield a final sliver of 60 grains per yard (4 grams/meter) weight. This sliver is then spun on a roving frame to a 1.0 hank (142 denier) roving.

This roving is next core-spun with a continuous filament 40 denier yarn of a spandex fiber made according to French Patent 1,388,558. In feeding the spandex, it is stretched 3.5X and the core-spun yarn is twisted 13 t.p.i. Z. The final yarn has a 1/40 Worsted Count (W.C.) This core-spun yarn is wound on a perforated bobbin without allowing it to relax from its spinning tension, and is heat-set in a steam chamber at 118° C. for 45 minutes after first evacuating the chamber.

A non-elastic fiber yarn is spun from a roving of the blended bicomponent fiber and homofiber. This yarn has a worsted count of 1/37 and 12 t.p.i. Z twist. It is plied with the above core-spun yarn with 6 t.p.i. S twist.

A fabric with a jersey stitch is knit from this plied yarn using a 12-cut Jacquard TA–4 knitting machine. After the fabric is boiled-off, it has a count of 28 courses and 16 wales per inch. The stretch for the lengthwise direction of the fabric is found to be 160% and that in the width direction 200%. These figures are determined by a conventional test involving stretching the fabric by hand to a point where further stretch becomes difficult and measuring the stretch with a rule. When the fabrics are washed at 60° C. and dried, it is found that there is no change in either of the dimensions of the fabric.

Seven sweaters knit from the plied yarn are worn for 200 hours each to determine pilling resistance. The results are shown in Table I below. In this test a rating of 3 or above is satisfactory. The ratings are based upon the number of pills per inch at different periods of testing.

TABLE I

Sweater No.	25 Hours	100 Hours	150 Hours	200 Hours
1	4.0	3.8	3.5	4.0
2	3.9	3.9	3.9	----
3	4.0	4.0	4.0	4.0
4	3.8	3.7	3.3	3.0
5	3.8	3.9	3.8	3.7
6	4.0	3.8	3.9	4.0
7	4.0	3.8	3.8	3.8
Average	3.9	3.7	3.6	3.7

This rating is considered excellent. Sweaters similarly knit from plied yarns in which the inelastic fibers are not self-crimping and which do not include weak fibers give pilling values below 2 and are not satisfactory for commercial production.

From the foregoing discussion and description, it is apparent that this is a novel and highly effective discovery in composite yarns. While the invention has been described by use of certain details, it will be apparent that changes can be made without departing from its scope. For example, the rovings in the example may be made varying the relative amounts of the two fibers from the 3 to 1 weight ratio given. Similarly, a substantial ratio of elastic to non-elastic components can be used, but a preferred product generally contains 3 to 15 percent of the elastic filaments, depending on the worsted count of the yarn produced and the denier of the spandex employed. In addition the various fibers can be of any conventional textile denier. Variations in elasticity and bulking can be made by varying the heat-setting conditions. Other changes will occur to those skilled in the art.

What is claimed is:

1. A high-bulk, elastic composite yarn comprising an initially stretched, straight, uncrimped elastic continuous filament of a segmented elastomer and a sheath consisting of at least two inelastic staple fibers helically sur-

rounding the filament, the sheath fibers being in engagement through the length thereof with the stretched filament and free of adhesion thereto, said sheath being composed of a blend of a low strength staple homofiber and a self-crimpable bicomponent staple fiber, and a second yarn of substantially the same composition as said sheath plied with said sheath-core yarn to provide a composite yarn.

2. A yarn in accordance with claim 1 in which said staple fibers are acrylic fibers.

3. A yarn in accordance with claim 2 in which the bicomponent fiber is a side-by-side bicomponent fiber of an acrylic terpolymer and an acrylic copolymer, and the low strength fiber is a homofiber acrylic staple.

4. A method comprising core-spinning uncrimped, stretched continuous filament of a segmented elastomer and a sheath of inelastic staple fibers consisting of self-crimpable staple fiber and low strength non-crimpable staple fiber, heat setting the resulting core-spun yarn under substantially the tension of its formation, and plying the heat-set core-spun yarn with a second yarn of said inelastic staple fibers to produce a composite yarn.

5. A method in accordance with claim 4 in which each of said sheath and second yarn is composed of about

25 percent of a bicomponent staple acrylic fiber and about 75 percent of low strength homofiber acrylic staple.

6. The method of claim 5 in which the inelastic fibers are twisted in a first direction, the core-spun yarn is twisted in the opposite direction of said inelastic fibers, and said second yarn is plied with said core-spun yarn with twist in the same direction as that of the core-spun yarn.

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FRANK J. COHEN, *Primary Examiner.*

W. H. SCHROEDER, *Assistant Examiner.*