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PRODUCTION OF ELASTIC STRETCH YARNS

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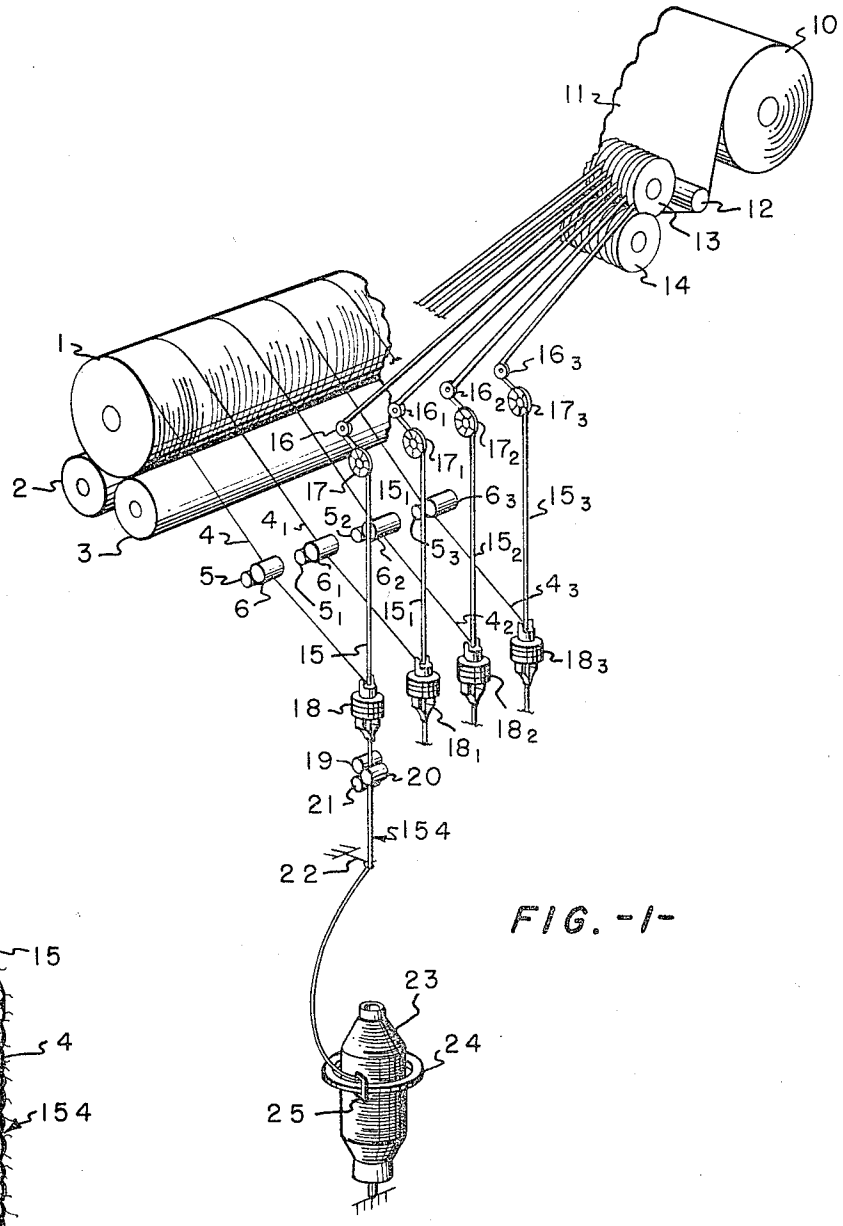


FIG. -1-

FIG. -2-

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PRODUCTION OF ELASTIC STRETCH YARNS

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This invention relates to the art of producing composite elastic stretch yarns. In particular, it relates to a method for producing lightweight bulky yarns with superior insulating characteristics, as well as to the product so produced.

Yarns having high moisture absorption, superior insulating properties for protection against the elements, good cushioning effect as a bulwark against shock, stretch for comfort and for resistance to deformations, textures which do not feel cold or clammy to the touch or which do not irritate or abrade are illustrative of textile properties eagerly sought by yarn manufactures. Few yarns, however, possess all of these characteristics or, if they do, such characteristics are exhibited only in varying degrees. Wool, for example, is an outstanding textile fiber. Wool yarn possesses all of these properties to some extent and for this reason, it has maintained a position of eminence among textile fibers for centuries. Thus, e.g. socks knitted of wool yarn provide a wearer with dry feet because of wool's natural ability to absorb moisture. Such woolen socks also provide a highly desirable cushioning effect because of the considerable bulkiness and resilience of wool, and also, the wool does not irritate or abrade.

Synthetic fibers, despite significant strides made in past years, are by and large deficient in the aforesaid properties and even where treated or otherwise processed to give some of these desirable characteristics, they nevertheless do not possess such characteristics in the desired degree. For example, essentially all synthetic fibers are by and large grossly lacking in their ability to absorb moisture. Certainly e.g., their ability in this regard, however treated or processed, falls far below that of wool. Moreover, none of the synthetic fibers are naturally crimped and even when artificially crimped to produce bulkiness and elasticity they do not possess such characteristics in the degree desired.

Whatever the nature of the textile fiber used in the making of a yarn today, however, there are many situations wherein greater bulk, especially bulk with light weight, is extremely desirable. Greater insulating value in a finished garment for locking in air for warmth, and for windbreaking characteristics, is, for example, a very basic need and any improvements in these directions will certainly have far reaching implications.

Efforts have been made in limited instances by workers of the art to produce materials of these various characteristics including great bulk with corresponding light weight. Fabrics have even been impregnated e.g. with rubber-like foams to produce conventional underpaddings, as for carpets. Rubber-like foams have even been sparsely wrapped with fibrous strands and strips of foams have even been woven into fabrics by interlacing of these strips with the fiber yarns. Such products, however, are entirely unsuitable for use as fine fabrics and for wearing apparel.

Providing yarns possessing the foregoing good qualities especially high bulk with corresponding light weight would represent a very desirable contribution to the art and a significant step toward, and is indeed the primary objective of the invention, as well as providing a novel method for the production of such yarns. More particularly it is an object to provide high bulk yarn constructions which, though of very light weight, possess fiber characteristics. More specifically, it is an object to provide such yarn constructions suitable for use in the production of fabrics.

These objects, and others, are achieved in accordance with this invention which provides bulky elastic composite yarns, these comprising a continuous filament flexible cellular plastic foam which constitutes the core and around which is provided a substantially continuous sheath composed essentially of substantially inextensible textile fibers or non-elastic staple yarns.

Suitably, such core is constituted of a single continuous strand of flexible plastic foam with cross sectional area ranging from about 0.015 to about 0.25 square inch, or more preferably from about 0.015 to about 0.065 square inch, and which foam is honeycombed with from about at least 60 to about 95 cells per linear inch, and preferably from about 70 to about 85 cells per linear inch, said foam in any instance having a specific gravity of from about 1 to about 3 pounds per cubic foot, and more preferably from about 1.5 to about 2.3 pounds per cubic foot.

These novel elastic composite yarns provide, in particular, tremendous bulk and extremely high insulating properties even though of very light weight. But moreover, these yarns provide essentially all of the normally desired properties of a textile yarn and for this reason are highly desirable for textile and apparel usages. Thus, the non-textile core provides tremendous bulk, unusual insulating, resiliency and cushioning properties but yet from all general outward manifestations such composite yarns have the appearance and properties of ordinary textile yarns. The composite yarns can thus be generally finished and woven, knitted, braided or otherwise processed as other ordinary textile yarns. These yarns, however, do provide very unusual properties not normally possessed by other yarns and for this reason the present invention gives rise to a whole new family of textile yarns of outstanding properties. The implications of this discovery are profound and that relatively large non-linear, non-textile cellular materials could be used for yarn constructions is indeed surprising. In fact, it appears that the spinning and formation of these novel composite yarns is practical only by observance of a series of interlocking conditions and variations as contemplated within the scope of the novel method of this invention.

Exemplary of materials suitable for providing such plastic foams are the rubber elastomers such as the natural rubber latexes and the synthetic foam rubbers such as polyvinylnitrile, rubber hydrochloride and the like, and including elastomeric materials as the flexible vinyl foams, e.g., polyvinylchloride foams or copolymers thereof such as polyvinylchloride copolymerized with polyvinylacetate or with polyvinylidene chloride, foams of polyvinylalcohol, cellular polyethylene and foams of related compounds such as polytetrafluroethylene, polychlorotrifluroethylene, and the like.

A superior composite yarn product is one constituted of a core of polyurethane foam, whether polyester or polyether. Yarn composites constituted in part of polyurethane foams are found to provide excellent stretch properties, excellent properties of insulation and high bulkiness and is substantially inert to many climatic conditions and can even be cleaned with normally used dry cleaning solvents. A particularly outstanding yarn composite of this type is one wherein wool, or a mixture of wool and other fibers, especially synthetic fibers, is spun about the cellular polyurethane strand. Such composite yarn provides excellent properties including not only great bulkiness and superior insulation properties, but also the outstanding properties of the wool.

Other outstanding yarn products however include those

formed of a cellular polyurethane core covered with synthetic textile fibers. Such yarn composites thus provide desirable properties especially that of tremendous bulk with light weight, this property being completely alien to most synthetic fibers, especially unless they are specially post treated or processed. In addition, composite yarns of various types can be formed which possess good qualities of moisture absorption even though the covering synthetic textile fiber per se would not normally possess such characteristics.

To produce such yarns in accordance with the present method a flexible plastic cellular foam strand or core is tensioned under a force sufficient to produce an elongation of the strand of at least about 140 percent, and preferably from about 140 to about 300 percent while a substantially non-elastic staple yarn is spun thereabout. Best results are obtained when the core is elongated no greater than about 200 percent. When elongation is less than about 140 percent there is no spin-covering produced and the core and fibrous covering are merely plied together and poor coverage of the core results. On the other hand where elongation is too great the yarn may knot and pile up. Moreover, in this instance bulk is significantly reduced and the elastic power for assisting in coverage of the core is adversely affected to an undesirable extent. In addition the surface of the foam is abraded.

In spin covering the core it is found necessary to provide sufficient differential tension upon the core and the fibrous covering so that the core goes to and remains at the center of the composite yarn and becomes properly covered. It is found that sufficient differential tension is provided if the cellular plastic core is elongated within the ranges specified and if the tension upon the non-elastic covering during spinning is significantly less than that applied upon the core. Generally the only tension that need be applied on the non-elastic covering is only sufficient force to carry the covering around the core.

It has been found that a weight ratio of non-elastic fiber: foam of from about 0.7:1 to about 1.5:1 provides best results. Oddly enough, as the weight ratio of non-elastic fibrous material:foam increases above this amount, proper coverage becomes more difficult to obtain and, in fact, segments and streaks of the core begin to show through. Thus, for a one run wool yarn used in covering a strand of polyurethane foam, 0.015 square inch in initial cross sectional diameter drawn to a draft of 2.4 it has been found that excellent results are obtained employing about five twists, or turns of fiber about the foam, per inch. However, even under otherwise identical conditions, as the number of twists per inch are increased above about eight turns per inch the quality of the yarn product becomes unacceptable and the core shows through the covering as spots and streaks. The reasons for this are not fully understood inasmuch as one would normally expect to obtain better coverage as the weight ratio of wool-to-foam is increased. Generally, it is found, however, that from about three to about seven twists per inch under the described conditions has been found to provide excellent yarns having all the external characteristics of a woolen yarn though yet possessing tremendous bulk with light weight.

Upon drafting of the foam core and spin covering it as described, upon release of tension the plastic foam strand recovers, at least to sufficient extent, its original unextended length at which time the coils of the convoluted fibrous material or yarn constituting the covering are pulled together and the coils impinge one against the other to substantially completely cover the core. The yarn so formed can then be woven, knitted, braided or otherwise made into fabrics.

This invention will be better understood by reference to the following detailed description and to the accompanying schematic drawings illustrating preferred embodiments.

In the drawing:

FIGURE 1 provides a schematic representation of the pertinent portions of an apparatus for carrying out the method and for forming the novel yarn products and

FIGURE 2 represents schematically a portion of a typical yarn product (not to scale) of this invention.

In the drawings whole numbers with subscripts refer to duplicated members, and the corresponding whole numbers without subscripts can refer to any one or all of the same members in a generic sense.

In the production of the composite yarns as shown in FIGURE 1 a sheet of flexible cellular plastic foam **11**, from supply roll **10** is passed about guide roller **12** and directed through a slitting device, e.g. such as those used in slitting paper, which device includes a pair of cutting rolls or members **13, 14**. These cutting members **13, 14** are provided with a series of consecutive parallel spaced sharp disc-shaped coacting rotary knives or blades which slit the plastic cellular foam into strands **15**, 15_1, 15_2, 15_3 of desired width. These discs, cut or slit by scissor action produced by the individual action of pairs of blades on opposite members **13, 14**. These strands **15** are individually directed about rollers **16**, 16_1, 16_2, 16_3, respectively, over feed wheels, **17**, 17_1, 17_2, 17_3 respectively, and then downwardly through the twister tubes **18**, 18_1, 18_2, 18_3, respectively.

Non-elastic individual yarns **4**, 4_1, 4_2, 4_3 are suppled from the jack spool **1** by rotation of this member by driving rolls **2, 3** and passed through guide or delivery rolls **5, 6** thence to twister tube **18**, 18_1, 18_2, 18_3, respectively, and thence through drafting rolls **19, 20, 21** only one set of which is shown. The latter drafting rolls **19, 20, 21** are driven at a rate of speed greater than that of the guide rolls **5, 6** to effect drafting of the yarn **4**; and therefore drafting is performed between and by the action of a pair of rolls **5, 6** and the drafting rolls **19, 20, 21**. Twister tube **18** holds the yarn so that as the tube **18** revolves "false" twist is imparted to the yarn **4** during the drafting operation.

Upon exit of yarn **4** and strand **15** from the nips of rollers **19, 20, 21** composite yarn **154**, schematically shown in FIGURE 2, is formed. In forming composite yarn **154**, twist is applied and yarn **4** is carried about the tensioned strand **15** by movement of the traveler ring **25** upon ring **24** about bobbin **23**, while the ring **24** is reciprocated vertically the length of bobbin **23**, this arrangement constituting a ring or flyer system. Upon emergence of the composite yarn **154** from the pigtail guide **22** tension can be relaxed and the composite yarn wrapped about bobbin **23**.

The novel products of this invention are made possible by the discovery that certain flexible plastic cellular foams if provided in strands having certain critical cross sectional areas and cellular characteristics can be covered with substantially non-elastic staple yarns, especially with wool and mixtures which include wool whereby substantially complete coverage of the core is provided.

The novel yarns of this invention can be woven, knitted, braided or otherwise made into fabrics of various types for use in covering a variety of purposes such as upholstery, knit wear, swim wear, coats, waist bands, socks, sock tops, and other apparel and industrial fabrics of the like. An important attribute of this invention however is that it provides novel yarns and fabrics which have a combination of high bulk, high stretch and high power characteristics which, nevertheless, have essentially all of the desirable characteristics of the textile staple fiber of which the composite is only partially composed.

The degree of bulk and elasticity of the composite yarn can be controlled to some extent by varying the percentages of textile filaments and the flexible cellular plastic foams, and also by the amount of twist applied upon combining these materials.

It is apparent that changes in variation can be made in the present novel yarn composite as well as in the method of their manufacture without departing the spirit and scope of the invention.

Having described the invention what is claimed is:

1. As an article of manufacture, a composite yarn suitable for knitting, weaving or for otherwise being made into fabric comprising a substantially non-elastic textile staple fibrous material which is spun about and substantially helically covers a core consisting essentially of a continuous stand of a flexible cellular plastic foam having from about 60 to about 95 cells per linear inch and a specific gravity ranging from about 1 to about 3.

2. The article of manufacture according to claim 1 wherein the non-elastic staple fibrous material comprises wool.

3. The article of manufacture according to claim 1 wherein the core comprises a cellular polyurethane foam.

4. The article of manufacture according to claim 1 wherein the core comprises a foam having from about 70 to about 85 cells per linear inch.

5. As an article of manufacture, a composite yarn suitable for knitting, weaving or for otherwise being made into fabric comprising wool spun at from about 3 to about 8 twists per inch helically about a continuous

strand of flexible cellular polyurethane foam having from about 60 to about 95 cells per linear inch and a specific gravity ranging from about 1 to about 3 and wherein the weight ratio of wool:foam ranges from about 0.7:1 to about 1.5:1.

6. The article of manufacture according to claim 5 wherein the core is comprised of a foam having about 70 to about 85 cells per linear inch.

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