Sept. 17, 1968 H. M. BLANCHETTE 3,402,096

VARIABLE BULK CONTINUOUS FILAMENT YARN

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FIG. 1.

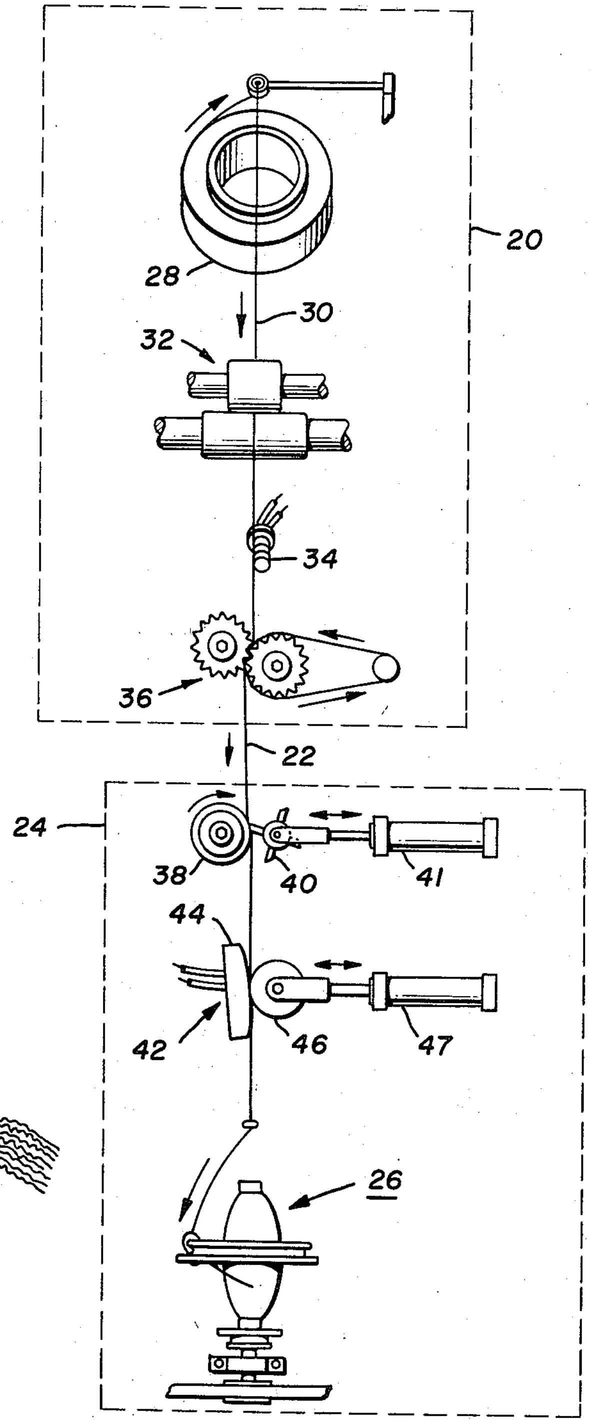
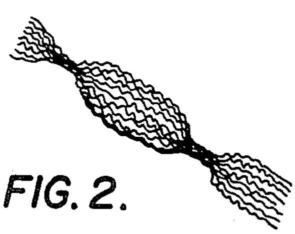


FIG. 2.



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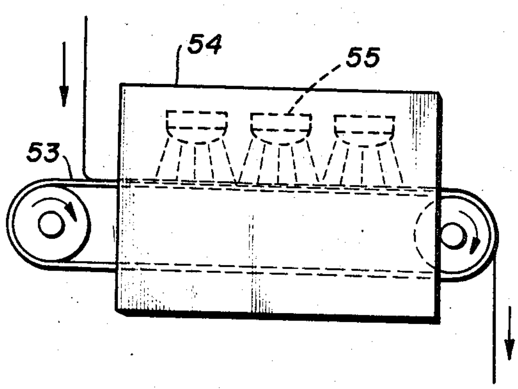

FIG. 3.

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VARIABLE BULK CONTINUOUS FILAMENT YARN

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Continuation-in-part of applications Ser. No. 281,396, Ser. No. 281,397, and Ser. No. 281,398, May 20, 1963. This application Apr. 13, 1967, Ser. No. 630,732
3 Claims. (Cl. 161—173)

ABSTRACT OF THE DISCLOSURE

An intermittently textured multi-continuous filament yarn made of a synthetic thermoplastic polymer is provided. The yarn is characterized by having a plurality of intermittently spaced regions wherein the filaments are fused together to form a compact threadline. The yarn exhibits a bulky character in the regions between the fused regions.

Cross references to related applications

The present application is a continuation-in-part application of applications Ser. Nos. 281,396–8, filed May 20, 1963, and now abandoned.

Background of the invention

There is a substantial market for novelty type yarns, i.e., those in which the properties or appearance of the yarn vary to some extent along the yarn axis. Such yarns are used in the manufacture of rugs, sweaters, etc., to give interesting and attractive surface effects. Typical novelty yarns include slubbed yarns, those having variable dyeing properties, variable sparkle, etc.

There are several well known types of crimped or textured yarns which provide a substantial increase in bulk as compared to the unbulked yarn. This increased bulk lends substantially greater degrees of desirable properties such as improved hand, insulating power, covering power, and in general, properties which more closely approximate those of known natural fibers. Such textured yarns have found widespread market acceptance in several applications and have proven to be superior to natural fibers in many applications. Textured yarns are produced, for example, by introducing crimps along a continuous man-made filamentary threadline. Other known methods for producing textured yarns include the conjugate spinning process wherein the filaments are composite and include parallel or eccentric components of different polymers bonded together, the components having different properties whereby upon treatment one of the components will shrink more than another. This introduces a crimp to the individual filaments and bulks the yarn.

Previous attempts to provide variable bulking along the length of a single yarn have included intermittently crimping, and the introduction of some uncrimped filaments. In accordance with a prior art procedure for providing a thick and thin filamentary yarn resulting from differential bulking, spaced lengths of highly twisted heat set yarn are detwisted with the portions of the yarn disposed between these spaced lengths remaining in a relatively highly twisted condition such that they contain at least 20 turns of twist per inch. However, such procedure is slow and expensive because of the required high twist.

Summary of the invention

In accordance with the invention a particular substantially untwisted multifilament yarn made of a synthetic thermoplastic polymer is provided. A substantially increased novelty effect is produced by thermochemically bonding together the several filaments in a threadline at intermittently spaced intervals either before or after the yarn is crimp textured. In the resulting fused regions, the yarn exhibits substantially no bulk and has a small apparent diameter, in sharp contrast to the unbonded bulky regions.

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Description of the drawing

For a more complete understanding of the nature and objects of the invention, reference should be made to the following detailed description taken in connection with the accompanying drawing, in which:

FIGURE 1 is a schematic front elevation view of exemplary apparatus for producing yarn according to the present invention;

FIGURE 2 is a perspective view of a portion of the novelty yarn produced by the present invention; and

FIGURE 3 is a schematic view of apparatus for more fully developing crimp in the yarn.

With reference now to FIGURE 1, it will be noted that the apparatus includes a source **20** of textured yarn **22** which is supplied to the bonding apparatus **24**, after which the yarn is taken up on suitable take-up means **26**. In the bonding apparatus **24**, spaced portions along the yarn are treated with a bonding agent, which is then cured. The yarn is heat treated in apparatus of FIGURE 3 to produce the intermittent crimp bulked product schematically illustrated in FIGURE 2.

The source **20** from which the textured yarn is provided is schematically illustrated as the apparatus more fully described in the U.S. Patent 3,024,516 to J. E. Bromley et al., and accordingly will not be described in detail. Other sources of textured yarn may be substituted for the crimping apparatus illustrated, and may include sources of conjugate spun yarn or yarn which is crimped by other means. Briefly stated, the illustrated source **20** includes a bobbin **28** of parallel substantially untwisted continuous filaments which serves as a source of uncrimped yarn **30**. Yarn **30** is withdrawn from bobbin **28** and passes through a cot roll assembly **32**. Yarn **30** next passes over a heated draw pin **34** and then a plurality of turns around a crimping assembly **36**, which includes meshing gears through which the threadline is passed. The resulting yarn **22** is provided with crimps which become more fully developed by permitting the yarn to relax. The rate of development of the crimp is greatly increased at elevated temperatures of 100° C. and above.

According to the present invention, this textured yarn **22** is next intermittently coated with a suitable agent for bonding or fusing the several filaments thereof into a compact bundle. As illustrated, yarn **22** passes adjacent to a conventional applicator roll **38**, which serves as a source of supply for the bonding agent. Roll **38** may be partly immersed in a reservoir of bonding agent so that the roll periphery is kept wet. Normally yarn **22** is not in contact with applicator roll **38**, which is positioned laterally spaced a small distance from the axis of the yarn. An intermittently actuable pressure roll **40** is provided on the opposite side of yarn **22** from roll **38** for intermittently pressing the threadline against the wetted periphery of applicator roll **38**, and is laterally moved into or out of contact with yarn **22** by hydraulic cylinder **41**. This mechanism provides for treating spaced portions along yarn **30** with the bonding agent while the intermediate portions remain dry and untreated. Pressure roll **40** may be actuated by any suitable control means, and may be actuated at either a regular or irregular rate. Suitable apparatus for producing this intermittent action of roll **40** is disclosed in U.S. Patent 3,299,780, wherein electrical signals produced by a special circuit controls the fluid fed from a fluid source to a cylinder, similar to hydraulic cylinder **41**.

The yarn **22** next passes through a heating region **42**, which as illustrated includes a heated plate **44**, which cures the bonding agent and fuses the several filaments together in the treated regions. Heating region 42 will preferably extend over a sufficient distance to insure that the thermo-chemical bonding agent is completely dried before yarn **22** is taken up on the take-up apparatus **26**. Suitable agents for bonding specific synthetic polymer threadlines are more fully described below, and can be conveniently applied to threadline **22** in a variety of ways other than with the applicator roll **38** and pressure roll **40** as illustrated. The compounds may be sprayed, brushed, rolled, patted or applied in other similar ways, so long as suitable means are provided to insure intermittent application thereof.

It is necessary that the threadline pick up an amount of the bonding agent sufficient to effect a reasonably strong coherency between the filaments. The amount of the bonding agent applied to the bundle of filaments prior to heating in heating assembly **42** can be varied to the relatively broad limits depending on thickness and width of the structure, the material and characteristics of the particular polymer filaments employed, the individual properties of the bonding agent employed, the physical properties desired in the final product, etc. Within the broader aspects of the invention from about 5–80 weight percent bonding agent can be added on a dry basis.

As above indicated the wetted regions are heated in order to set the bonding agent and effectuate a strong cohesion among the filaments. Heating of the filaments is feasible by means of radiation, convection, or conduction. Preferably the bundle of filaments is heated by direct contact with a heated surface in order to improve the heat transfer to the threadline and promote rapid filamentary fusion. In this heating step the temperature of the threadline is preferably raised to about 50–250° C., preferably 50–150° C., this being well below the melting point of the filaments. Advantageously the threadline is positively pressed against the heated surface, as by a roller **46**. Roller **46** may be actuated in synchronism with the intermittent application of the bonding agent so as to urge threadline **22** into contact with heated plate 44 only when a wetted portion of threadline **22** would contact plate **44**. Suitable mechanisms for intermittently actuating roller **46** are well known in the mechanical arts, such as hydraulic cylinder **47**, and accordingly will not be specifically described. However, apparatus disclosed in U.S. Patent 3,299,780 mentioned above can be used to produce controlled intermittent action of roller **46**. Pressure of about one-half to 100 pounds per square inch is satisfactory, although any pressure is suitable that will insure that the several filaments lie closely adjacent during the heating process to insure compactness in the bonded regions. Prudent selection of optimum conditions is not difficult.

After the heating step, the threadline is cooled prior to any further operation that would undesirably disturb the individual filaments of which the bonded structure is composed. The cooling may be quickly accomplished by directly applying a coolant thereto. However, merely allowing the threadline to reach equilibrium at room temperature is quite satisfactory.

If roller **46** is not disengaged when dry portions of the threadline pass adjacent to the heated plate 44, there will be a tendency to bulk the unbulked regions of the threadline. It would be desirable in such a case to maintain the tension in the heating region sufficiently low that the developed crimp is not destroyed. For this reason it is normally preferable to remove threadline **22** from direct contact with the heated plate **44** except when the wetted portions of the threadline are in contact with plate **44**, such as by withdrawing roller **46**. This permits substantially higher tensions to be employed in this region without destroying the crimp in the unwetted yarn regions, which facilitates rapid processing of the yarn.

It should be particularly noted that the yarn treated according to the present invention may have crimps which may or may not have been fully developed prior to bonding or that the crimping may be performed after the intermittent bonding.

In FIGURE 3 apparatus is shown for more fully developing the crimp in the yarn imparted by the crimping assembly of FIGURE 1. The yarn is subjected to a dry heat treatment in a relaxed condition. Obviously, the heat treatment also can be accomplished with a hot aqueous medium such as steam or by a combination of dry and wet heat. As shown, the yarn either before or after being bonded with apparatus 24 is directed onto a conveying belt **53** which carries the yarn through a heated zone provided by cabinet **54** having a radiant heat applicator means **55**, such as an array of heating lamps, thus more fully developing the crimpiness in the yarn. Of course, other arrangements can be employed for subjecting the yarn to elevated temperatures while under little or no tension.

The present invention is applicable to a wide variety of synthetic continuous filament yarns. The yarn is made from thermoplastic fiber-forming resins and can be extended by drawing and then show increased molecular orientation along the axis thereof. The yarn may be formed from these resins by known techniques, including melt extrusion, wet spinning and dry spinning. As examples of the fiber-forming synthetic polymers the following may be mentioned: polyethylene; polypropylene; polyurethanes; copolymers of vinyl acetate and vinyl chloride; the copolymers of vinylidene chloride and a minor proportion of mono-olefinic compounds copolymerizable therewith, such as vinyl chloride, homopolymers of acrylonitrile, copolymers of acrylonitrile and a minor proportion of at least one mono-olefins compound copolymerized therewith and polymer blends containing polymerized acrylonitrile in a major proportion; copolymers of vinyl chloride and acrylonitrile; linear polyesters of aromatic dicarboxylic acids and dihydric compounds, such as polyethylene terephthalate; linear polycarbonamides such as nylon-66, nylon-6, nylon-4, nylon-7, nylon-610 and other fiber-forming copolymers, e.g., 6/66, 6/610/66, 66/610, etc.

Filaments having a normal cross section such as that obtained using a circular spinning orifice during filament formation can be treated. However, multi-lobal yarn and yarn having axial passages can likewise be treated in accordance with the present process.

Yarn having some minor amount of twist can be processed. However, it is preferred to start with a source of yarn having zero twist, since an advantage of the present invention is that high twist is not required, and should be avoided. The total denier of the yarn can vary as well as the denier of the individual filaments, the ordinary deniers of commercially available yarns being completely suitable.

The bonding agents are active so as to soften portions of the yarn and to render the same stickable at the temperatures employed. The solvents can be composed of an active substance normally solid at room temperature but readily dissolvable in an inert volatile diluent to form a single phase liquid. When the portions of the yarn carrying the solvents are heated, the diluent flashes therefrom and the action of the active substance is dissipated. Specific solvents will be selected with regard to the type of yarns being processed.

For treating nylon yarns, solutions of multi-hydroxybenzenes have been found to be effective solvents. Dihydroxybenzene compounds which can be employed as the active substance in the solvents include resorcinol, hydroquinone and pyrocatechol. A trihydroxybenzene, for example, is pyrogallol. The multi-hydroxybenzenes are not limited to the foregoing specific compounds since derivatives thereof can also be used to effect cohesion and the stabilization of the yarn. The preferred procedure is to dissolve the compounds in a suitable inert diluent. Dihydroxybenzenes and trihydroxybenzenes are readily soluble in water, common alcohols (methanol, ethanol, etc.) and common ethers (dimethyl ether, diethyl ether, etc.). It has been found that a preferred procedure involves dissolving a predetermined amount of the benzene compound in water or methanol. An aqueous or methanolic solution containing about 5–80 percent dihydroxybenzene or trihydroxybenzene on a weight basis gives good results. The preferred concentration is 30–40 weight percent. The concentration of the active substance in the evanescent solvent will depend on many factors, such as the characteristics of the particular substance employed, the amount of liquid placed on the nylon yarn, the polymeric structure of the yarns, etc.

Another effective solvent for use in treating nylon yarns is molten chloral hydrate or a solution thereof. Chloral hydrate is also readily soluble in water, common alcohols (methanol, ethanol, etc.) and common ethers (dimethyl ether, diethyl ether, etc.). A preferred procedure involves dissolving a predetermined amount of chloral hydrate in water or methanol. An aqueous or methanolic solution containing about 25–90 weight percent chloral hydrate gives good results. The preferred concentration of chloral hydrate in solution is 40–85 weight percent.

For treating acrylic filament yarns (i.e., yarn in which the fiber-forming polymeric substance is a long chain synthetic polymer composed of about 85 percent or more by weight of polymerized acrylonitrile units) solutions of aliphatic cyclic carbonates are effective solvents. These carbonates can be selected from the group of the cyclic carbonates of 1,2-; 2,3-; and 1,3-dihydric aliphatic alcohols. Such aliphatic cyclic carbonates include ethylene carbonate, propylene carbonate, trimethylene carbonate, 1,2-butylene carbonate, 1,3-butylene carbonate, 2,3-butylene carbonate, isobutylene carbonate and mixtures thereof. Especially useful of the foregoing group is ethylene carbonate. An aqueous solution containing about 5–80 percent aliphatic cyclic carbonate on a weight basis gives good results. The preferred concentration of aliphatic cyclic carbonate is 40–60 weight percent.

From the above description and the accompanying drawing it is apparent that there has been provided a novelty yarn having variable bulking, together with a process and apparatus for producing such yarn. The novel steps of wetting intermittent portions of the yarn with a bond-inducing compound, either alone or in solution, and then curing the bonding agent provides a method which is applicable broadly to various types of crimped or bulked yarn.

The process may be applied either before or after the latent crimps are induced in the threadline, thus affording great flexibility in adapting the present apparatus and processes to produce variable bulked yarn. The intermittent application of the bonding agent and the subsequent curing of the bonding agent provide for restraining the yarn against bulking in axially spaced regions along the yarn, which may be regularly or irregularly spaced to provide various novelty effects.

In addition, the preferred intermittent synchronized application of the curing heat only to the regions wetted with bonding agent permits the use of relatively high tension throughout the process without either bulking or destroying the crimp in the unbonded regions.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An intermittently textured yarn comprised of a plurality of continuous untwisted filaments of a synthetic thermoplastic polymer, said yarn being characterized by:

(a) having all the filaments across the cross section of said yarn fused together in each of a plurality of intermittently spaced apart regions along the length of said yarn to form a compact thread line at said regions; and

(b) the filaments of said yarn being crimped between the spaced fused regions and unbonded between said regions to any adjacent filament, whereby a yarn is formed having variable bulking along the length thereof.

2. The intermittent textured yarn defined in claim **1** wherein the polymer composing said yarn is nylon.

3. The intermittent textured yarn defined in claim **1** wherein the polymer composing said yarn is an acrylonitrile polymer.

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