March 9, 1943. C. S. FRANCIS, JR 2,313,058

TEXTILE PRODUCT AND METHOD OF MAKING THE SAME

Filed July 17, 1941

Fig. 1.

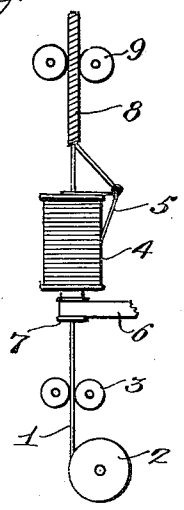


Fig. 2

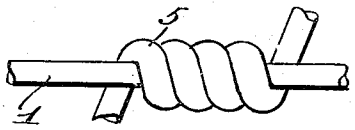


Fig. 3.

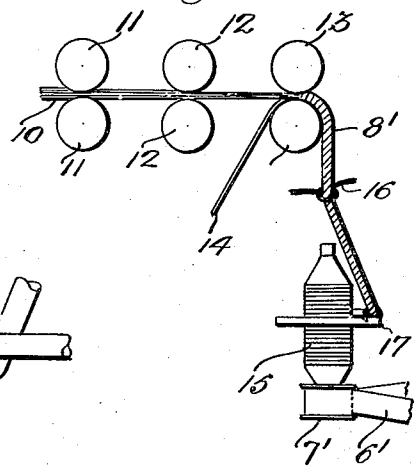


Fig. 4.

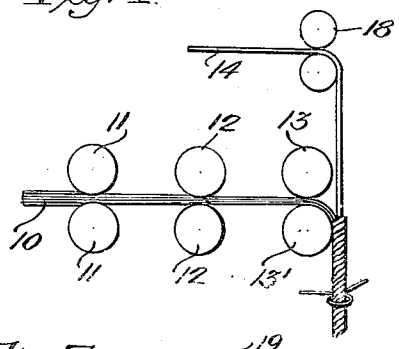


Fig. 5.

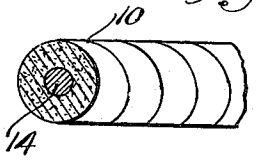


Fig. 6

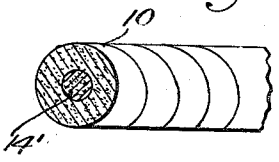


Fig. 7

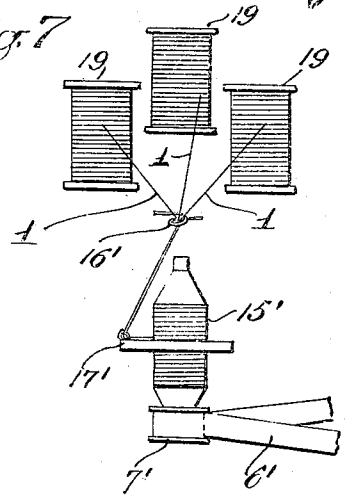
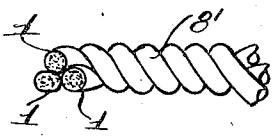


Fig. 8.



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by his Attorneys.
Howson & Howson

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2,313,058

UNITED STATES PATENT OFFICE

2,313,058

TEXTILE PRODUCT AND METHOD OF MAKING THE SAME

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Application July 17, 1941, Serial No. 402,812

23 Claims. (Cl. 57—140)

This invention relates in general to textiles and in particular to a yarn and to a process for its production, and to correlated improvements designed to enhance the quality, structure and properties of textiles so as to extend their uses. This application is a continuation-in-part of my copending application Serial No. 157,018 filed August 2, 1937, now Patent No. 2,253,000.

It is frequently desirable to modify the natural properties of textiles so as to improve certain characteristics, and adapt the textile to other uses. Heretofore attempts to modify flexibility, permeability, resistance to abrasion and laundering, shrinkage, stretching, untwisting, unravelling and the like have consisted in applying an external coat to the yarn or thread. While this has attained some of the objects, nevertheless such compositions have adversely affected or destroyed desired features as appearance, texture, surface absorptivity and handle. Further, the textile no longer appeared to be the same material, and it was difficult, at times even impracticable, to dye, print, and carry out other finishing operations. These methods are all "surface altering processes."

In my parent U. S. Patent No. 2,253,000 I have disclosed and claimed one method of solving this problem by mixing together, prior to the completion of spinning, at least two types of fibres, one of which is a synthetic resin fibre having an inherent tackiness upon heating, spinning said mixture of fibres into yarn, subsequently rendering such resin fibres tacky by heat to effect a strong and substantially permanent adhesion between the fibres. The present invention relates to the same process as said Patent No. 2,253,000, but in the present invention the association of the fibres is accomplished by means other than by mixing the fibres together prior to the completion of spinning.

The general objects of the invention include, among others, to permanently increase the strength of textiles by increasing the frictional resistance of the fibres one upon another; to improve the appearance, "handle," flexibility and other physical characteristics; to increase the resistance to wear and laundering; and to permanently increase the tensile strength and resistance to untwisting of yarns, threads and cords of all kinds.

The specific objects of the invention are, inter alia, to provide a cord characterized by a superior strength, a lower stretch and shrinkage, to provide a thread having permanently increased strength, less shrinkage and decreased tendency to untwist; to prevent distortion of fabrics as by "laddering" and "running" of the yarns; to utilize in the fabrication of yarns shorter fibres than those heretofore employed, while maintaining or increasing the strength; and to provide fabric characterized by an increased stiffness and improved resistance to wear, abrasion and laundering.

Other objects will in part be obvious and will in part appear hereinafter.

According to the present invention, multi-ply yarns adapted for use in making stabilized textiles are produced by twisting together a strand of textile fibres with a strand of thermoplastic fibres and heating said thermoplastic fibres to render them tacky and bind the fibres in the yarn.

In the specification and claims the term "strand" is used in a generic sense and includes one or a plurality of continuous filaments, a sliver or roving of staple fibres, and a preformed singles yarn. While these specific terms have their usual meaning in the art, the expression "composite multi-ply yarn" designates a yarn comprising two or more strands which tend to maintain separate identities in the article before activation. The composite yarn of the present invention is not to be confused with the singles yarns of mixed fibres produced by commingling at least two types of fibres as in my parent Patent No. 2,253,000.

For a more complete understanding of the nature and objects of the invention, reference should be had to the accompanying drawing in which:

Fig. 1 is a side elevation of suitable means for carrying out one embodiment of the process of the invention;

Fig. 2 is a representation of a yarn by use of the means illustrated in Fig. 1;

Fig. 3 is a side elevation of suitable means for carrying out a second embodiment of the process;

Fig. 4 is a side elevation of other means for carrying out another embodiment of the process;

Figs. 5 and 6 are perspective views of products capable of being produced by either of the means shown in Figs. 3 and 4;

Fig. 7 represents suitable means for doubling yarns to make a plied yarn in accordance with the present invention; and

Fig. 8 is a perspective view of a plied yarn made with the apparatus illustrated in Fig. 7.

For the non-adhesive textile fibre there may be used any suitable natural or synthetic fibres of textile-making length, for example cotton, flax, jute, and other vegetable fibres; wool, hair, silk and other animal fibres; asbestos, glass,

mineral wool; also artificial fibres or filaments formed of cellulose compounds, such as regenerated cellulose or cellulose hydrate of all kinds, cellulose derivatives, such as the esters, the ethers, whether soluble in water, alkali or organic solvents, mixed cellulose ethers, mixed cellulose ester-ethers, hydroxy-alkyl and carboxy-alkyl ethers of cellulose and xanthates of the cellulose ethers, cellulose thiourethanes, cellulose xantho-fatty acids, and fibres formed from natural or synthetic resins of all kinds, which resinous fibres should be of the type that will not be rendered tacky at the temperature employed to render the thermoplastic fibres tacky.

The potentially adhesive fibre may comprise any thermoplastic synthetic resinous material or thermoplastic non-fibrous cellulosic material capable of being formed into fibres which have an inherent tackiness upon heating to a temperature below that at which the textile fibres are damaged or rendered tacky and which are non-tacky at room temperature, such, for example, as the resins formed by the polymerization of various organic compounds such as cumarone, indene hydrocarbons, vinyl, styrene, sterol, aldehyde, furfural, ketones, urea, thiourea, phenol-aldehyde resins, either alone or modified with oils, urea-aldehyde resins, amine-aldehyde resins, sulfonamide-aldehyde resins, polyhydric alcohol-polybasic acid resins, drying oil-modified alkyd resins, resins formed from acrylic acid, its homologues and their derivatives, sulfur-olefine resins, resins formed from dicarboxylic acids and diamines (nylon type); fibres formed from synthetic or artificial rubber such for example as polymerized butadiene, olefine-polysulfides, e. g. "Thiokol," isobutylene polymers, chloroprene polymers and polyvinyl-halides, e. g. "Koroseal," fibres formed from a resin comprising the product of co-polymerizing two or more resins, such, for example, as co-polymers of vinyl halide and vinyl acetate, co-polymers of vinyl compound and styrol compound; and also fibres formed from a mixture of resins, such for example as a mixture of vinyl resins and acrylic acid resins or methacrylic resins, a mixture of polyolefine resins and phenol-aldehyde resins, or a mixture of two or more resins from the different classes just named.

The thermoplastic resins above mentioned may be classified as:

(*a*) Heat-non-convertible resins such for example as glycol polybasic acid resins, vinyl resins and the acid type phenol-aldehyde resins, and the like.

(*b*) Heat-convertible resins such for example as a glycerol-polybasic acid resin, polyolefine resins, phenol-aldehyde resins and the like.

(*c*) An element-convertible resin (which becomes infusible through the action of certain elements, such as oxygen and sulphur), such for example as glycerol-polybasic acid-drying oil resins and olefine sulphur resins.

In addition to the synthetic resins, there may be employed for the potentially adhesive fibre, a fibre formed from a thermoplastic cellulose derivative such, for example, as a cellulose ester, a cellulose ether, a mixed cellulose ester-ether, or a mixed cellulose ether. In particular, the thermoplastic cellulose derivative fibre may be a fibre of cellulose acetate, cellulose nitrate or an organic soluble cellulose ethyl ether, and the like; also fibres formed from a mixture of cellulose derivatives and resins, such for example as a fibre formed by extruding a mixture of cellulose nitrate and an oil soluble phenol-aldehyde resin, or a cellulose acetate and an acrylic acid resin, or an organic soluble cellulose ether and a vinyl resin; also fibres formed from polyamide resins such as those formed from polybasic acids and aliphatic diamines (nylon type), either unstretched or prestretched; and fibres formed from a natural or synthetic rubber and rubber derivatives.

For the thermoplastic fibre, it is preferred to employ a resin fibre because the resin fibres, as compared to the cellulose derivative fibres, are tougher and harder, become tacky at lower temperatures and cool to form tough or pliable products. Moreover, the resin fibres are inert to acids, alkalies and dry cleaning fluids, and are not water-swelling. This latter property prevents distortion of the adhesive bond, tends to stabilize the twist and shrinkage of the fabric, and the adhesive is more permanent so that the wet and dry tensile strength of the adhesive bond will be substantially the same. Finally, the resin fibres exhibit, particularly when plasticized, a high tensile strength and a true elasticity, practically as great as that of natural silk.

The non-adhesive textile fibres and/or the potentially adhesive fibres may be prestretched fibres or filaments. In such cases the shrinking treatment advantageously includes treatment with a suitable chemical reagent or heat to effect a shrinkage of the prestretched fibre. The resulting fibre-shortening will produce yarn shrinkage and augment the decrease in fabric dimension.

The articles of the invention are fabricated from the composite yarns comprising at least two dissimilar types of strands at least one of which type is thermoplastic. The term "potentially thermoplastic strand" as used herein and in the claims designates that strand which is rendered adhesive under the conditions of heat treatment, as distinguished from the strand which under the same conditions is not rendered adhesive; that is, the invention contemplates that both the strands may actually be thermoplastic but that only one of them is rendered adhesive under the particular conditions of heating.

The thermoplastic fibres are rendered tacky by use of hot air, hot water or by contact with hot surfaces, with or without the addition of a solvent or plasticizer, and with or without the use of pressure, and such treatments may be carried out on the yarn or fabrics made therefrom, and the expression "treating the potentially thermoplastic strand to render said strand adhesive" as used in the claims includes treating the yarn before, during, or after fabrication into a fabric.

While the fibres are in an adhesive condition, the yarn or fabric preferably is subjected to a squeezing or compacting treatment to promote adhesion of the associated fibres at their points of contact as by passing the fabric between pressure rollers. The squeezing may be effected by the means employed for mechanically shrinking fabrics as described hereinafter.

Deactivation may be accomplished by heating to a higher temperature, as in the case of a heat-convertible resin fibre, or by cooling, as in the case of a thermoplastic resin or cellulose derivative fibre.

A plasticizer advantageously may be applied to the thermoplastic fibres and/or to the fabric before the activation of the fibres. The plasticizer

may function to increase the flexibility of the fibres and, when employed with thermoplastic fibres, the plasticizer may serve, in addition to modify the thermal softening point. The plasticized thermoplastic fibres can be rendered cementitious by heating to a temperature below that at which the non-thermoplastic textile fibres in the textile would be detrimentally affected by such heating. The plasticizer may be allowed to remain in the textile or it may be removed by suitable means such as washing and extraction. The removal of the plasticizer will raise the temperature at which thermoplastic material in the textile will again be rendered soft and cementitious, thus adapting the textile for use at more elevated temperatures than would be the case if the plasticizer were present. The plasticizer may serve also as a shrinking agent or as a latent activating agent for the thermoplastic fibres.

In carrying out the process of the invention with the apparatus shown in Fig. 1, a strand 1 consisting of thermoplastic fibres is withdrawn from a spool 2 and passed through a pair of pressure rollers 3 and thereafter through the center of a rotatable yarn spool 4 which carries thereon a supply of a strand 5 of textile fibres, the spool 4 being rotated by means of the belt 6 which drives the roll 7. As the strand 1 passes upward through the yarn spool 4, the strand 5 is spirally wound around the strand 1 to produce the composite yarn 8 which then passes through the pressure rolls 9 from which the composite yarn may be reeled up. The composite yarn 8 is shown in an enlarged view in Fig. 2 from which it is noted that the strand 1 in this embodiment lies in a substantially straight condition, whereas the strand 5 is spirally wound around the strand 1. When the composit yarn is heated sufficiently to render the fibres of the strand 1 tacky, but insufficiently to destroy the filamentary form of the strand 1, the spiral wrappings of the strand 5 will be bound together and prevented from untwisting or separating or from becoming displaced with respect to the strand 1. It is to be understood that, if desired, the strand 5 may consist of thermoplastic fibres, in which case the strand 1 consists of the non-thermoplastic textile fibres. The twisting of the strand 5 about the strand 1 in the apparatus of Fig. 1 will normally cause a certain amount of twist to be imparted to the strand 1 and this will normally result in the production of an unbalanced composite yarn which will tend to kink. This result may be avoided if desired by pre-twisting the yarn 1 or by imparting twist to the strand 1 before it passes through the pressure rollers 3. The twist put into the strand 1 should be in the opposite direction to the twist imparted by the covering operation and the amount may be easily regulated so as to produce a balanced yarn. If desired a second strand may be applied over the strand 5 by the use of a second spool positioned above the rollers 9.

The process of the invention may also be carried out by employing the rolls of a drafting frame as illustrated in Figs. 3 and 4. In that embodiment shown in Fig. 3 one of the strands comprises a roving 10 which is drawn through the drafting rolls 11, 12 and 13 in conventional manner. There is also passed through the nip of the last pair of rolls 13 a second strand which, for example, is shown as a filament 14 in Fig. 3. By maintaining the filament 14 under suitable tension, the roving may be caused to become twisted about the filament 14 as the composite yarn is spun between the nip of the rolls 13 and the bobbin 15, the composite yarn 8' passing through a pig-tail 16 through the ring traveler 17 on to the spool 15 which is rotated by means of the belt 6' which drives the roll 7'. In this embodiment either the roving 10 or the filament 14 may be thermoplastic and it is to be understood that while only a single roving is illustrated, a plurality of rovings may be fed through the drafting rolls and twisted simultaneously about a single core strand 14. By varying the relative tension on the rovings 10 and the strand 14, it is possible to cause the strand 14 to become twisted about the rovings.

In that embodiment shown in Fig. 4, the strand 14 is not passed through the nip of the draftings rolls 13, but is first passed between a pair of pressure rolls 18 which are positioned above the rolls 13 so that the strand 14 passes tangentially to the rolls 13 in a downward direction and contacts the roving adjacent the surface of the lower roll 13'. The roving 10 is caused to be twisted about the strand 14 by the use of suitable means as shown in Fig. 3. As in the embodiment illustrated in Fig. 3, the rovings 10 or the strand 14 shown in Fig. 4 may consist of thermoplastic fibres and two or more rovings may be employed.

When a roving 10 is twisted about a continuous filament 14, there may be produced by the apparatus shown in Figs. 3 and 4 composite yarn such as that illustrated in Fig. 5 and the heating of the thermoplastic fibres will stabilize the composite yarn structure thus shown. Alternatively, by using a roving in place of the continuous filament 14 in the apparatus of Figs. 3 or 4, there may be produced a composite yarn such as that illustrated in Fig. 6 which comprises a core strand 14' comprising a multiplicity of fibres about which is twisted a covering strand 10 also comprising a multiplicity of fibres. In the embodiment shown in Fig. 6 either the core 14' or the covering strand 10 may consist of thermoplastic fibres.

The composite yarn of the present invention may comprise a plied yarn which can be produced, for example, by the use of the apparatus shown in Fig. 7 in which a plurality of strands 21 carried on the several spools 19 are passed through a common pig-tail 16' and then through a flier 17' and wound up on the spool 15' which is driven by means of the belt 6' and the driven roll 7'. The several strands 21 are doubled in passing from the pig-tail 16' to the spool 15'. The composite yarn 20 produced with the apparatus illustrated in Fig. 7 is shown in Fig. 8, this product differing from the composite yarn shown in Fig. 2 in that in the article shown in Fig. 8 all of the strands are twisted about each other as in a conventional plied thread or cord. It is to be understood that one or more of the strands 21 in the composite cord 20 illustrated in Fig. 8 may be formed of continuous filaments, or in whole or in part of thermoplastic fibres, the heating of which will bind the fibres in the product, stabilize the yarn twist and the relation of the yarns to each other in the cord. The binding of the fibres and the strands to each other will also prevent separation and blooming of the plies in the cord which is prevalent in cords formed of smooth surfaced fibres or from continuous filament yarns and in particular from yarns composed of siliceous fibres, such as glass fibres, asbestos fibres, rock wool, and slag fibres. By causing the potentially thermoplastic strands to be substantially on the surface of the composite yarns, the activation may be such as to provide the composite

yarn with a substantially continuous coating of the material resulting from the activation of the thermoplastic material. This will be advantageous in the manufacture of plied yarns where adhesion between the plies is desirable in preventing yarn slippage in fabrics, and also beneficial when it is desired to impart a uniform color to the yarns, in which case the color is carried by the potentially thermoplastic strand. When the substantially thermoplastic strand is substantially only in the center of the yarn, the external appearance of the yarn is not altered, although the core of potentially thermoplastic yarn serves to strengthen the yarn.

Among the textiles which may be produced are multi-ply yarns, threads and cords of all kinds which may be used as warp or as filler (weft) in making fabrics, or in association with other yarns of like or unlike character, in weaving, knitting, netting, lacing, and other textile constructions, for the preparation of threads and cords of all kinds. Also fabrics may be made from the multi-ply yarns by suitable processes, for example, weaving, knitting, netting, lacing, braiding, crocheting, and the like, such fabrics being adapted for various uses such as collar cloth, shirting, garments, garment liners, bedding, table covers, book cloths, artificial leather, balloon and airplane fabrics, and many other uses. There may be produced also sewing threads, fishing cords, tying cords, and, in particular, cords for purposes requiring high abrasion resistance.

I claim:

1. In a process of making a composite multi-ply yarn, the steps comprising associating a potentially thermoplastic strand with a non-thermoplastic strand by twisting one of said strands about the other, and treating said potentially thermoplastic strand to render said strand adhesive and bond said strands together.

2. In a process of making a composite multi-ply yarn, the steps comprising associating a potentially thermoplastic strand with a non-adhesive strand by wrapping one of said strands about the other, and treating said potentially thermoplastic strand to render said strand adhesive and bond said strands together.

3. In a process of making a composite multi-ply yarn, the steps comprising drafting a strand of fibres to form a roving, associating said drafted strand with another strand by twisting one of said strands about the other, one of said strands being potentially thermoplastic and one of said strands being non-thermoplastic, and treating said potentially thermoplastic strand to render the same adhesive and bond said strands together.

4. In a process of making a composite multi-ply yarn, the steps comprising doubling by twisting together a potentially thermoplastic strand with a non-thermoplastic strand, and treating said potentially thermoplastic strand to render said strand adhesive and bond said strands together.

5. In a process of making a composite multi-ply yarn, the steps comprising associating a potentially thermoplastic filament with a non-thermoplastic filament by twisting one of said filaments about the other, and treating said potentially thermoplastic filament to render said filament adhesive and bond said filaments together.

6. In a process of making a composite multi-ply yarn, the steps comprising associating a strand consisting of a multiplicity of potentially thermoplastic fibres with a strand comprising a multiplicity of non-thermoplastic fibres by twisting one of said strands about the other, and treating said potentially thermoplastic fibres to render said fibres adhesive and bond said strands together.

7. In a process of making a composite multi-ply yarn, the steps comprising associating a yarn consisting of a potentially thermoplastic material with a yarn comprising a non-thermoplastic material by twisting one of said yarns about the other, and treating said potentially thermoplastic material to render it adhesive and bond said yarns together.

8. In a process of making a textile comprising composite multi-ply yarns, the steps comprising associating a potentially thermoplastic strand with a non-thermoplastic strand by twisting one of said strands about the other to form a composite yarn, forming said yarn into a fabric, and heating said fabric to render said potentially thermoplastic strand adhesive to bond said potentially thermoplastic strand to said non-thermoplastic strand and said yarn to a contiguous yarn in said fabric.

9. As an article of manufacture, a composite multi-ply yarn comprising at least one potentially thermoplastic strand twisted with at least one non-thermoplastic strand, the thermoplastic strand in said yarn exhibiting a strong and substantially permanent adhesion to the non-thermoplastic strand due to the thermal tackiness after heating of said thermoplastic strand, whereby said composite yarn structure is stabilized.

10. As an article of manufacture, a composite multi-ply yarn comprising a potentially thermoplastic filament and a non-thermoplastic filament twisted together, said first filament exhibiting a strong and substantially permanent adhesion to said second filament due to the thermal tackiness after heating of said thermoplastic filament, whereby said composite yarn structure is stabilized.

11. As an article of manufacture, a composite multi-ply yarn comprising a strand formed of a multiplicity of potentially thermoplastic fibres twisted with a strand comprising a multiplicity of non-thermoplastic fibres, the fibres in said first strand exhibiting a strong and substantially permanent adhesion to the fibres in said second strand due to the thermal tackiness after heating of said first strand, whereby said composite yarn structure is stabilized.

12. As an article of manufacture, a textile fabric comprising a composite multi-ply yarn comprising a yarn formed of a potentially thermoplastic material doubled with a yarn formed of a non-thermoplastic material, the yarn of thermoplastic material exhibiting a strong and substantially permanent adhesion to the yarn of non-thermoplastic material due to the thermal tackiness after heating of said fabric, composite yarn and fabric, whereby the yarns of said composite yarn are bonded to each other and said composite yarn is bonded to a contiguous yarn in said fabric.

13. As an article of manufacture, a textile fabric comprising a composite multi-ply yarn comprising a strand formed of a potentially thermoplastic resin twisted with a non-thermoplastic strand, the first strand exhibiting a strong and substantially permanent adhesion to the second strand due to the thermal tackiness after heating of said composite yarn and fabric, whereby

the strands of said composite yarn are bonded to each other and said composite yarn is bonded to a contiguous yarn in said fabric, whereby said composite yarn structure is stabilized.

14. As an article of manufacture, a textile fabric comprising a composite multi-ply yarn comprising a strand formed of a potentially thermoplastic cellulose derivative twisted with a non-thermoplastic strand, the first strand exhibiting a strong and substantially permanent adhesion to the second strand due to the thermal tackiness after heating of said composite yarn and fabric, whereby the strands of said composite yarn are bonded to each other and said composite yarn is bonded to a contiguous yarn in said fabric.

15. As an article of manufacture, a textile fabric comprising composite multi-ply yarns having at least one potentially thermoplastic strand twisted with at least one non-thermoplastic strand, the thermoplastic strand in said yarns exhibiting a strong and substantially permanent adhesion to the non-thermoplastic strand due to the thermal tackiness after heating of said composite yarn and fabric, whereby the strands of said composite yarn are bonded to each other and said composite yarn is bonded to a contiguous yarn in said fabric.

16. A process of making a textile fabric comprising composite multi-ply yarns, the steps comprising associating a potentially thermoplastic strand with a non-thermoplastic strand by wrapping one of said strands about the other to form a composite yarn, forming said yarn into a fabric, and heating said fabric to render said potentially thermoplastic strand adhesive to bond said strands to each other in the yarns and to bond said yarns to contiguous yarns in the fabric.

17. A process of making a textile fabric comprising composite multi-ply yarns, the steps comprising drafting a strand of fibres to form a roving, associating said roving strand with another strand by twisting one of said strands about the other to form a composite yarn, one of said strands being potentially thermoplastic and one of said strands being non-thermoplastic, forming said composite yarn into a fabric and heating said fabric to render said thermoplastic strand adhesive to bond said strands to each other in the yarns and to bond said yarns to contiguous yarns in the fabric.

18. A process of making a textile fabric comprising composite multi-ply yarns, the steps comprising wrapping a potentially thermoplastic strand about a non-thermoplastic strand to form a composite yarn in which the thermoplastic strand forms the external surface thereof, forming said composite yarn into a fabric, and treating said fabric with heat and pressure to render said potentially thermoplastic strand adhesive to bond said strands to each other in the yarns and to bond said yarns to contiguous yarns in the fabric.

19. A process of making a composite multi-ply yarn, the steps comprising drafting a strand of potentially thermoplastic fibres to form a roving, twisting said roving strand about a non-thermoplastic strand to form a composite yarn, and heating said composite yarn to render said thermoplastic strand adhesive to bond said strands together.

20. A process of making a composite multi-ply yarn, the steps comprising drafting a strand of non-thermoplastic fibres to form a roving, twisting said roving about a thermoplastic core strand to form a composite yarn, and heating said composite yarn to render said thermoplastic core strand adhesive to bond the roving strand to the surface of said core strand.

21. A composite stabilized yarn comprising a non-thermoplastic strand and a thermoplastic strand, one of said strands forming a sheath about the other strand and united thereto as a result of the activation of said thermoplastic strand.

22. In a process of making a knitted fabric having a reduced tendency toward laddering, the steps comprising knitting into a fabric a composite multi-ply yarn comprising a potentially adhesive strand twisted with a non-adhesive strand, and treating said fabric to render the potentially adhesive strand adhesive to bond said potentially adhesive strand to said non-adhesive strand and to bond said multi-ply yarns to contiguous yarns in said fabric to retard laddering.

23. A knitted fabric formed with a composite multi-ply yarn comprising a potentially adhesive strand twisted with a non-adhesive strand, the potentially adhesive strand being bonded to the non-adhesive strand and said multi-ply yarn being bonded to a contiguous yarn in said fabric as the result of the activation of said potentially adhesive strand whereby laddering in said fabric is retarded.

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