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(54) **Knittable yarn and safety apparel**

Strickfähiges Garn und Schutzkleidung

Fil tricotable et vêtement de protection

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US-A- 4 384 449 **US-A- 4 413 110**
US-A- 4 470 251 **US-A- 4 912 781**

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Description

Technical Field

The invention relates to a cut-resistant yarn suitable for machine knitting according to the preamble of claim 1, known, for instance, from US-A-4 912 781 and to safety garments made with the yarn.

Background Art

Cut-resistant yarn utilizing stainless steel wire strands and high tensile strength aramid strands, such as Kevlar made by E.I. DuPont de Nemours Corp., and gloves made therefrom are shown in U.S. -A- 4,384,449 and in U.S. -A- 4,470,251. These gloves have proven highly successful. One other fiber, a high strength stretched polyethylene fiber manufactured and marketed by Allied Corporation, Morris Township, Morris County, N.J., U.S.A., has heretofore also provided good cut resistance when used in place of aramid fiber. The Allied fiber is sold under the name Spectra and is described in detail in U.S. -A- 4,413,110. Other fibers have not provided equal cut resistance along with other desirable characteristics for such products.

A composite yarn, described as cut-resistant and suitable for knitting cut-resistant gloves, is disclosed in U.S. -A- 4,912,781, comprised of a multifilament synthetic yarn, preferably nylon, forming a core, and an abrasion and cut-resistant monofilament covering yarn, preferably stainless steel, knitted onto and encasing the core yarn in a series of cut-resistant loops. The cover is not wrapped around the core, nor is it a multifilament synthetic fiber.

Disclosure of the Invention

According to the present invention there is provided a cut-resistant yarn suitable for machine knitting, with a core fiber and a covering yarn, characterized in that the covering yarn is a helical wrapping of multifilament synthetic fiber contacting the core and having a tenacity greater than 9 grams per dtex (10 grams per denier), and one of the synthetic fibers of the covering yarn or the fiber of the core is a high strength liquid crystal polymer having an initial tensile modulus of at least 540 grams per dtex (600 grams per denier) and a yarn count of 222 dtex to 1667 dtex (denier of about 200 to 1,500).

The yarn utilizes a yarn or fiber strand or component, spun from Vectran liquid crystal polymer, of high strength to provide high cut resistance. The yarn or fiber is a high performance filament yarn sold by Hoechst Celanese Corporation, Charlotte, North Carolina, under the name Vectran HS. This yarn or fiber has essentially the same strength as the aramid fiber sold under the name Kevlar, but has better abrasion resistance. At the same time, it has significantly better heat resistance than high strength stretched polyethylene fiber, thus

overcoming a different shortcoming of each of Kevlar and Spectra for use in a cut resistant yarn used for apparel and particularly for cut resistant gloves, while providing the substantial advantages that those two materials have over other materials in terms of cut resistance and other characteristics in a composite yarn. Thus, knit fabric suitable for gloves and other safety garments utilizing Vectran HS fiber has greater abrasion resistance than similar fabric made with aramid fiber or a combination of aramid and nylon fiber, yet is itself nonabrasive and comfortable to wear, and such fabric can be laundered at high temperatures conventionally used for industrial fabrics without degrading the fabric.

In preferred forms, an embodiment of the invention utilizes wire in the core, and another embodiment does not, but instead relies on a limited number of filaments of significant denier to comprise the liquid crystal polymer yarn or fiber of the core.

In their broad aspects, the embodiments of the present invention that utilize wire in the core provide a cut-resistant yarn suitable for machine knitting, comprising a core having at least one strand of flexible metal wire having a diameter of from about 0.051 mm to about 0.25 mm (0.002 inch to about 0.010 inch), and at least one strand of high strength liquid crystal polymer fiber such as Vectran HS fiber, having an initial tensile modulus of at least 540gms per dtex (600 grams per denier) and of a yarn count of between 222 dtex and 1667 dtex (a denier between about 200 and 1,500; and a wrapping of synthetic fiber wound about the core, the wrapping having a tenacity greater than 9 grams per dtex (10 grams per denier) and preferably greater than the tenacity or tensile strength of the metal wire. In their broad aspects, the embodiments of the invention that do not utilize wire in the core provide a cut-resistant yarn suitable for machine knitting, comprising a core having a strand of high strength liquid crystal polymer fiber, such as Vectran HS fiber, having an initial tensile modulus of at least 540 grams per dtex (600 grams per denier) and a yarn count of between 222 dtex and 1667 dtex (a denier of between about 200 and 1,500), and formed of from 1 to 50 filaments, or so-called "ends."

The invention further provides a cut-resistant machine-knitted article of apparel, one such article being a flexible glove, at least in part made of yarn having the constructions as described above.

In preferred constructions, the yarn utilizes either two wrappings of Vectran HS fiber, each of a yarn count of from about 222 dtex to about 889 dtex (a denier of from about 200 to about 800), which provide high cut resistance, abrasion resistance, and heat resistance; or two wrappings, one of Kevlar or other high strength aramid and one of Spectra or other high strength stretched polyethylene, each of a yarn count of from about 222 dtex to about 889 dtex (from about 200 to about 800 denier), which provide very high cut resistance. In preferred constructions of the embodiments that do not include wire in the core, the core filaments or ends of the

Vectran HS fiber are each of a yarn count between 4.4 and 556 dtex (between 4 and 500 denier). In such a construction, a strand of another high strength synthetic fiber, such as Spectra or Kevlar, may also be used in the core along with the Vectran HS fiber.

A glove or other article of apparel utilizing a preferred yarn construction has not only high resistance to cutting, but also good wear qualities and comfort, does not take a set during use, is non-abrasive, provides a good appearance, and is cleanable and long wearing.

The above and other features and advantages of the invention will become more apparent from the detailed description that follows.

Brief Description of the Drawings

Figure 1 is a fragmentary, diagrammatic, view of a yarn embodying the present invention;

Figure 2 is a fragmentary, diagrammatic, view of a second yarn embodying the present invention;

Figure 3 is a fragmentary, diagrammatic, view of a third yarn embodying the present invention; and

Figure 4 is a diagrammatic view of an article of apparel, i.e., a knitted glove, made of yarn embodying the present invention, such as the yarn shown in Figures 1, 2 and 3.

Best Mode for Carrying Out the Invention

The depicted glove A is exemplary of a safety article of apparel embodying the present invention and is a safety or protective glove suitable to be worn by operatives in the food processing and other industries where sharp instruments or articles, such as knives, or material having sharp edges, for example, sheet metal, glass and the like, are handled, and is made of a composite multistrand yarn B, C or D constructed in accordance with the present invention. The glove A has the usual finger and thumb stalls 4, 6 respectively, and a wrist part 8 incorporating an elastic thread or yarn. The glove is made using conventional methods and glove knitting machinery.

The yarn B employed in the glove A comprises a core part 10 and two windings 12, 14 of synthetic fiber wound thereon in opposite directions one on top of the other. The fact that the wrappings 12, 14 are in different directions balances the forces incident to the wrappings so the yarn has no unusual twist or tendency to coil and assists in holding the wrappings in place on the core 10. The windings are between four and twenty turns per inch and preferably about eight to twelve turns per inch. The core part 10 of the yarn B comprises two strands of annealed stainless steel wire 16 and 18, and one strand 20 of Vectran HS fiber, marketed by Hoechst Celanese Corporation. In another preferred embodiment, only one strand of annealed wire identical to the strand 16 is provided in the core.

The core structure 10 is designed to provide cut re-

sistance, knittability, flexibility and life to the yarn; and the wrappings 12, 14 retain the core and create body. One or both of the wrappings 10, 12 are of high strength synthetic fiber to contribute significantly to the cut resistance of the yarn.

The stainless steel wire 16 of the core part of the yarn B has a diameter of about 0.076mm (0.003 inch). Stainless steel wire of the size mentioned, of 304 stainless steel, fully annealed, which has a tensile strength of about 7730 to 9486 kilograms per square centimeter (110,000 to 135,000 pounds per square inch), is believed to have optimum flexibility and life.

The strand of synthetic fiber 20 in the core 10 of the yarn B is a high strength relatively nonstretchable multifilament synthetic fiber of Vectran HS having a tensile strength greater than that of the wire. The Vectran HS liquid crystal polymer fiber has an initial tensile modulus of at least about 540 grams per dtex (600 grams per denier). It has a tenacity (tensile strength at break) of about 18 to 23 grams per dtex (20 to 25 grams per denier) and its elongation at break is about 2.2 to 2.5 percent. The size of the strand 20 is 1000 dtex (900 denier), but other sizes are suitable, from about 222 dtex to about 1667 dtex (about 200 to about 1,500 denier), more preferably from about 556 dtex to about 1333 dtex (about 500 to about 1200 denier), and most preferably from about 1000 dtex to about 1333 dtex (about 900 to about 1200 denier).

The first or inner wrapping 12 on the core 10 of the yarn B is a high strength synthetic fiber, preferably a multifilament high strength fiber material, such as Vectran HS is used for the strand 20. Because Vectran HS fiber material has good abrasion resistance and heat resistance along with its cut resistance, it is advantageously used for the outer wrapping 14 as well as for the inner wrapping 12. Thus, in the embodiment shown, the outer wrapping 14 of the yarn B is identical to the inner wrapping 12, except wrapped in the opposite direction. The use of a single high strength fiber material for both wrappings 12 and 14 simplifies inventory and processing procedures and gives improved cut and abrasion resistance over the use of two aramid wrappings or an aramid inner wrapping and a nylon outer wrapping and better heat resistance over the use of two high strength stretched polyethylene wrappings or an inner high strength stretched polyethylene inner wrapping and a nylon outer wrapping. While a polyester outer wrap may be used in place of the outer Vectran HS wrap, a reduction in cut resistance will result. Each wrapping 12 and 14 is of yarn count of from about 222 dtex to about 1667 dtex (a denier of from about 200 to about 1500), more preferably from about 222 dtex to about 1111 dtex (about 200 to about 1000 denier), and most preferably from about 222 to about 889 dtex (about 200 to about 800 denier). Preferably each wrapping is of a yarn count of about 222 dtex (about 200 denier) when the yarn is used for a glove knitted with two strands of the yarn (i.e., two strands of yarn are threaded concurrently through a knit-

ting needle), or when the yarn is used for a lighter weight glove having greater flexibility and comfort. For a glove or protective garment knit from a single strand of yarn and also having very high cut resistance, it is preferred that the inner and outer wrappings be of greater yarn count (denier), preferably from about 444 dtex to 667 dtex (400 to 600 denier). The overall diameter of the yarn B should be no greater than 1.27mm (0.05 inch), and preferably no greater than 0.76mm (0.03 inch), to facilitate machine knitting.

Cut resistance of the yarn B and the glove A when made of the yarn B is in part a function of the quantity of metal wire in the yarn. However, stainless steel core strands in excess of 0.102mm (0.004 inch), in diameter reduce the flexibility and knittability of the yarn and the wearing qualities of garments made of such yarn. Plural steel strands are advantageous for flexibility over one larger strand where increased cut resistance is desired. Two to six stainless steel core strands of about 0.051mm to about 0.152mm (0.002 inch to about 0.006 inch), in diameter can be employed in typical applications. Stainless steel strands of a diameter less than about 0.051mm (0.02 inch), have a shorter life, are relatively expensive and have not been found to be otherwise sufficiently advantageous to warrant the increased cost. Stainless steel strands having diameters between about 0.051mm (0.002 inch), and about 0.102mm (0.004 inch), have been found to be most satisfactory. Stainless steel is preferred for the wire strands employed in preferred embodiments of the invention and is important for use in gloves and other garments used in the food industry. Other kinds of metal wire strands, if desired for special purposes, may be used, such as, aluminum, copper, bronze or steel.

The use of a multifilament high strength liquid crystal polymer fiber strand, such as Vectran HS fiber strand, in the core is very advantageous. Multifilament strand is very linear and slides and/or flows well relative to the other parts of the core during fabrication and subsequent use of an article of apparel produced therewith. The high strength multifilament core strand, which is relatively unstretchable, takes a great deal if not the major part of the tensile load to which the yarn is subjected during knitting. It also appears to increase the flexibility of the core part of the yarn over an all metal core and in turn makes the yarn more easily knit, i.e., imparts to the yarn greater knittability. It also improves cut resistance. The synthetic wrappings 12, 14 of multifilament high strength liquid crystal polymer fiber such as Vectran HS fiber contribute to the cut resistance of the yarn. The wrapping 12 provides a desirable rigid backup surface for the outer wrapping 14, which tends to fill out the valleys of the wrapping immediately therebeneath. The multifilament wrappings 12, 14 wound flat about the core, producing a yarn with a smooth surface that aids the knitting process and that has a good appearance, a non-abrasive surface, and that provides heat resistance and maximum comfort.

An alternative yarn C employed in the glove A comprises a core 30 and three wrappings 32, 34 and 36 of synthetic fiber about the core, one on top of another and in an opposite direction. The wrappings have between four and twenty turns per 25.4 mm (inch) and preferably about eight to twelve.

The core 30 is a strand of Vectran HS fiber, and has a yarn count of about 222 to about 1667 dtex (denier of about 200 to about 1500) and is comprised of from one to 50 filaments or ends, each of which has a yarn count from about 4.4 dtex to about 556 dtex (denier of from about 4 to about 500). The use of relatively few filaments of relatively high yarn count (denier), preferably a yarn count (denier) of at least 13 dtex (12 denier) and more preferably at least 22 dtex (20 denier), results in the core strand behaving somewhat like a monofilament core and allows the Vectran HS to function as a replacement for the steel wire in the core, but without the need for another high strength synthetic fiber along with it, as is the case with the wire. Of course, an additional high strength synthetic fiber can be used with it, if desired.

One of the wrappings 32, 34 is a high strength aramid fiber, such as Kevlar, and the other is a high strength stretched polyethylene fiber, such as Spectra. In the embodiment shown, the wrap 32 is Kevlar and the wrap 34 is Spectra. The wraps each have a yarn count of about 222 to about 1667 dtex (denier of about 200 to about 1500) and preferably 222 dtex to 889 dtex (200 to 800 denier). The use of a combination of Spectra and Kevlar has been found to provide greater strength than when two equivalent sized wraps of only one of the two materials are used. The third and outer wrap 36 is of a soft synthetic fiber, such as polyester or nylon, having a yarn count of about 222 to about 1111 dtex (denier of about 200 to about 1000). The diameter of the yarn C is between about 0.25mm and about 1.27mm (0.01 and about 0.05 inch), and preferably no greater than 0.76mm (0.03 inch).

A construction D is shown in Figure 3, which is identical to the construction C shown in Figure 2 (identical parts being identified with identical reference numerals, but with a prime) except that an additional core strand 37 of high strength stretched polyethylene, such as Spectra, or high strength aramid, such as Kevlar, of yarn count 222 dtex to 1333 dtex (200 to 1200 denier) is provided.

The depicted glove A is a safety glove especially advantageous for use in the food processing industries and is highly cut resistant, abrasive resistant, readily cleanable at high temperatures, comfortable to wear, nice appearing, flexible and relatively non-absorbent. The last characteristic of the glove is very important in the food processing industries. The glove is also chemical, abrasive and fatigue resistant, is also resistant to the transfer of heat or cold, is conformable, does not acquire a set during use, is non-shrinkable, is light in weight, and provides a secure grip.

Gloves knit from yarn described above using high

strength liquid crystal polymer fibers, such as Vectran HS fibers, provide increased cut resistance over yarn that utilizes comparable quantities of aramid fiber and provide improved abrasion resistance. Wash and dry tests show it has substantially less shrinkage than high strength stretched polyethylene.

While the yarn of the invention has been described and shown incorporated into a knit safety glove, it is to be understood that the yarn of the present invention can be used to make other fabrics and articles of apparel, safety or otherwise, such as wrist guards, protective sleeves, gaiters, safety aprons, etc. for use in the meat processing and other industries.

While variations in certain of the materials and sizes of the strands employed in preferred embodiments of the invention herein described can be made, the preferred embodiments of the yarn of the present invention are believed to produce the optimum balance between strength, resistance to cutting, resistance to heat, appearance, comfort, knittability, wearability, cleanability, and cost.

From the foregoing description of preferred embodiments of the invention it will be apparent that the advantages of the invention heretofore enumerated and others have been accomplished and that there have been provided an improved knittable yarn and safety articles of apparel made therewith having superior qualities.

Claims

1. A cut-resistant yarn (C, D) suitable for machine knitting, with a core (10, 30, 30', 37) fiber (20, 30, 30', 37) and a covering yarn (12, 32, 32'), characterized in that the covering yarn is a helical wrapping of multifilament synthetic fiber contacting the core and having a tenacity greater than 9 grams per dtex (10 grams per denier), and one of the synthetic fibers of the covering yarn or the fiber of the core is a high strength liquid crystal polymer having an initial tensile modulus of at least 540 grams per dtex (600 grams per denier) and a yarn count of 222 dtex to 1667 dtex (denier of about 200 to 1,500).
2. A cut-resistant yarn (C, D) as set forth in claim 1, characterized by an additional wrapping (14, 34, 34') of synthetic fiber, the wrapping strands having a yarn count of about 222 dtex to 1111 dtex (denier of about 200 to 1000) and a tensile strength greater than 7730 kilograms per square centimeter and wherein the core fiber comprises no more than 50 filaments.
3. A cut-resistant yarn (C, D) as set forth in claim 1, characterized by three wrappings (32, 34, 36; 32', 34', 36') one (32, 32') being a high strength aramid fiber having a yarn count of 222 dTex to 1667 dtex (denier of about 200 to 1500), another (34, 34') being a high strength stretched polyethylene fiber having a yarn count of 222 dtex to 1667 dtex (denier of about 200 to 1500), and an outer wrapping (36, 36') of a synthetic fiber having a yarn count of about 222 dtex to 1111 dtex (denier of about 200 to 1000), and wherein the overall diameter of the yarn is no greater than about 1.27 mm (0.05 inch).
4. A cut-resistant yarn (B) as set forth in claim 1, characterized in that the core (10) includes a flexible metal wire (16, 18) having a diameter between about 0.051 mm to 0.254 mm, and said wrapping (12 or 14) of synthetic fiber is a high strength liquid crystal polymer fiber having a yarn count of 222 dtex to 1333 dtex (denier of about 200 to 1200).
5. A cut-resistant yarn (B) as set forth in claim 4, characterized by a second wrapping (14) of high strength liquid crystal polymer fiber and wherein both wrappings have an initial tensile modulus of at least 540 grams per dtex (600 grams per denier).
6. A cut-resistant yarn (B) as set forth in claim 4, characterized in that the core (10) comprises at least two and no more than six strands (16, 18) of fully annealed stainless steel wire having a diameter of from about 0.051 mm to about 0.152 mm.
7. A cut-resistant yarn (B) as set forth in claim 4, characterized in that the overall diameter of the yarn is no greater than about 1.27 mm.
8. A cut-resistant yarn (B) as set forth in claim 4, characterized in that the high strength liquid crystal polymer fiber is in the core (10) and has an initial tensile modulus of at least 540 grams per dtex (600 grams per denier) and a yarn count of about 1000 dtex to 1333 dtex (denier of about 900 to 1200), and there are two wrappings (12, 14) of synthetic fiber wound about the core, one wrapping (12) having an additional high strength liquid crystal polymer fiber with an initial tensile modulus of at least 540 grams per dtex (600 grams per denier) and a yarn count of between about 222 dtex and 889 dtex (denier of between about 200 and 800), and the overall diameter of the yarn being no greater than about 1.27 mm.
9. A cut-resistant yarn as set forth in claim 2, characterized in that each of the filaments of the core fiber (20, 30, 30') has a yarn count of from 4.4 dtex to 556 dtex (denier of from 4 to 500).
10. Cut-resistant apparel (A) knitted from the yarn (B, C, D) as set forth in any one of claims 1-9.
11. A cut-resistant glove (A) knitted from the yarn (B, C, D) as set forth in any of claims 1-9.

Patentansprüche

1. Schneidfestes Garn (C, D), das sich zum Maschinenstricken eignet und einen Kern (10, 30, 30', 37), eine Faser (20, 30, 30', 37) und einen Hüllfaden (12, 32, 32') umfaßt, dadurch gekennzeichnet, daß der Hüllfaden eine spiralförmige Umhüllung aus einer multifilen Synthesefaser ist, die den Kern berührt und eine Reißfestigkeit von mehr als 9 Gramm pro dtex (10 Gramm pro Denier) besitzt, und eine der Synthesefasern des Hüllfadens bzw. die Faser des Kerns aus einem hochfesten Flüssigkristallpolymer besteht mit einem anfänglichen Zugmodul von mindestens 540 Gramm pro dtex (600 Gramm pro Denier) und einer Garnnummer von 222 dtex bis 1667 dtex (etwa 200 bis 1500 Denier). 5
2. Schneidfestes Garn (C, D) nach Anspruch 1, gekennzeichnet durch eine zusätzliche Umhüllung (14, 34, 34') aus Synthesefaser, wobei die Hüllfäden eine Garnnummer von etwa 222 dtex bis 1111 dtex (etwa 200 bis 1000 Denier) und eine Zugfestigkeit von mehr als 7730 Kilogramm pro Quadratzentimeter besitzen, und wobei die Kernfaser nicht mehr als 50 Filamente umfaßt. 20
3. Schneidfestes Garn (C, D) nach Anspruch 1, gekennzeichnet durch drei Umhüllungen (32, 34, 36; 32', 34', 36'), von denen eine (32, 32') aus einer hochfesten Aramidfaser mit einer Garnnummer von 222 dtex bis 1667 dtex (etwa 200 bis 1500 Denier), eine andere aus einer hochfesten gestreckten Polyethylenfaser mit einer Garnnummer von 222 dtex bis 1667 dtex (etwa 200 bis 1500 Denier), und eine äußere Umhüllung (36, 36') aus einer Synthesefaser mit einer Garnnummer von etwa 222 dtex bis 1111 dtex (etwa 200 bis 1000 Denier) besteht, und wobei der Gesamtdurchmesser des Garns nicht mehr als etwa 1,27 mm (0,05 Zoll) beträgt. 30
4. Schneidfestes Garn (B) nach Anspruch 1, dadurch gekennzeichnet, daß der Kern (10) einen flexiblen Metalldraht (16, 18) mit einem Durchmesser zwischen etwa 0,051 mm und 0,254 mm umfaßt, und die Umhüllung (12 oder 14) aus Synthesefaser aus einer Faser aus einem hochfesten Flüssigkristallpolymer mit einer Garnnummer von 222 dtex bis 1333 dtex (etwa 200 bis 1200 Denier besteht). 35
5. Schneidfestes Garn (B) nach Anspruch 4, gekennzeichnet durch eine zweite Umhüllung (14) aus einer hochfesten Faser aus Flüssigkristallpolymer, wobei beide Umhüllungen einen anfänglichen Zugmodul von mindestens 540 Gramm pro dtex (600 Gramm pro Denier) besitzen. 40
6. Schneidfestes Garn (B) nach Anspruch 4, dadurch gekennzeichnet, daß der Kern (10) mindestens zwei und höchstens sechs Litzen (16, 18) aus einem hochgeglühten Edelstahldraht mit einem Durchmesser von etwa 0,051 mm bis etwa 0,152 mm besitzt. 45
7. Schneidfestes Garn (B) nach Anspruch 4, dadurch gekennzeichnet, daß der Gesamtdurchmesser des Garns nicht mehr als etwa 1,27 mm beträgt. 50
8. Schneidfestes Garn (B) nach Anspruch 4, dadurch gekennzeichnet, daß die Faser aus hochfestem Flüssigkristallpolymer im Kern (10) liegt und einen anfänglichen Zugmodul von mindestens 540 Gramm pro dtex (600 Gramm pro Denier) und eine Garnnummer von etwa 1000 dtex bis 1333 dtex (etwa 900 bis 1200 Denier) besitzt, und daß zwei Umhüllungen (12, 14) aus Synthesefaser um den Kern gewickelt sind, wobei eine Umhüllung (12) zusätzlich eine Faser aus hochfestem Flüssigkristallpolymer enthält mit einem anfänglichen Zugmodul von mindestens 540 Gramm pro dtex (600 Gramm pro Denier) und einer Garnnummer zwischen etwa 222 dtex und 889 dtex (zwischen etwa 200 und 800 Denier), und der Gesamtdurchmesser des Garns nicht mehr als etwa 1,27 mm beträgt. 55
9. Schneidfestes Garn nach Anspruch 2, dadurch gekennzeichnet, daß jedes der Filamente der Kernfaser (20, 30, 30') eine Garnnummer von 4,4 dtex bis 556 dtex (4 bis 500 Denier) besitzt.
10. Schneidfestes Kleidungsstück (A), das aus dem Garn (B, C, D) nach einem der Ansprüche 1-9 gestrickt ist.
11. Schneidfester Handschuh (A), der aus dem Garn (B, C, D) nach einem der Ansprüche 1-9 gestrickt ist.

Revendications

1. Fil (C, D) résistant à la coupe et convenant au tricotage, ayant une fibre (20, 30, 30', 37) d'âme (10, 30, 30', 37) et un fil de revêtement (12, 32, 32'), caractérisé en ce que le fil de revêtement est un enroulement en hélice d'une fibre multifilaments de synthèse qui est au contact de l'âme et qui a une ténacité supérieure à 9 g/dtex (10 grammes par denier), et l'une des fibres de synthèse du fil de revêtement ou la fibre de l'âme est un polymère cristallin liquide de résistance mécanique élevée ayant un module initial de traction d'au moins 540 g/dtex (600 grammes par denier) et ayant une dimension de 222 à 1 667 dtex (denier d'environ 200 à 1 500).
2. Fil (C, D) résistant à la coupe selon la revendication 1, caractérisé par un enroulement supplémentaire

- (14, 34, 34') de fibres de synthèse, les brins de l'enroulement ayant une dimension d'environ 222 à 1 111 dtex (denier d'environ 200 à 1 000) et une résistance à la traction supérieure à 7 730 kg/cm², et la fibre d'âme ne comprend pas plus de 50 filaments. 5
3. Fil (C, D) résistant à la coupe selon la revendication 1, caractérisé par trois enroulements (32, 34, 36 ; 32', 34', 36') dont l'un (32, 32') est formé d'une fibre de résine aramide de résistance mécanique élevée ayant une dimension de 222 à 1 667 dtex (denier d'environ 200 à 1 500), un autre (34, 34') est une fibre de polyéthylène étiré de résistance mécanique élevée ayant une dimension comprise entre 222 et 1 667 dtex (denier d'environ 200 à 1 500), et l'enroulement externe (36, 36') et une fibre de synthèse ayant une dimension de fil d'environ 222 à 1 111 dtex (denier d'environ 200 à 1 000), et le diamètre total du fil ne dépasse 1,27 mm (0,05 pouce). 10 15 20
4. Fil (B) résistant à la coupe selon la revendication 1, caractérisé en ce que l'âme (10) possède un fil métallique souple (16, 18) dont le diamètre est compris entre environ 0,051 et 0,254 mm, et l'enroulement (12 ou 14) de fibre de synthèse est une fibre de polymère cristallin liquide de résistance mécanique élevée ayant une dimension de 222 à 1 333 dtex (denier d'environ 200 à 1 200). 25 30
5. Fil (B) résistant à la coupe selon la revendication 4, caractérisé par un second enroulement (14) d'une fibre de polymère cristallin liquide de résistance mécanique élevée, et dans lequel les deux enroulements ont un module initial de traction d'au moins 540 g/dtex (600 grammes par denier). 35
6. Fil (B) résistant à la coupe selon la revendication 4, caractérisé en ce que l'âme (10) comprend au moins deux et au plus six brins (16, 18) de fil d'acier inoxydable totalement recuit ayant un diamètre compris entre environ 0,051 et 0,152 mm. 40
7. Fil (B) résistant à la coupe selon la revendication 4, caractérisé en ce que le diamètre total du fil ne dépasse pas 1,27 mm environ. 45
8. Fil (B) résistant à la coupe selon la revendication 4, caractérisé en ce que la fibre de polymère cristallin liquide de résistance mécanique élevée se trouve dans l'âme (10) et a un module initial de traction d'au moins 540 g/dtex (600 grammes par denier) et une dimension de fil d'environ 1 000 à 1 333 dtex (denier d'environ 900 à 1 200), et il comporte deux enroulements (12, 14) de fibres de synthèse formés autour de l'âme, un premier enroulement (12) ayant une fibre supplémentaire de polymère cristallin liquide de résistance mécanique élevée ayant un module initial de traction d'au moins 540 g/dtex (600 grammes par denier) et une dimension de fil comprise entre environ 222 et 889 dtex (denier d'environ 200 à 800), et le diamètre total du fil ne dépasse pas 1,27 mm environ. 50 55
9. Fil résistant à la coupe selon la revendication 2, caractérisé en ce que chacun des filaments de la fibre d'âme (20, 30, 30') a une dimension de fil comprise entre 4,4 et 556 dtex (denier compris entre 4 et 500).
10. Article d'habillement (A) résistant à la coupe, tricoté à partir du fil (B, C, D) selon l'une quelconque des revendications 1 à 9.
11. Gant (A) résistant à la coupe tricoté à partir du fil (B, C, D) selon l'une quelconque des revendications 1 à 9.

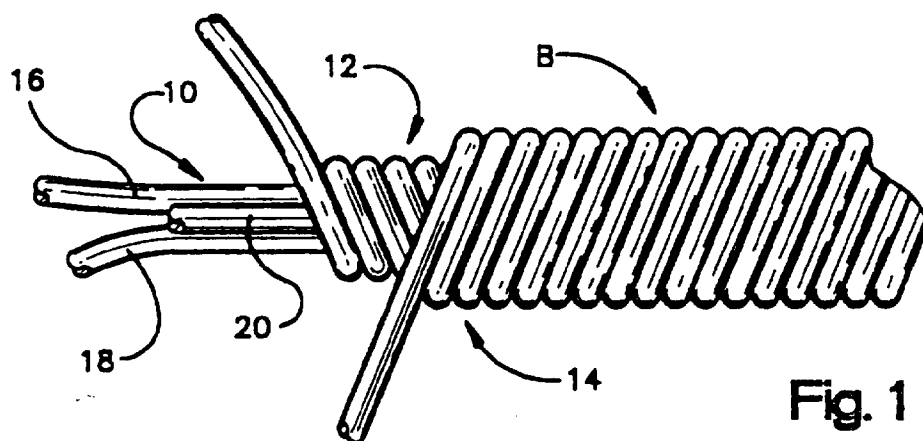


Fig. 1

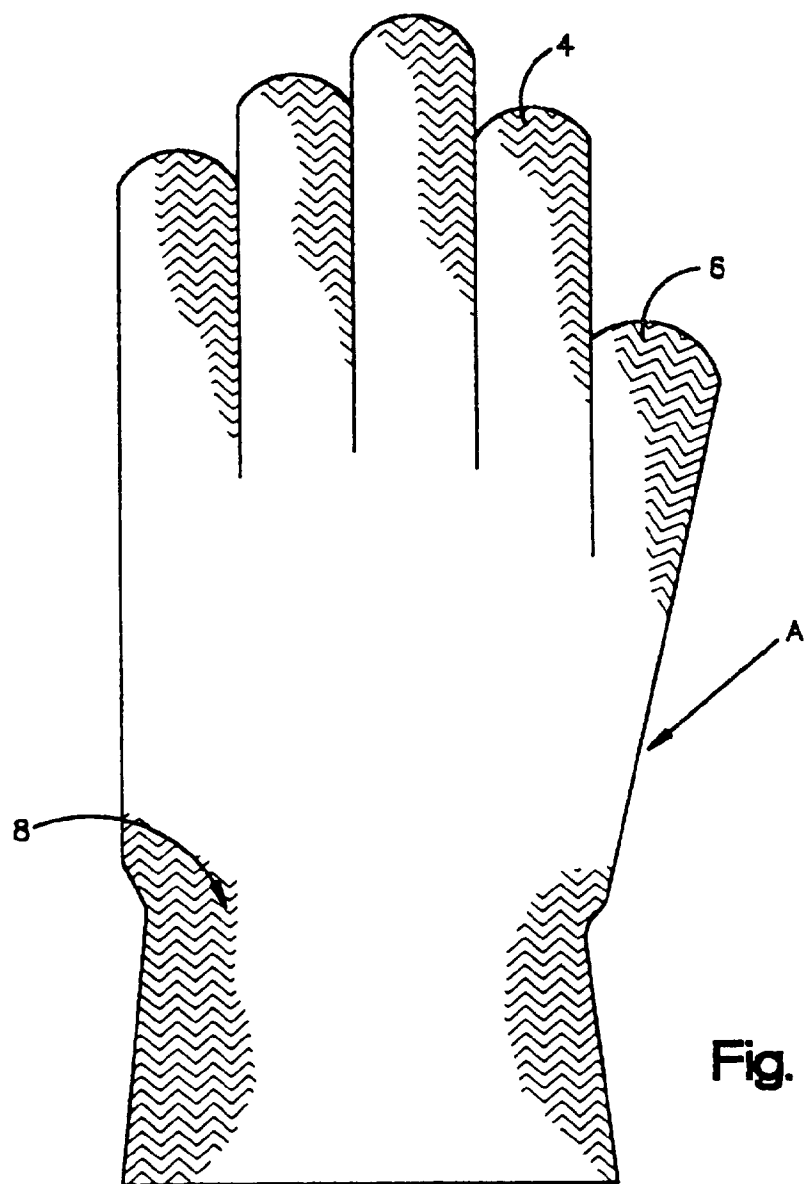


Fig. 4

