US 20070062173A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2007/0062173 A1**

Hummel (43) **Pub. Date: Mar. 22, 2007**

(54) **CUT AND ABRASION RESISTANT YARN AND PROTECTIVE GARMENT MADE THEREFROM**

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(21) Appl. No.: **11/210,336**

(22) Filed: **Aug. 24, 2005**

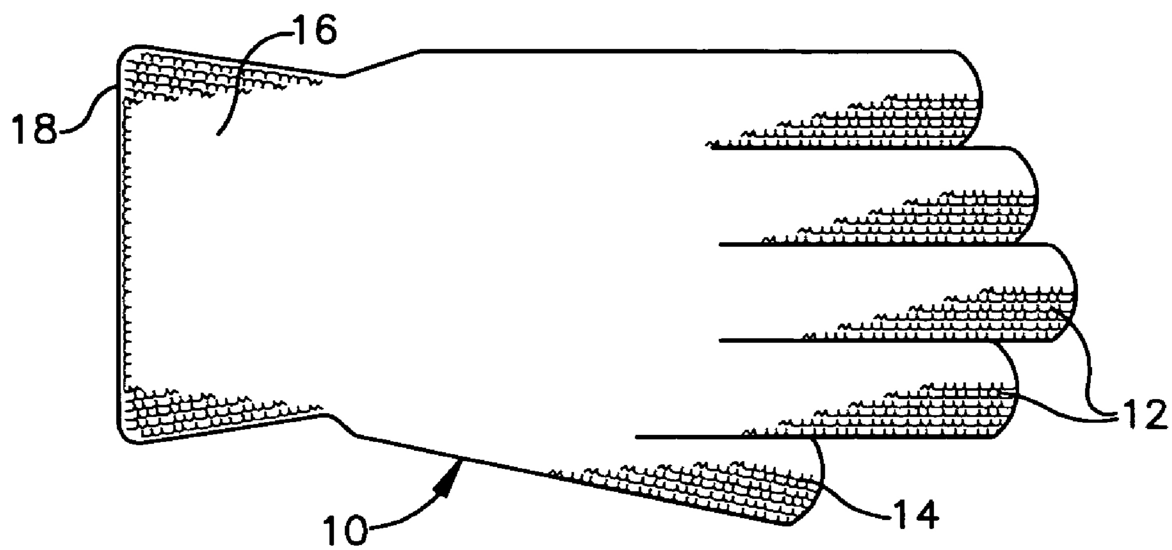
Publication Classification

(51) **Int. Cl.**
D02G 3/36 (2006.01)

(52) **U.S. Cl.** **57/210**

(57) **ABSTRACT**

Provided is a cut and abrasion resistant yarn and safety garment made from such yarn. The yarn includes a cut-resistant core material, covered by a first wrap having at least one strand of a polymeric material wrapped about the core. A second wrap is included and is wrapped about the first wrap in an opposite direction. The second or outer wrap includes at least one strand having a low coefficient of friction. Also provided is a method of making a protective garment from the inventive yarn wherein the protective garment has increased cut and abrasion resistance.



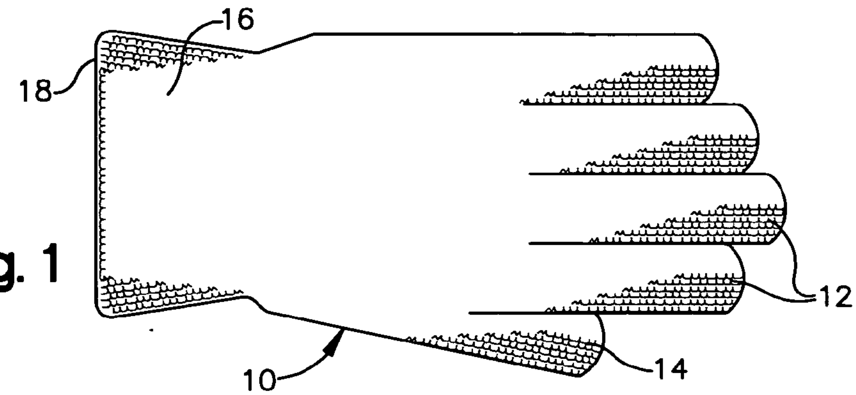


Fig. 1

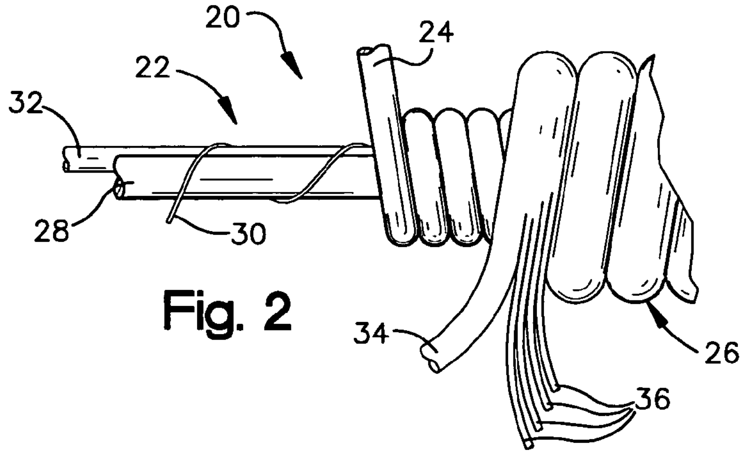


Fig. 2

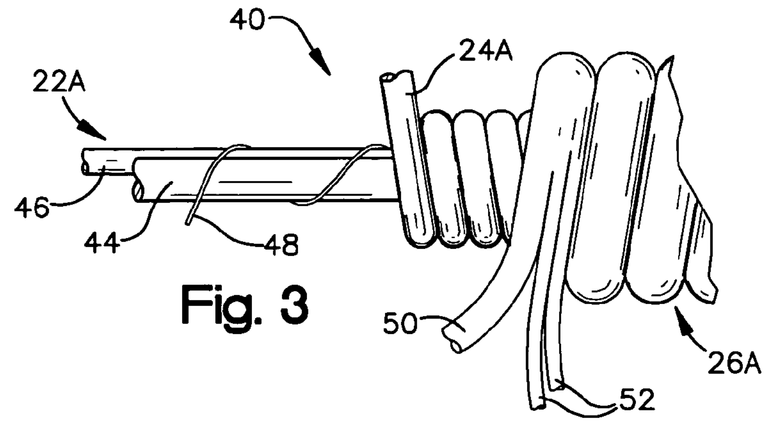


Fig. 3

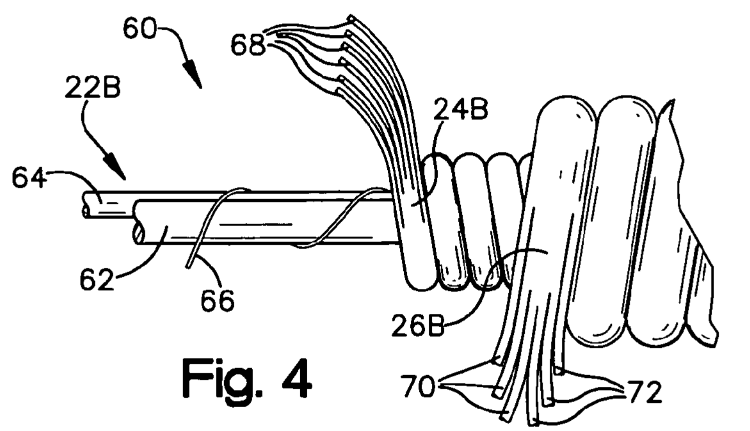


Fig. 4

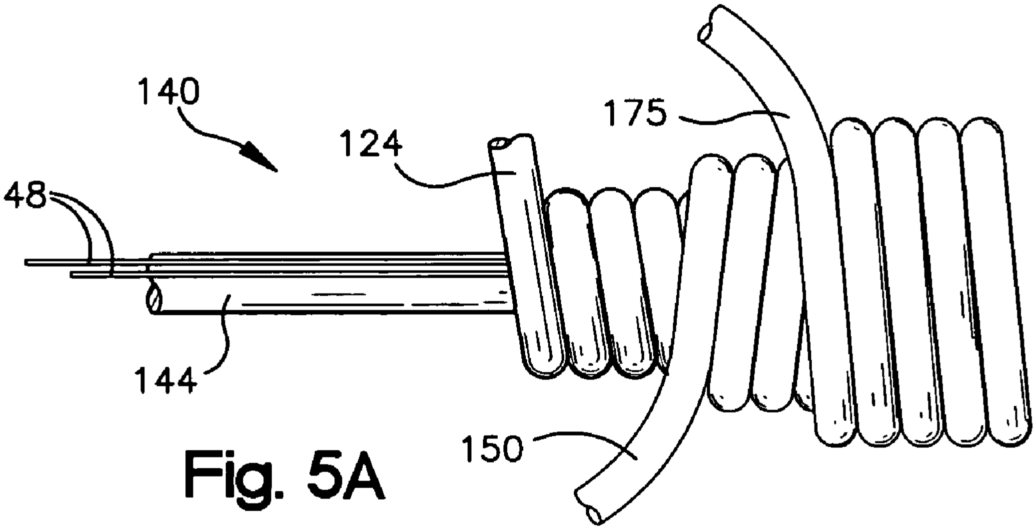


Fig. 5A

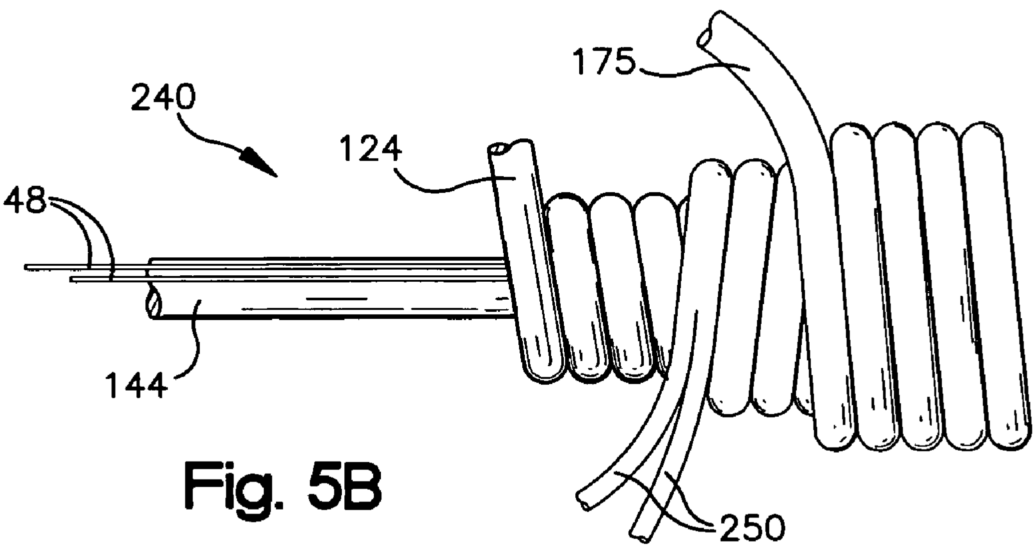


Fig. 5B

CUT AND ABRASION RESISTANT YARN AND PROTECTIVE GARMENT MADE THEREFROM

FIELD OF THE INVENTION

[0001] The present invention relates to yarn for machine knitting and to safety garments made with the yarn.

BACKGROUND

[0002] Gloves and other protective apparel are typically worn by individuals handling and processing food, such as individuals working in the meat packing industry. Preferably, the gloves should be cut-resistant to maximize the useful life of the glove and to provide a degree of protection to the wearer against injury. In addition, the glove should not overly limit the wearer's needed dexterity and tactile sensitivity.

[0003] The disclosure of U.S. Pat. No. 4,651,514 issued to Collett provides an example of a cut-resistant yarn. The disclosed cut-resistant yarn has a core of nylon with a first wrap of an aramid fiber and a second wrap of a textured nylon.

[0004] An example of a cut-resistant glove is provided by the disclosure of U.S. Pat. No. 5,568,657 issued to Cordova et al. "Comparative Example 10" of the Cordova patent discloses a yarn having a core of ECG 75 fiberglass filaments and 650 denier SPECTRA. overwrapped with counter opposing helixes of 650 denier SPECTRA. SPECTRA. is the name of a high-density polyethylene fiber manufactured by Honeywell. "Comparative Example 12" of the Cordova patent discloses a yarn having a core of ECG **75** fiberglass filaments and a 500 denier polyester fiber overwrapped with counter opposing helixes of the same 500 denier polyester fiber. Although the above referenced cut-resistant yarns, gloves and apparel are satisfactory for their intended purposes, there is a need for a yarn which provides both cut-resistant and abrasion-resistant properties. Protective gloves are quickly worn by sharp instruments, not just by direct contact of the instrument with the glove but also by "scratching" by the instrument over the glove. This "scratching" causes instruments to abrade the glove, thus, decreasing the useful life of the glove or garment.

SUMMARY OF THE INVENTION

[0005] The present invention provides a cut and abrasion resistant, knittable composite yarn that utilizes a strand or fiber that has incorporated therein a material that causes the outer surface of the fiber or strand to have lower coefficient of friction than fibers or strands of comparable denier and weight. A preferred suitable yarn is of a diameter suitably for machine knitting and is flexible enough to be used for making protective gloves. Preferably, the yarn is of composite construction utilizing synthetic fibers and a cut-resistant material as part of the core.

[0006] In the preferred embodiment, the yarn comprises a core having at least one fiber of a cut-resistant material within the core. The material of the core can be any cut resistant material such as but not limited to polyethylene, fiberglass and metal wire and can be any combination of cut-resistant materials as know to those of skill in the art. In one embodiment, the core includes a strand of polyethylene, a stand of fiberglass material and stainless steel wire. The polyethylene that is typically employed has a denier in the range from about 215 to about 1200. The fiberglass that is typically employed has a size in the range from about 150 to about 450. Further, the stainless steel wire is that typically used has a diameter of about 0.002 inches.

[0007] The preferred embodiment includes a wrap about the core that comprises at least one strand or fiber having a low coefficient of friction material. One suitable low coefficient of friction fiber is commercially know as Friction Free and is available from Friction Free Technologies, Inc. having a principal place of business at 30 East 39th Street, New York, N.Y. The low coefficient of friction material incorporates polytetrafluoroethylene which provides a lower coefficient of friction throughout the fiber. The low coefficient of friction fiber that is typically used has a denier of about 70. In another embodiment, the low coefficient of friction material may be combined with other materials, such as but not limited to polyester, to make up a wrap about the core. In yet another embodiment, several fibers of low coefficient of friction material each having a denier of about 70, are combined with one or more polyester fibers to produce a wrap about the core. The polyester fiber combined with the low coefficient of friction material preferably has a denier ranging from about 70 to about 300.

[0008] In yet another embodiment, the yarn of the present invention includes a first wrap about the core and a second wrap about the first wrap where the second wrap includes the low coefficient of friction material. Preferably, the first wrap comprises at least one or more polyester fibers having a denier ranging from about 70 to about 420. This first wrap is wrapped about the core at a rate ranging from about 8 to about 10 turns per inch. A second wrap is wrapped in an opposite direction about the first wrap and the second wrap includes at least one strand or fiber of a low coefficient of friction material. It is recognized that the second wrap can include at least one additional fiber of different material, such as polyester. The second wrap is wrapped about the first wrap at a rate of about 8 to about 10 turns per inch.

[0009] In the several embodiments of the present invention, the low coefficient of friction material, preferably, is in the outermost wrap. This allows for the greatest abrasion resistance since this material will be the first to contact any abrasive surface. However, the low coefficient of fiction material can be employed in any internal wraps or in the core to aid or increase the cut and/or abrasion resistance of the garment. For instance, if a low coefficient of friction material is placed in the core it is also preferable to have the low coefficient of friction material in the outer wrap although it is not necessary.

[0010] The fibers used in conjunction with the low coefficient of friction fibers are preferably polyester due to its comfort and lower cost. However, other fibers and cut-resistant fibers such as spun Kevlar, normal spun fibers, acrylic, liquid crystal polymer, polyolefin and the like may be employed along with the low coefficient of friction fibers. As is apparent to those of ordinary skill in the art in view of this disclosure, any combination of known cut-resistant fibers and any configuration may be employed with the low coefficient of friction fibers.

[0011] The present invention is also directed to a method of making a cut and abrasion resistant garment, such as a glove, including a low coefficient of friction material. The method preferably includes the steps of providing a knittable, cut and abrasion resistant yarn comprising a cut-resistant core having at least one cut-resistant fiber, a first wrap about the core wherein said first wrap includes at least one fiber of a polyester material; and a second wrap about said first wrap wherein said second wrap includes at least one fiber including a low coefficient of friction material. The yarn is then knitted on a knitting machine in the form of a cut resistant garment such as a glove.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** is a diagrammatic view of an article of apparel, i.e., a knitted glove, made of yarn embodying the present invention and shown in FIGS. **2** through **4**;

[0013] FIG. **2** is a fragmentary, diagrammatic view of a first yarn embodying the features of the present invention;

[0014] FIG. **3** is a fragmentary, diagrammatic view of a second yarn embodying the features of the present invention;

[0015] FIG. **4** is a fragmentary, diagrammatic view of a third yarn embodying the features of the present invention;

[0016] FIG. **5**A is a fragmentary, diagrammatic view of a prior art yarn for comparison purposes; and

[0017] FIG. **5**B is a fragmentary, diagrammatic view of a fourth yarn embodying the features of the present invention.

DETAILED DESCRIPTION

[0018] The glove **10** depicted in FIG. **1** is exemplary of a safety article of apparel embodying the yarn of 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. The glove is knitted from a multi-strand composite yarn in accordance with FIGS. **2**-**4** and **5**B. The glove **10** includes the usual finger and thumb stalls, **12** and **14**, respectively, and a wrist portion **16** incorporating an elastic thread or yarn and a cuff trim overwrapping **18**. The glove **10** is made using conventional methods and glove knitting machinery, such as a Shima Seiki glove knitting machine.

[0019] FIGS. **2**-**4** and **5**B illustrate different embodiments incorporating the features of the present invention. Turing first to FIG. **2**, a yarn **20** comprises a core **22**, a first wrap about the core **24** and a second wrap **26** about the first wrap **24**. The wrappings **24** and **26** include synthetic fibers and are wound about the core **22**. The second wrapping **26** is wrapped about the core **22** in an opposing direction than that of the first wrapping **24**. The fact that each wrappings **24**, **26** is wrapped about the core in an opposite direction than the previous wrapping has been known to balance 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 **22**. The core **22** includes a strand **28** of a polyolefin material such as polyethylene (known in the industry as Spectra) having a denier of about 650, a second strand **30** being stainless steel wire having a diameter of about 0.002 inches, and a third strand **32** being a 150 denier fiberglass material. The strand **28** and the third strand **32** typically lay side by side having the second strand **30** of stainless steel wire wrapped about the first strand **28** and third strand **32** to complete the makeup of the core **22**.

[0020] The first wrapping **24** is a single strand of 420 denier polyester wrapped at a rate of 8-10 turns per inch about the core **22**. The second wrapping **26** or outer wrap is wrapped about the first wrap **24** in an opposite direction as the first wrap **24** at a rate of 8-10 turns per inch. The second wrap **26** includes a first fiber **34** of 220 denier polyester and four additional fibers **36** each having a low coefficient of friction material and each fiber having a denier of 70. The fibers **34** and **36** of the second wrap can be intertwined or separate, depending on what effects are desired. The low coefficient of friction fibers **36** are typically extruded, impregnated, laminated or coated with a low coefficient of friction material added during the process of making the fiber. Typically the low coefficient of friction material is polytetrafluoroethylene or commonly known and sold under the tradename Teflon®. The construction of the low coefficient of friction fibers is further detailed in U.S. Pat. No. 6,596,207 to Gunn and U.S. Pat. No. 6,143,368 to Gunn, both of which are hereby incorporated by reference in their entirety. The yarn illustrated in FIG. **2** may be employed with a 13 gauge Shima knitting machine to knit a cut and abrasion resistant glove.

[0021] FIG. **3** sets forth a second embodiment incorporating the features of the present invention. An alternative yarn **40** of the present invention includes a core part **22**A having a strand **44** of a polyolefin material such as polyethylene (known in the industry as Spectra) having a denier of 1200, a second strand **46** being a 150 size fiberglass material, and a third strand **48** being a 0.002 inch diameter stainless steel wire. The first strand **44** and the second strand **46** typically lay side by side with the third strand **48** of stainless steel wire wrapped about the first strand **44** and second strand **46** to complete the makeup of the core **22**A. A first wrap **24**A about the core **22**A is a polyester material that has a denier of about 420 and is wrapped about the core **22**A at a rate of about 8-10 turns per inch. A second wrap **26**A includes three fibers of material. The first fiber **50** is a polyester material having a denier of 300. The second and third fibers **52** are fibers which incorporate a low coefficient of friction material where each fiber has a denier of about 70. The fibers **50** and **52** of the second wrap **26**A can be intertwined with each other or wrapped separate, depending on the desired effects. The second wrap **26**A is wrapped about the first wrap **24**A in an opposite direction at a rate of 8-10 turns per inch. The yarn illustrated in FIG. **3** may be employed with a 7 gauge Shima knitting machine to knit a cut and abrasion resistant glove.

[0022] FIG. **4** illustrates a yarn of a third embodiment **60** having a core **22**B, a first wrap **24**B about the core **22**B and a second wrap **26**B about the first wrap **24**B. The core **22**B includes a first strand **62** of a 450 size fiberglass material, a second strand **64** of a polyolefin material such as polyethylene (known in the industry as Spectra) that has a denier of 215, and a third strand **66** being stainless steel wire having a diameter of 0.002 inches. The first strand **62** and the second strand **64** typically lay side by side having the third strand **66** of stainless steel wire wrapped about the first strand **62** and second strand **64** to complete the makeup of the core **22**B. A first wrap **24**B is wrapped about the core **22**B and is made up of six strands **68** of polyester material where each individual strand has a denier of 70. The first wrap **24**B is wrapped about the core at a rate of 8-10 turns per inch. A second and outer wrap **26**B is wrapped about the first wrap **24**B and includes three strands **70** of polyester material each strand having a denier of **70** and three strands **72** of a material having a low coefficient of friction where each strand of low coefficient of friction material has a denier of 70. The second wrap **26**B is wrapped about the first wrap **24**B at a rate of 8-10 turns per inch in an opposite direction as the first wrap **24**B. The yarn illustrated in FIG. **4** may be employed with a 10 gauge Shima knitting machine to knit a cut and abrasion resistant glove.

[0023] While specific deniers and other features of the preferred embodiments have been set forth, different values can be selected within acceptable ranges to provide useful cut-resistant yarns. The specific values selected will of course cause a variation in cut-resistance, flexibility, weight and thickness of the yarn and the fabric knitted therefrom, and cost. The preceding embodiments employ fibers having specific deniers, however, other known fibers may be used in their place. The cut-resistance of a yarn employing a metal wire is in part a function of the diameter of the metal wire. Multiple strands are advantageous for flexibility over one larger strand or the one strand of wire is combined with other strands of polymeric fibers. Other kinds of metal other than stainless steel may be employed, such as aluminum, copper, bronze and steel. Stainless steel wire as used in the present invention has a diameter of about 0.002. Thicker diameters may be used where increased cut resistance is desired and smaller diameters may be employed where flexibility is more desired over cut-resistance. The various wrappings about the core can have from 2-20 turns per inch. Metal strands can also be employed in the wrappings and can have from 2 to 12 turns per inch. The core bundling wrappings, if present, can have from 2 to 20 turns per inch. The first wrapping about the core and additional wrappings will have from 8 to 12 turns per inch. Further, in the preceding embodiments, a wrap that include several fibers of one or more materials each having the same or different deniers, the sum of the deniers of each fiber equals the total denier of the wrap. For instance, with regard to the third embodiment, the outer wrap **26**B has a total of six strands of fibers each having a denier of 70 for a total denier of the outer wrap **26**B of about 420.

[0024] The depicted glove **10** in FIG. **1** when knit from any of the yarns illustrated in FIGS. **2-4** is a safety glove especially advantageous for use in the food processing industries and is highly cut and abrasion resistant, readily cleanable at high temperatures, comfortable to wear, attractive appearing, flexible and relatively non-absorbent, all of which are important in the food processing industry. The glove is highly chemical-resistant and fatigue resistant, and 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. The following example compares the performance of a glove constructed with low friction yarn that is shown in FIG. **5**B with a glove constructed of standard yarn that is shown in FIG. **5**A. Both yarns had a 650 Spectra core **144** including two strands of 0.003 stainless steel wire **148** followed by a first wrap of 400 Kevlar **124** at 12 turns per inch and a third wrap **175** of 440 polyester at 8 turns per inch. The standard yarn includes a second wrap **150** of 650 Spectra at 8 turns per inch (FIG. **5**A) while the low friction yarn includes a second wrap **250** of two strands of the low friction fiber at 8 turns per inch (FIG. **5**B).

EXAMPLE 1

[0025]

Glove Made of Standard Yarn	Glove Made with Low Friction Yarn
Core: 650 Spectra & 2/0.003 SS Wire	Core: 650 Spectra & 2/0.003 SS Wire
1st Wrap: 400 Kevlar (12)	1st Wrap: 400 Kevlar (12)
2nd Wrap: 650 Spectra (8)	2nd Wrap: 300/2 Friction Free (8)
3rd Wrap: 440 Polyester (8)	3rd Wrap: 440 Polyester (8)
Cut Test	
CPPT(grams): 6591	CPPT(grams): 6314
CPPT(lbs.): 14.49	CPPT(lbs.): 13.89
Abrasion	
Weight Loss (1000 cycles) 0.45	Weight Loss (1000 cycles) 0.33
Total cycles: 9350	Total cycles: 10,500

[0026] As can be seen from the test results above, the glove made with the low friction yarn exhibited a significant improvement in abrasion resistance while still maintaining acceptable cut resistance.

[0027] While the yarn of the invention has been described and shown incorporated into a knit 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 industries where cut and abrasion resistant safety apparel is needed.

1. A knittable cut-resistant yarn for use in protective wear comprising:

a core having at least one fiber of cut-resistant material; and

at least one wrap wrapped about the core wherein an outermost one of said at least one wrap includes at least one fiber comprising a low coefficient of friction material.

2. The yarn of claim 1 wherein said low coefficient of friction material comprises a polytetrafluoroethylene coating.

3. The yarn of claim 1 wherein said low coefficient of friction material comprises extruded polytetrafluoroethylene.

4. The yarn of claim 1 wherein said cut-resistant fiber of the core is selected from the group consisting of a polyethylene strand, a fiberglass strand, and a stainless steel wire.

5. The yarn of claim 4 wherein said stainless steel wire has a diameter of about 0.002 inches.

6. The yarn of claim 4 wherein said polyethylene strand has a denier ranging from about 215 to about 1200.

7. The yarn of claim 4 wherein said fiberglass strand has a size ranging from about 150 to about 450.

8. The yarn of claim 1 wherein said outermost wrap includes a plurality of fibers of a low coefficient of friction material and a plurality of fibers of a second material.

9. The yarn of claim 8 wherein said second material is polyester.

10. The yarn of claim 9 comprising three fibers of a low coefficient of friction material, each fiber of the low coefficient of friction material having a denier of about 70, and three fibers of a polyester material, each polyester fiber having a denier of about 70.

11. The yarn of claim 9 comprising two fibers of a low coefficient of friction material, each fiber of the low coefficient of friction material having a denier of about 70, and one fiber of a polyester material having a denier of about 300.

12. The yarn of claim 9 comprising four fibers of a low coefficient of friction material, each fiber of the low coefficient material having a denier of about 70, and one fiber of a polyester material having a denier of about 220.

13. (canceled)

14. The yarn of claim 1 wherein said at least one wrap comprises a polyester material having a denier of about 420.

15. The yarn of claim 1 wherein said at least one wrap comprises six fibers of a polyester material, each fiber of the polyester material having a denier of about 70.

16. The yarn of claim 1 wherein said at least one wrap comprises two strands of the low coefficient of friction material, each strand having a denier of about 300.

17. A method of constructing a cut and abrasion resistant glove comprising the steps of:

providing a knittable cut and abrasion resistant yarn comprising

a core comprising at least one cut-resistant fiber and

at least one wrap wrapped about the core, an outermost one of said at least one wrap including at least one fiber comprising a low coefficient of friction material; and

knitting said yarn on a knitting machine in the form of a glove.

18. The method of claim 17 wherein said low coefficient of friction material comprises a polytetrafluoroethylene coating.

19. The method of claim 17 wherein said low coefficient of friction material comprises extruded polytetrafluoroethylene.

20. A knittable cut-resistant yarn for use in protective wear comprising a core having at least one fiber of cut-resistant material, and a single wrap wrapped about the core and including at least one fiber comprising a low coefficient of friction material.

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