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Lilani(10) **Pub. No.: US 2005/0186875 A1**(43) **Pub. Date: Aug. 25, 2005**(54) **FIREFIGHTER GARMENT OUTER SHELL
FABRIC UTILIZING CORE-SPUN DREF
YARN****Publication Classification**(51) **Int. Cl.⁷ D03D 15/00; D03D 25/00**(52) **U.S. Cl. 442/189; 442/181; 442/190;
442/301**(75) **Inventor: Harish N. Lilani, Lafayette Hill, PA
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(57) **ABSTRACT**

The present invention is directed to a fabric that is particularly well suited for use as the outer shell fabric of the firefighter's garment. The preferred fabric is 40% Melamine formaldehyde (Basofil) and 60% Para-Aramid (Kevlar) woven of spun yarns and core-spun DREF yarns. The core spun yarn includes one or more filament cores selected from a polymer group consisting of PBO, Aramid, Liquid Crystal Polymer (LCP), Carbon and P-84, with or without a fine metallic wire co-core, and a staple sheath blend consisting of one or more fibers selected from a group consisting of Meta-Aramid, Para-Aramid, Copolyamide, PBI, PBO, P-84, Carbon, Kynol, PFR Rayon and/or Modacrylic fibers.

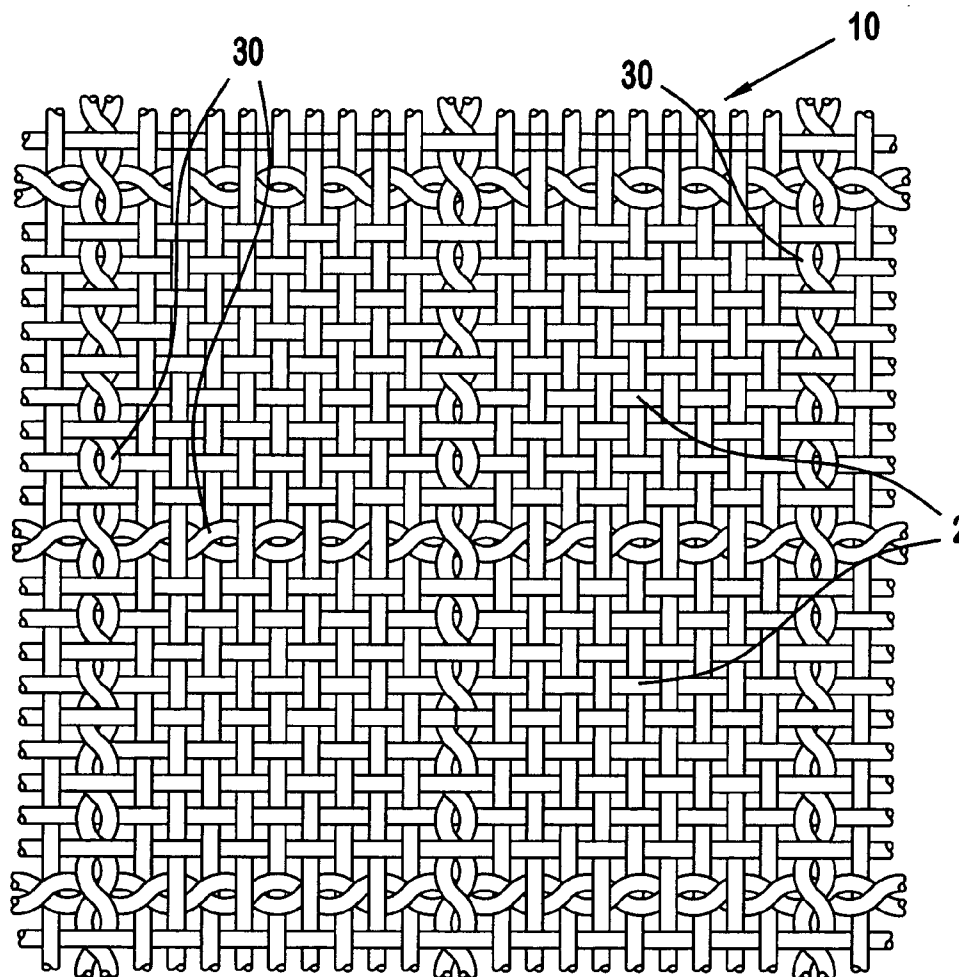
(73) **Assignee: Norfab Corporation, Norristown, PA**(21) **Appl. No.: 11/050,215**(22) **Filed: Feb. 3, 2005****Related U.S. Application Data**(60) **Provisional application No. 60/541,314, filed on Feb.
3, 2004.**

FIG. 1

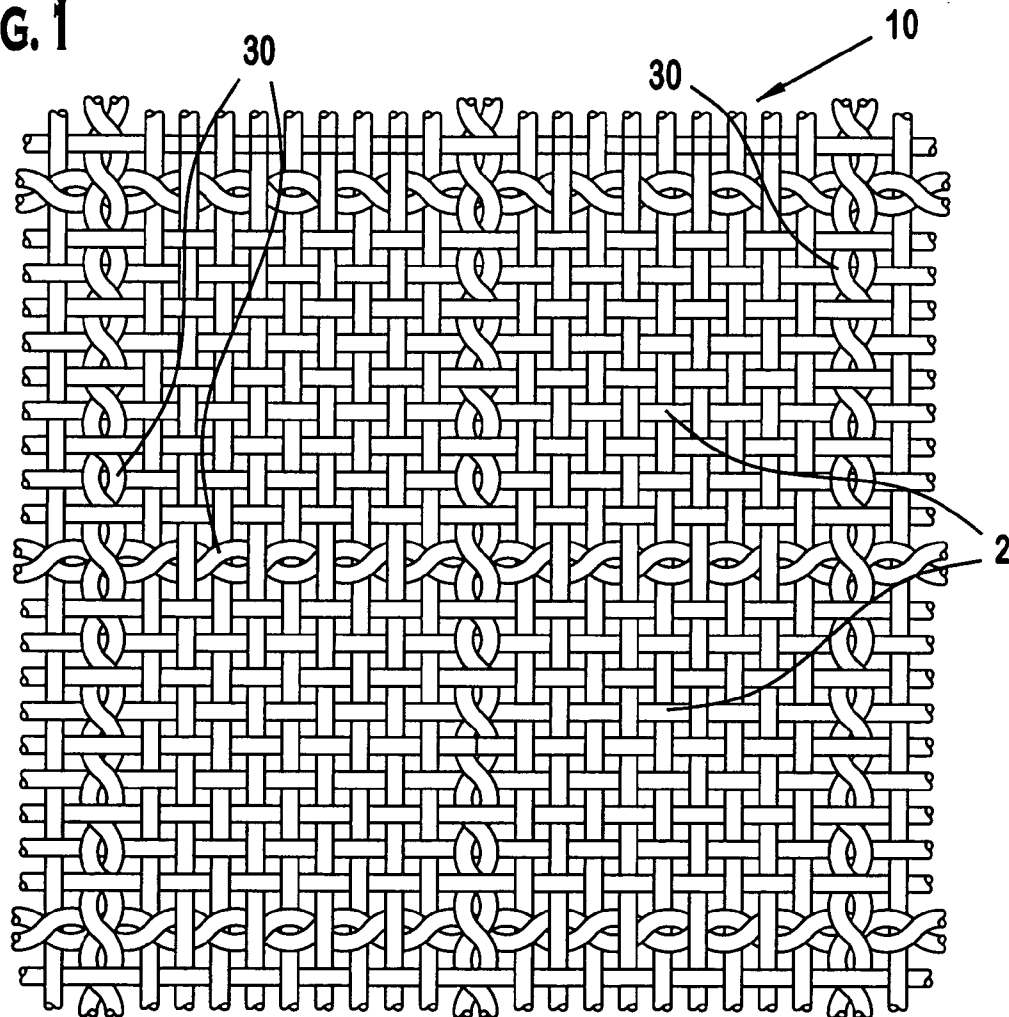
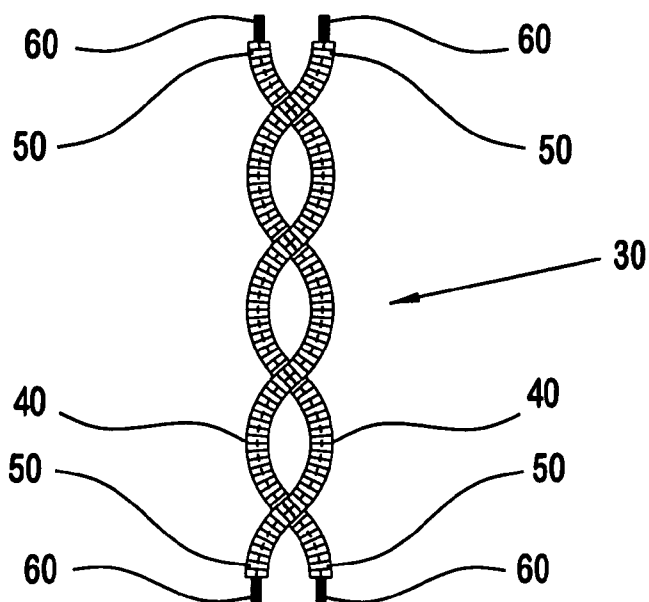


FIG. 2



FIREFIGHTER GARMENT OUTER SHELL FABRIC UTILIZING CORE-SPUN DREF YARN

CROSS REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims the benefit of U.S. provisional application No. 60/541,314, filing date Feb. 3, 2004 which is incorporated by reference as if fully set forth.

FIELD OF INVENTION

[0002] Firefighting turnout garments are primarily comprised of three layers of fabrics. The outermost fabric layer is a sturdy, water repellent fabric known as the outer shell. The middle fabric layer is a thin breathable fabric and is known as the moisture barrier. The innermost fabric layer is generally a bulky fabric and is known as the thermal liner. Each of the fabric components, as well as firefighting turnout garments made using these three components, must meet minimum performance criteria which are set forth in the National Fire Protection Association (NFPA) 1971 Standard on Protective Ensemble for Structural Firefighting, 2000 Edition. Under the NFPA 1971-2000 standard, the outer shell must meet the minimums for flame-resistance, thermal shrinkage resistance, heat resistance, cleaning shrinkage, tear resistance, water absorption resistance and breaking strength resistance before and after five to ten laundering cycles.

[0003] Most outer shell fabrics are made from high-heat and flame resistant fibers such as Basofil® (melamine), Nomex® (meta-aramid), Kevlar® (para-aramid), P-84™ (copolyimide), PBI® (polybenzimidazole), PBO (poly-p-phenylenebismisoxazole), Carbon and Technora® (para-aramid) and Kynol™ (phenol) or a blend thereof. One commonly used fabric is made from a blend of 40% PBI® (polybenzimidazole) fibers and 60% Kevlar® (para-aramid) fibers. PBI® (polybenzimidazole) fiber is used for its heat and flame resistance and para-aramid fibers are used for their strength and wear resistance. Most outer shell fabrics are produced from staple fibers made into ring-spun yarns, however, it is also known to use certain filament yarns. Most outer shell fabrics range in weight from six to eight ounces per square yard (6 to 8 OSY) and the yarns are in a cotton count ranging from 14/2 to 22/2. The fabrics typically have common weave patterns, such as plain or twill, which include a rip-stop weave in the pattern. The rip-stop weave provides tear resistance and suitable tensile properties.

[0004] Under the NFPA 1971-2000 Standard, the minimum trap tear values for the outer shell fabric must be at least 22 lbs. in the warp and filling direction before and after five laundering cycles. Generally, outer shell fabrics made from the blends of Meta-Aramid, Para-Aramid, Copolyimide, Poly-P-Phenylenebismisoxazole, and Carbon fibers meet the minimum trap tear requirements. It is a common practice to achieve higher trap tear values by employing the principles of "rip stop weave" which incorporates the use of multi-end and/or stronger yarns in the rip stop weave portion of the outer shell fabric. Generally, the design of the rip stop weave varies depending on the yarn count, weave construction, fabric weight and fiber blend. However, it is known to incorporate the rip stop weave in the warp direction of the outer shell fabric every six to twelve ends and in the filling direction every six to twelve picks. Thus, the distribution of

the rip stop weave yarn in the body of the outer shell fabric provides adequate trap tear values.

[0005] U.S. Pat. No. 5,299,602 discloses a woven outer shell fabric made for firefighter garments where the warp yarns are multi-filament aramid yarns and the weft yarns are either multi-filament or spun aramid yarns. The use of "bare" multi-filament yarns in the structure of the fabric is disclosed.

[0006] U.S. Pat. Nos. 6,065,153 and 6,192,520 disclose a woven outer shell fabric for a firefighter garments. The disclosed fabric has a plain, twill or rip stop weave and the yarns are a mixture of PBI and aramid fibers.

[0007] One popular outer shell fabric is a woven fabric of spun yarns consisting of 40% Basofil and 60% Para-Aramid fiber blend. This outer shell fabric produced in plain or twill construction by NOR*FAB Corporation is marketed under the brand name "OMNI 45". This rip stop fabric is made from 16.3/2 cc. spun yarns consisting of 40% Basofil and 60% Para-Aramid fibers by weight. The fabric construction employs 43 ends/inch with every tenth end being 2 ends of 16.3/2 cc. yarn and 35 picks/inch with every eighth pick being 2 ends of 16.3/2 cc. yarn to create a rip stop weave structure in the warp and filling direction of the fabric.

[0008] U.S. Pat. No. 6,624,096 B2 discloses a woven fabric of spun yarns and "bare" multi-filament yarns which include an aramid filament. The weight ratio of said spun yarn to said multi-filament yarn ranges from 85:15 to 92:8 with the filament count ranging from 200 to 1500 denier. The use of "bare" filament yarn in the rip stop weave of the 40% PBI/60% Kevlar fabric by the increase in the trap tear values of the fabric from 40×35 lbs. to 63×63 lbs. and also by the residual Trap Tear values of 26.6×23.6 lbs. after six weeks of the exposure to sunlight based on the ASTM D5733 method.

[0009] Although, the physical properties of the outer shell fabric with "bare" filament Aramid yarn may provide some improvement, a "bare" filament yarn is subject to the risk of being directly exposed to ultra-violet radiation, heat/flames, moisture, flexing and aging either in use or during the laundering process. This would lead to rapid filament yarn failure/fracturing and a substantial decrease in the physical properties of the outer shell fabric.

DETAILED DESCRIPTION OF THE DRAWINGS

[0010] For the purpose of illustrating the invention, there is shown in the drawings a preferred form of the invention; however, the invention is not limited to the precise arrangements and instrumentalities shown.

[0011] FIG. 1 is a plane view of the outer shell fabric made according to the present invention.

[0012] FIG. 2 is a magnified view of a 2-ply DREF Core-Spun yarn used in the design of the outer shell fabric.

DESCRIPTION OF THE INVENTION

[0013] Referring to the drawings wherein like numerals indicate like elements there is shown in FIG. 1 an illustration of the outer shell fabric 10 made according to the present invention. When woven, the fabric 10 has a pale yellow color with a "raised checkered" pattern created by the 2-ply DREF core spun rip stop yarn 30, however, the

woven fabric **10** is generally dyed to black, yellow, tan and/or navy blue colors. The fabric **10** is preferably woven with spun yarns **20** and 2-ply DREF core spun rip stop yarns **30**. The fabric **10** preferably weighs approximately 7.8 OSY and is woven in both plain and rip stop weaves, however, the fabric weight can range from 6 to 9 OSY, and be constructed with weaves selected from the group consisting of plain, twill, rip stop, satin, herringbone and oxford.

[0014] The DREF core-spun yarn maybe inserted among the spun yarns in, both the warp and weft, at an insertion ratio of 1:4 to 1:25, and preferably at 1:9. Generally, the fabric is treated with a suitable water/moisture resistant finish, which is a well known treatment in the industry.

[0015] The spun yarn **20** is preferably a 16.3/2 cotton count and is made from a blend of 40% Melamine formaldehyde (Basofil)/60% Para-Aramid (Kevlar) staple fibers. The spun yarns may range in size from 36/2 to 12/2 cc., and include a first staple polymer selected from a group consisting of Meta-Aramid, Copolymer, PBI, Poly-P-Phenylenebenzobisoxazole, Carbon and Melamine formaldehyde, and a second staple of an aramid polymer.

[0016] Meta and Para-Aramid staple fibers are commercially available under the trade name of TWARON®, CONEX®, and TECHNORA® from Teijin Co. of Asaka, Japan; or NOMEX® or KEVLAR® from DuPont of Wilmington, Del.; or P-84 from Lenzing AG of Lenzing, Austria; or KERMELO® from Rhodia Inc. of Cranberry, N.J.

[0017] FIG. 2 illustrates a magnified view of the 2-ply rip stop yarn **30** used in the structure of the outer shell fabric. The 2-ply yarn **30** consists of 2 ends of the DREF core-spun singles yarn **40** twisted with approximately 3.2 twist multiplier^(TM). The resultant yarn count of the 2-ply yarn **30** is 4.7/2 cc.

[0018] The singles yarns **40** are core-spun DREF III yarns with a resultant yarn count of 9.5/1 cc. The DREF core spun yarn **40** contains a 100% filament PBO core and a sheath fiber blend **50** comprised of 40% melamine formaldehyde (Basofil)/60% para-aramid (Kevlar) sheath fiber blend. The core spun yarn **40** can be comprised of one or more filament or stretch broken spun cores selected from the polymer group consisting of PBO, Aramid, Liquid Crystal Polymer (LCP), Carbon and P-84, with or without a fine metallic wire co-core, and a staple sheath blend **50** consisting of one or more fibers selected from the group consisting of Meta-Aramid, Para-Aramid, Copolyimide, PBI, PBO, P-84, Carbon, Kynol, PFR Rayon and/or Modacrylic fibers.

[0019] Although, the preferred filament core yarn **60** is 27.8 Tex (278 d Tex), the core yarn **60** may range from 6 to 600 Tex. In the core spun yarn **40**, the ratio of filament core yarn **60** to the sheath fiber blend **50**, is approximately 45:55, however, the ratio of core yarn **60** to the sheath fiber blend **50** may be in ranges from 10:90 to 90:10.

I claim:

1. A textile fabric of interwoven yarns comprising:

a plurality of yarns that are spun yarns including staple fibers selected from the group consisting of PBI, PBO, melamine formaldehyde, P-84, Carbon and Kynol; and a plurality of core-spun DREF yarns comprised of a polymer sheath and at least one core filament.

2. The fabric of claim 1 wherein the core-spun DREF yarn core filament is selected from the polymer group consisting of PBO, Aramid, Liquid Crystal Polymer (LCP), Carbon and P-84.

3. The fabric of claim 1 wherein the core-spun DREF yarn has a sheath of staple fibers selected from the group consisting of Meta-Aramid, Para-Aramid, Copolyimide, PBI, PBO, P-84, Carbon, Kynol, PFR Rayon and Modacrylic fibers.

4. The fabric of claim 1 wherein fabric has a weight ranging from 6 to 9 OSY.

5. The fabric of claim 1 wherein its weave is selected from the group consisting plain, twill, rip stop, satin, herringbone and oxford.

6. The fabric of claim 1 wherein the core-spun DREF yarn has a Tex ranging from 11 to 1100.

7. The fabric of claim 1 wherein the core filament of the core-spun DREF yarn has a Tex ranging from 6 to 600.

8. The fabric of claim 1 wherein the DREF yarn has weight ratio of core to sheath ranging from 90:10 to 10:90.

9. A core spun Dref yarn comprised of:

at least one core filament yarn selected from the group consisting of PBO, Aramid, Liquid Crystal Polymer (LCP), Carbon and P-84; and

a sheath of staple yarns selected from the group consisting of Meta-Aramid, Para-Aramid, Copolyimide, PBI, PBO, P-84, Carbon, Kynol, PFR Rayon and/or Modacrylic fibers.

10. The yarn of claim 9 wherein the core includes at least one metallic filament.

11. The yarn of claim 9 wherein the sheath is comprised of at least two fibers selected from the group.

12. The yarn of claim 11 wherein the core includes at least one metallic filament.

13. A firefighter's turnout garment having a layer of woven fabric comprising:

spun yarns having fibers selected from the group consisting of PBI, PBO, melamine formaldehyde, P-84, Carbon and Kynol; and

core-spun DREF yarns having at least one core filament and a sheath of fibers selected from the group consisting of Meta-Aramid, Para-Aramid, Copolyimide, PBI, PBO, P-84, Carbon, Kynol, PFR Rayon and Modacrylic fibers.

14. The firefighter's turnout garment of claim 13 wherein the layer of woven fabric is an outermost layer.

15. The firefighter's turnout garment of claim 13 wherein the core yarn is metallic.

16. The firefighter's turnout garment of claim 15 wherein the layer of woven fabric is an outermost layer.

17. The firefighter's turnout garment of claim 13 wherein the layer of woven fabric is an outermost layer.

18. The firefighter's turnout garment of claim 13 wherein the spun yarn has a cotton count ranging from 36/2 to 12/2.

19. The firefighter's turnout garment of claim 13 wherein the spun yarn is a staple fiber blend of 40% Melamine formaldehyde (Basofil)/60% Para-Aramid (Kevlar).

20. The firefighter's turnout garment of claim 13 wherein the weave includes a rip stop yarn that is a 2-ply yarn consisting of two ends of DREF core spun singles yarn twisted with a twist multiplier of about 3.2.

21. The firefighter's turnout garment of claim 13 wherein the spun yarn has a cotton count of 16.3/2.

22. The firefighter's turnout garment of claim 21 wherein the weave includes a rip stop yarn that is a 2-ply yarn consisting of two ends of DREF core spun singles yarn twisted with a twist multiplier of about 3.2.

23. The firefighter's turnout garment of claim 22 wherein the layer of woven fabric is an outermost layer.

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