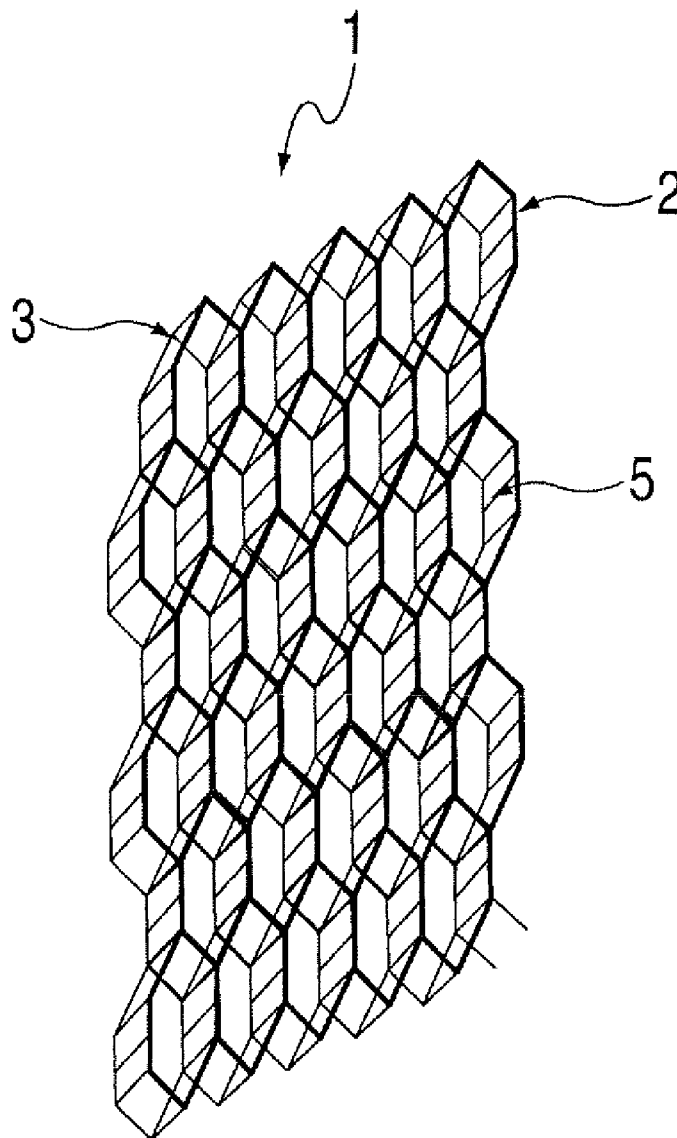




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GEHRING, JR.(10) **Pub. No.: US 2012/0177904 A1**(43) **Pub. Date: Jul. 12, 2012**(54) **UNDER BODY ARMOR COOLING VEST AND
FABRIC THEREOF****Publication Classification**(76) Inventor: **George GEHRING, JR.**, Garden
City, NY (US)(51) **Int. Cl.**
D03D 13/00 (2006.01)(52) **U.S. Cl.** **428/220; 442/1**(21) Appl. No.: **11/858,302**(57) **ABSTRACT**(22) Filed: **Sep. 20, 2007****Related U.S. Application Data**(60) Provisional application No. 60/847,307, filed on Sep.
26, 2006, provisional application No. 60/847,305,
filed on Sep. 26, 2006, provisional application No.
60/847,002, filed on Sep. 25, 2006, provisional appli-
cation No. 60/847,186, filed on Sep. 26, 2006.

A vest made of a light weight spacer fabric material that is permeable to air circulation and voluminous enough to have a significant thermal insulative value is provided. The spacer fabric material is also non-absorbent, hard wearing, compression resistant, readily cleanable, as well as non-burning and non-dripping when exposed to flames. The spacer fabric material includes fabric faces of an open mesh construction connected by a system of monofilament threads for promoting fabric rigidity.



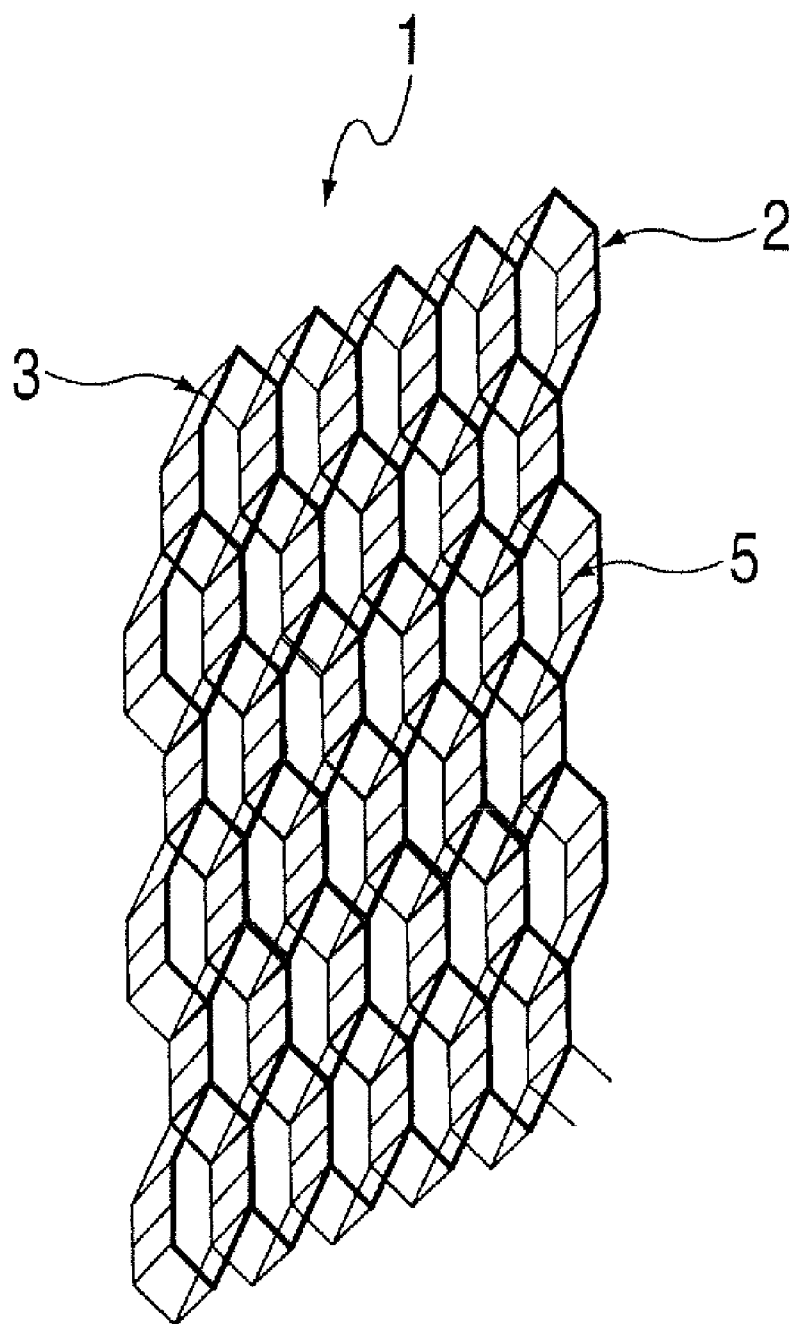


FIG. 1

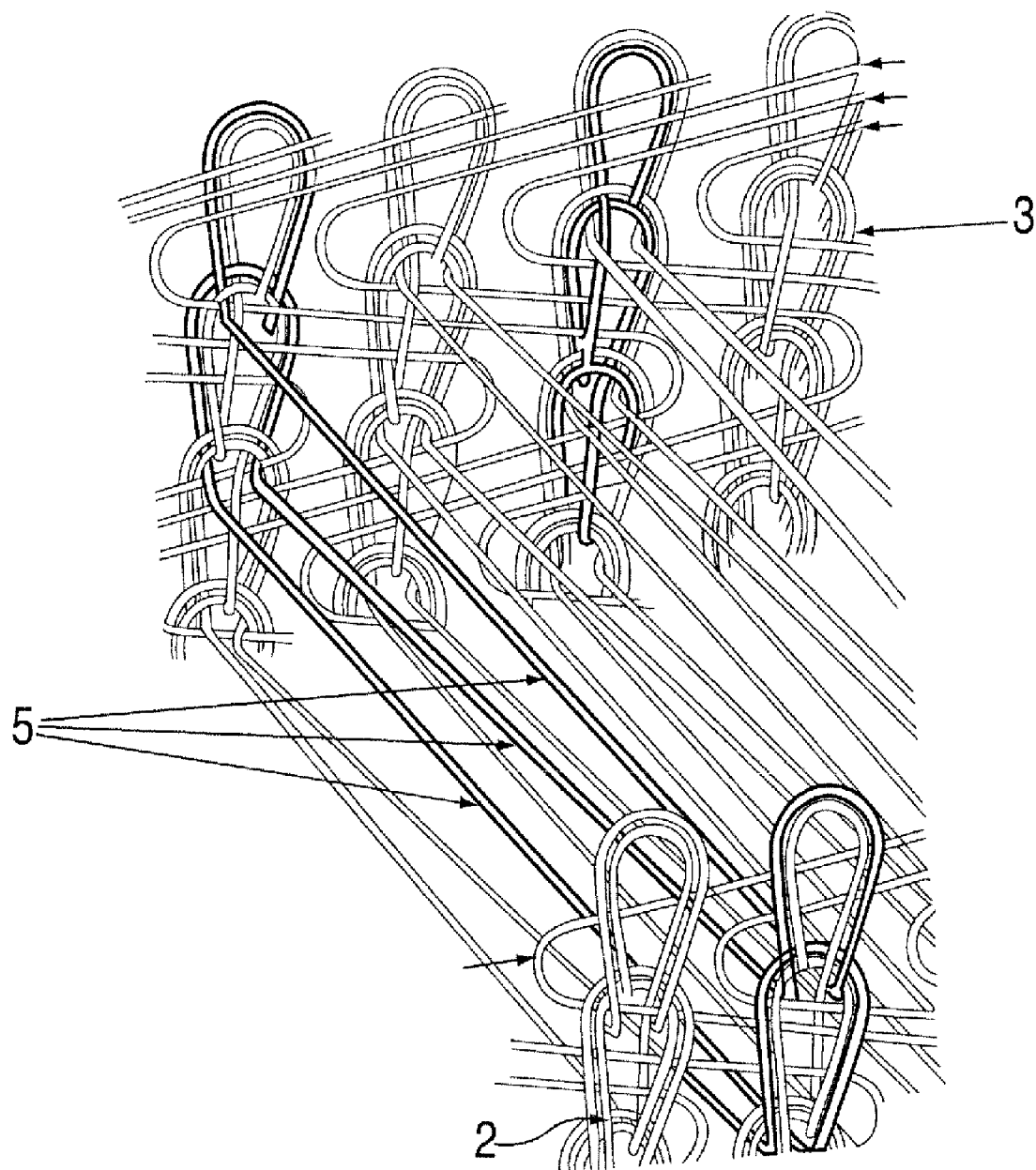


FIG. 2

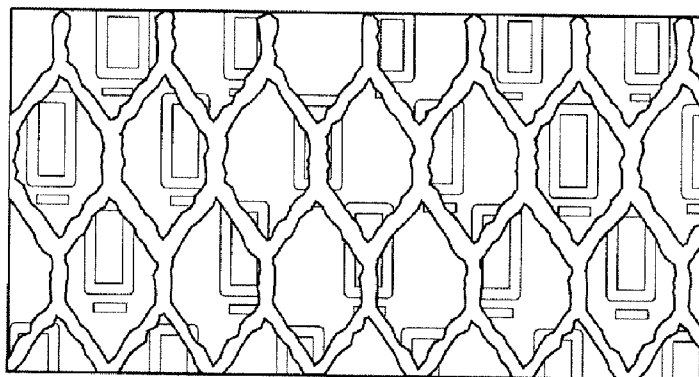


FIG. 3a

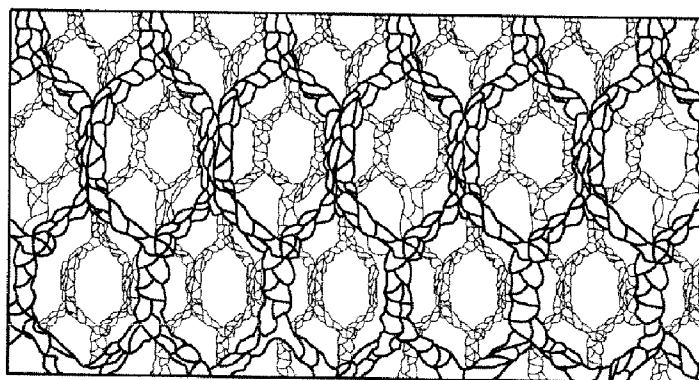


FIG. 3b

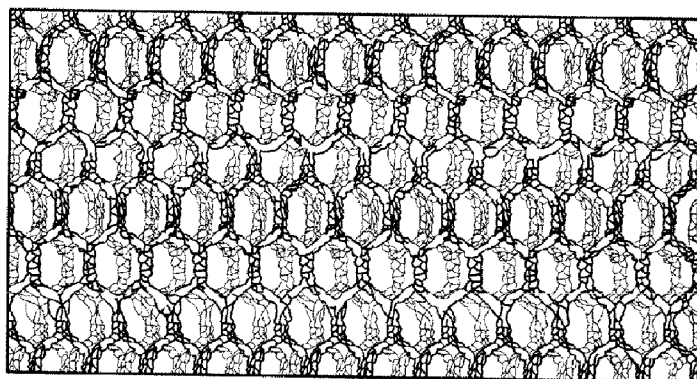


FIG. 3c

UNDER BODY ARMOR COOLING VEST AND FABRIC THEREOF

[0001] This application claims priority of Provisional Application No. 60/847,307 filed Sep. 26, 2006. The subject application is also related to the following applications: Fabric for Protection against Electric Arc Hazards 60/847,305 filed Sep. 26, 2006 U.S. patent application Ser. No. _____ filed _____.

Improved High Performance Fire Resistant Fabrics and the Garments Made Therewith

[0002] 60/847,002 filed Sep. 25, 2006; U.S. patent application Ser. No. _____ filed _____, and Knit Elastic Mesh Loop Pile Fabric for Orthopedic and other Devices 60/847,186 filed Sep. 26, 2006 U.S. patent application Ser. No. _____ filed _____.

BACKGROUND OF THE INVENTION

[0003] This invention relates to an under body armor cooling vest, and, more particularly, to a spacer fabric for an under body armor cooling vest.

[0004] Wearing a body armor in hot, humid climate imposes serious thermal stress on soldiers serving in sub-tropic or tropic environments where temperatures may reach 120° F. Such stress reduces a soldier's fighting capabilities and field endurance.

[0005] Another disadvantage of wearing body armor is the armor's limited permeability, which induces perspiration and thus diminishes wearing comfort. In other words, poor moisture management of the vest fabric is another problem in wearing conventional body armor. Particularly, the armor will retain much of the perspiration that is formed against the skin, thereby creating a feeling of clamminess and discomfort. Moreover, because of the tight fitting nature of most conventional body armor, fungus, mold and other microorganism growth is unfortunately encouraged.

[0006] Another problem in using conventional body armor is the restricted freedom of movement the armor imparts. In most prior art designs, the body armor is heavy and its straps impinge on the soldier's uniform so as to restrict freedom of movement. Muscle fatigue is also caused by the armor weight, which normally rests on soldiers' shoulders.

[0007] While some type of insulating garment material, such as a vest, may be disposed between a soldier's uniform and the body armor to be worn, such a garment has certain disadvantages. For example, most types of insulating garments feature significant added weight to the clothing system worn by the soldier, which is a distinct disadvantage in a hot climate.

[0008] Prior art insulating garment materials also exhibit a low permeability to air and moisture vapor, thereby leading to wearing discomfort, as well as limited air circulation between a soldier's uniform and his body armor, thus inhibiting any type of cooling effect from being produced.

[0009] Also, static charges may be generated in the course of the vest rubbing against the uniform and the body armor components. The buildup of static charges may, under certain circumstances, reach a voltage level that is sufficient to create a spark discharge, which can ignite fuel fumes, gas or explosive dust.

[0010] Accordingly, it would be desirable to provide an improved fabric for an under body armor cooling vest that overcomes these disadvantages.

SUMMARY OF THE INVENTION

[0011] In order to reduce thermal stress on soldiers fighting in high temperature environments, a vest made from an improved fabric material is provided to be worn under the body armor. The purpose of such a vest is to create air circulation between the soldier's uniform and the body armor and the cooling effect generated thereby.

[0012] The inventive vest is made of a light weight spacer fabric material that is permeable to air circulation and voluminous enough to have a significant thermal insulative value. The fabric material is also non-absorbent, hard wearing, compression resistant, readily cleanable, as well as non-burning and non-dripping when exposed to flames.

[0013] The fabric material of the present invention is a three dimensional warp knit spacer fabric. The spacer fabric comprises an open mesh construction on both of the fabric faces connected by a system of monofilament threads for imparting fabric rigidity, depth and impact absorbing properties. The mesh construction ensures the ready movement of air between the soldier's uniform and the body armor.

[0014] In particular, both fabric faces of the inventive spacer fabric comprise an open mesh construction of a fire retardant non-slip yarn such as spun modacrylic. The inventive fabric also includes a plurality of monofilament threads of polypropylene sulfide (PPS) connected between the two fabric faces.

[0015] Accordingly, it is an object of the invention to provide an improved fabric construction for an under body armor cooling vest.

[0016] Another object of the invention is to provide an improved fabric construction for an under body armor cooling vest that is both light weight and permeable to air circulation.

[0017] A further object of the invention is to provide an improved fabric construction for an under body armor cooling vest that is resilient and impact absorbing.

[0018] Still another object of the invention is to provide an improved fabric construction for an under body armor cooling vest that is flame resistant.

[0019] Yet another object of the invention is to provide an improved fabric construction for an under body armor cooling vest that is rendered anti-static.

[0020] Other objects and advantages of the invention will be obvious and/or apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] FIG. 1. is a schematic view of one form of the spacer-fabric of the invention;

[0022] FIG. 2 is an enlarged perspective view showing the spacer fabric of the invention; and

[0023] FIGS. 3a, 3b and 3c are enlarged elevational views of various forms of the inventive fabric.

DETAILED DESCRIPTION

[0024] The fabric material of the present inventive vest is a three dimensional warp knit spacer fabric. The spacer fabric comprises an open mesh construction on both fabric faces connected therebetween by a system of monofilament yarns

for imparting fabric rigidity, depth and impact absorbing properties. The mesh construction of the inventive fabric ensures the continuous movement of air between the uniform and the body armor.

[0025] More particularly, both fabric faces of the inventive spacer fabric comprise an open mesh knit construction made of high performance yarns that are resistant to melting, dripping and burning at high temperature conditions. Yarns that are suitable for the fabric faces of the inventive fabric comprise fire retardant non-slip yarns such as spun modacrylics.

[0026] The choice of modacrylic fibers or yarns for application in the fabric material of the invention is based on their excellent fire retardancy performance combined with their non-melt, non-drip and self-extinguishing properties. These are critically important attributes in battlefield environments. If sufficiently high temperatures are reached on exposure to fire or explosion, a garment made with the inventive fabric will just carbonize by forming a protective charred barrier. This prevents propagation of flames protecting the wearer from severe burn injuries.

[0027] Modacrylics have a high, so called, LOI value as compared with other fibers. The LOT represents the minimum oxygen concentration of an O_2/N_2 mix required to sustain combustion of a material. The LOI is determined by the ASTM Test D 2862-77. Modacrylics have an LOI value preferably between about 28 and 33, while conventional polyesters have a much lower value of 20-22.

[0028] Additionally, a very important aspect of wearing comfort is the so called "moisture management" factor. This is often represented as the moisture vapor transport index or MVT, which reflects the efficiency in which a fabric moves perspiration away from the skin or underlying garment and causes it to evaporate into the ambient atmosphere. The MVT of the modacrylics used in the inventive fabric is between about 2500 g/meters squared/24 hours ASTM E96.

[0029] While modacrylics are essentially hydrophobic, the capillary action of their fibrous yarn mass wicks the perspiration away and moves it to the outer face of the inventive garment where it is free to evaporate.

[0030] An important advantage of the modacrylic yarns is their relatively low cost, ready availability and very good processability at every stage of fabric manufacture.

[0031] Modacrylics are spun from an extensive range of copolymers of acrylonitrile. The type of modacrylic fibers that can be produced within this broad category are capable of wide variation in properties, depending on their composition. Sonic examples of commonly available modacrylics are: "Vere" by Eastman Corp., "Creslan" by Am Cyanamid Co., "Acrilan" by Monsanto Corp., "Kancaron" by Kaneka Co. and "Orlon" by DuPont Co.

[0032] Modacrylic fibers used in the inventive fabric preferably have a tenacity of up to 2.8 gram/denier, an elongation at break of between about 35 and 40%, and a fusing temperature of between about 371 and 410° F. The modacrylic fibers used in the inventive fabric also have a moisture regain (the amount of water by weight held by the fiber under controlled atmospheric conditions), of between about 0.4 and 4.0%.

[0033] Other high temperature resistant fibers or yarns may also be used in the inventive fabric, either in combination with modacrylics or entirely on their own. One such fiber comprises aramid fibers, such as Kevlar and Nomex. Such fibers feature excellent thermal stability and are virtually non-flammable. These fibers have a very high resistance to heat and are resistant to melting, dripping and burning at a temperature of

at least 700° F. Moreover, their LOI value is preferably in the range of between about 28 and 30.

[0034] Kevlar, made by Dupont Co., is a para-aramid fiber having a very high tenacity of between 28 and 32 gram/denier and outstanding heat resistance. Other para-aramid fibers suitable for the inventive fabric include Twaron by AKZO Co. and Technora by Teijin Co.

[0035] Another type of aramid fiber suitable for the inventive fabric is "Nomex", made by DuPont and "Conex" made by Teijin Co.

[0036] Yet other types of flame resistant fibers are organic fibers composed of polybenzimidazole, such as PBI made by Celanese Corp. These fibers have an LOI of between about 35-40 and are resistant to melting, dripping and burning at a temperature of at least 750° F.

[0037] Further high temperature resistant fibers or yarns may comprise certain polyester yarns that are resistant to melting, burning and dripping at a temperature of at least 700° F.

[0038] The inventive fabric also includes a plurality of monofilament yarns that are connected between the fabric faces and which that are highly resistant to melting, burning and dripping at high temperatures, such as yarns of polypropylene sulfide (PPS).

[0039] The monofilament yarns which connect the two mesh layers of the inventive fabric must be stiff enough to keep the two mesh faces apart in order to allow air to circulate between the vest made with the inventive fabric and the wearer's body. In particular, the monofilament interconnecting yarns preferably have a denier of at least 300, and preferably between about 300 and 600. Going below this range will result in the monofilament components collapsing under the compressive stress, while going over the range would produce monofilaments too stiff and inflexible for knitting. The PPS yarns should have a tenacity of between about 3.0 and 4.0 gram/denier with elongation at break of between about 35 and 45%, a moisture regain of between about 0.4 and 0.8%, and a resistance to melting, dripping and burning at a temperature of at least 500° F.

[0040] Knitting of monofilaments brings into consideration the concept of yarn flexural rigidity as the resistance to flexing, bending and forming into loops. The factors determining the rigidity for a filament are: its length, diameter, radius of curvature of the loop it is bent into and elasticity of the material. Connection between these factors is established by the following equation:

$$P \times L = \frac{M \times D^4}{R} \times C$$

[0041] Where M is the modulus of stretch (force required to produce a unit of extension) D is the filament diameter, L is its length, P is the force applied on the filament. R is the radius of loop's curvature and C is a constant.

[0042] The modulus of flexural rigidity may be defined as the force required to bend a unit length of a filament over a unit radius of curvature.

[0043] To be of a good knitting property, the filament should have a low modulus of flexural rigidity, that is it should require relatively low effort to form them into loops. However, in a spacer fabric where the monofilaments serve as connecting threads, the modulus of flexural rigidity must be such as to prevent them from collapsing on compression, but

at the same time, enable them to be formed into loops without undue difficulty. The modules of flexural rigidity of the monofilament yarns that connect the fabric faces is preferably between about 35-165 MFG/CM2 (Megagram Force) based on Hearle Fiber Stiffness Test.

[0044] The schematic structure and example of the spacer fabric of the invention is illustrated in FIGS. 1 and 2. Fabric 1 comprises two component webs or layers, namely front face 2 and back face 3. Back face 3 is attached to front face 2 by a system of interconnecting yarns 5 filling the interval or distance between the faces. This distance may be set from between about 2 and 15 millimeters depending on product requirements as far as air circulation, thus significantly enhancing the comfort factor of the inventive system.

[0045] Significantly, the yarns of the two fabric faces are resistant to melting, burning and dripping at a temperature of at least 700° F. The yarns of the two fabric faces have a yarn count of between about 12/2 c.c and 32/2 c.c. (two ply yarn). For a single ply yarn, the yarn count of the two fabric faces is between about 6/1 c.c. and 16/1 c.c.

[0046] The yarns of the fabric faces are ideal in transporting moisture therealong. This inhibits microorganism growth, thereby preventing the accumulation of any significant odor. In particular, the yarns of the two fabric faces are hydrophobic. The moisture regain of the fabric is extremely low, preferably in the range of between about 0.4 and 4.0%. The fabric faces themselves are of an open pore structure, further precluding the retention of moisture.

[0047] Interconnecting yarns 5 (see FIG. 2) are most preferably monofilament PPS yarns in order to increase resilience; as stated; the yarns have a size or fineness of between about 300 and 600 denier. The higher their denier, the greater the resilience to deformation under the influence of impact. The same applies to the density of the threads per square inch in the fabric. This density may be varied by suitable guide bar threading, machine gauge, knitting tightness, the number of guide bars carrying those threads and the knitting construction used to generate each of the fabric faces.

[0048] As stated before as well, the interconnecting yarns of the inventive fabric are also resistant to melting, burning and dripping at a temperature of at least 500° F.

[0049] The inventive fabric itself is resistant to collapse at a pressure of up to 2-3% residual deformation after removal of compressive load, ASTM 3574 & 1667.

[0050] Faces 2 and 3 of the inventive fabric may be knit independently of each other by their own set of guide bars, a technique well known to those skilled in the art. This permits making each face from a different knitting construction and using different yarns types and deniers, if required. For example, back face 3, placed against the wearer's body, may be made from high tenacity yarns, having a tenacity of between about 18 and 30 grams/denier.

[0051] Construction of both front face 2 and back face 3 of the inventive fabric is an open or mesh form (porous) for optimum air circulation. The yarns of back face 3 are essentially hydrophobic (non absorbent). The capillary action of their fibrous mass or bundle wicks the perspiration away from the skin surface and moves it to face 2 where it is free to evaporate.

[0052] Optionally, the yarns of back face 3 are made of yarns that have been rendered hydrophilic in order to enhance transport of perspiration and other body fluids (i.e., capillary action to the front face of the fabric), thereby keeping the skin surface dry; the yarns of the front face of the fabric should

then always be hydrophobic in order to prevent the accumulation of perspiration and thus promote moisture evaporation.

[0053] Also, each of the face fabrics may be made in different weights, thickness, porosity, degree of stability, mesh opening size and other physical characteristics to suit the purpose of providing optimum trauma protection.

[0054] The inventive fabric is resilient and impact absorbing. This is built into the fabric by a system of monofilament threads of PPS connecting the fabric faces. This system offers protection from the blunt trauma effects arising when a bullet or shrapnel impacts the body armor. Fabric resilience itself is defined as the property of recovery from compression of the original fabric configuration in shape and/or thickness following removal of the strain or pressure that has caused the deformation. In other words, the spacer fabric of the invention should spring back to its original state or volume after being compressed and/or crushed. The resilience of the inventive fabric should be between about 2-3% residual deformation after removal of compressive load, ASTM 3574 & 1667.

[0055] In addition, because of the yarns used and the knitting construction used, the inventive fabric will not ravel, fray or lose its integrity.

[0056] The fabric is constructed with flame resisting components, which will not burn, melt, or drip so as to cause injury to the wearer. This is of a particular importance in a burning or smoldering environment, such as those encountered by soldiers in battlefield situations. Thus, vests made from the inventive fabric will not contribute to any form of combustion.

[0057] The air which flows through a vest made with the fabric of the invention carries away and ultimately evaporates perspiration from a soldier's uniform so as to generate a comfort enhancing cooling effect. Because of its open construction, the inventive fabric exhibits great porosity or permeability, which induces free movement of air and the desired cooling effect it produces. The air permeability is the rate of air flow through the fabric under differential pressure between two fabric surfaces. It is expressed in units of cubic feet of air per minute per square foot of fabric at a stated pressure differential between the two fabric surfaces. Testing for air permeability is covered by the ASTM D-737-69.

[0058] The inventive fabric is advantageous due to its high air permeability. This is, in part, achieved by varying the opening or hole size of the mesh of the fabric faces and the depth of the fabric. The mesh opening size of the two fabric faces ranges from between about 6 and 12 mm and the depth or thickness of the fabric itself ranges from between about 3 and 15 mm. The inventive fabric is light in weight in a range of between about 14 and 17 oz/yd.

[0059] The inventive fabric will not hold and absorb moisture, perspiration, mold or micro-organisms liable to cause odor. This is because of the very low moisture absorbent properties of the yarns, plus the optional preference of anti static fiber components, as discussed below.

[0060] The inventive fabric may be rendered anti-static by including conductive yarns or fibers in its structure. In this regard, there are several conductive yarns or fibers on the market that can be used. The preferred conductive yarn used in the inventive fabric of the present invention is the X-static product made by Noble Fiber Technologies, Inc. This is a nylon fiber coated with a silver layer in order to render it conductive.

[0061] The conductive yarn fiber is preferably blended or intermixed with the modacrylic or other yarns that are used in

the mesh faces of the inventive fabric. In other words, the nylon yarns coated with silver are knitted together with yarns used for the two fabric faces. Blending the silver coated nylon fibers with modracrylics prevents buildup of static charges liable to produce a spark discharge and the hazard of setting off explosion in gasoline vapors or other combustible materials. Anti-static filament yarns may also be used instead of being blended in fibrous form. This, however, will require the use of an extra guide bar to accommodate the said yarn.

[0062] The presence of conductive fibers that may be used in the inventive fabric also will impart antimicrobial properties, which suppresses development of objectionable odors. The use of the conductive fibers also renders the fabric antibacterial.

[0063] A vest made with the inventive fabric may be cleaned in a detergent bath, rinsed and then air dried.

[0064] The inventive fabric is preferably formed on a warp knit basis utilizing two needle bar Raschel equipment. However, it may also be generated on a weft knit basis involving flat or circular knitting machines or using some type of plastic extrusion technology.

[0065] It should be understood that the fabric example below represents just one constructional option. Many other variations may be generated by those skilled in the art.

Example 1

[0066] One type of fabric as per the present invention contains the following yarns:

[0067] 22/2's c.c. spun modacrylic package dyed 35.3%

[0068] 450 denmonofil (polypropylene sulfide) heat resistant, solution dyed 64.7%

[0069] The presence of package dyed yarn eliminates the need for fabric dyeing, which is difficult for this type product.

[0070] The construction of the fabric in Example 1 is as follows:

FABRIC CONSTRUCTION			
Beam Number	Inches Rack	Ends Total	Yarn
2(front)	64"	608	22/2 Modacrylic
3	134"	1216	22/2 Modacrylic
4	664"	1200	450-1 PPS (Polyphenylene sulfide)
5	134"	1216	22/2 Modacrylic
6	54"	608	22/2 Modacrylic

[0071] The threading chart for Example 1 is as follows:

				
Bar 6 (back).	.11.1.1.1.1.1.1.1.1..	...	.11.1.1.1.1.1.1.1.1.1.	2
Bar 5.	11111111111111111111111111111111.	...	11111111111111111111111111111111.	1
Bar 4.	11111111111111111111.....	...	11111111111111111111.....	0
Bar 3.	.11111111111111111111111111111111	...	.11111111111111111111111111111111	0
Bar 2 (front)	11.1.1.1.1.1.1.1.1.1..	...	11.1.1.1.1.1.1.1.1.1..	3

[0072] The stitch construction for Example 1 is as follows:

STITCH CONSTRUCTION						
	BAR 2 (front)	BAR 3	BAR 4 Connector	BAR 5	BAR 6 (Back)	
F	3-3	0-1	0-1	1-1	2-2	
B	3-3	1-1	1-0	1-0	0-0	
F	1-1	1-0	1-0	0-0	0-0	
B	1-1	0-0	0-1	0-1	2-2	
F	3-3				2-2	
B	3-3				0-0	
F	1-1				0-0	
B	1-1				2-2	
F	2-2				2-2	
B	2-2				1-1	
F	0-0				1-1	
B	0-0				3-3	
F	2-2				3-3	
B	2-2				1-1	
F	0-0				1-1	
B	0-0				3-3	
F	2-2				3-3	
B	2-2				1-1	
F	1-1				1-1	
B	1-1				2-2	

[0073] In Example 1, because the fabric is made with pre-dyed yarns, there is no dyeing involved. The fabric in Example 1 is stabilized and set by tenter framing at a temperature of 330 F at the speed of 25 yds/min. The finished fabric had a fabric width of 54 inches and a weight of 12.5 oz/vd.

[0074] In FIG. 3a, a fabric of the invention is shown with a mesh structure on the front face and mesh openings on the rear face.

[0075] In FIG. 3*b*, a fabric of the invention is shown with large mesh openings on the front face and smaller mesh openings on the rear face.

[0076] In FIG. 3c, a general view of the mesh spacer fabric of the invention is shown.

[0077] It will thus be seen that the objects set forth above, among those made apparent, from the preceding description, are efficient attained by the practice of the subject invention.

[0078] The scope of the invention will be indicated in the claims.

1. A three dimensional spacer fabric comprising first and second fabric faces having open mesh constructions made from high performance yarns that are resistant to melting, dripping and burning at a temperature of at least 700° F. and a plurality of monofilament yarns connecting said faces and which are resistant to melting, burning and dripping at a temperature of at least 500° F.

2. The fabric of claim 1, wherein the yarns of the fabric faces are selected from the group consisting of modacrylic yarns, aramid yarns and polybenzimidazole yarns, and wherein the connecting yarns comprise polypropylene sulfide yarns.

3. The fabric of claim 2, wherein the yarns of the fabric faces have a yarn count of between about 12/2 c.c. and 32/2 c.c.

4. The fabric of claim 2, wherein the yarn of the fabric faces comprise modacrylic yarns having an LOI value of between about 28 and 33.

5. The fabric of claim 4, wherein the modacrylic yarns have a tenacity up to 2.8 grams/denier, an elongation at break of

between about 35 and 40%, and a fusing temperature of between about 371 and 410° F.

6. The fabric of claim 4, wherein the modacrylic yarns have a moisture regain of between about 0.4 and 4.0%.

7. The fabric of claim 2, wherein the yarns of the fabric faces comprise aramid yarns having an LOI value of between about 28 and 30.

8. The fabric of claim 7, wherein the aramid yarns comprise para-aramid yarns.

9. The fabric of claim 2, wherein the yarns of the fabric faces comprise polybenzimidazole, having an LOI value of between about 35 and 40.

10. The fabric of claim 2, wherein the polypropylene sulfide yarns have a denier of between about 300 and 600.

11. The fabric of claim 2, wherein the polypropylene sulfide yarns have a tenacity of between about 3.0 and 4.0 grams/denier and an elongation at break of between about 35% and 45%.

12. The fabric of claim 2, wherein the polypropylene sulfide yarns have modules of flexural rigidity of between about 35 and 165 MGF/CM2 (Megagram Force) Based on Hearle Fiber Stiffness Test.

13. The fabric of claim 2, wherein the fabric has a moisture regain of between about 0.4 and 4.0.

14. The fabric of claim 2, wherein one of said fabric faces has a tenacity of between about 18 and 30 grams/denier.

15. The fabric of claim 2, wherein the yarns of one of said faces are rendered hydrophobic and the yarns of the other of said faces are rendered hydrophilic.

16. The fabric of claim 2, wherein the fabric has a resilience of up to about 2-3% residual deformation after removal of compressive load, ASTM 3574 & 1667.

17. The fabric of claim 2, wherein the open mesh construction of the two fabric faces defines a plurality of openings, each having a size of between about 6 and 12 mm.

18. The fabric of claim 2, wherein the thickness of the fabric is between about 3 and 15 mm.

19. The fabric of claim 1, further including conductive yarns intermixed with the yarns of the fabric faces.

20. A three dimensional spacer fabric comprising first and second fabric faces of an open mesh construction and made from modacrylic yarns, and a plurality of monofilament polypropylene sulfide yarns connecting said fabric faces.

21. A three dimensional spacer fabric comprising first and second fabric faces of an open mesh construction and made from yarns selected from the group consisting of modacrylic yarns, aramid yarns and polybenzimidazole yarns, and a plurality of non-filament yarns connecting said fabric faces.

22. The fabric of claim 21, wherein said fabric face yarns comprise modacrylic yarns.

* * * * *