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(54) **MULTI-LAYER HEAT BARRIER FABRIC**

MEHRSCICHTIGE HITZEDÄMMFASER

TISSU MULTICOUCHE FORMANT BARRIÈRE THERMIQUE

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Description

TECHNICAL FIELD

[0001] This invention is about the heat barrier that prevents the heat transfer, allows removal of the body moisture while preventing the ingress from the liquid and provides full protection against the heat stress when exposed to elevated temperatures.

[0002] This invention is especially about the protective, respirable, watertight, inflammable fabric that prevents the heat transfer when exposed to elevated temperatures and provides full protection against heat stress.

BACKGROUND OF THE INVENTION

[0003] This invention is developed for use in clothing capable of resisting excessive heat. It provides protection in areas exposed to elevated temperatures in particular for clothing of the firefighters.

[0004] The protective clothing like the clothing for the firefighters is in general consisted of an exterior fabric, heat barrier and interior fabric. The biggest problems faced by the firefighters are the extreme heat generated, heat stress and the skin burns as a result of contact with the fluids used to extinguish and suppress the fire.

[0005] Today fire, flame, explosion and similar elevated temperatures and excessive heat give rise to injuries. The protective clothing of the firefighters exposed to excessive heat and elevated temperatures specific to the fire, flame and explosion in general consist of an exterior fabric; heat barrier and interior fabric. The biggest problems faced by the firefighters are the extreme heat generated, heat stress and the skin burns as a result of contact to the fluids used to extinguish and suppress the fire.

[0006] There are three types of heat transfer that gives rise to injuries upon occurrence of a fire, flame and explosion generating excessive heat and elevated temperatures. They are conduction, convection and thermal radiation. The conduction is the transfer of heat by direct contact of the heat with an object. The convection is the transfer of heat via a medium (like air). The thermal radiation is, however, the transfer of the heat in the form of the light energy.

[0007] The water is a poor insulator and it transfers heat even without a contact. Wet protective clothing increases the risk of injury via conducted heat. Therefore, it is extremely crucial for a fabric to be watertight. Another type of conduction heat injury occurs as a result of rapid transfer of the heat on the surface through the layers of the clothing, since there is no air between the layers. This generally causes injuries on knees and arms. Therefore, the layers of the fabric should not be too close to each other. The convection heat transfer makes the heat to be felt even if there is no direct contact with the flame. Therefore, the protective clothing should be used, even if there is no contact with the flame or very hot objects. Thermal Radiation is a type of heat transfer, where the heat is

conveyed from hot objects in the form of the light energy. Thermal Radiation may also take place if there is a latent heat. In such cases, the burns are likely, even if the temperature is only 80 degrees. Therefore, it will be necessary to use protective clothing against thermal radiation.

[0008] An example of a protective multi-layer heat barrier is disclosed in the document EP-1.433.394.

AIM OF THE INVENTION

[0009] This invention eliminates the heat stress. It has long service life. The barrier subject of this invention does not deteriorate the mobility when used as interior layer. It provides conform during use. It is watertight. Furthermore, it is inherently moisture/steam permeable. It is inflammable.

[0010] This invention is more effective compared with other barriers. It is cost effective, flexible, light and more durable even if it provides high degree of insulation. Furthermore, other heat barriers contain arimide nonwoven fabric. This, however, gives rise to various problems. The product subject of this invention, however, incorporates woven or nonwoven active carbon.

[0011] This invention is developed to be used for clothing capable of resisting excessive heat. In particular, such clothing provides protection against excessive heat and elevated temperature generated upon a fire, flame, explosion and the like.

[0012] This invention introduces multi-layer fabric. The fabric provides sufficient time to escape from the fire and delays the heat transfer. It provides comfort even under extremely elevated temperatures.

[0013] The fabric is consisted of multi-layers, however it is still light, flexible and durable. It does not catch fire. It is comfortable, does not prevent mobility, and does not permeate the liquids; however it allows steam and air diffuse through it, features high strength, durable, can be washed, reduces heat stress and provides heat insulation.

[0014] Thanks to its multi-layer structure, this special fabric prevents the heat stress. In particular, the intermediate layer greatly reduces the heat the inner layer is exposed and reduces heat while expelling body moisture through the gap it provides, which ensures the air circulation.

[0015] Depending on the degree of the temperature exposed, the number of the layer or density of the fabric might be increased.

REFERENCE NUMBERS

[0016]

1. Exterior fabric
2. Woven or nonwoven active carbon fabric
3. Membrane
4. Interior fabric
5. Silicone extrusions

- 6. Barrier fabric
- 7. Intermediate fabric

SHORT DESCRIPTION OF DRAWINGS

[0017]

- Figure 1: 2-layer heat barrier view
- Figure 2: 3-layer heat barrier view
- Figure 3: Schematic diagram of the invention

DETAILED DESCRIPTION

[0018] The invention is comprised of exterior fabric (1), membrane (3), barrier fabric (6), intermediate fabric (7) and interior fabric (4).

[0019] Exterior fabric (1) is made from inflammable material, since it may come into direct contact with the flame. Exterior fabric (1) may be made from either metaaramide, paraaramide, PBO (Poly-p-phenylene benzobisoxazole), PBI (Polybenzimidazole), carbon, inflammable viscon (FR viscose), inflammable polyester or mixture of these in braided, woven or nonwoven form.

[0020] Membrane (3) is made from respirable fabric that allows steam heat transfer, however, preventing the ingress of the liquids. The membrane (3) may be made from EPTF/PU.

[0021] Barrier fabric (6) may be made from braided, woven or nonwoven metaaramide, paraaramide, PBO (Poly-p-phenylene benzobisoxazole), PBI (Polybenzimidazole), carbon, inflammable viscon (FR viscose), inflammable polyester or the mixture of these.

[0022] Intermediate fabric (7) may be made from metaaramide, paraaramide, PBO (Poly-p-phenylene benzobisoxazole), PBI (Polybenzimidazole), carbon, inflammable viscon (FR viscose), inflammable polyester or their mixtures in braided, woven or nonwoven form, which can create gap in between.

[0023] Just like exterior fabric (1), interior fabric (4) may be made from paraaramide, PBO (Poly-p-phenylene benzobisoxazole), PBI (Polybenzimidazole), inflammable viscon (FR viscose), inflammable polyester or their mixtures in braided, woven or nonwoven form.

[0024] As shown in figure 1, 2-layer heat barrier comprised of woven active carbon or nonwoven active carbon fabric (2) is formed by laminating membrane (3) that will expel the body moisture and prevent the ingress of the fluids. Its overall specific weight is about $160 \pm 25 \text{ gr/m}^2$

[0025] As shown in figure 2, 3-layer heat barrier consisted of woven active carbon or nonwoven active carbon fabric (2) is formed by laminating membrane (3) that will expel the body moisture and prevent the ingress of the fluids and combining silicone extrusions (5) to woven active carbon or nonwoven active carbon fabric (2).

The silicone extrusions (5) are heat resistant and installed homogenously. Silicone extrusions (5) are about 0.5 — 2.0 cm apart and extending to 0.5 — 2.0 cm from the surface of the fabric. These extrusions (5) ensure the

circulation of the air by creating air gaps between exterior fabric (1) and barrier. This provides ventilation. It delays the transfer of the hot air to come into contact with the body and ensures more effective protection by reducing the stress caused by the hot air. The insulation is enhanced thanks to the extrusions (5). Its overall specific weight is about $225 \pm 25 \text{ g/m}^2$.

[0026] The durability of 2-layer heat barrier (1) and 3-layer heat barrier (2) up to 300 degrees are tested. The firefighter clothing can be produced by making use of arimide as exterior fabric (3), 2-layer heat barrier (1) or 3-layer heat barrier (2) and arimide as interior fabric (4) (fig.1 and 2).

[0027] As shown in figure 3, Just like exterior fabric (1), interior fabric (4) may be made from paraaramide, PBO (Poly-p-phenylene benzobisoxazole), PBI (Polybenzimidazole), inflammable viscon (FR viscose), inflammable polyester or their mixtures in braided, woven or nonwoven form.

[0028] First layer is exterior fabric (1). Like exterior fabric (1), interior fabric (4) may also be made from metaaramide, paraaramide, PBO (Poly-p-phenylene benzobisoxazole), PBI (Polybenzimidazole), carbon, inflammable viscon (FR viscose), inflammable polyester or their mixture. Compared with exterior fabric, interior fabric (4) is exposed to the heat to a lesser degree and therefore might be lighter than exterior fabric. There is a membrane (3) on top of barrier fabric (6) to absorb the body moisture, ensure the steam transfer, however to prevent the ingress of liquids from outside to come into contact with both barrier (6) and body. This membrane (3) features water tightness, however allows the steam infusion, in addition to its resistance to excessive heats. Meanwhile, the membrane (3) enhances the strength of the fabric. The membrane (3) is glued to the fabric by using especially reactive polyurethane glue that is capable to resist excessive heat. Thus, it does not loose its laminated structure, come apart from the fabric or loose its properties when exposed to excessive heat. The laminated structure is resistant to washing. Intermediate fabric (7) between barrier fabric (6) and interior fabric (4) is exclusively made from metaaramide, paraaramide, PBO (Poly-p-phenylene benzobisoxazole), PBI (Polybenzimidazole), inflammable (FR viscose), inflammable polyester or their mixture in braided, woven or nonwoven form, complete with the fabric that can create an air gap in between. This layer reduces the heat exposure to the interior fabric (5) that is in contact with the body, creates an air gap and enhances respiration. It prevents slipping of the barrier with its increased friction.

[0029] The descriptive examples of this invention are as follows.

Example 1:

[0030]

1. Kermel 200+-25 gr/m² (exterior) fabric (1).

2. Nonwoven fabric (2) made from mixture of meta aramide -para aramide
3. EPTF/PU membrane (3) fabricated by polyurethane layer lamination on top of the polyurethane membrane. It is a membrane with specific weight of about 35+-15 g/m², steam permeability of 35,000 g/m²/24 hours, oil repellant rate of 6, water tightness of 10 m and featuring pathogen resistance.
4. Warp knitting by making use of Kevlar thread, layer in the form of mesh to create the air gap
5. Kermel 145+- 25 g/m² interior liner

[0031] The fabric (2) woven from the active carbon is glued to EPTF/PU membrane (3) on engraving lamination machine with dotted reactive polyurethane hot adhesion glue. PU side of EPTF membrane (3) faces outside. Polyurethane glue with special reactivity is used in the lamination to enhance the respirability. 50-100 dots per centimeter square are typical. The lamination provides the resistance up to 270 degree. No deterioration or peeling is observed during washing in 60-degree water.

Example 2:

[0032]

1. Kermel 200+-25 g/m² exterior fabric (1)
2. Fabric woven (2) from active carbon
3. EPTF/PU membrane (3) is produced by the polyurethane layer lamination on polyethylene membrane (3). It's a membrane (3) with specific weight about 35+-15 g/m², steam permeability 35,000 g/m²/24 hour, oil repellant rate 6, water tightness 10 m and featuring blood pathogen resistance.
4. Warp knitting by making use of Kevlar thread, layer in the form of mesh to create the air gap
5. Kermel 145+- 25 g/m² interior fabric (4).

[0033] The fabric (2) woven from the active carbon is used instead of the system provided under example 1 and no.2 meta aramide-para aramide mixture the unwoven fabric (2). The fabric (2) woven from the active carbon is glued to EPTF/PU membrane (3) at engraving lamination machine with dotted reactive polyurethane hot adhesion glue. PU side of EPTF membrane (3) faces outside. Polyurethane glue with special reactivity is used in the lamination to enhance the respirability. 50-100 dots per centimeter square are typical. The lamination provides the resistance up to 270 degree. No deterioration or peeling is observed during washing with 60-degree water.

Claims

1. A protective multi-layer heat barrier fabric which comprises exterior fabric (1), against excessive heat,

the fabric comprises, a membrane (3), a barrier fabric (6), an intermediate fabric (7) and an interior fabric (4); **characterized in that**;

- 3-layer heat barrier is formed by woven active carbon or nonwoven active carbon fabric (2) by laminating said membrane (3) together with combining silicone extensions (5) that will expel the body moisture and prevent the ingress of the fluids,
- the silicone extensions (5) being heat resistant located at about 0.5 - 2.0 cm apart and extending to 0.5 - 2.0 cm from the surface of the fabric to ensure the circulation of the air by creating air gaps between exterior fabric (1) and barrier.

2. A protective multi-layer heat barrier fabric according to any preceding claims where the membrane (3), it is **characterized by** being the portion on top of the barrier fabric (6) glued by making use of special reactive polyurethane capable of providing endurance to excessive heats.

3. A protective multi-layer heat barrier fabric according to any preceding claims where the barrier fabric (6), it is **characterized by** being on top of the intermediate fabric (7) together with the membrane (3) that will prevent the contact with the body, while providing steam heat transfer to expel the body moisture, however, preventing ingress of the liquids.

4. A protective multi-layer heat barrier fabric according to any preceding claims where the intermediate fabric (7) it is **characterized by** being between the barrier fabric (6) and interior fabric (4), providing a layer exclusively made from metaaramide, paraaramide, PBO (Poly-p-phenylene benzobisoxazole), PBI (Polybenzimidazole), inflammable (FR viscose), inflammable polyester or their mixture In braided, woven or nonwoven form, complete with the fabric that can create an air gap in between.

5. A protective multi-layer heat barrier fabric according to any preceding claims where **characterized by** its being the fabric comprised of an intermediate layer (fabric)(7) on top of interior layer (4) that provides the connection with barrier fabric (6), barrier fabric (6) on top of intermediate layer (fabric)(7), membrane (3) on top of barrier fabric (6) and exterior fabric on top of membrane (3).

Patentansprüche

1. Schützende mehrschichtige Wärmesperrtextilie, die eine äußere Textilie (1) gegen übermäßige Wärme umfasst, wobei die Textilie eine Membran (3), eine Sperrtextilie (6), eine Zwischentextilie (7) und eine

innere Textilie (4) umfasst, **dadurch gekennzeichnet, dass:**

— eine dreischichtige Wärmesperre aus Aktivkohlegewebe oder -vlies (2) gebildet ist, indem die Membran (3) mit kombinierenden Silikon-
ausweitungen (5) laminiert ist, welche Körper-
feuchtigkeit ableitet und den Eintritt von Fluiden
verhindert,
— die Silikon-
ausweitungen (5) wärmebeständig
sind, etwa 0,5 bis 2,0 cm voneinander beabstan-
det sind und sich bis zu 0,5 bis 2,0 cm von der
Oberfläche der Textilie erstrecken, um die Luft-
zirkulation sicherzustellen, indem sie zwischen
der äußeren Textilie (1) und der Sperrschicht
Luftspalte erzeugen.

2. Schützende mehrschichtige Wärmesperretextilie nach einem der vorhergehenden Ansprüche, wobei die Membran (3) **dadurch gekennzeichnet ist, dass** sie der Abschnitt auf der Oberseite der Sperrtextilie (6) ist, der unter Verwendung eines speziellen reaktiven Polyurethans geklebt wurde, das Beständigkeit gegen übermäßige Wärme bereitstellen kann.

3. Schützende mehrschichtige Wärmesperretextilie nach einem der vorhergehenden Ansprüche, wobei die Sperrtextilie (6) **dadurch gekennzeichnet ist, dass** sie sich zusammen mit der Membran (3) auf der Oberseite der Zwischentextilie (7) befindet, wobei die Membran den Kontakt mit dem Körper verhindert, während sie einen Dampf- und Wärmetransfer bereitstellt, um die Körperfeuchtigkeit abzuleiten, den Eintritt der Flüssigkeiten jedoch verhindert.

4. Schützende mehrschichtige Wärmesperretextilie nach einem der vorhergehenden Ansprüche, wobei die Zwischentextilie (7) **dadurch gekennzeichnet ist, dass** sie sich zwischen der Sperrtextilie (6) und der inneren Textilie (4) befindet und zusammen mit der Textilie, die dazwischen einen Luftspalt erzeugen kann, eine Schicht bereitstellt, die ausschließlich aus Meta-Aramid, Para-Aramid, PBO (Poly([p-phenylen-benzobisoxazol])), PBI (Polybenzimidazol), schwerentflammbarer Viskose FR, schwerentflammbarem Polyester oder deren Mischungen in geflochtener, gewebter oder Vliesform besteht.

5. Schützende mehrschichtige Wärmesperretextilie nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** sie die Textilie ist, die aus einer Zwischenschicht (-textilie) (7) auf der Oberseite der inneren Schicht (4) besteht, welche die Verbindung mit der Sperrtextilie (6) bereitstellt, aus einer Sperrtextilie (6) auf der Oberseite der Zwischenschicht (-textilie) (7), einer Membran (3) auf

der Oberseite der Sperrtextilie (6) und einer äußeren Textilie auf der Oberseite der Membran (3).

5 Revendications

1. Tissu multicouche faisant barrière thermique, comprenant : un tissu extérieur (1) contre la chaleur excessive, ce tissu comprenant une membrane (3), un tissu faisant barrière (6), un tissu intermédiaire (7) et un tissu intérieur (4) ; caractérisé en ce qui :

— le tissu formant barrière à la chaleur à 3 couches est formé de textile de carbone actif tissé ou de de carbone actif non tissé (2) en laminant ladite membrane (3) tout en combinant des extensions en silicone (5) qui évacueront l'humidité du corps et empêcheront l'immission des fluides,

— les extensions en silicone (5) étant résistantes à la chaleur, situées à environ 0,5 à 2,0 cm l'une de l'autre et s'étendant jusqu'à environ 0,5 à 2,0 cm de la surface du tissu pour assurer la circulation de l'air en créant des intervalles d'air entre le tissu extérieur (1) et la barrière.

2. Tissu multicouche faisant barrière thermique selon la revendication précédente, la membrane (3) étant **caractérisée par le fait qu'elle** est la partie du dessus du tissu formant barrière (6) collée en utilisant du polyuréthane réactif spécial capable de lui conférer une endurance aux chaleurs excessives.

3. Tissu multicouche faisant barrière thermique selon l'une quelconque des revendications précédentes, le tissu formant barrière (6) étant **caractérisé par le fait qu'il** est sur le dessus du tissu intermédiaire (7) avec la membrane (3) qui empêchera le contact avec le corps tout en assurant un transfert thermique de vapeur pour évacuer l'humidité du corps en empêchant toutefois l'immission des liquides.

4. Tissu multicouche faisant barrière thermique selon l'une quelconque des revendications précédentes, le tissu intermédiaire (7) étant **caractérisé par le fait qu'il** se trouve entre le tissu formant barrière (6) et le tissu intérieur (4), en formant une couche faite exclusivement de métaaramide, paraaramide, PBO (poly-p-phénylène benzobisoxazole), PBI (polybenzimidazole), viscose FR inflammable, polyester inflammable ou leurs mélanges sous forme tressée, tissée ou non tissée, et complète avec le tissu qui peut créer un intervalle d'air entre eux.

5. Tissu multicouche faisant barrière thermique selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'il** est le tissu composé d'une couche intermédiaire (de tissu) (7) sur le dessus de

la couche intérieure (4) qui assure la connexion avec le tissu formant barrière (6), le tissu formant barrière (6) sur le dessus de la couche intermédiaire (de tissu) (7), la membrane (3) sur le dessus du tissu formant barrière (6) et le tissu extérieur sur le dessus de la membrane (3). 5

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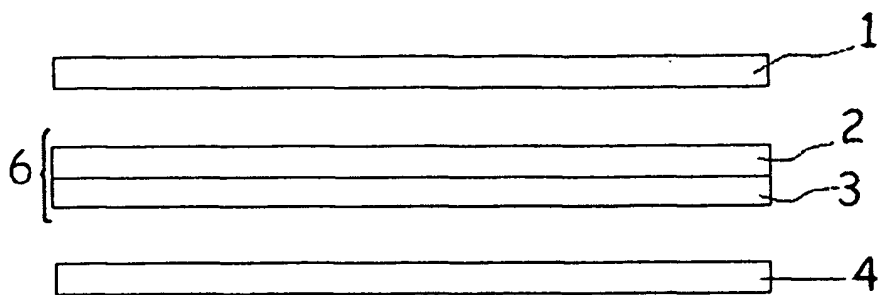


Fig. 1

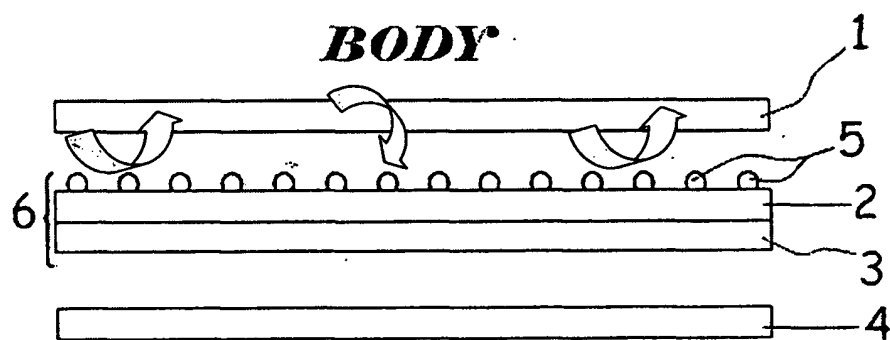


Fig. 2

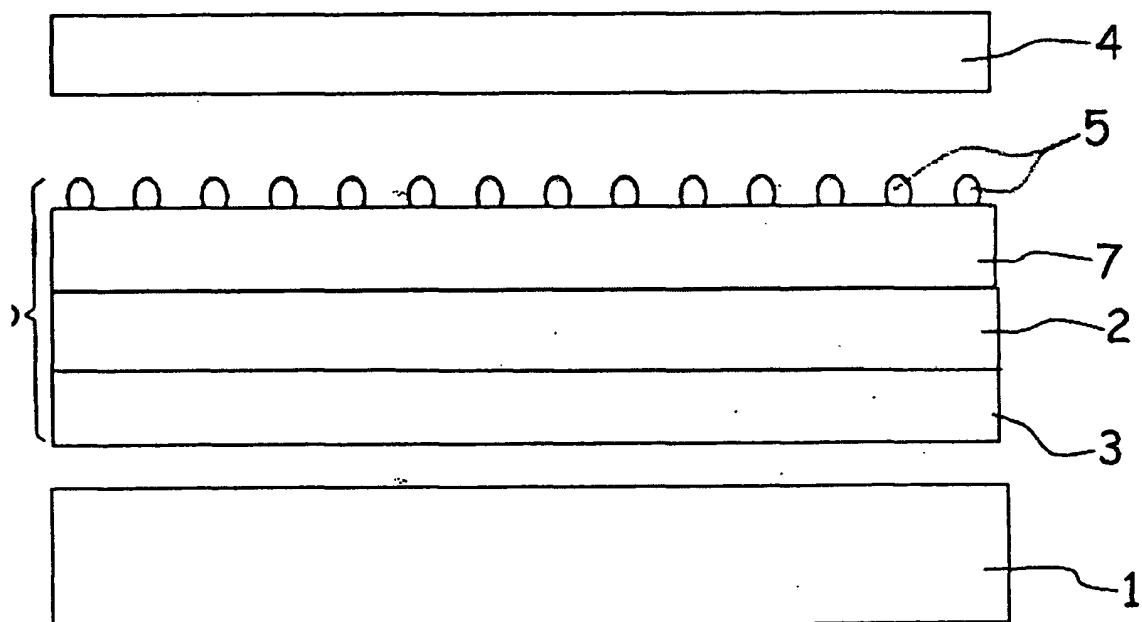


Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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