



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) **EP 1 473 059 A2**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.11.2004 Bulletin 2004/45

(51) Int Cl.7: **A62B 17/00**

(21) Application number: **04252461.1**

(22) Date of filing: **28.04.2004**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IT LI LU MC NL PL PT RO SE SI SK TR**
Designated Extension States:
AL HR LT LV MK

(72) Inventor: **Fernando, Semage Rupasiri
Glenrothes Fife KY6 2QG (GB)**

(74) Representative: **Newell, Campbell et al
Marks & Clerk Scotland
19 Royal Exchange Square
Glasgow G1 3AE (GB)**

(30) Priority: **29.04.2003 GB 0309736**

(71) Applicant: **Ardmel Automation Limited
Glenrothes, Fife KY6 2SD (GB)**

(54) **Thermal protection clothing**

(57) The present invention relates to a thermal protection garment (1) for cooling a wearer exposed to high temperatures. The garment has a first outer layer (2) of heat resistant material, a second inner layer (4) of breathable material, and a separator layer (6) between the outer layer and the inner layer spacing them apart. The separator layer is formed and arranged so as to define a plurality of air channels (26), between the outer

and inner layer, which are in vapour-transmitting communication with the inner layer. The air channels each have at least one wall portion of a flexible material readily and reversibly deformable as a result of activity by a wearer, whereby humid air in the channels is pumped through exhaust vents (40). A multi-layer garment material assembly suitable for fabricating thermal protection garments is also described.

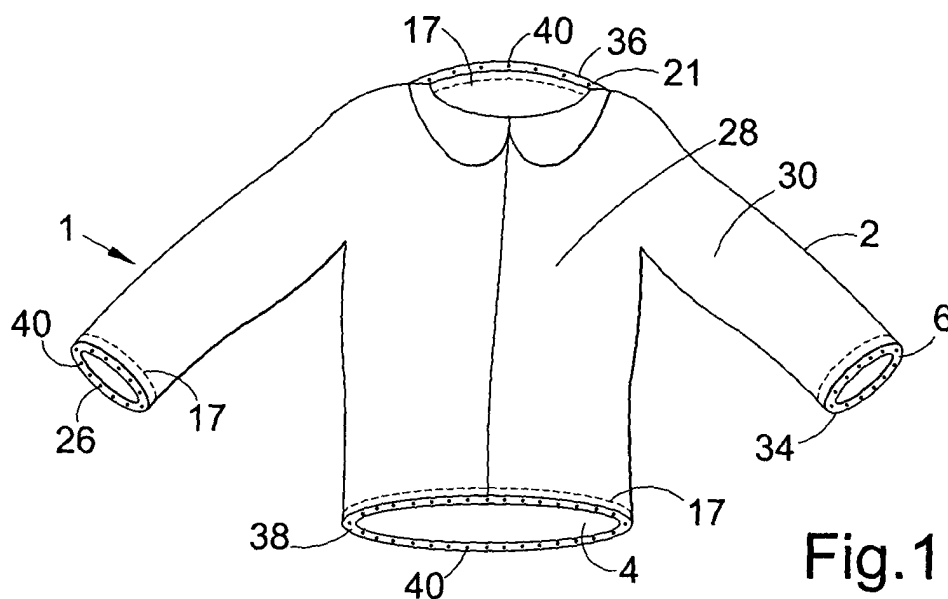


Fig.1

EP 1 473 059 A2

Description

[0001] The present invention relates to material from which thermal protection garments may be fabricated and thermal protection garments.

[0002] There exists a problem in providing fire fighters, and other workers or individuals exposed to extremes of temperature, with protective clothing, which provides adequate heat and flame resistant properties to prevent the wearer being burnt, while also providing sufficient comfort to the wearer to enable the wearer to continue to perform in an effective manner. One major problem experienced by those exposed to high temperatures when wearing existing protective clothing, such as fire fighters' suits, is heat fatigue. While the fire fighters are protected from injury when wearing protective garments which are presently available, they can nevertheless become over heated within the suits, with significant performance impairment and possibly even adverse health consequences.

[0003] It is an object of the present invention to reduce or overcome at least one of the above mentioned problems or disadvantages.

[0004] In a first aspect the present invention provides a thermal protection garment for cooling a wearer exposed to high temperatures, said garment comprising; a first outer layer of heat resistant material; a second inner layer of breathable material; and a separator layer between said first outer layer and said second inner layer spacing said first outer layer and said second inner layer apart, said separator layer being formed and arranged so as to define a plurality of air channels between said first outer layer and said second inner layer, said air channels and said second inner layer being in vapour-transmitting communication; said air channels being in communication with an exhaust vent for venting humid air therethrough, in use of the garment; said air channels each having at least one wall portion of a flexible material readily and reversibly deformable in use of the garment as a result of ambulatory and other activity by a wearer, in use of the garment, so as to repeatedly vary the cross-sectional area of the channels in use of said garment, whereby humid air in said channels is pumped therethrough and exhausted therefrom as a result of such activity.

[0005] Thus the present invention provides a garment which allows excess body heat and perspiration to be removed from the immediate vicinity of the body with increased efficiency, thereby preventing overheating of the wearer and preventing a build up of perspiration on the body surface, or at least significantly reducing the rate of build up of heat and/or perspiration inside the garment.

[0006] There are various materials suitable for the breathable inner layer which are available, which permit the passage of air and water vapour therethrough. A non-exhaustive list of suitable materials includes hydrophilic materials, microporous materials, monoacr-

ylate, paraaramide, aramide, paraaramide and aramide mixtures sold under the brand names Nomex (RTM) and Kermel (RTM), fire retardant fleece.

[0007] It will be appreciated that the particular type of heat resistant material used for the outer layer will depend on the environment in which the garment is to be worn. For example, where the garment is to be worn by fire fighters or individuals at risk of exposure to naked flames, the outer layer is preferably flame retardant. It is also advantageous for the outer layer of, for example, a fire fighter's garment to be waterproof or water repellent. In other situations the outer layer may have features such as chemical resistance, if the user is at risk from exposure to chemicals etc. The outer layer may also be hydrophilic or microporous. Suitable materials for the outer layer include monoacrylate, paraaramide, aramide, paraaramide and aramide mixtures sold under the brand names Nomex (RTM) and Kermel (RTM), fire retardant fleece. The outer and or inner layers may themselves comprise laminates of more than one layer of suitable materials.

[0008] It will be appreciated that the separator layer can be formed and arranged in a number of ways so as to fulfil the requirements of spacing the outer and inner layers apart and defining the air channels therebetween. The air channels themselves can follow a variety of routes, for example, they could run in a direction generally transverse to the thickness of the garment, with the exhaust vent being located at the surface of the outer layer. In practice, however, it is preferable to have elongate air channels running generally in the plane of the garment material. Air channels arranged in this way pump the air therein more efficiently because the force applied to the walls of the air channel, when a body part is flexed on movement, will be applied generally normal to the channel walls. Typically, for ease of construction, the walls of the channels run generally parallel to the surface of the garment, though they could form a more or less convoluted path within the thickness of the separator layer.

[0009] In a particularly convenient form of the invention the separator layer could be in the form of a layer of material with a series of protrusions on either or both sides of the separator material layer. The protrusions could be formed integrally, or alternatively formed separately and stitched or attached by adhesive or any other convenient means, to a central sheet portion of the separator layer. Preferably the protrusions would be in the form of elongate strips, typically of rectangular, circular or triangular cross-section, with the air channels being formed between the strips when the outer and/or inner layer is laid over the separator layer. It will be apparent that where there is material of the separator layer between the breathable inner layer and the air channels, for example, when the air channels are formed on the side of the separator layer of material proximal to the outer layer of the garment, or within the separator layer itself, it is necessary for the layer of material of the sep-

arator layer between the breathable layer and the air channels, also to be breathable, in order to allow the air vapour being removed from the wearer to be transmitted into the air channels.

[0010] It has been found that felt is a particularly convenient material to use for the separator layer, described above, with felt protrusion strips stitched thereto. The felt offers sufficient rigidity and padding to keep the outer and inner layers apart and form the air channels, while being sufficiently flexible to provide ease of movement for a wearer, as well as itself providing a degree of thermal insulation.

[0011] The separator layer could be in the form of a relatively thick sheet of material with a series of internal passages extending therethrough. The material would need to have sufficient give or flexibility to permit reversible deformation of the channel walls when the deformation forces induced by the users movement is transmitted, for example, materials with spongy or rubbery characteristics which can be readily squeezed would be suitable.

[0012] Alternatively, an array, conveniently an inter-linked array, of small padding blocks or padding strips of reversibly deformable material, such as a polymerised foam material, could be placed between the inner and outer layer. As pressure is applied to the outer surface of the garment, the padding blocks or strips would be compressed and the outer and inner layers of the garment driven together, pumping air out of the compressed channels.

[0013] Preferably the air channels are provided with an air inlet distal to the exhaust vent. Fresh air from the atmosphere can be drawn in through the air inlet to replace the air vapour exhausted from the exhaust vent. As the fresh air circulates through the air channels, body heat and vapour can continually be removed.

[0014] The exhaust vents and air inlets can simply be in the form of the open ends of the channels at an edge portion of the garment, for example, the bottom edge of a jacket and the cuffs of a jacket, or the bottom of the legs of a pair of trousers and the waist band of a pair of trousers. Alternatively a more sophisticated valve mechanism could be included. It is also possible to merge a number of the channels to feed into or from a single exhaust vent or air inlet, respectively.

[0015] In a further aspect the present invention provides a multi-layer garment material assembly suitable for use in the fabrication of a thermal protection garment for cooling a wearer of a said fabricated thermal protection garment, when exposed to high temperatures, said material assembly comprising;
a first layer of heat resistant material, said first layer being an outer layer of a said thermal protection garment when in use of said material assembly;
a second layer of breathable material, said second layer being an inner layer of a said thermal protection garment when in use of said material assembly; and
a separator layer disposed between said first and sec-

ond layers spacing said first and second layers apart, said separator layer being formed and arranged so as to define a plurality of air channels between said first and second layers, said air channels being in vapour-transmitting communication with said second breathable layer; said air channels each having at least one wall portion of a flexible material readily and reversibly deformable so as to repeatedly vary the cross-sectional area of said channels when said material assembly is subjected to a form of deformation to which said assembly would be subjected to when incorporated into a said thermal protection garment by an ambulating or other motilely active wearer of a said garment, whereby air in said channels is pumped therethrough.

[0016] It will be appreciated from the description hereinabove that the outer layer, inner layer and separator layer are formed of material with sufficient flexibility to enable a garment to be made which provides reasonable comfort and ease of movement for the wearer, and enables the wall portion or walls of the air channel to be reversibly deformed.

[0017] The layers of the material assembly need not be permanently secured together prior to incorporation into a garment, and could, for example, simply be presented as a multi-layer assembly rolled up together in a similar fashion to that customary in the fabric industry. Alternatively, to ease handling of the material assembly it may be convenient to have the layers joined together by temporary and/or permanent securing means, for example, using temporary tacking along an edge or periodic securing stitches which could be removed if not desired in the final garment.

[0018] In practice it has been found that it is convenient to make each of the outer layer of the garment, the inner layer of the garment and the separator layer of the garment separately as a discrete garment-form unit, for example a jacket. Once the separate units are made they are assembled together and secured by any suitable means, for example, by adhesive or tacking around the openings e.g. at the cuffs, bottom hem and collar, in the case of a jacket.

[0019] Further preferred features and advantages of the present invention will appear from the following detailed description given by way of example to some preferred embodiments illustrated with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of a thermal protection jacket according to the present invention;

Figs. 2 to 4 are cross-sectional views along the thickness of alternative embodiments multi-layered garment materials according to the present invention; and

Fig. 5 is a rear view of a thermal protection jacket according to the present invention showing an exhaust vent.

[0020] Fig. 1 shows a thermal protection jacket 1 for

use by a fire fighter. The jacket has an outer layer 2 of flame retardant monoacrylate material and an inner layer 4 of breathable material, which is also of monoacrylate material. The outer layer 2 and inner layer 4 are spaced apart by a separator layer 6 such as those shown in Figs. 2 to 4.

[0021] In Fig. 2 the separator layer 6 is made from flame retardant felt or flame retardant wadding and comprises a central sheet of felt 8, onto both faces 10, 12 of which, elongate strips of felt 16 are stitched. The strips 16 have a generally rectangular cross-section and run generally parallel to each other with strips 16 on opposite sides of the felt sheet 10, 12 being mutually offset.

[0022] In the jacket 1, the outer layer 2, the inner layer 4 and the separator layer 6, are held together in a sandwich arrangement by stitching 17 at the cuffs 34, neck 36 and waist band 38 of the jacket 1, thereby holding the inner surface 18 of the outer layer 2 and the inner surface 20 of the inner layer 4 in contact with the strip faces 22, 24 of alternate strips 16. Air channels 26 are formed and arranged between the felt strips 16 and the outer layer 2 and the inner layer 4. In the jacket 1 shown in Fig. 1 the air channels 26 run down the length of the body 28 and arms 30.

[0023] While Fig. 2 shows the felt strips 16 and the air channels 26 to be of approximately similar cross section, this need not be the case, for example, the strips could be approximately 1 to 1.5 cm wide and the air channels approximately 3 cm wide.

[0024] When a fire fighter wears the jacket 1, the breathable inner layer 4 allows perspiration and heated air generated by the body to pass through the inner layer 4 and into the air channels 26. When the fire fighter flexes, for example, his arm or bends over etc, folds or creases in the jacket form, deforming the air channels 26 and reducing their cross-sectional area, as indicated by the dashed lines. The pressure, causing the deformation of the air channels, results in a bellows effect pumping air 32 in the channels 26 out along the channels 26.

[0025] In the jacket 1 of Fig. 1 the channels are open at the cuffs of the arms 34, neck 36 and waist band 38, and the pumped air 32 flowing through the channels 26 can simply be exhausted from the open ends 40 and replaced with atmospheric air.

This removes moist, humid air and perspiration from the fire fighter's body and the channels 26 are replenished with fresh air by suction when the walls of the air channels resume their original, undeformed, position, to help cool the wearer.

[0026] In Fig. 3 an alternative embodiment of the material assembly is shown. The outer layer 2 and inner layer 4 are of flame retardant fabric and Kermel (RTM) paraarmide and aramide mixture material, respectively and the separator layer 6 is formed from a wad of flame retardant breathable material 42 through which a series of internal passages 44 forming the air channels 26 have been formed. The wad 42 is sufficiently flexible to allow

ease of movement of the wearer and enable the walls of the internal passages 46 to deform inwardly and pump air 32 within the passages along the channels constituted thereby 26. As the separator layer 6 is of breathable material, perspiration from the wearer is transmitted easily from the inner surface of the garment 48 to and along the channels 26.

[0027] In Fig. 4 the outer layer and inner layer are held apart and supported by spaced apart strips of separator material 50, such as fire retardant foam and have a generally square-shaped cross-section 52. The inner surfaces 18, 20 of the outer and inner layers 2, 4, respectively, are joined to opposite faces 54 of the strips 50 by stitching or a suitable adhesive. Air channels 26 are formed between adjacent strips 50. When pressure is applied to a surface of the garment, for example, on flexing a limb, the foam strips 50 are compressed driving the inner layer 4 towards the outer layer 2, reducing the cross-sectional area of the air channels 26, as shown by the dashed line, and pumping air 32 along the channels 26.

[0028] It will be appreciated that the thickness of the separator layer can be varied depending on the size of the air channels, the degree of additional padding and protection desired, etc. Padded protection can be particularly advantageous when working in certain environments.

[0029] In Fig. 5 the back 55 of a jacket 1 is shown which has a collar 56, the back portion 57 of which serves as a cover flap 58. The flap 58 is held slightly raised above the outer surface 60 of the jacket 1 by flap supports 62. The air channels 26 of the jacket (only one shown) exhaust from the jacket via a vent opening 64 underneath the flap 58 and the exhausted air flows out from under the raised flap 58.

[0030] It will be appreciated that whilst the present invention is described with particular reference to a jacket, it is equally applicable to a wide range of other garments, such as trousers, boiler suits, gloves etc.

Claims

1. A thermal protection garment (1) for cooling a wearer exposed to high temperatures, said garment comprising;
 - a first outer layer (2) of heat resistant material;
 - a second inner layer (4) of breathable material; and
 - a separator layer (6) between said first outer layer and said second inner layer spacing said first outer layer and said second inner layer apart, said separator layer being formed and arranged so as to define a plurality of air channels (26) between said first outer layer and said second inner layer, said air channels and said second inner layer being in vapour-transmitting communication; said air channels being in communication with an exhaust vent (40) for venting humid air (32) therethrough, in use of the

garment; said air channels each having at least one wall portion of a flexible material readily and reversibly deformable in use of the garment as a result of ambulatory and other activity by a wearer, in use of the garment, so as to repeatedly vary the cross-sectional area of the channels in use of said garment, whereby humid air in said channels is pumped therethrough and exhausted therefrom as a result of such activity.

2. A thermal protection system as claimed in claim 1 wherein said breathable inner layer (4) is selected from the group of materials including hydrophilic materials, microporous materials, monoacrylate, paraaramide, aramide, paraaramide and aramide mixtures and fire retardant fleece. 10
3. A thermal protection garment as claimed in claim 1 or claim 2 wherein the outer layer (2) is flame retardant. 15
4. A thermal protection garment as claimed in any one of claims 1 to 3 wherein said outer layer (2) is waterproof or water repellent. 20
5. A thermal protection garment as claimed in any one of claims 1 to 3 wherein said outer layer (2) is hydrophilic. 25
6. A thermal protection garment as claimed in any one of claims 1 to 5 wherein said outer layer (2) is microporous. 30
7. A thermal protection garment as claimed in any one of claims 1 to 6 wherein said outer (2) and or inner layers (4) comprise laminates of more than one layer of materials. 35
8. A thermal protection garment as claimed in any one of claims 1 to 7 wherein said air channels (26) run in a direction generally transverse to the thickness of the garment, with the exhaust vent being located at the surface of the outer layer. 40
9. A thermal protection garment as claimed in any one of claims 1 to 7 wherein said air channels (26) are elongate and run generally in the plane of the garment material. 45
10. A thermal protection garment as claimed in any one of claims 1 to 9 wherein the walls of the channels (26) run generally parallel to the surface of the garment. 50
11. A thermal protection garment as claimed in any one of claims 1 to 10 wherein said separator layer (6) is in the form of a layer of material with a series of protrusions on either or both sides of the separator ma-

terial layer.

12. A thermal protection garment as claimed in claim 11 wherein the protrusions (16) are stitched or attached by adhesive or any other convenient means, to a central sheet portion of the separator layer. 5
13. A thermal protection garment as claimed in claim 11 or claim 12 wherein the protrusions are in the form of elongate strips (16), having a cross section shape selected from rectangular, circular or triangular cross-sections, with the air channels being formed between the strips when the outer (2) and/or inner layer (4) is laid over the separator layer. 10
14. A thermal protection garment as claimed in any one of claims 1 to 13 wherein said separator layer (6) is of felt material with felt protrusion strips (16) attached thereto. 15
15. A thermal protection garment as claimed in any one of claims 1 to 14 wherein said separator layer (6) is in the form of a relatively thick sheet of material (42) with a series of internal passages (44) extending therethrough. 20
16. A thermal protection garment as claimed in any one of claims 1 to 15 wherein there is provided an array, of small padding blocks or padding strips (50) of reversibly deformable material placed between said inner and outer layer. 25
17. A thermal protection garment as claimed in any one of claims 1 to 16 wherein said air channels (26) are provided with an air inlet distal to the exhaust vent. 30
18. A thermal protection garment as claimed in any one of claims 1 to 17 wherein said exhaust vents and air inlets are in the form of the open ends of the channels (40) at an edge portion of the garment. 35
19. A thermal protection garment as claimed in any one of claims 1 to 18 wherein a number of the channels merge to feed into or from a single exhaust vent (64) or air inlet, respectively. 40
20. A multi-layer garment material assembly suitable for use in the fabrication of a thermal protection garment for cooling a wearer of a said fabricated thermal protection garment, when exposed to high temperatures, said material assembly comprising; a first layer of heat resistant material (2), said first layer being an outer layer of a said thermal protection garment when in use of said material assembly; a second layer of breathable material (4), said second layer being an inner layer of a said thermal protection garment when in use of said material assembly; and 45

a separator layer (6) disposed between said first and second layers spacing said first and second layers apart, said separator layer being formed and arranged so as to define a plurality of air channels (26) between said first and second layers, said air channels being in vapour-transmitting communication with said second breathable layer; said air channels each having at least one wall portion of a flexible material readily and reversibly deformable so as to repeatedly vary the cross-sectional area of said channels when said material assembly is subjected to a form of deformation to which said assembly would be subjected to when incorporated into a said thermal protection garment by an ambulating or other motilely active wearer of a said garment, whereby air in said channels is pumped there-through.

20

25

30

35

40

45

50

55

