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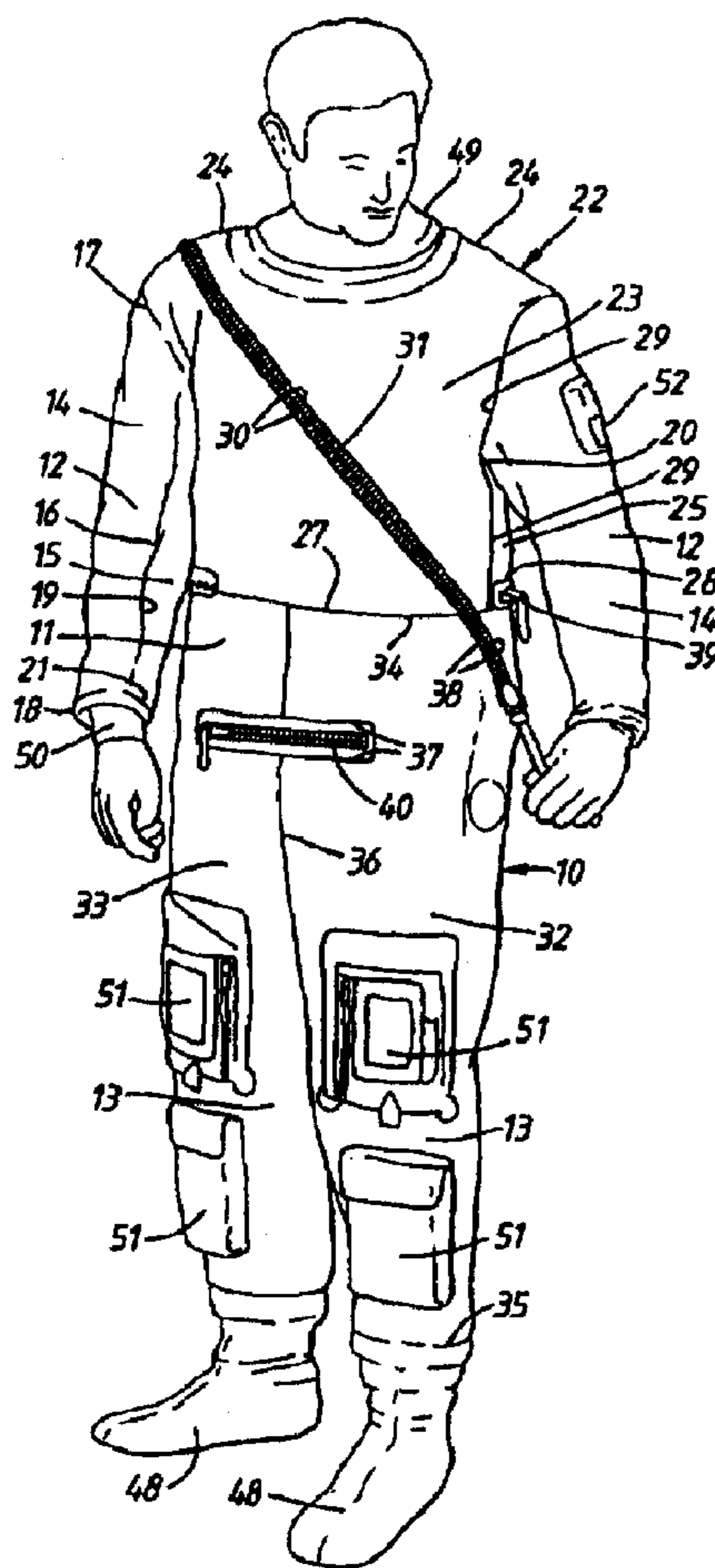
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(54) **VETEMENT DE PROTECTION**

(54) **PROTECTIVE GARMENT**



(57) L'invention concerne une combinaison (10) d'immersion essentiellement formée par une multiplicité de panneaux. Chaque panneau présente une couche (41) extérieure ininflammable et ignifugée et une couche (42) intérieure perméable à la vapeur d'eau et sensiblement imperméable à l'eau lors d'une immersion dans l'eau.

(57) An immersion suit (10) is largely formed from a plurality of panels. Each panel has an outer layer (41) that is fire- or flame-resistant and an inner layer (42) which provides water vapour permeability and which is substantially impermeable to water when immersed in water. The inner and outer layers (41, 42) of each panel



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Ces couches intérieures et extérieures (41, 42) de chaque panneau ne sont pas attachées dans une zone sensiblement continue de chaque panneau. Lorsque la combinaison est portée par un utilisateur immergé dans l'eau, les couches intérieures (42) empêchent l'eau de pénétrer dans ladite combinaison. Les couches extérieures (41) protègent les couches intérieures (42) lorsque la combinaison est exposée à un embrasement éclair. Ainsi, si l'utilisateur est par la suite immergé dans l'eau, les couches intérieures (42) peuvent encore empêcher l'eau de pénétrer dans la combinaison. Les couches intérieures et extérieures (41, 42) n'étant largement pas attachées (et non liées les unes aux autres), la perméabilité à la vapeur d'eau de la combinaison (10) s'en trouve maximisée, ce qui contribue à réduire la conduction thermique entre les deux couches (41, 42). En outre, des accessoires de combinaison tels que des poches peuvent être cousus sur la couche extérieure (41) uniquement. Les couches intérieures (42) n'étant pas atteintes par ces coutures, il n'est pas nécessaire d'étanchéifier ces couches intérieures (42) à proximité desdites coutures.

are unconnected in a substantial continuous area of each panel. In use, the inner layers (42) prevent entry of water into the suit when the suit is worn by a wearer immersed in water. The outer layers (41) protect the inner layers (42) when the suit is worn during exposure to a flash fire. In this way, if the wearer subsequently becomes immersed in water, the inner layers (42) are still able to prevent entry of water into the suit. As the inner and outer layers (41, 42) are largely unconnected (and not bonded together), this helps to maximise the water vapour permeability of the suit (10) and helps to reduce conduction of heat between the two layers (41, 41). Additionally, attachments to the suit such as pockets can be stitched to the outer layer (41) only. As the inner layers (42) are not penetrated by this stitching, sealing of the inner layers (42) in the vicinity of the stitching is not necessary.



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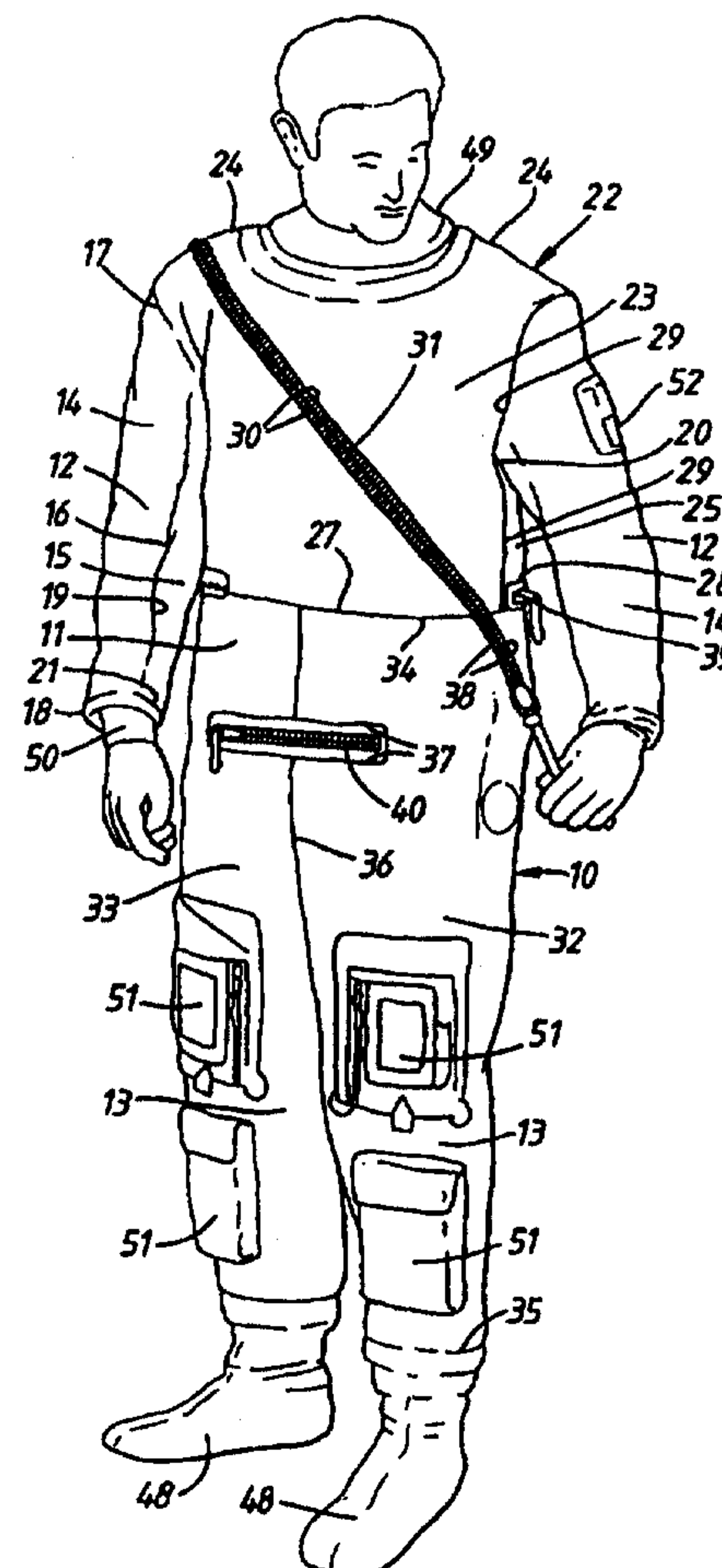
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<p>(21) International Application Number: PCT/GB97/03163 (22) International Filing Date: 18 November 1997 (18.11.97)</p> <p>(30) Priority Data: 9623816.7 18 November 1996 (18.11.96) GB 9708194.7 23 April 1997 (23.04.97) GB</p> <p>(71) Applicant (for all designated States except US): WARDLE STOREYS (SAFETY & SURVIVAL EQUIPMENT) LIMITED [GB/GB]; Grove Mill, Earby, Barnoldswick BB18 6UT (GB).</p> <p>(72) Inventor; and (75) Inventor/Applicant (for US only): LITTLER, Stephen [GB/GB]; 25 Harvest Lane, Moreton, Wirral, Merseyside L46 7UF (GB).</p> <p>(74) Agent: MATHISEN, MACARA & CO.; The Coach House, 6/8 Swakeleys Road, Ickenham, Uxbridge, Middlesex UB10 8BZ (GB).</p>		<p>(81) Designated States: CA, NO, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).</p> <p>Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>

(54) Title: PROTECTIVE GARMENT

(57) Abstract

An immersion suit (10) is largely formed from a plurality of panels. Each panel has an outer layer (41) that is fire- or flame-resistant and an inner layer (42) which provides water vapour permeability and which is substantially impermeable to water when immersed in water. The inner and outer layers (41, 42) of each panel are unconnected in a substantial continuous area of each panel. In use, the inner layers (42) prevent entry of water into the suit when the suit is worn by a wearer immersed in water. The outer layers (41) protect the inner layers (42) when the suit is worn during exposure to a flash fire. In this way, if the wearer subsequently becomes immersed in water, the inner layers (42) are still able to prevent entry of water into the suit. As the inner and outer layers (41, 42) are largely unconnected (and not bonded together), this helps to maximise the water vapour permeability of the suit (10) and helps to reduce conduction of heat between the two layers (41, 41). Additionally, attachments to the suit such as pockets can be stitched to the outer layer (41) only. As the inner layers (42) are not penetrated by this stitching, sealing of the inner layers (42) in the vicinity of the stitching is not necessary.



PROTECTIVE GARMENT

The invention relates to a protective garment.

One type of protective garment is an immersion suit. An immersion suit is designed to prevent entry of water into the suit when the suit is worn by a wearer immersed in water. This protects the wearer against the effects of being immersed in water, particularly by providing protection against hypothermia. Immersion suits may be worn by aviators, sailors, workers on off-shore oil/gas installations and other persons who are not regularly immersed in water but who face a risk of accidental immersion in water.

A known type of immersion suit uses a thermoplastic membrane attached to a fabric. The membrane is substantially impermeable to water, that is to say liquid water, but is permeable to water vapour so as to allow escape of perspiration when the suit is worn out of water. However, the thermoplastic membrane of such suits is readily damaged in a flash fire, as can be experienced in an aircraft, ship or off-shore oil/gas installation, such that the impermeability to water is lost. Hence, if a wearer of the suit is first exposed to a flash fire and subsequently enters the

water, the water can enter the suit and the protection provided by the suit is diminished. Other known immersion suits are constructed from a water-vapour-permeable fabric comprising fibres which, when immersed in water, swell such that the fabric becomes impermeable to water. Unfortunately, such fabric has low resistance to flame/fire.

A protective garment having an outer layer of fire-retardant fabric and an inner layer of microporous material bonded to the outer layer by a web of low-melt polyamide fibres is disclosed in GB-A-2199787. Accordingly, there is no substantial area of the outer and inner layers that are not bonded together.

In accordance with the invention, there is provided a protective garment comprising a plurality of panels, each panel having an outer layer which is fire or flame-resistant and an inner layer which provides water vapour permeability and which is substantially impermeable to water when immersed in water, the inner and outer layers of each panel being unconnected in a substantial continuous area of said each panel.

The outer layer protects the inner layer when this suit is exposed to flame or fire.

The following is a more detailed description of an embodiment of the invention, by way of example, reference being made to the appended, schematic drawings in which:

Figure 1 is a perspective view of an immersion suit according to the invention being worn by a wearer; and

Figure 2 is a cross-sectional view of a seam between two panels of the suit of Figure 1.

As shown in Figure 1, the suit 10 has a torso-covering body portion 11, two sleeves 12 and two legs 13.

The body portion 11, the sleeves 12 and the legs 13 are formed largely by a plurality of panels.

Each sleeve 12 includes an outer panel 14 that covers the outer side of a wearer's arm and an inner panel 15 that covers the inner side of a wearer's arm. As the arrangement of the panels 14, 15 in each sleeve 12 is identical, only one sleeve 12 is described below.

It will be appreciated from the description given below that, in

most cases, the edges of the panels described below lie inside the suit 10 and so the lines leading from the reference numerals in Figure 1 do not terminate precisely at the corresponding edges but indicate the general position of the edges.

Bearing this in mind, the outer sleeve panel 14 has two longer edges 16 connected by an upper edge 17 and a lower edge 18. The inner sleeve panel 15 also has two longer edges 19 connected by an upper edge 20 and a lower edge 21. Respective edge regions extending adjacent each longer edge 16, 19 of each arm panel 14, 15 are used to secure the two panels 14, 15 together at two seams. Hence, one edge region of the outer panel 14 is secured to one edge region of the inner panel 15 and the other edge region of the outer panel 14 is secured to the other edge region of the inner panel 15. The upper edges 17, 20 are shaped so that together they form the upper end of the sleeve 12 (lying around the upper arm of a wearer) and the lower edges 18, 21 are shaped so that together they form the lower end of the sleeve 12 (lying around the wrist of a wearer).

An upper part of the body portion 11 includes a single panel 22 which is doubled over to form the chest portion 23, shoulder portion 24 and back portion 25 of the suit 10. This upper body

portion panel 22 also has an aperture 26 which receives the neck of a wearer.

The upper body portion panel 22 is generally rectangular with spaced front and rear waist edges 27, 28 interconnected by two side edges 29. However, the panel 22 is cut from the junction of the front waist edge 27 and the side edge 29 across the chest portion 23 to the right shoulder portion 24 to form two spaced diagonal edges 30. These edges 27, 28, 29, 30 form the periphery of the panel 22.

Respective edge regions extending adjacent the two side edges 29 of the upper body portion panel 22 are included in a number of seams. The edge region extending adjacent the left side edge 29 has two opposed end parts that are secured together at a seam to connect the chest and back portions 24, 25 of the suit 10 below the left sleeve 12. The remaining, central part of this edge region is secured at seams to respective edge regions of the inner and outer panels 14, 15 of the left sleeve 12 - each sleeve panel edge region extending adjacent the upper edge 17, 20 of the corresponding sleeve panel 14, 15. The edge region extending adjacent the right side edge 29 is included in seams in a similar manner to the left edge region - the central part of the right

edge region forming seams with the right arm panels 14, 15.

Respective edge regions extending adjacent the two spaced diagonal edges 30 of the upper body portion panel 22 are each secured, in a waterproof fashion, to respective sides of a first waterproof zipper 31 that, as shown in Figure 1 and described below, extends below the upper body portion panel 22 to the left hip of the suit 10.

Each leg 13 includes a single leg panel 32, 33. The two leg panels 32, 33 also form a lower part of the body portion 11 comprising hip, stomach, groin and buttock portions of the suit 10.

The leg panels 32, 33 are similar and so only one, the left leg panel 32, will be described below in detail.

The left leg panel 32 is elongate with opposed waist and ankle edges 34, 35 that are connected by two side edges (only one of which is indicated at 36 in Figure 1). Each side edge 36 has an upper part and a lower part, the upper parts corresponding to a wider portion of the left leg panel 32, adjacent the waist edge 34 and the lower parts corresponding to a narrower portion

of the panel 32, adjacent the ankle edge 35.

The left leg panel 32 is cut from one of the upper parts of the side edges 29, that lies at the front of the suit 10, into the left leg panel 32, to form two parallel, horizontal edges 37 in the groin region of the suit 10.

The left leg panel 32 is also cut from the waist edge 34, into the panel 32, to form two parallel edges 38 that extend diagonally through the left hip region of the suit. Each diagonal edge 38 is aligned with a respective diagonal edge 30 of the upper body portion panel 30.

The edges 34, 35, 36, 37 and 38 form the periphery of the panel 32.

The right leg panel 33 is the mirror image of the left leg panel 32 except that it does not have the diagonal cut at the hip. The names and reference numerals used above for parts of the left leg panel 32 will be used below for the corresponding parts of the right leg panel 33.

For each leg panel 32, 33, a region extending adjacent the lower part of one side edge 36 is secured at a seam to a region extending adjacent the lower part of the other side edge 36 so that the narrower portion of the leg panel 32, 33 forms a leg 13.

Respective regions lying adjacent the two cut top parts of the side edges 36 of the two panels 32, 33 are secured to each other at a seam at the front of the suit. The arrangement is such that each of the horizontal edges 37 of the cuts is aligned with a respective horizontal edge 37 in the other leg panel 32, 33. Respective regions lying adjacent the other two top parts of the side edges 36 (those that are not cut) are secured to each other at a seam at the rear of the suit 10. Hence, the two wider portions of the two leg panels 32, 33 form the hip, stomach, groin and buttock portions of the suit 10.

Respective regions extending adjacent the two waist edges 34 of the two leg panels 32, 33 are secured, at the front of the suit 10, to a region extending adjacent the front waist edge 27 of the upper body portion panel 22 at a seam, and at the rear of the suit, in a waterproof fashion, to one side of a second waterproof zipper 39. The other side of the second waterproof zipper is secured to a region lying adjacent the rear waist

edge 28 of the upper body portion panel 22.

The part of the first waterproof zipper 31 that extends below the upper body portion panel 22 is secured, in a waterproof fashion, at one side, to a region lying adjacent one of the diagonal edges 38 of the left leg panel 32 and, at the other side, to a region lying adjacent the other diagonal edge 38.

A third waterproof zipper 40 is secured, in a waterproof fashion, between respective regions adjacent the two horizontal edges 37 of the left leg panel 32 and between respective regions adjacent the two horizontal edges 37 of the right leg panel 33. This zipper can be opened for urination.

As shown in Figure 2, each panel of the suit 10 is formed from a respective outer layer of material 41 and a respective inner layer of material 42. The inner layer of material 42 (for each panel) is impermeable to water when the suit 10 is immersed in water and is permeable to water vapour when not immersed in water. A known type of material that is suitable is a breathable fabric made up of fibres that swell on immersion in water so as to render the material impermeable to water.

The material of the outer layer 41 (of each panel) has a high resistance to fire or flame and is preferably permeable to water vapour. A suitable material for the outer layers 41 is a flame-retardant, water-vapour-permeable material composed of aramid fibres, e.g. Nomex (Trade Mark).

For each panel, the inner and outer layers of material 41, 42 are only connected (as described below) at regions adjacent the edges of the panel - i.e. the regions by which the panels are secured to adjacent panels at seams, the regions by which the panels are secured to zippers or the regions by which the edges are secured to boots or seals as described below.

All the seams described above between pairs of adjacent panels (and between the layers making the panels) are formed in the same way, as follows.

As shown in Figure 2, the layers 41, 42 making up two adjacent panels are stitched together at respective edge regions of the panels by a line of stitching 43 that extends generally parallel to the edges 44 of the panels. This forms the panels and connects the panels simultaneously. The respective areas of the panels lying between the line of stitching 43 and the

corresponding edges 44 lie together, at the inside of the suit, such that the respective outer layers 41 contact one another. These areas are also held together by further stitching 45 between the line of stitching 43 and the diagonal edges 44. The two areas are folded over towards one of the panels. In this way a seam is formed between the two panels. The seam and the surrounding area is covered, at the inside of the suit, by a waterproof adhesive 46. The adhesive 46 is, in turn, covered by a tape 47 which extends along the seam. The arrangement is such that the seam is waterproof.

The ankle edge end of each leg 13 is attached to a flexible waterproof boot 48.

The neck aperture 26 of the upper body portion panel 22 is secured to a resilient, annular, waterproof seal 49 which seals around the neck of a wearer of the suit 10. The neck seal is covered, at the outside of the suit, by a collar of fire-resistant fabric which is arranged so as not to interfere with the sealing between the neck seal 49 and the wearer's neck.

Each sleeve 12 is provided with a tubular, flexible waterproof cuff seal 50. Each cuff seal 50 is secured, at one end, in a

waterproof manner, around the inside of the inner and outer sleeve panels 14, 15. Hence, an arm of a wearer of the suit 10 extends through the cuff seal 50 which forms a waterproof seal around the wrist of the arm. As shown in Figure 1, each cuff seal 50 is secured to the corresponding inner and outer sleeve panels 14, 15 slightly upwardly of the lower end of the sleeve so that the sleeve panels 14, 15 protect the cuff seal 50. Each cuff seal 50 is also provided, on its outside, with a collar of fire-resistant fabric.

Each leg 13 is provided, externally, with two pockets 51 of different designs. The left sleeve 12 is also provided, externally, with a pocket 52. The pockets 51, 52 are secured to the suit 10 by stitching to the outer layer of material 41 only of the corresponding panel. As the stitching does not penetrate the inner layers of material 42 of the panels, there is no need to seal the inner layers in the vicinity of the pockets 51, 52.

In operation, a wearer dons the suit 10 by opening the first waterproof zipper 31 and stepping into the legs 13. The wearer then inserts his right arm into the right sleeve 12 such that his hand passes through the associated cuff seal 50. The wearer then inserts his head through the neck seal 49 and his left arm

through the left sleeve 12 until his left hand passes through the associated cuff seal 50. The first waterproof zipper 31 can then be closed to seal the suit 10.

During normal use, when the wearer is not immersed in water, perspiration in the form of water vapour permeates through the inner layers of material 42 and subsequently through the outer layers of material 41 to the outside of the suit 10. Additionally, water vapour condensing on the outside of the inner layers of material 42 can wick across the outer layers of material 41 to the outside of the suit 10.

The fact that the outer and inner layers of material 41, 42 are unconnected in the central areas of the panels (the areas lying within the edge regions) results in a high permeability to water vapour in these areas. As the central areas are relatively large compared to the edge regions, the overall water vapour permeability of the suit is high.

If the wearer of the suit 10 becomes immersed in water, the water can pass through the outer layers of material 41 to the inner layers of material 42. However, on contacting the inner layers of material 42 the fibres of the inner layers 42 swell so that

the inner layers of material 42 become impermeable to water. In this way, water is prevented from reaching the body of the wearer within the suit 10. The cuff seals 50 and the neck seal 49 prevent entry of water into the suit 10 between the suit and the wrists of the wearer and between the suit and the neck of the wearer. As all the seams of the suit 10 and all connections between the panels and the waterproof zippers 31, 39, 40, between the panels and the boots 48 and between the panels and the seals 49, 50 are waterproof, no water enters the suit 10.

If, before immersion in water, the wearer of the suit 10 is exposed to a flash fire, the outer layers of material 41 provide protection to the inner layers of material 42 such that, on subsequent immersion in water, the inner layers of material 42 prevent entry of water into the suit 10, as described above.

The fact that the outer and inner layers of material 41, 42 are unconnected in the central areas of the panels (the areas lying within the edge regions) helps maximise the protection against fire provided by the outer layers 41 to the inner layers 42 in these areas. As the layers 41, 42 are not held tightly together in the central areas, conduction of heat between the layers is reduced.

It will be appreciated that the suit 10 described above may be modified. In particular, the arrangement of panels described above may be modified as required for any particular application. Also, the positioning of the waterproof zippers 31, 39, 40 and the pockets 51, 52 can be changed.

Instead of using the material of the inner layers 42 described above, a water-vapour-permeable material that is permanently impermeable to water could be used.

Whereas the inner and outer layers 41, 42 of the panels described above are unconnected in the central areas of the panels, the layers of each panel could be stitched together in spaced regions of the central area - the spaced regions forming a low proportion of the area of the central area - so that the layers 41, 42 were largely unconnected in the central area. This might facilitate donning and doffing of the suit 10 and would require sealing of the inner layer in the stitched regions.

The use of a plurality of panels, each panel having a fire-resistant outer layer and a water-impermeable and water-vapour-permeable inner layer is also appropriate to the manufacture of other protective garments.

CLAIMS

1. A protective garment comprising a plurality of panels, each panel having an outer layer which is fire or flame resistant and an inner layer which provides water vapour permeability and which is substantially impermeable to water when immersed in water, the inner and outer layers of each panel being unconnected in a substantial continuous area of said each panel.
2. A protective garment according to claim 1, wherein each panel has an edge region extending around the periphery of said each panel and by which said each panel is secured to at least an adjacent panel or panels, the continuous area of said each panel forming all or substantially all of the area of said panel lying inwardly of said edge region.
3. A protective garment according to claim 1 or claim 2, wherein the panels of at least one pair of adjacent panels are detachably secured to each other by means of one or more zip fasteners.
4. A protective garment according to any preceding claim, wherein the panels of at least one pair of adjacent panels are

permanently secured to each other at a seam by stitching, the seam being sealed to prevent passage of water therethrough.

5. A protective garment according to claim 4, wherein the stitching of said panels of the or each pair is a line of stitching adjacent respective peripheral edges of said panels, respective areas of the same layer in said panels between the line of stitching and the associated edges being in contact.

6. A protective garment according to claim 5, wherein the seal is formed by covering the seam with adhesive and covering the adhesive with tape.

7. A protective garment according to claim 5, wherein the seal is formed by covering the seam with a heat/pressure-applied, adhesive-coated tape.

8. A protective garment according to any preceding claim, wherein one or more of the panels define an aperture through which, in use, a portion of a wearer passes, the panel or panels around said aperture being secured to one or more seals for sealing again said portion of the wearer to prevent the passage of water.

9. A protective garment according to claim 8, wherein the or each seal includes a flame-retardant protective collar or cover to protect the seal from flame.
10. A protective garment according to any preceding claim, wherein the outer layers comprise flame-retardant, water-vapour-permeable material comprising aramid fibre.
11. A protective garment according to any preceding claim, wherein the garment is an immersion suit.
12. A protective garment according to any preceding claim, wherein the inner and outer layers of each panel are the only layers of said each panel.
13. A protective garment substantially as hereinbefore described with reference to the accompanying drawings.

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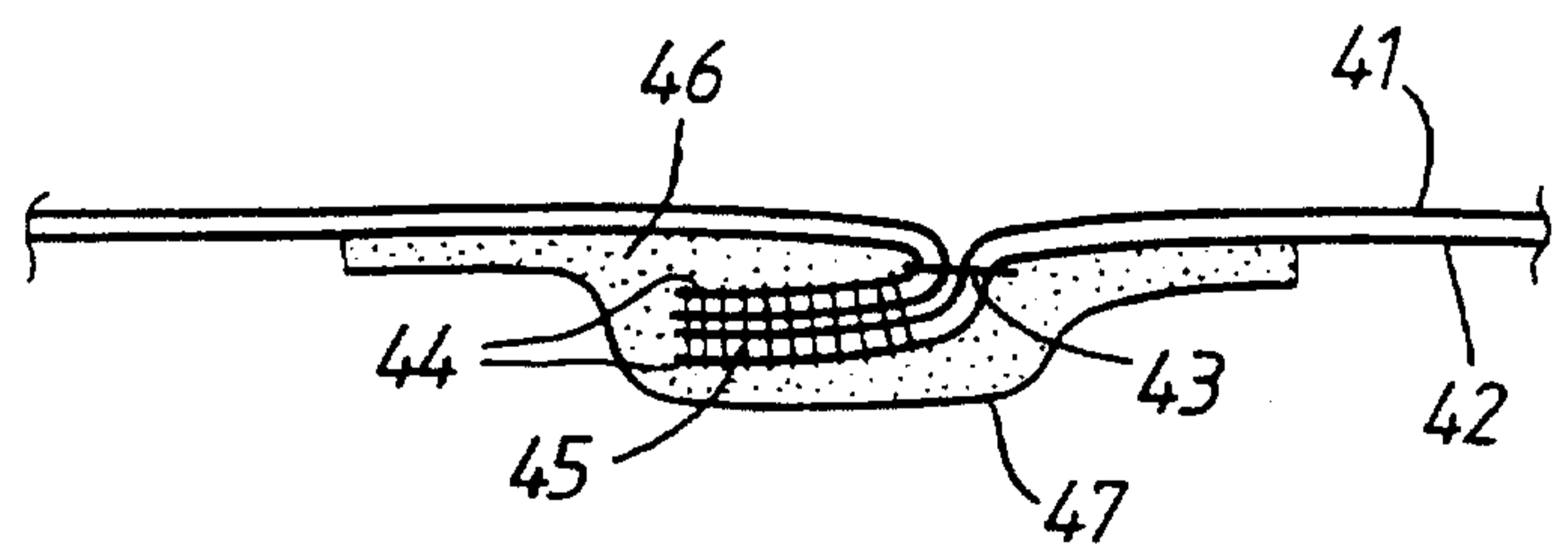
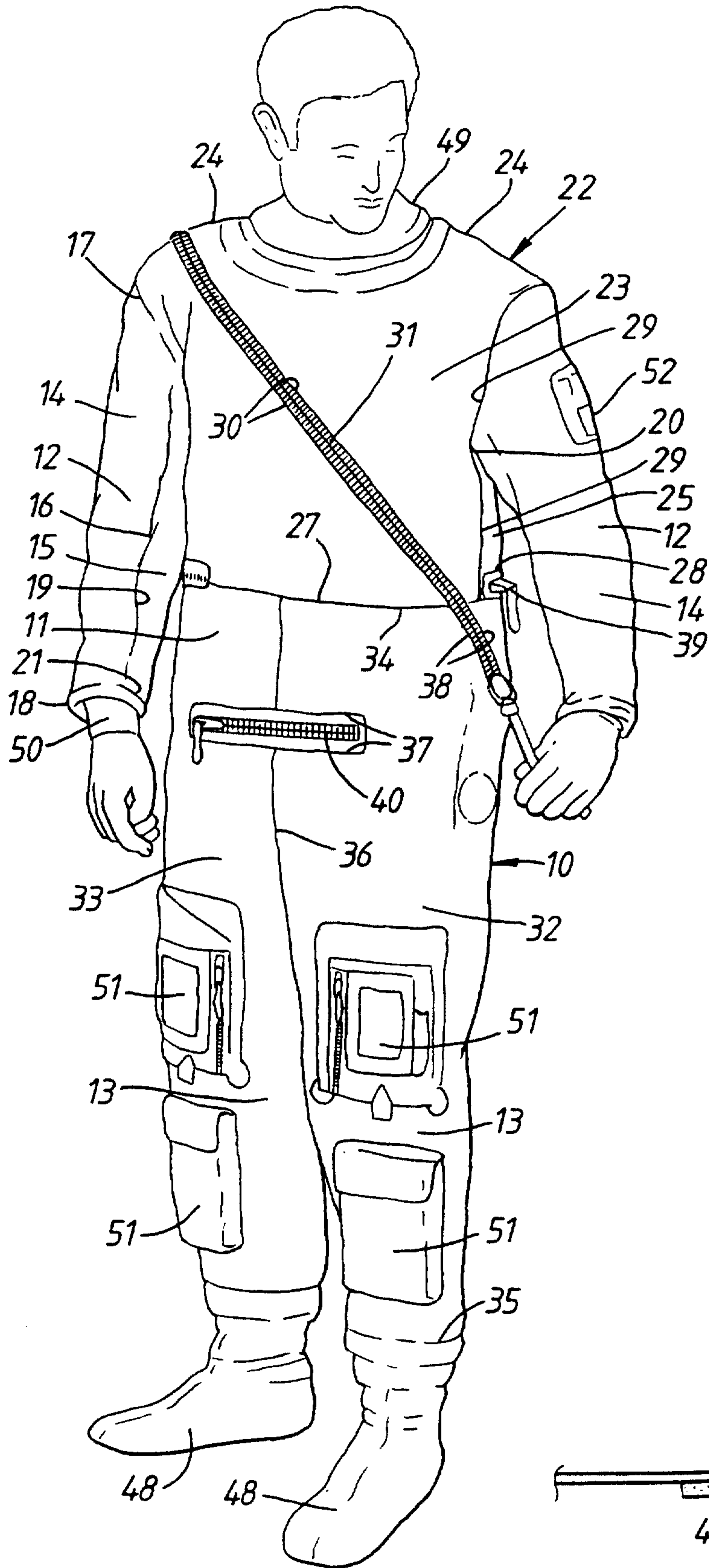


Fig.1

Fig.2