PROTECTIVE GARMENT

This invention relates to an inflatable garment to act as a rescue device for people who fall into water or in other hazardous situations and to a garment comprising body armour. Such a garment might be worn by a member of the armed forces, police and the like.

It is known to provide a life jacket, vest or similar garment with an inflatable bladder or balloon to provide the wearer with buoyancy when he falls into water. In most garments there are opposed flaps or similar which are held closed when the bladder is deflated but which separate on inflation of the bladder to provide an increase in volume of the garment to house the inflated bladder. The flap portions are held together by a zip system such as a burstable zip system. Zips cannot cope with flap portions that are not straight and burst zips cannot easily be reused. VELCRO can be used alone or with a zip, but only for a short length. It is one object of this invention to provide a garment having such an expandable portion and which will cope with irregularities in the wall of the garment and have other advantages.

In those garments comprising body armour, the armour might comprise flexible penetration resistant material and/or, for extra protection, a rigid ceramic plate. The provision of buoyancy is useful in some situations and the prior art includes several proposals for garments comprising buoyant material such as foam sheets as well as armour. However, buoyant foam provides only light protection and may not support the weight of high level protective armour.

US patent specification 5584737 proposes a garment comprising pockets for receiving anti-ballistic inserts and buoyancy elements including an inflatable chamber. Another example of

protective garment is illustrated in PCT/GB99/01114, in which there is shown body armour and a gas inflatable bag with inflation means for inflating the bag to provide buoyancy to the wearer of the garment when immersed in water.

One problem associated with the prior art is that the shock waves from the impact of a bullet into the body armour can result in degradation of the buoyancy aid.

The present invention and its preferred embodiments seek to overcome, or at least mitigate the problems of the prior art.

One aspect of the invention provides a protective body garment comprising an outer layer of penetration resistant armour, a gas inflatable bladder and inflation means for inflating the bladder to provide buoyancy to the wearer of the garment when immersed in water, and an inner support means to support the inner surface of the bladder. The inflatable bladder is placed between the inner support means and the outer layer of armour. Optionally, the inner support means is an inner support layer comprising a layer of plastics material or a layer of body armour.

In one class of embodiments, the inner support layer is provided by a plurality of sections held within one or more pockets of the garment to be placed between the bladder and a user's body thereby to encourage the shock wave from a bullet to be transmitted directly from the outer layer to the inner layer to be dissipated by spreading the pressure over the inner support layer.

According to an optional feature of this aspect of the invention, the inner support means is in contact with an inner surface of the bladder. Optionally, the inner support means overlies the

bladder so that the peripheral portion of the inner support means is in contact with the outer layer.

The body armour may comprise a plurality of components which are either flexible or flexibly connected together, whereby the armour expands on inflation of the gas bladder. Optionally, the garment comprises portions interconnected by expansion joints which, when the bladder inflates, permit the portions to move to provide room for the bladder to expand. Preferably, the expansion joints comprise folded strips of material connected between the portions. In some embodiments, the expansion strips on the material may enclose the whole or at least part of the inflation bladder. Alternatively, the strips may operate merely to retain the inflation unit between the inner support layer and outer layer of armour, thereby allowing the bladder to be displayed.

In some embodiments, there further comprises protrusions of the inner and outer walls of the vest proximate the expansion joints. The protrusions are held together by releasable interengaging means which are separated to increase the size of the garment to accommodate the volume of the bladder when inflated.

The garment may further comprise valve means connected to the bladder for limiting pressure in the bladder when it is inflated.

In some embodiments, the body armour may include a metal mesh. The garment may also include padding to reduce trauma.

The garment may comprise an inner vest connectable to an outer jacket. In such use, the vest and the jacket each comprise a gas inflatable bag and each bag has pressure limiting valve means connected thereto.

Preferably, the interengaging means comprises at lease one row of spaced apart male and female connectors along the wall portions.

According to another another aspect of the invention, there comprises an inflatable garment in the general form of a vest, the garment containing an inflatable device, the garment having wall portions which when the device is deflated are held together by releasable interengaging means and when the device is inflated are separated to increase the size of the garment to accommodate the volume of the inflated device. Optionally, the interengaging means may comprise at least one row of spaced apart male and female connectors along the wall portions. Preferably, the interengaging means are rows of spaced apart facing press studs protruding from the wall portions.

In some embodiments, the inflation device comprises a gas cylinder arranged to inflate a bag automatically and a valve through which the gas can escape from the bladder and which can be used to add more gas to the bladder.

According to an optional feature of this aspect of the invention, the valve is connected to a blow tube accessible by the mouth of the wearer. The garment may include a collar portion which is set low so that head movement of a wearer of the jacket also wearing a helmet will not foul the helmet.

The garment may include a body locating devices which are released upon full inflation of the bladder.

Exemplary embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawing in which:

FIGURE 1 is a front elevation of a protective sleeveless jacket or "vest";

FIGURE 2 is a section on the line X - X in Figure 1;

FIGURE 3 corresponds to FIGURE 2 but showing a bladder used in the vest in its inflated state;

FIGURE 4 illustrates the shape of inner support means and bladder according to one embodiment of the invention;

FIGURE 5 is a front elevation of a vest according to a second embodiment before inflation;

FIGURE 6 is a side elevation through Y-Y of the vest of Figure 5 after inflation;

FIGURE 7 is a sectional view of a releasable seam portion of the vest shown in Figure 5 before inflation of the housed bladder; and

FIGURE 8 is a sectional view of the seam portion shown in Figure 7 after inflation.

In the embodiment illustrated in Figure 1 to 3, there comprises a sleeveless jacket or vest 100 having a body 102 with armholes 103. The vest is openable down the front by way of a Velcro or zip fastener (not shown) concealed behind an overlapping lapel 104 on one side of the vest. At the sides of the vest, below the arm-holes 103 there could be provided adjustment means (not shown) for example openable seams joined by Velcro fasteners.

Of course, in other embodiments, the vest or jacket may possess sleeves and other changes to the style without departing from the scope of invention.

The vest comprises one or more layers of padding and protective armour. In this embodiment, there is a first layer of material 105a for example Nylon or p.v.c. which encloses flexible body armour. Preferably, the outer layer 138 of body armour comprises padding 106, made up of a plurality of layers of Kevlar, a layer of relatively flexible plastics material 107, and a layer of steel mesh 108. The layer of plastics material 107 which could be backed with semi-rigid plastics foam (not shown) acts as a so-called trauma pack, i.e. which spreads the pressure due to weapon contacts and helps reduce bruising. The mesh 108 helps to resist knife attacks.

As well as the flexible body armour, the vest may also comprise one or more respective rigid bullet-proof plates or shells 109 that can be removably fitted in pockets formed in the front and back of the vest. These plates could by made from a ceramic based material or steel for example. Further padding or rigid armour members (117 shown in dashed lines) can be fitted over the shoulders of a wearer of the vest 100, appropriate fasteners (e.g. VELCRO strips) being provided on the shoulders of the vest.

The particular make up of the body armour can be chosen as desired. For example, the steel mesh 107 may not be appropriate sometimes or the armour could comprise plastics foam material (not shown). The rigid plates 109 may not be necessary or the pockets for them can be fitted so that the wearer can use the plates if he wants to, or if not, he can just leave the relevant pocket empty.

In another class of embodiments, it is envisaged that the outer layer 138 of body armour comprises hard body armour only, for example ceramic plate, boron carbide or silicone carbide, so that the shock waves do not pass through the outer layer, thereby reducing the risk of damage. Alternatively, sufficient pure soft armour can be used with the same desired effect.

The vest further comprises an inflation unit, provided in the embodiment illustrated in Figures 2, 3 and 4 by an inflatable flotation bladder 110 placed within the vest, and shaped so that it extends from one or both sides of the front of the vest over the shoulder portions and across the top of the wearer's back. Of course, in other embodiments, the inflation unit may comprise more than one bladder that can be inflated by independent inflatable means, or a single bladder with a multiplicity of interconnected chambers, shaped to better conform to the shape of the user. When required, the bladder can be inflated by an immersion-responsive automatic inflation device 111 (Figure 1), incorporating a compressed-gas bottle 112 and a manual override facility, such as a pull cord 150. Such a device 111 is well known and automatically inflates the bladder 110 when the device 111 is immersed but not if only splashed by spray or a wave. If required, the cord pull 150 can be operated to cause the device 111 to inflate the bladder 110 even if it is not immersed. The device 111 may be of the kind known and commercially available for use in inflatable life jackets.

The bladder may also be inflated or topped-up when necessary by a mouth tube 113 with a non-return valve (not shown). Both the device 111 and tube 113 are mounted on the front of the vest so as to be easily available for operation by the wearer but, if preferred, could be concealed, say in or behind suitable pockets or flaps (not shown) provided in the vest.

The bladder 110 is located between the body armour 106 and the internal surface 105b of the vest, i.e. between the armour and the body of the wearer, so as to reduce the chance of weapon damage to the bladder. To provide room for the bladder to inflate and expand inwardly folded strips of material 114 are provided around the armholes 103 and, as appropriate around other parts, connecting the front and rear portions of the vest, to form expansion joints 115 as shown best in Figures 2 and 3. When the bladder 110 inflates, the strips 114 are unfolded and pushed outwardly by the bladder. These joints enable the armour 106 to move away from the wearer's body and permit the bladder 110 to expand outwards and sideways as shown. Further expansion joints like the joints 115 may be provided elsewhere, for example, at the back of the vest below the neck line 101.

In other embodiments, the folded strips are replaced with one or more straps (not shown) connecting the front and rear parts of the inner and outer layer 105a, 105b, to provide for expansion of the bladder 110, but preventing the bladder from becoming detached from the vest. One benefit of this approach is that the straps allow the bladder to be visible. It is preferred that the bladder is brightly coloured, for example yellow, red or orange and the strap arrangement will enhance visibility of the bladder once immersed in water.

The bladder is designed, specifically by extending round the back of the jacket and down at each side of the jacket front, to tend to self-right an unconscious person wearing the vest.

In some embodiments, the inner and outer layers 105a, 105b are connected together when the bladder is in its flat condition. Thus, connection is provided by releasable interengaging means which are separated to increase the size of the garment thereby to accommodate the volume of the bladder when inflated. The second embodiment shown in Figures 5 to 8 illustrates one example of the interengaging means.

As illustrated in Figures 2 and 3, there further comprises inner support means, which in this embodiment is provided by a layer of material 130, placed intermediate the bladder 110 and the body of the wearer. The inner support layer 130 is provided to support the innermost wall of the bladder and to reduce the likelihood of rupture. Preferably, the material is a layer of plastics material and more preferably, it is a layer of body armour, for example Kevlar. Alternatively, it is envisaged that the inner support layer could be made up of another material, for example stiffened foam, a metal or other material that is sufficiently hard to support the bladder and prevent the inner layer of the bladder from being damaged by the shock waves.

The inner support layer 130 is shaped to follow the shape of the bladder 110. In Figure 4, there is show a simplified drawing of the inner support layer 130, which is provided by a plurality of sections 132, 134, 136. The sections 132, 134, 136 are placed in contact with the inner surface of the bladder 110. Preferable, the sections 132, 134, 136 are placed within pockets of the vest to retain the sections in the correct positions.

In use, the bladder 110 is sandwiched between the inner support layer 130 and outer layer of body armour 138. In the event that a bullet is fired into the body armour, the shock waves from the impact of the bullet will be transmitted from the outer layer 138, through the bladder 110 to be absorbed by the inner support layer 130. In the preferred embodiment, the inner support layer 130 is shaped to be larger than the area of the bladder 110, so that the peripheral portions of the support layer are in direct contact with the outer layer of body armour 138. Beneficially this encourages the shock wave to be transmitted directly from the outer layer to the inner layer so as to be dissipated by spreading the pressure over the inner support layer, thereby helping to reduce bruising.

In one class of embodiments, the inflation device 111 comprises a sensitive servo-valve that regulates the pressure in the respective bladder. The inflation device and corresponding valve can operate together while better regulating the overall buoyancy effect and avoiding over-pressure.

The inner bladder is protected from bullet fragmentation, stab attack or the like by the body armour.

Upon the inflation units being activated they will expand with the body armour being moved away from the user to allow expansion of surrounding body armour. In the event of a wearer using an item or being subject to other confined conditions, the armour will not inflate to an extent as to crush the occupant.

Whether or not both inflation bladders are provided, the inflation device being operable as a pressure regulating servo-valve is useful because it prevents over inflation in say the case of the vest 100 and prevents harm to the wearer of the vest. In other words, regulation of bladder pressure by the servo-valve forms an additional or alternative means, over and above the expansion joints 115, for preventing or ameliorating harm to the wearer.

It is envisaged the vest can be used in a wide variety of applications, for example as a protection garment for flight crews, police and military personnel.

In some embodiments, a collar is provided, in which case, the Kevlar padding 106 (and plastics material if desired) of the flexible body armour extends up into the collar whilst the

steel mesh 108 stops just below the collar. There could be a separate padding member or rigid bullet-proof member (not shown) that can be removably fitted in the collar.

A second embodiment of the vest V is illustrated in Figures 5 to 8 which comprises a body 200 having armholes 202. The vest is openable down the front by way of a Velcro or zip fastener (not shown) concealed behind an overlapping lapel 204 on one side of the vest. At the sides of the vest, below the arm-holes 206 there are seams 208, as will be explained below. The front of the vest has pockets to contain various items, in the usual way, such as a radio location device for a rescue team to find a pilot in the sea.

The vest comprises layers of waterproof material such as Nylon or p.v.c. or the like, defining a cavity or hollow interior. Incorporated into the vest, there is an inflatable flotation bladder 210 which extends up from the front of the vest at one side then over the shoulder at this side and across to the other side of the vest at the top of the wearer's back, then back over the other shoulder and down at the other side of the front of the vest. The bladder is designed, specifically by extending round the back of the jacket just below the collar 212 and down at each side of the jacket front, to tend to self-right an unconscious person wearing the vest.

When required, the bladder can be inflated by an immersion-responsive automatic inflation device 214, incorporating a compressed-gas bottle 216 and a manual override facility, such as a pull cord 218. The device 214 automatically inflates the bladder 210 when the device 214 is immersed but not if only splashed by spray or a wave. If required, the cord pull can be operated to cause the device 214 to inflate the bladder 210 even if it is not immersed.

The device 214 may be of the kind known and commercially available for use in inflatable life jackets. The bladder may also be inflated or topped-up when necessary by a mouth tube 220 with a non-return valve (not shown). Both the device 214 and tube 220 are mounted on the front of the vest so as to be easily available for operation by the wearer but, if preferred, could be concealed, say in or behind suitable pockets or flaps (not shown) provided in the vest.

To provide room for the bladder to inflate and expand inwardly folded seams or strips of material 208 are provided around the armholes 202 to form expansion joints (described above in the first embodiment) as shown best in Figures 6, 7 and 8. When the bladder 210 inflates, the strips 208 are unfolded and pushed outwardly by the bladder. These seams permit the bladder 210 to expand outwards and sideways as shown. Further expansion seams like the seams 208 may be provided elsewhere, for example, at the back of the vest just below the collar 212. The seam comprises two wall portions 234a, 234b connected to the main outer wall of the vest V.

The margins of the wall portions are provided with releasable interengaging means, preferably in the form of press studs 230, and 232, arranged in one or more rows 236. The stud 230 is a male connector and the stud 232 is a female connector. The facing pairs of connectors are arranged for simple press stud engagement which is done in manufacture of the vest.

In other embodiments, the interengaging means is provided by a hook and loop securing strip, for example Velco™ or a stitching arrangement. The stitching connects wall portions 234a, 234b and is adapted to break when the bladder is inflated, in like manner to that described below.

The interengagement of the press studs holds the facing wall portions close together even if the walls are not truly aligned and parallel. When the bladder 210 is inflated, typically by a sudden expansion, the connection between the facing pairs of studs 230 and 232 is broken and the seam 208 opens out to provide sufficient extra volume for the vest to reach the fully inflated condition without breaking the front zip, which would tend to move the vest away from the body of the wearer. Because the individual press stud connections are broken this is better than a zip where only relies on an axial movement along the length thereof.

In some embodiments, for example, as shown in Figure 6 the collar 212 of the vest 200 shown is cut low, leaving the height of the neck of the wearer exposed. This is preferred as it provides a space for the helmet H of say a helicopter pilot which would otherwise be obstructed as the pilot moves his head sideways.

The embodiment of the vest is shown in bare detail. The vest may contain extra layers such as body armour to provide resistance to bullets and stabs or to reduce trauma, for example as shown in Figure 1.

In addition to giving buoyancy the sudden inflation of the bladder may be used to expel, in whole or in part, items in the pockets of the vest such as a light beacon, whistle or the aforementioned location device.

It will be recognized that directional references such as inner, outer, upper or lower do not limit the feature to such orientation, but merely serve to distinguish one feature from another.

CLAIMS

1. A protective body garment comprising an outer layer of penetration resistant armour, a gas inflatable bladder and inflation means for inflating the bladder to provide buoyancy to the wearer of the garment when immersed in water, and an inner support means to support the inner surface of the bladder, wherein the inflatable bladder is placed between the inner support means and the outer layer of armour.

2. A protective body garment as claimed in claim 1 wherein inner support means is an inner support layer comprising a layer of plastics material or a layer of body armour.

3. A protective body garment as claimed in claim 2 wherein the inner support layer is provided by a plurality of sections held within one or more pockets of the garment to be placed between the bladder and a user's body thereby to encourage the shock wave from a bullet to be transmitted directly from the outer layer to the inner layer to be dissipated by spreading the pressure over the inner support layer.

4. A protective body garment as claimed in any of claims 1 to 3 wherein the inner support means is in contact with an inner surface of the bladder.

5. A protective body garment as claimed in any preceding claim wherein the inner support means overlies the bladder so that the peripheral portion of the inner support means is in contact with the outer layer.

6. A protective body garment as claimed in any preceding claim, wherein the body armour comprises a plurality of components which are either flexible or flexibly connected together, whereby the armour expands on inflation of the gas bladder.

7. A protective body garment as claimed in any preceding claim, wherein the garment comprises portions interconnected by expansion joints which, when the bladder inflates, permit said portions to move to provide room for the bladder to expand.

8. A protective body garment as claimed in claim 7, wherein the expansion joints comprise folded strips of material connected between said portions.

9. A protective body garment as claimed in any of claims 6 to 8, further comprising protrusions from the inner and outer walls of the vest proximate the expansion joints, wherein the protrusions are held together by releasable interengaging means which are separated to increase the size of the garment to accommodate the volume of the bladder when inflated.

10. A protective body garment as claimed in any preceding claim, comprising valve means connected to said bladder for limiting pressure in the bladder when it is inflated.

11. A protective body garment as claimed in any preceding claim, wherein the body armour includes a metal mesh.

12. A protective body garment as claimed in any preceding claim, including padding to reduce trauma.

13. A protective body garment as claimed in any preceding Claim, including automatic immersion sensitive inflation means for said bladder.

14. A protective body garment as claimed in any preceding claim comprising an inner vest connectable to an outer jacket.

15. A protective body garment as claimed in claim 14, wherein the vest and the jacket each comprise a gas inflatable bag and each bag has pressure limiting valve means connected thereto.

16. A protective body garment comprising an outer layer of penetration resistant armour, a gas inflatable bladder and inflation means for inflating the bladder to provide buoyancy to the wearer of the garment when immersed in water.

17. A protective body garment as claimed in claim 15 wherein the body armour comprises a plurality of components which are either flexible or flexibly connected together, whereby the armour expands on inflation of the gas bladder.

18. A protective body garment as claimed in claim 17 wherein the components include one or more straps, whereby the inflatable bladder is visible when the bladder expands.

19. An inflatable garment in the general form of a vest, the garment containing an inflatable device, the garment having wall portions which when the device is deflated are held together by releasable interengaging means and when the device is inflated are separated to increase the size of the garment to accommodate the volume of the inflated device.

20. An inflatable garment as claimed in claim 19, wherein the interengaging means comprising at least one row of spaced apart male and female connectors along the wall portions.

21. A garment according to Claim 20, wherein the interengaging means are rows of spaced apart facing press studs protruding from the wall portions.

22. A garment according to any of claims 19 to 21, wherein the inflation device comprises a gas cylinder arranged to inflate a bag automatically and a valve through which the gas can escape from the bladder and which can be used to add more gas to the bladder.

23. A garment according to Claim 22, wherein the valve is connected to a blow tube accessible by the mouth of the wearer.

24. A garment according to any Claims 19 to 23, including a collar portion which is set low so that head movement of a wearer of the jacket also wearing a helmet will not foul the helmet.

25. A garment according to any Claims 19 to 24, including body locating devices which are released upon full inflation of the bladder.