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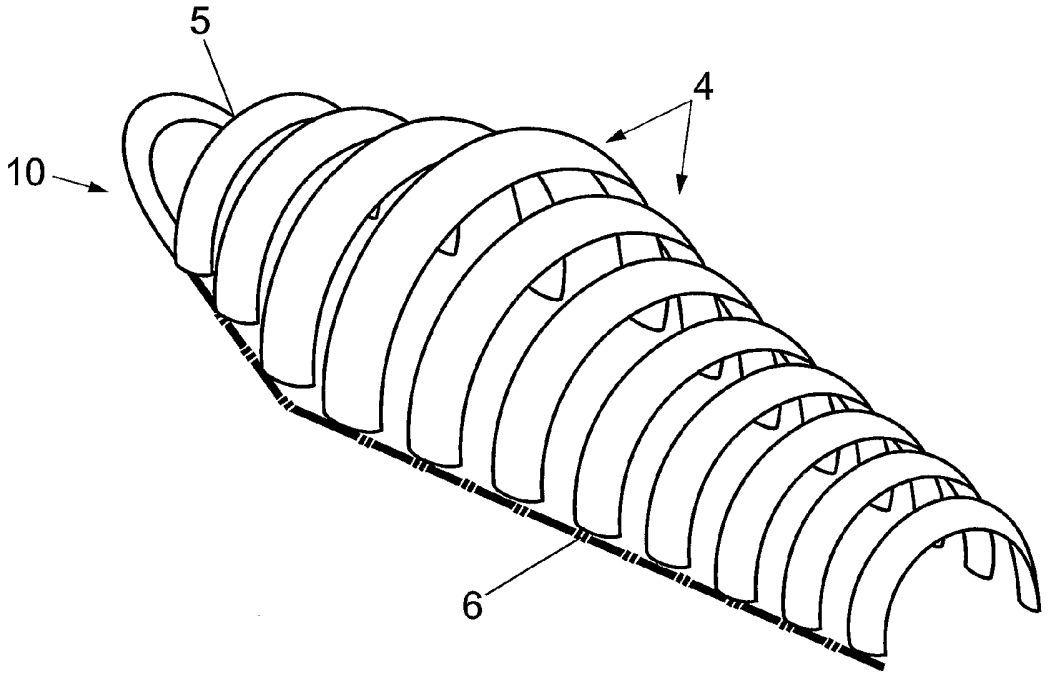
(54) **Title:** INFLATABLE HERMETICALLY SEALABLE SHELTER



(57) **Abstract:** A portable hermetically sealable shelter comprising an inflatable element (4). The disclosed shelter relates to a portable inflatable shelter, that can be completely environmentally sealed, *i.e.* airtight and watertight. The shelter may be used for protecting a user from nuclear, biological and il chemical hazards as well as other environmental hazards such as extremes of temperature, pressure and reptile or insect attacks.

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Inflatable Hermetically Sealable Shelter

The present invention relates to shelters, particularly but not exclusively to hermetically-sealable, portable inflatable shelters.

Background of the Invention

The armed forces of many nations are instructed and trained in the donning and use of NBC (Nuclear, Biological & Chemical) suits, which in conjuction with respirators act as a barrier against the threats of known NBC substances. The use of these suits and systems are widely adopted. There remains, however, an acknowledged and recognised deficiency with the NBC suit system, in particular the NBC suit does not allow the user to sleep nor rest effectively due to the uncomfortable nature, restrictions and limitations imposed by the NBC suit and respirator system.

There currently exist inflatable tents, shelters and sleeping bags. For example those described in US Patent Nos 3,986,505, 4,124,908, 4,301,791 and 4,607,655 to Power, Burns et al, Franco and Bixler Donald respectively which all show litter type devices with attachments for transporting victims. All four Patents describe covers comprised of flaps, some of which are inflatable, affixed by mechanical means or by Velcro™ and include to some degree the use of inflatable sections with other sections to provide insulation. None of these devices are suited to anti-NBC warfare purpose as they are not truly gas and fluid sealed (i.e. hermetically sealed) and would not afford the protection level necessary to the survivability of the user.

None of the shelters described in the prior art can be considered suitable for therapeutic purposes to any degree.

Furthermore, as the previously described shelters are not hermetically sealed, they cannot safely transport cadavers, remains or infected contagious individuals to a place of treatment or quarantine without risk to others.

STATEMENT OF INVENTION

According to the present invention there is provided a hermetically sealable shelter comprising an inflatable element. It is highly preferable

that the shelter is portable. It is especially preferred that it may be easily carried by one person.

The term "hermetic" or derived terms as used herein means complete and airtight.

Preferably the shelter comprises upper and lower sections which are joined along their peripheries to form an chamber having an opening, the shelter further comprising means to hermetically seal the opening. Generally the means to hermetically seal the shelter allows repeated opening and sealing of the shelter. The means to hermetically seal the opening may suitably be an airtight zip.

Suitably the upper and lower sections of the shelter are joined by high frequency welding.

Optionally the shelter further comprises a door section. The door section is sized and shaped to cover the opening and may have one half of the airtight zip, the corresponding half being located on one or both of the upper and lower sections.

Preferably the inflatable element comprises a three layer structure comprising an outer, an inner and a core layer. A lumen is defined by space between the inner and outer layers, and this lumen is partitioned by the core layer thus providing two separate air chambers. These air chambers are the inflatable parts of the inflatable element. At

least one valve is provided to allow inflation of the air chambers.

The presence of the core layer is advantageous as it forms a diaphragm which separates the two halves of the lumen and therefore, if one side is punctured, the other side remains inflated. It is thus important that the two air chambers are isolated from one another once inflated. It is convenient if inflation of each air chamber can be carried out simultaneously through a single valve. This may be conveniently be achieved using a one-way diaphragm valve (preferably a balanced diaphragm valve) which has one air inlet and two outlets, one outlet going to each air chamber. Once inflated the diaphragm prevents air escape from each air chamber independently of the other.

Alternatively a separate valve may be used for each air chamber but this is less convenient to use.

Preferably linear regions of the three layer structure are bonded, thus defining a plurality of interconnected elongated air compartments in the air chamber. Suitably these linear regions are bonded by fusing together by high frequency welding.

It is preferable that substantially the entire upper sections of the shelter are made from inflatable elements. More preferably,

substantially the entire upper and lower sections are made from inflatable elements.

Preferably the core layer of the three layer structure is formed of a material which provides protection against thermal, nuclear, biological or chemical hazards. For an NBC role the core layer is suitably Gore-Tex NBC fabric or Porvair NBC fabric, Blucher GmbH Saratoga, Acvell NBC and DuPont Nomex Saratoga. Prior art shelters do not include a carbon based anti-radiation barrier layer between the user and the outside environment which is advantageous for an NBC role. To protect from extremes of temperature the core layer may be Dupont solar film.

Preferably the shelter is sized and shaped to accommodate one person, with excess space reduced to a minimum. This is particularly preferred in a survival or rescue shelter where it is undesirable that the person must warm up a large volume of air at the expense of body heat.

Preferably the shelter is further provided with one-way air inlet and outlet valves. These valves may be conveniently provided with attachment means for attaching various fitments which may be required in different situation. For an NBC shelter the inlet valve may be adapted to receive a chemical and biological filter unit, suitably a NATO standard replaceable NBC filter canister.

Prior art shelters do not incorporate the use of valves, air filters and exhaust valves to cleanse the air from biological and chemical threats.

Optionally the shelter may be provided with one or more breathing tubes attached to the inlet and outlet valves. This allows the shelter to function whilst buried or submerged.

Optionally the shelter may be provided with means to facilitate therapy or transport of the occupant. These include, but are not restricted to: ports for intravenous (IV) access, view panels made of transparent material, body movement restraints for head, neck and/or limbs, spine and/or head supports and carrying straps or attachments for a carrying cradle.

In another embodiment the shelter is provided with means to raise the pressure inside the shelter above atmospheric pressure. Alternatively it may be desirable to lower the pressure inside the shelter below atmospheric. In this regard it is preferable that the shelter has stiffening means to resist expansion or collapse of the shelter when the pressure is increased or decreased respectively.

Unlike prior art shelters, embodiments of the present invention can be used to facilitate the administration of enriched air, drugs and fluids or they can have the inner victim chamber pressurised

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Unlike prior art shelters, embodiments of the present invention can be used to facilitate the administration of enriched air, drugs and fluids or they can have the inner victim chamber pressurised

to an extent whereupon decompression sickness can be treated.

The present invention thus relates to a portable inflatable shelter, that can be completely environmentally sealed, i.e. airtight and watertight.

In one embodiment it is particularly suited for use in emergency and military situations where, due to the likelihood of NBC attack or exposure to the elements, there is a risk to life. The shelter of the present invention may be employed in varying conditions and terrain to perform a multi-use role, combatting NBC hazards or the risks posed by hypothermia, heat stroke, exposure, insect or reptile attack or the like. Alternatively the shelter can be used as a below ground or snow submerged shelter, either as a lifesaving measure or by choice as a covert hide. Due to it's inflatable nature, whilst not in use, it can be carried rolled up ready for instant use on the webbing of soldiers as personal equipment.

Furthermore in an alternative embodiment the shelter can be used as a victim recovery and support system, a sealed body or human remains bag. In this embodiment the prent invention allows the transportation, for long periods if required, of cadavers, human remains and infected and contagious individuals in an isolated or quarantined environment without threat and risk to others.

In the role of victim support system it is advantageous that the shelter is totally sealed and therefore independent of the outside air and ambient pressure. The invention can be employed to treat and support victims of sub aqua diving; decompression sickness and other related illnesses such as baratrauma and spontaneous pneumothorax, as the partial pressure can be raised or lowered by rescuers via controllable inlet and outlet air valves. In this regard it is beneficial if the shelter is relatively rigid to resist expansion or collapse, when the pressure inside is raised or lowered respectively. Likewise for victims of smoke inhalation, damage to the lungs or chest, or those suffering from altitude sickness or oxygen deprivation can have the internal air enriched or pressurised via an internal fixed bottled oxygen supply or external piped air/oxygen supply.

Where an embodiment of the present invention is used for casualty control, portage, monitoring, access and administration of fluids, drugs, gas and physical support all are accomplished via inherent built in design features such as IV (intravenous) ports, polyamide view panels, air tight access zips, aluminium support and portage cradle, body movement restraints for head, trunk and limbs, gas/air controllable inlet and outlet valves, spine and head support pads.

Victim/remains transportation is facilitated via the use carry straps attachments as is the lifting and transportation by helicopter.

Other purposes, functions and objectives will become apparent and clear from the following descriptions of embodiments of the invention, which are given by way of example only.

Brief description of the Drawings

Fig 1 is a section across a tri-laminate structure used in the manufacture of the shelter of the invention showing top layer, core layer (diaphragm) and base layer. Indicated is the linear node point (3) where, via the use of high frequency (HF) plastic welding, all three layers are joined and made gas and watertight.

Fig 2 illustrates the structure obtained when air under pressure is forced between the fused layers thus inflating elongated air compartments.

Fig 3 shows moulded ABS plastic valve used to allow air to be pumped between layers.

Fig 4 illustrates the rib-like structure of a plurality of compartments created via the use of continuous HF welding.

Fig 5 is an end elevation Figure 4 after inflation, with the core layer shown as a dotted line.

Figs 6 and 7 both show a perspective view of the upper dome (Fig 6) on the lower base (Fig 7) used in the manufacture of the shelter in accordance with the present invention. In Fig 6, as indicated, every second elongated air compartment are not shown to aid visualisation. Fig 6 illustrates a semi-elliptical domed structure (DS) created by the inflation of the elongated air compartments. Fig 7 illustrates as an opened out plan perspective, the base pad (BP) of the shelter. On view are the pillow and spine pad (7a), the door or ingress (11) and the foot or end section. Also on show are the carry straps (14), air seal zip (10), polyamide window/mesh screen (9) and air exhaust valve (8) and respirator air filter (12). The complete shelter is created when the (DS) and (BP) are HF welded and thereby fused along edge seam (6) creating a hermetic seal.

Fig 8 shows the shelter in plan and side elevation and provides an indication of size and scale relative to the user.

Fig 9 is a cross-sectional view through the base section of the shelter. The base pad can either be deflated or inflated, conditions and user preference permitting.

Fig 10 is an end view of the shelter and shows the door section and illustrates the positions of the

polyamide/mesh screen (9) and one-way valves (8) and (12) surrounded by the airtight zip (10). Fig 11 illustrates the manner in which the rescue shelter can be formed to create a capacious carry bag.

Fig 12 is a cross-sectional illustration viewed from the inside of the shelter and illustrates the position either side of the users head of a respirator filter (12) and the spent air exhaust valve (8). Also shown is the polyamide/mesh window (9) and airtight zip (10). Introduced in this drawing is the inclusion of the hardened steel peg (17), which is provided to secure the shelter on sloping surfaces.

Fig 13 is a cross section through the door section (11) with the external surface on the left-hand side of the drawing. Indicated are the airtight zip (10) and a plastic O-ringed threaded moulding (16), of which there are two, which are used to secure valves (12) and (8) respectively to the door section (11). Also shown is a section of the base section through an elongated air chamber (4).

Fig 14 shows plan and end elevations illustrating an embodiment of the shelter suitable for military purposes. Shown in plan and end elevation are the manners in which the upper layer (1) of the domed structure (DS) can be printed or created using pre-printed fabrics to provide a military camouflage option. Also described is a camouflage netting

(DSa) option for enhanced camouflaging and concealment. The end elevation contained in Fig 14 indicates, by reference to the scale and the position of the human head, the low air volume contained within the inner void of the shelter(V).

Fig 15 illustrates a plastic extendable/retractable deep breathing tube (18 and 18a) which may be attached to the threaded moulding (16).

Fig 16 indicates the shelter buried in a trench, in line with current military thinking. The deep breathing tubes (18 and 18a) allow the invention to be partially or completely buried in the earth, sand or snow as an added NBC or covert precaution.

Fig 17 illustrates an embodiment of the shelter suitable to be used as a survival shelter, whereupon the outer surface of the shelter is international orange in colour with a help message (20) printed in yellow on the dome structure (DS).

Fig 18 shows a 3000 mm distress pole (19). This may be configured from part of the carry cradle ((29) Fig 22) and is provided with a battery operated strobe light.

Fig 19 illustrates in plan view the shelter adapted for use as part of a rescue system, showing front zip position running full length (22) a polyamide patient monitoring panel (21) and left and right intravenous line inlet ports (23 and 23a) are

shown. The lift straps (24) are extended to enable the rescuer shoulder portage.

Fig 20 shows an end view looking in on the patient with the door section (11) open. Seen is an oxygen bottle (25) and patient restraining straps (26). The location of the decompression facility i.e. air manifolds (inlet manifold and outlet manifold (IM)) and internal air pressure gauge (OM) is shown; both of these are located and attached to door flap but in the drawing are illustrated as if the door section were in the closed position. The location of the intravenous (IV) inlets are shown in parts (23 and 23a). The aluminium cradle fixing sleeves (27) which run along base are shown. The base pad options, i.e. inflatable or solid foam, are shown by parts (7BPS) and (7BP).

Fig 21 shows the aluminium pole which elevates the fluids for intravenous administration and is described as IV bladder support (28), which affixes via a tee piece (28a) directly to and is supported by the lift cradle (29).

Fig 22 illustrates the fully demountable aluminium lift cradle and sled attachment (29) which is constructed from sleeved lengths of tubular aluminium fiction fitted one upon the other to create a sturdy but light lifting frame. The lifting cradle is attached and held in position within sleeves of Condura Webbing sleeves (27) integral to the base pad (BP).

Figure 23 shows a shelter in military camouflage with parts (18 and 18a) deep breathing tubes, being used as the basis of a deep snow breathing system. A removable anti condensation liner made from 10 mm Gore-Tex Fleece (30) is shown.

Figs 24 and 24a plan and end elevations of shelters to demonstrate that the final appearance and decoration of the shelter can be altered by the use of differing colour fabrics, different fabric use, camouflage netting and by colour printing techniques. The end elevation also illustrates the position of the mesh panel (31), which is normally stored rolled up behind the polyamide view panel (9).

Figure 25 shows the preferred embodiment encased within an over bag similar to a duvet cover (32). The bag is held in place principally by the expansion of the preferred embodiment. This technique is utilised to enhance characteristics of the invention and in some cases to double the thickness of the barrier material. The over bag can be formed from NBC material, solar film or Infra Red barrier materials. The over bag can comprise or be made of bullet proof and/or fragmentation proof material like NIJ level 3 ballistic composite, which is available from Armor Holdings, USA and Highmark Limited, Northern Ireland. This list is non exhaustive and includes many other finishes and special purpose materials

and chemical treatments such as impregnated anti mosquito chemicals, and fire retardant/fire barrier covers for fire-fighter use.

Detailed Description of a Preferred Embodiment

Construction Technique of Basic Shelter

A shelter system for use in NBC warfare and hostile conditions can be manufactured as follows, with references to Figs 1 to 25:

It is generally constructed as a hermetically sealable, self-supporting inflatable structure. The shelter is formed from an upper and a lower section, the upper section forming a domed structure and the lower section forming a base pad. A chamber is thus defined between the upper and lower sections which can accommodate a user.

At least the upper section is comprises, and is advantageously formed substantially entirely from, an inflatable element. Generally the lower section is also formed from an inflatable element, although a non-inflatable lower section could also be used. Alternatively the upper and lower sections could be formed from a single inflatable element.

The inflatable elements are derived from a plurality of airtight air compartments (4) created by high frequency (HF) plastic welding of a tri-laminate (three layered structure) of textiles.

The outer and inner layers (1) of the tri-laminate are PVC coated polyester fabric and the inner core (diaphragm) layer (2) consists of a material specified for the actual purpose, such as NBC barrier fabric. Such fabrics are derived from a laminate of suitable textiles and may comprise an outer layer, or coating, of oleophobol and an inner carbon layer. Several suitable fabrics are available and are sold under the trade names Gore-Tex NBC, Porvair NBC, Blucher GmbH Saratoga, Acvell NBC and DuPont Nomex Saratoga. These fabrics generally protect the user from at least one of nuclear, biological or chemical agents and any fabric with the ability to prevent ingress of these agents would be suitable for use in the present invention. Such fabrics often utilise carbon, in the form of activated charcoal, to filter out or neutralise harmful materials. For a thermal barrier, DuPont Polyester solar film or any other heat reflective material such as foil can be used as the core material. These materials are fire retardant and chemical resistant.

Suitably other materials could be present between the layers of the tri-laminate such as insulating fibrous materials like hollow fibre or feathers. Other outer, inner and core materials will be used as applicable to particular situations. New applications and new materials are, by invention or requirement, likely to be made available for use.

The materials for either the semi-elliptical Upper section (dome structure (DS)) or lower section (base pad (BP)) are assembled independently as a loose assemblage in the requisite layer order and laid out on a HF plastic welding/cutting platen with outer and inner layers (1) and core layer (2) in place. The outlines and necessary Computer Aided Design (CAD) drawings being pre-programmed in a Gerber or DX format to the scale roughly illustrated in Fig 8.

Thereafter once assembled and laid out in the platen, the composite textile layers are cut out via a CNC (Computer Numerically Controlled) tangential head cutter to the specified dimensions ensuring that a seam edge (6) of for example, about 60 mm is left to act as a joint between outer and inner layers. Those familiar with the HF welding art will readily appreciate that for commercial reasons, the cutting out will be undertaken on several composite layers at any one time.

After cutting out, the layers are separated back to a single tri-laminate composite in preparation for HF welding to take place.

For the upper section (domed structure) shown in Fig 6 the tri-laminate composite layer is now CNC High Frequency welded (as best illustrated in Fig 4). The seams around the edges of the inflatable element are joined. Additionally, a sequence of nodes and heat fused lines (3) are directed by a

CNC High Frequency (HF) welding machine through and along the textile layers forming, in effect, a plurality of connected open-ended air compartments between the outer (1), core (2) and inner (1) layers (see Fig 4). These compartments terminate at their extreme outer ends in a longitudinal air passage (4a). This passage serves to deliver air via an air inlet valve (5), located as shown in Figs 6 and 7, to all areas of the structure. The passage (4a) runs the full length of both lower sides of the structure. When inflated the air chambers (4) on either side of the core fabric (2) are independent and sealed from each other, thus preventing total loss of air from the inflatable element by puncture as only half the air will be lost.

The valve (5) may suitably be a one-way diaphragm valve. The valve has one inlet and two outlets; one outlet going to each air chamber. When air is being forced into the inflatable element the diaphragm deflects to allow air to enter the air chambers through both outlets. Once the inflatable element is inflated the diaphragm prevents escape of the air from both chambers independently. The increased pressure in the air chambers forces the diaphragm against a shoulder thus causing an airtight seal.

Air seal zip (10) elements are HF plastic welded in place, as is the air inlet/outlet valve (5) of the upper dome structure (DS). The air seal zip is of

the type widely available in the diving industry. It comprises two layers of neoprene reinforced polyester situated on the underside of the zip surface and facing up and inward towards the inner opposing teeth of the zip structure. The height of the neoprene seal is slightly lower than the height of the teeth of the zip. When the zip mechanism is operated, the zip slider draws the neoprene seal up vertically and locks it in position by the claws of the teeth behind it. Thus, the two faces of the neoprene are clamped together forming an air and waterproof seal. This system can withstand substantial pressures from both fluid and gas.

The lower section (base pad (BP)) is marked out and cut in a similar fashion as the domed structure, prior to HF welding. A door section (11), which is integral with the lower section, is advantageously provided with flanges for securing the exhaust valve (8) and inlet valve (12), which are screw fixed in place. The air zip (10) element for the door flap is HF welded in place.

A polyamide view (9) window and mesh screen (31) are HF plastic welded in place as are flanges for an air inlet Schrader type valve (IM) and the air outlet/pressure gauge Schrader type valve (OM) as shown in Fig 20. Likewise the low-pressure air inlet/outlet valve (5) can be HF welded in position, which allows inflation of the base bad (lower section).

Construction of the basic shelter (as shown in Figs 6 to 11)

Once cut out and HF welded, the domed structure (DS) and the base pad (BP) are brought together. The peripheral seams (6) are aligned one upon the other and thereafter fused by HF plastic welding to form the shelter with an inner void (v). At this point Condura webbing straps (14,24) of approximately 50 mm, and cradle sleeves (27) are attached by nylon stitching to the edge seam (6). The straps (14,24) are arranged in pairs, one handle on each side of the shelter. Each pair of handles is formed from one continuous loop of webbing. The loop of webbing is sufficiently long that it can pass underneath the base pad leaving the ends of the loop projecting, thus forming the carrying handles. The webbing is stitched at each seam to fix the handles in place. This method of construction means that the strain of lifting the shelter is borne by the webbing material, and not by the less strong tri-laminate structure. When the shelter is inflated, the expansion of the domed structure (DS) is resisted by the strap (14) reinforced base pad (BP) thus ensuring the domed structure (DS) adopts a curved conformation.

By adopting the production process and technique recommended, a hermetically-sealable void will be created, which is accessible via an airtight zip (10). When inflated, for example via a low pressure car type foot pump, the shelter will

provide a cocoon shaped structure to which an individual can gain ingress through the door section (11). Once inside the individual can close the airtight zip and be confident of being within a void that is not subject to the external environment.

If a replaceable respirator filter canister (12) is fitted to the inside of the door section (11) at position (16), the outside air drawn in will be filtered to remove or scrub out harmful chemicals or biological substances.

The void is designed to be of a relatively low volume. This allows maximum heating of the internal air by the users own body heat generation. This principle is further aided by both the air/thermal barrier created by the inflated outer walls and base pad, and secondly, by the use of heat reflective core materials within the tri-laminate structure used in the construction of the walls and base.

There thus has been outlined the materials and production technique and process required to produce a shelter according to the invention.

One of the advantageous aspects of the invention is its capacity of being used in various ways to fulfil many roles and functions.

It should be understood that the phraseology and terminology employed herein are for the purpose of best description and should not be regarded as limiting or restrictive.

Survival Shelter

This is best illustrated in Figs 17, 18 and 23.

The survival shelter embodiment is generally of the same configuration and construction as the basic shelter described above with exception that the weight of textile layers is reduced to a lighter weight composition and the core layer (2) is of a heat reflective material such as Du Pont solar film. The shelter can be bright international orange in colour and the words HELP or their equivalent in other languages is printed upon the upper dome (DS). Supplied is a 3000 mm aluminium pole with a strobe and distress marker flag (19) to increase visibility of the shelter. Also included are two deep breathing tubes (16), which fit to the exterior of the door flap on the flanges (16), these tubes allow the user to breathe despite the shelter being buried under snow. A more extreme embodiment is the extreme conditions shelter, Drawing 8 whereupon a Gore-Tex or Thinsulate fleece liner (30) is added to combat condensation and the extreme cold. The outer layers (1) may be camouflaged for covert military applications.

Rescue Shelter

This embodiment is best illustrated in Figs 19 to 22.

Again this embodiment is constructed as described above. In this case the tri-laminate composite has, as its core layer, a heat reflective substrate. For example this may include DuPont solar film or an other material of similar characteristics. The introduction of this type of core layer acts to prevent heat loss from the inner void (v) in cold conditions and overheating due to solar energy in hot conditions. The weight of the outer textiles (1) is increased to polyester covered with PVC at 750 gm^{-2}. Although this increases bulk and weight, scuff resistance and protection to the patient from scrapping against rough terrain or rock faces is dramatically improved.

The shelter may be further stiffened and reinforced by the addition of an aluminium cradle (29), which fits securely into sleeves provided for the purpose (27) underneath the base pad. Adjustable victim restraint straps (26) are attached to the cradle (29). The straps pass through the base pad (BP) and are firmly anchored on the cradle (29). The purpose of these restraints is to immobilise the casualty in such a manner to prevent further damage to neck and spine and to aid in portage and recovery by airlift. Added to this is an IV

bladder support pole (28), which fits via a tee piece connector (28a) directly onto the support cradle (29), its purpose being to secure and elevate the fluids bladder thus assisting in the intravenous delivery of fluids to the victim.

The IV line is passed through the outer wall of the domed structure (DS) via sealable flaps (23 and 23a). Casualty monitoring is permitted by the introduction of a polyamide view panel HF welded on the upper surface of the domed structure (DS). The introduction of a further air seal zip (22) running full length along the upper central mid line of the domed structure (DS) allows ease of victim placement and removal without undue strain on either the casualty or rescuers.

A Velcro™ fitting to secure an oxygen cylinder is positioned at point (25) and can be seen in Fig 20. The oxygen can be either delivered via a facemask or by closing off the inner void (v) and allowing the oxygen to enrich the inner void (v) atmosphere. This is achieved by pre-setting the exhaust valve (8). The shelter can advantageously be used to administer oxygen to a patient placed inside.

Altitude sickness is generally treated via the application of a face mask directing enriched air or oxygen into the victim directly. Two problems arise from this method:

- exhaled oxygen is spent and wasted to the atmosphere; and

- the enriched air or oxygen is at ambient temperature, usually cold, causing further body cooling.

By contrast the use of the shelter has the following advantages:

- as a contained low volume environment, the oxygen is re-breathed several times and oxygen supply can be saved; and
- as the oxygen is fed into the shelter and not directly to the victim via a mask, the air temperature will be higher than that of compressed gas. It can be more easily absorbed, and will have less of a cooling effect.

The rescue shelter can, for transportation purposes, be reconfigured into a carry pack, whereupon the inner void can be used to carry first aid equipment, spare oxygen and fluids.
It is considered the embodiment in this configuration could be of great benefit to mountaineers and other suffering from altitude sickness as well as the rescue services for general search and rescue activities.

Military NBC Shelter

The embodiment is best illustrated in Figs 14 to 16.

This embodiment is constructed generally as before but with the inclusion of NATO approved NBC materials such as Gore-Tex NBC graphite enriched fabrics as the core layer (2). As this material cannot readily be HF welded, the core fabric is encapsulated in a polyurethane PU (plastic) prior to its introduction into the tri-laminate composite. In this manner the PU encapsulate can be HF welded without damage to the graphite layer. Thereafter the construction is treated as previously described.

Additionally a replaceable NBC cover, similar to a duvet cover, may be provided, as illustrated in Figs 24 and 25. In this case the NBC material covers the complete shelter and is held in place by the internal pressure of the embodiment and with flaps secured by Velcro over the door flap (11).

Personal Issue NATO standard replaceable NBC filter canisters are used to scrub the incoming outside air and are fitted by the user at point (12), and possibly (8) as required. As an added precaution, and inline with prescribed military training, the embodiment is capable of being partially buried in a 1200 mm deep fire trench. To allow breathing, two deep breathing tubes are supplied which can be fitted directly to the outside ring flanges (16). The benefits of this shelter are many fold and can be extended outside the role of pure NBC use. The invention can replace the requirement for more bulky equipment, four of which are required to

achieve a similar task; namely the sleeping bag, NBC suit, waterproof Bivvy bag and waterproof solo tent. Moreover, as the shelter according to the invention is totally sealed gas and watertight, it can be used for causality evacuation, body bag duties, human remains containment, temporary mortuary duties, isolation and containment of contagious or infected casualties.

The above description relates to preferred embodiments of the invention, but should in no way be taken to restrict the scope of the application to the described embodiments.

Claims

1. A portable hermetically sealable shelter comprising an inflatable element.

2. A shelter as claimed in claim 1 wherein the shelter comprises upper and lower sections which are hermetically joined along their peripheries to form an chamber having an opening, the shelter further comprising means to hermetically seal said opening.

3. A shelter as claimed in claim 2 wherein substantially the entire upper section of the shelter is made from at least one inflatable element.

4. A shelter as claimed in either one of claims 2 or 3 wherein substantially the entire upper and lower sections of the shelter are made from at least one inflatable element.

5. A shelter as claimed in any preceding claim wherein the means to hermetically seal the opening is an airtight zip.

6. A shelter as claimed in any preceding claim further comprising a door section.

7. A shelter as claimed in any preceding claim wherein the inflatable element comprises a three layer structure having an outer, an inner

and a core layer, the space between the inner and outer layers defining a lumen which is partitioned by the core layer to form separate air chambers, the inflatable element further comprising at least one valve allowing each air chamber to be inflated.

8. A shelter as claimed in claim 7 wherein the inflatable element has a valve allowing inflation of both air chambers simultaneously, but which isolates each air chamber from the other once inflated.

9. The shelter as claimed in either one of claims 7 or 8 wherein the valve is a one-way diaphragm valve.

10. A shelter as claimed any one of claims claim 8 to 10 wherein linear regions of the three layer structure are bonded, thus defining a plurality of connected elongated air compartments.

11. A shelter as claimed in any one of claims 7 to 10 wherein the core layer of the three layer structure is formed of a material which provides protection against thermal, nuclear, biological or chemical hazards.

12. A shelter as claimed in claim 11 wherein the core layer is made of at least one of Gore-Tex NBC fabric, Porvair NBC fabric, Blucher GmbH

Saratoga, Acvell NBC, DuPont Nomex Saratoga and Dupont solar film.

13. A shelter as claimed in any preceding claim wherein the shelter is sized and shaped to accommodate one person, with excess space reduced to a minimum.

14. A shelter as claimed in any preceding claim wherein the shelter is further provided with one-way air inlet and outlet valves.

15. A shelter as claimed in claim 14 wherein the inlet and/or outlet valves are provided with attachment means.

16. A shelter as claimed in claim 15 wherein a chemical and biological filter unit is attached to the inlet valve.

17. A shelter as claimed in any preceding claim wherein the shelter is provided with at least one means to facilitate therapy or transport of an occupant.

18. A shelter as claimed in claim 17 wherein the at least one means to facilitate therapy or transport of an occupant is selected from the list comprising ports for intravenous access, view panels made of transparent material, body movement restraints for head, neck and/or

limbs, spine and/or head supports, carrying straps, and attachments for a carrying cradle.

19. A shelter as claimed in any preceding claim wherein the shelter is provided with means to raise or lower the pressure inside the shelter relative to atmospheric pressure.

20. A shelter as claimed in any preceding claim wherein the shelter has stiffening means to resist expansion or collapse of the shelter when the pressure in the shelter is increased or decreased.

21. A shelter as claimed in any preceding claim wherein the shelter is provided with an oxygen source.

22. A shelter as claimed in any preceding claim further comprising a thermal insulating liner.

23. A shelter as claimed in claim 22 comprising a liner made of Gore-Tex or Thinsulate fleece material.

24. Use of a shelter according to any preceding claim for protecting a subject from the environment.

25. The use as claimed in claim 24 for protecting a subject from nuclear, biological or chemical

agents present in the environment, extremes of cold or heat, insect or reptile attack.

26. The use as claimed in either one of claims 24 or 25 wherein the person is an infected, wounded, injured or hypothermic person.

27. A method of making an inflatable portion for a hermetically sealable shelter, said method comprising the steps of;

- providing an inner layer of fabric, an outer layer of fabric and a core layer of fabric sandwiched therebetween;
- providing at least one valve spanning the periphery of the layers; and
- joining the layers together around their peripheries thus defining a lumen which is partitioned by the core layer to form separate air chambers, and wherein the at least one valve is held in position to allow inflation of each air chamber.

28. The method as claimed in claim 26 wherein the layers are further joined along lines to defining a plurality of connected elongated air compartments.

29. The method as claimed in either claim 25 or 26 wherein the layers are joined by high frequency welding.

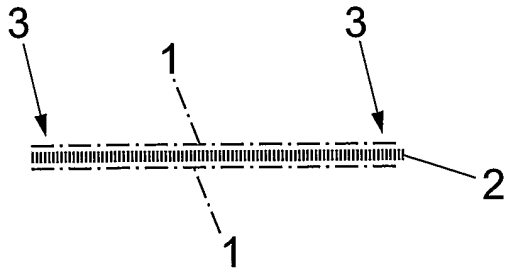
30. A method of making a portable hermetically sealable shelter, said method comprising the step of incorporating at least one inflatable portion made according to the method of any one of claims 27 to 29 into a portable hermetically sealable shelter.

31. The method as claimed in claim 30 comprising the following steps:
- providing two inflatable portions;
- joining the inflatable portions together to form upper and lower sections of the shelter; and
- providing sealing means adapted to reversibly hermetically seal the upper and lower sections of the shelter together.

32. The method as claimed in claim 31 wherein the sealing means is an airtight zip.

33. The method as claimed in any one of claims 30 to 32 further comprising providing a door section.

Fig. 1



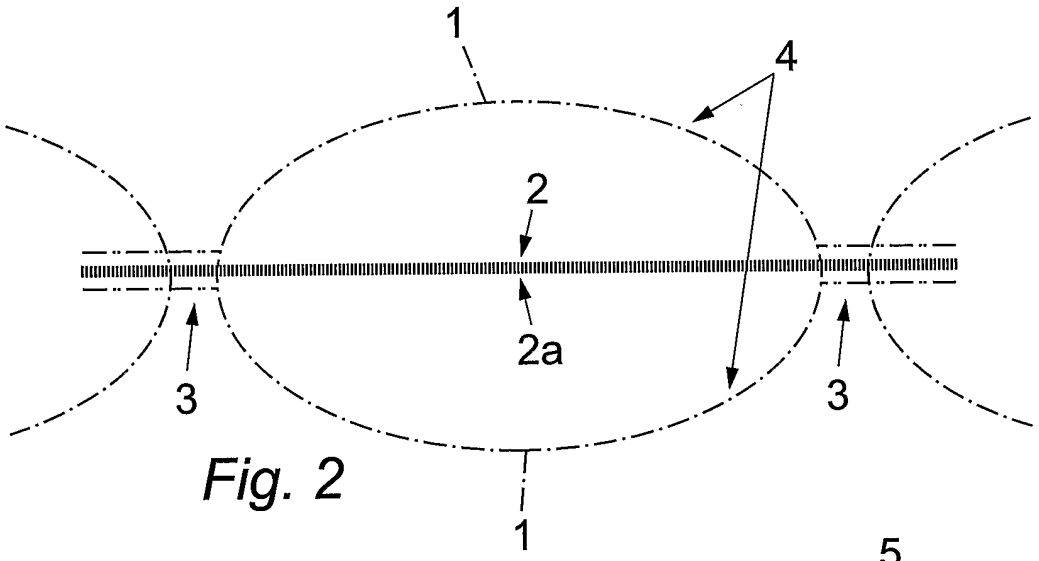
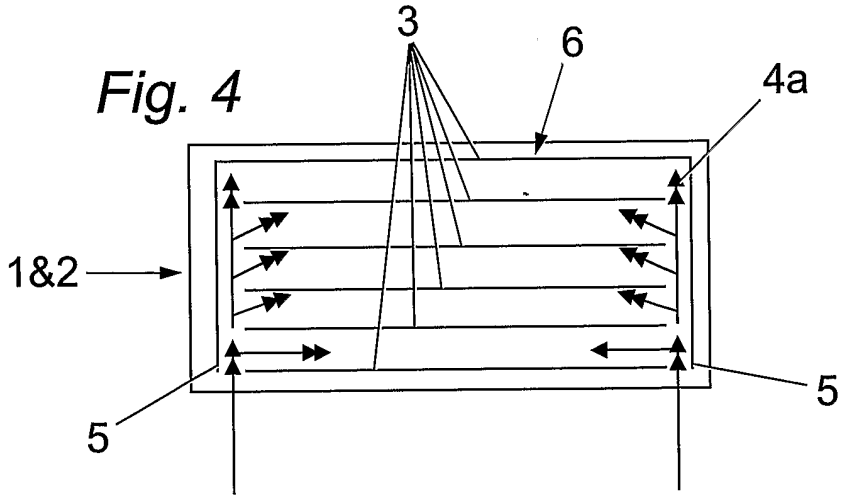


Fig. 2

Fig. 4



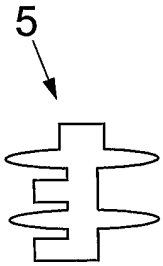
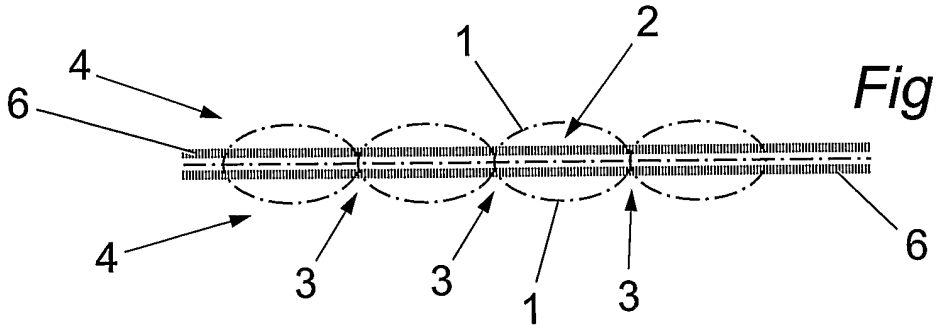


Fig. 3

Fig. 5



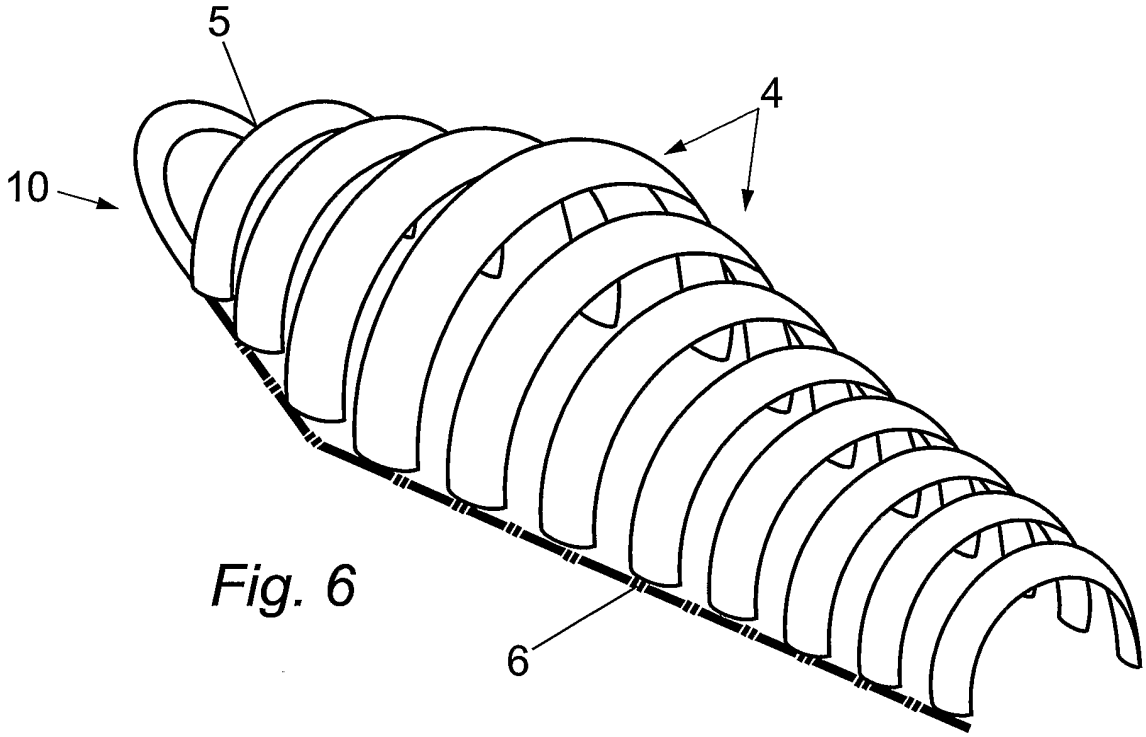


Fig. 6

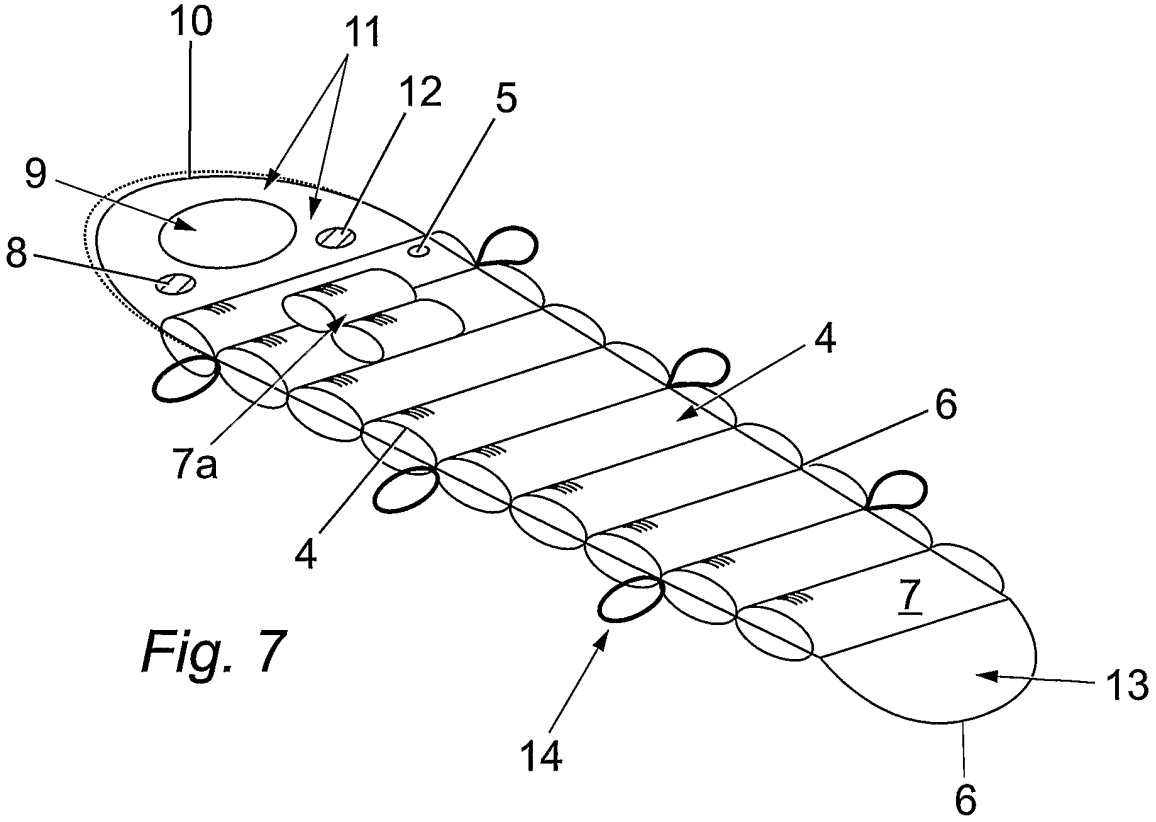


Fig. 7

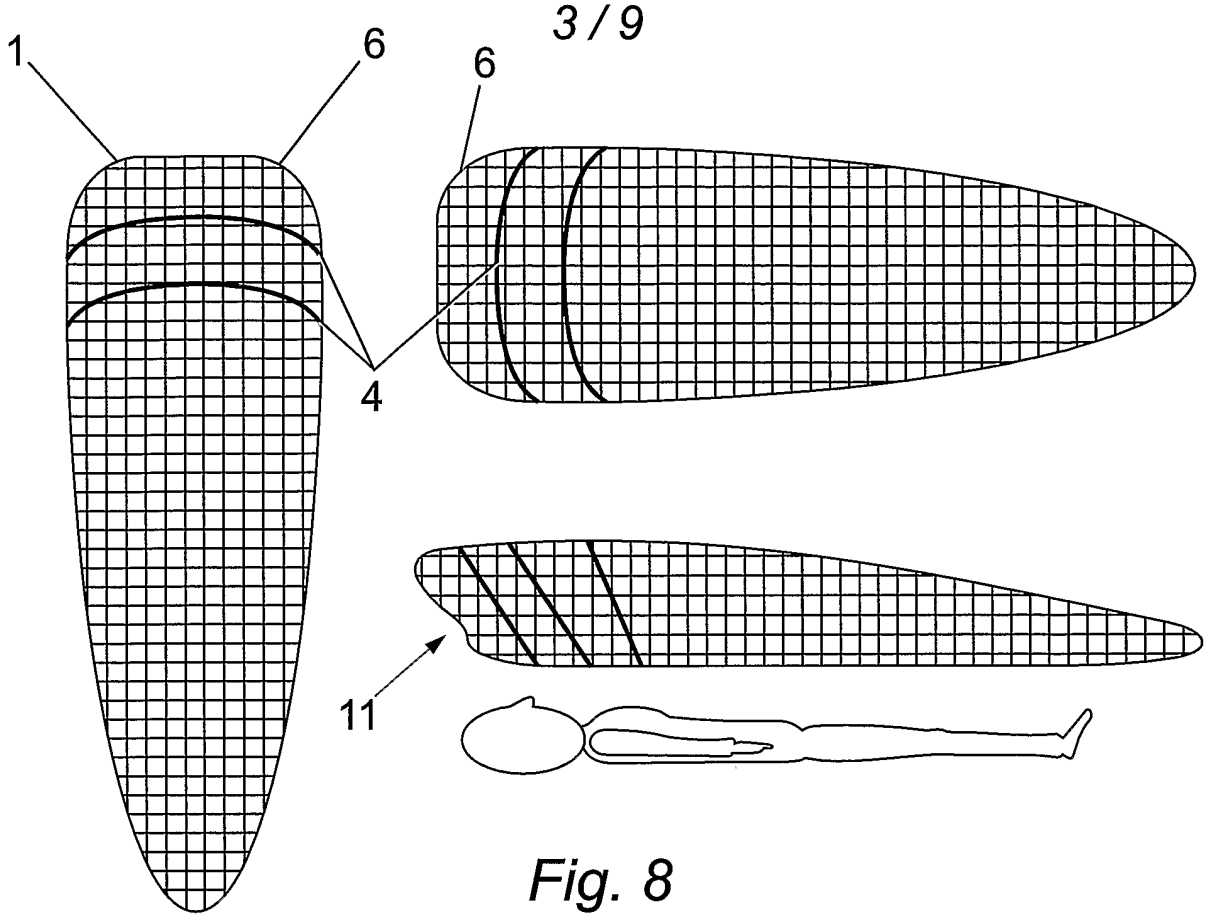


Fig. 8

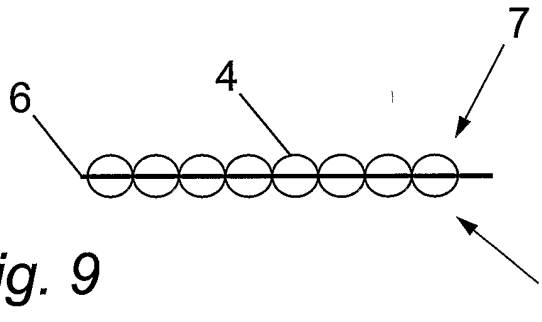


Fig. 9

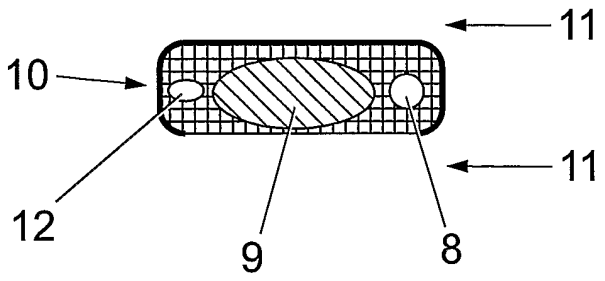


Fig. 10

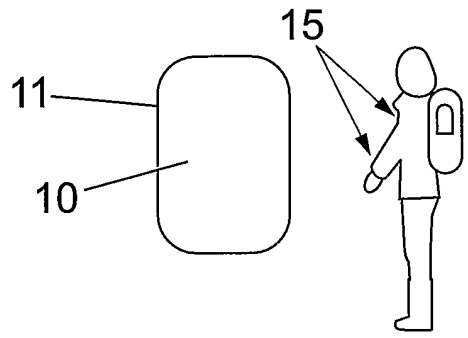


Fig. 11

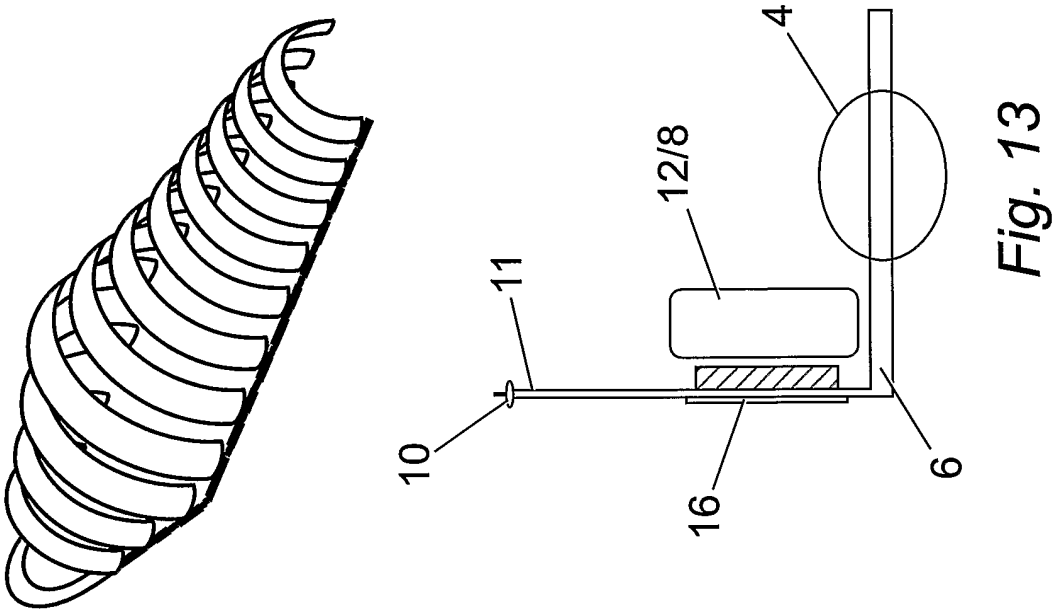


Fig. 13

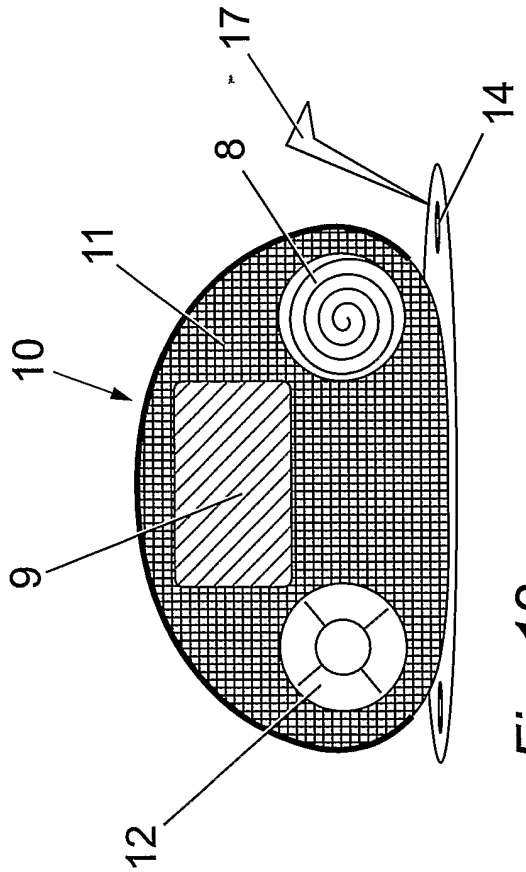


Fig. 12

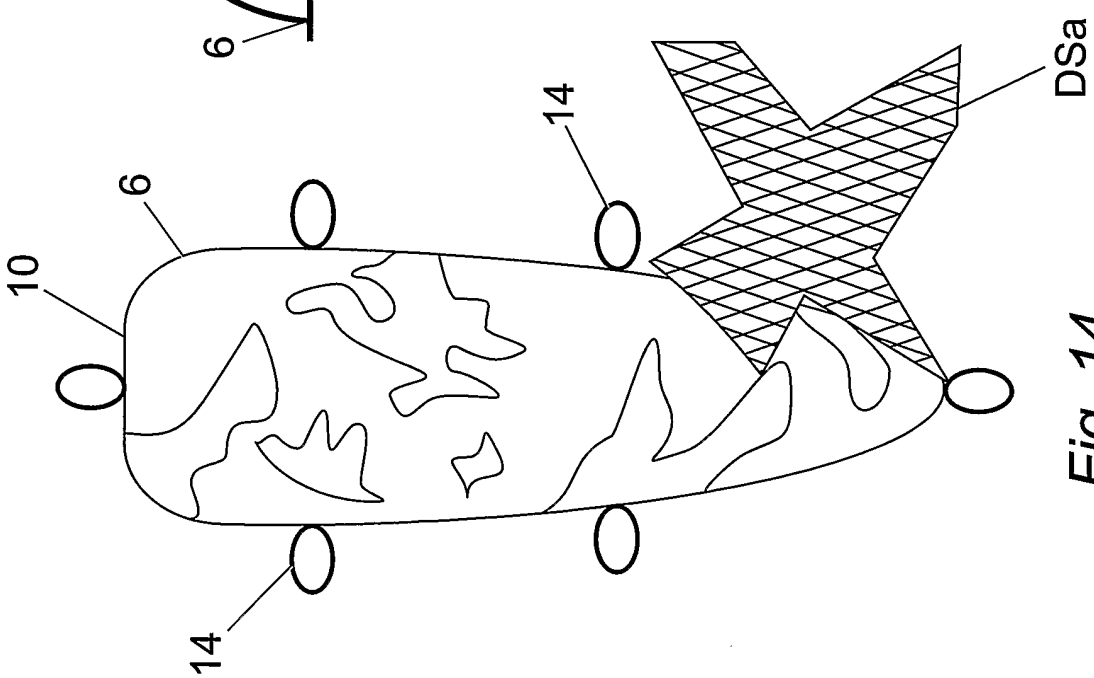
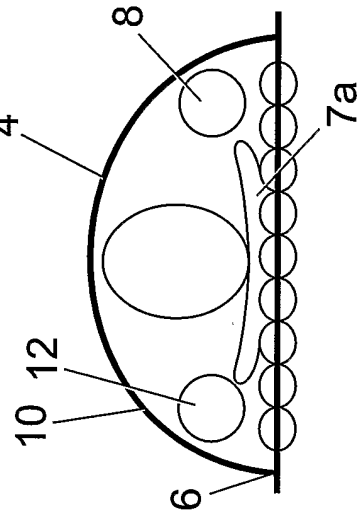


Fig. 14



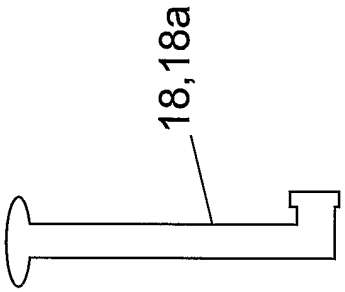


Fig. 15

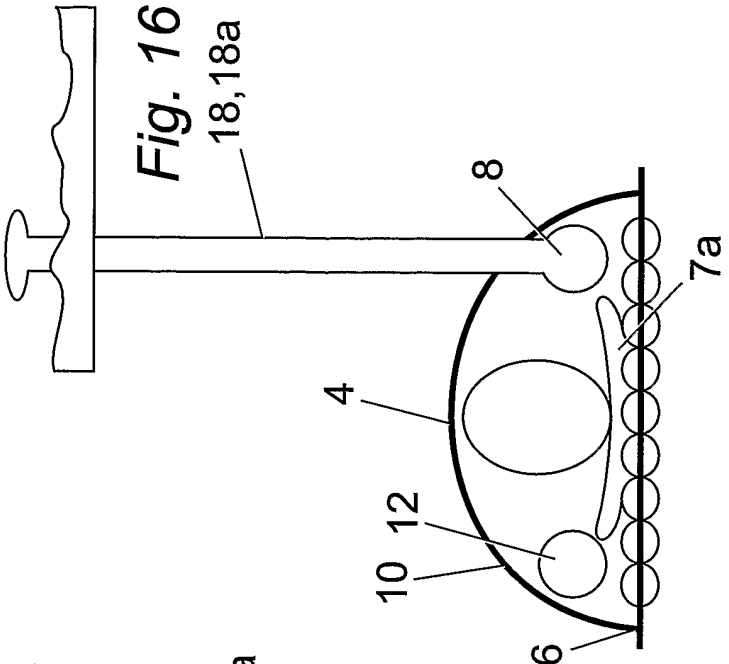


Fig. 16

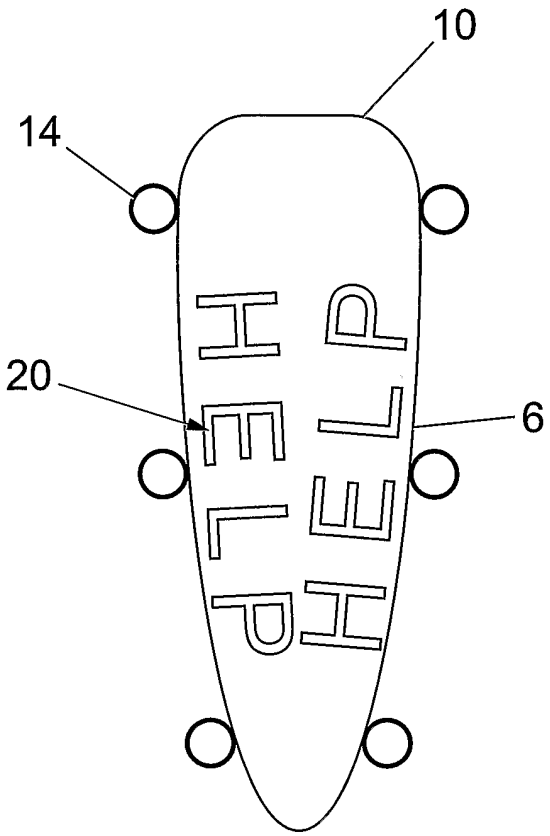


Fig. 17

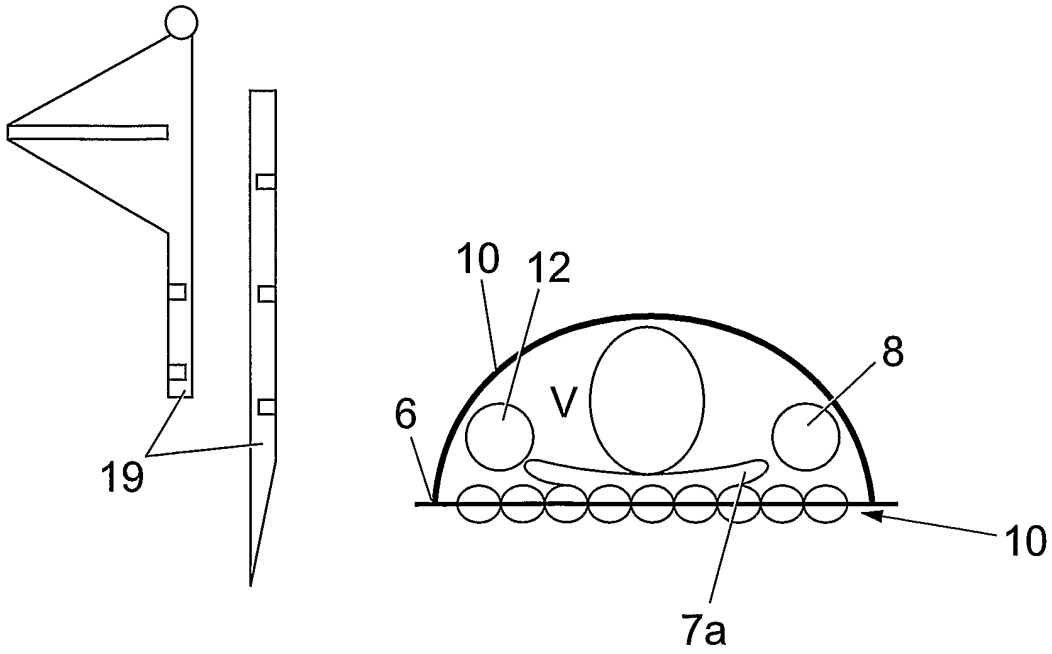


Fig. 18

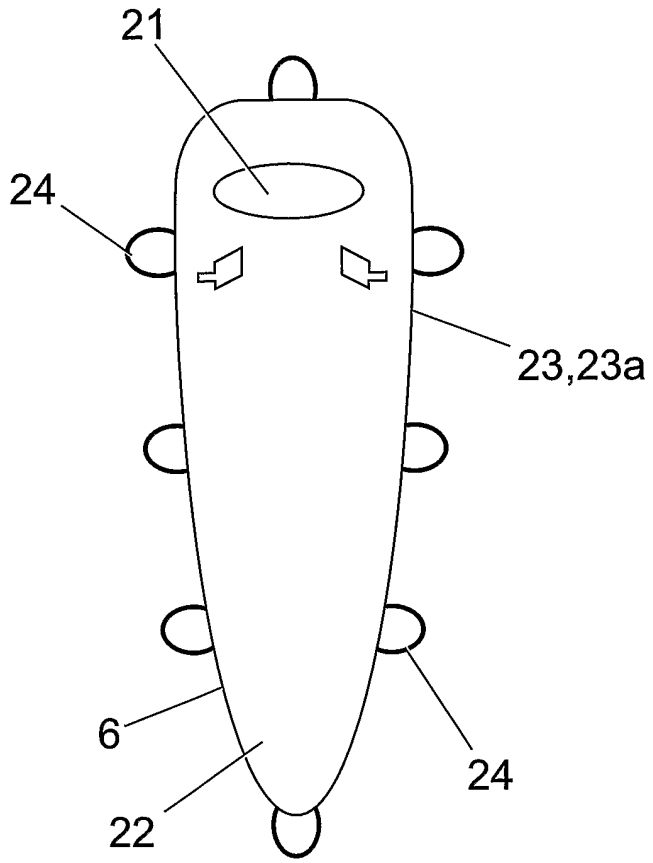


Fig. 19

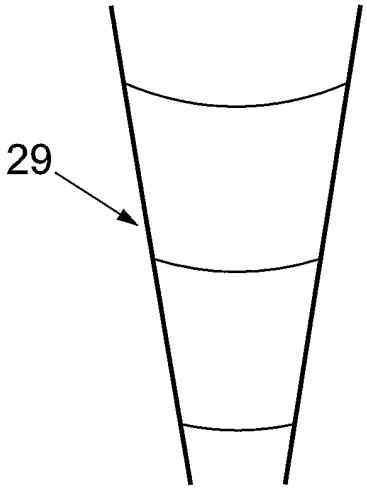


Fig. 22

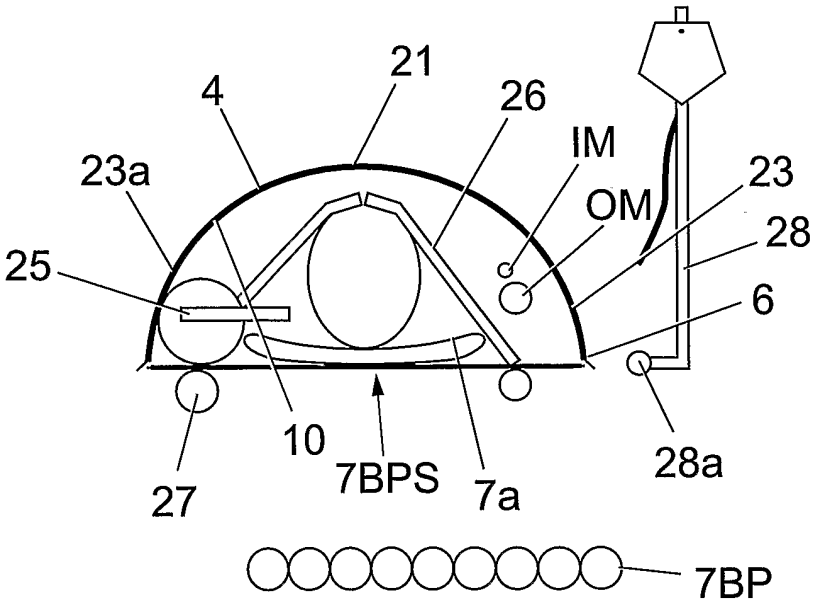


Fig. 20

Fig. 21

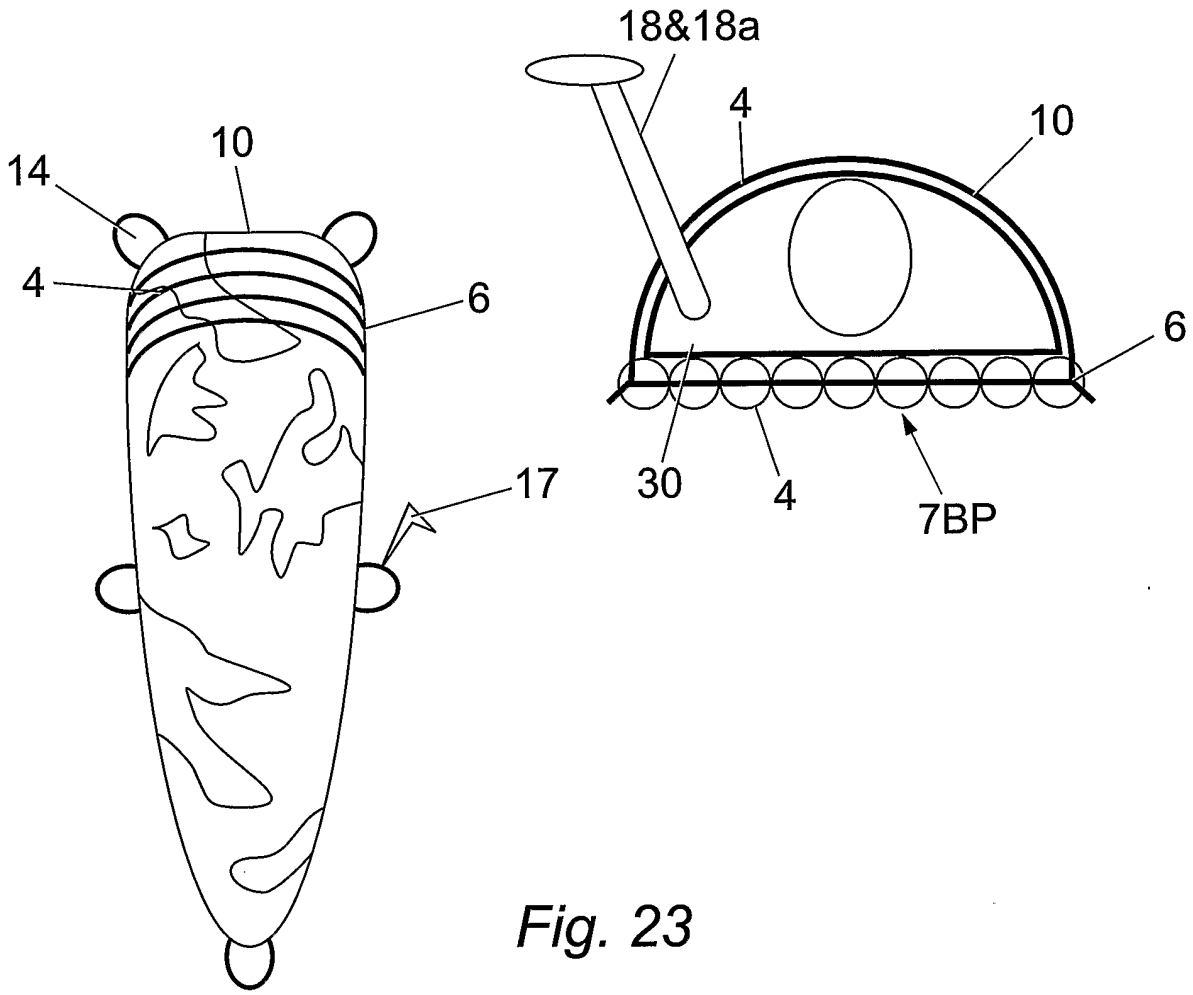


Fig. 23

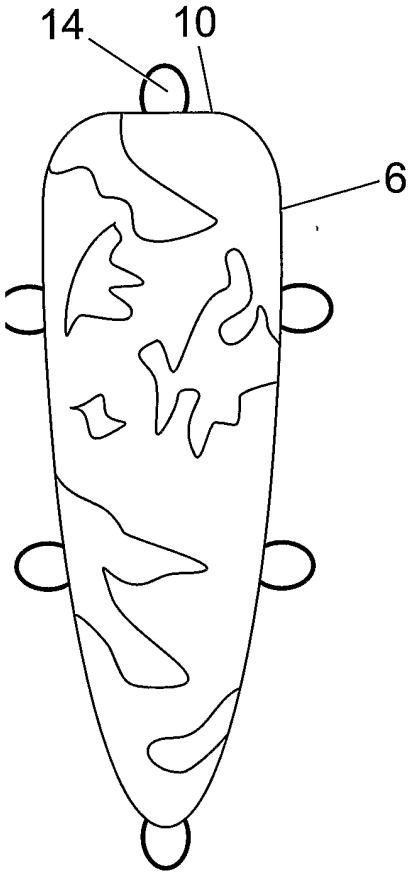


Fig. 24

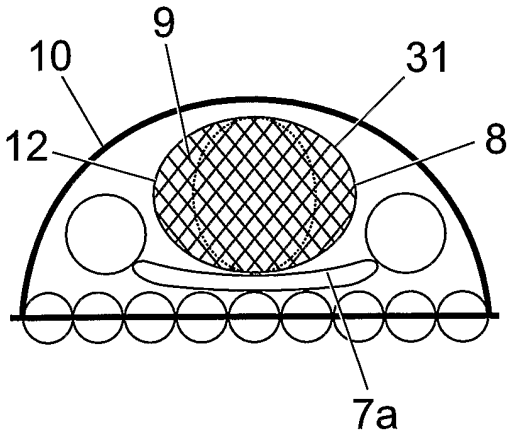


Fig. 24a

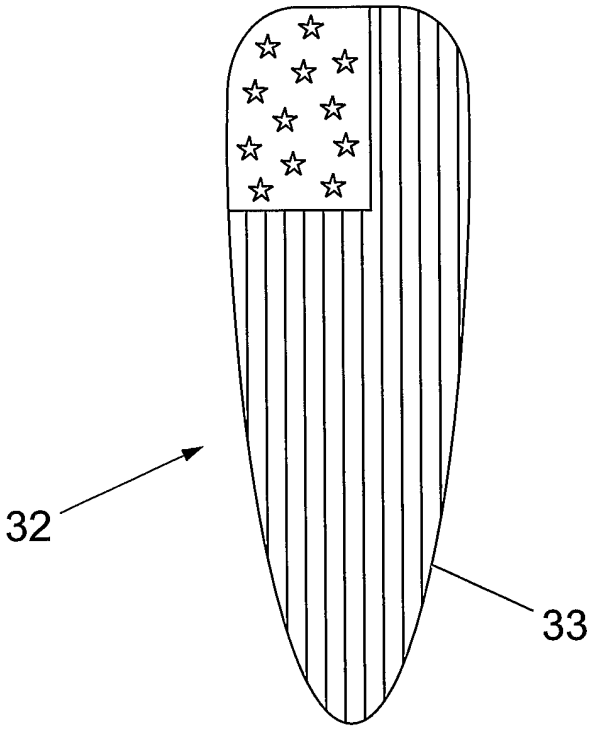


Fig. 25

INTERNATIONAL SEARCH REPORT

Inte ıl Application No
PCT/GB2004/002414

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E04H1/12 E04H15/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E04H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 607 655 A (BIXLER DONALD E ET AL) 26 August 1986 (1986-08-26) cited in the application	1-8,10, 13,15, 17,22, 27,28, 30-33
A	the whole document	9,11,12, 14, 18-21, 23-25,29

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° *Special categories of cited documents:*

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 October 2004	03/11/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Stefanescu, R

INTERNATIONAL SEARCH REPORT

Inte ial Application No
PC1/GB2004/002414

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 660 951 A (CADWELL SIDNEY M) 9 May 1972 (1972-05-09)	1-4,6-8, 10,11, 13,19, 21,22, 24-28, 30,31,33
A	column 5, line 33 - column 8, line 43; figures 2-8	5,9,12, 14,17, 18,20, 23,29,32
X	GB 2 137 250 A (BRIEN NEIL MICHAEL O) 3 October 1984 (1984-10-03)	1-3,5,6, 8,13,17, 21,24-26
A	the whole document	9,14-16, 18-20, 22,23, 27,30-33
X	GB 2 104 569 A (SECR DEFENCE) 9 March 1983 (1983-03-09)	1-3,5,6, 13,24-26
A	the whole document	4,8,9, 14,15, 17,19, 20,22,23
X	DE 86 27 545 U (ALFRED KÄRCHER) 28 January 1988 (1988-01-28)	1,2,6,8, 13,15, 17,20, 22,24,26
A	page 6, line 20 - page 9, line 16; figure 1	9,18,19, 21,23,25
A	US 6 260 306 B1 (MELNYK STEVEN G ET AL) 17 July 2001 (2001-07-17)	1-3, 5-10, 13-15, 17,19, 20,24, 26,27, 29-31,33
	column 2, line 40 - column 6, line 57; figures 1-7	

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int ial Application No
PCT/GB2004/002414

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4607655 A	26-08-1986	NONE	
US 3660951 A	09-05-1972	DE 1299404 B GB 1137182 A	18-12-1968
GB 2137250 A	03-10-1984	NONE	
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DE 8627545 U	28-01-1988	DE 8627545 U1	28-01-1988
US 6260306 B1	17-07-2001	NONE	

INTERNATIONAL SEARCH REPORT

Box No. IV Text of the abstract (Continuation of item 5 of the first sheet)

A portable hermetically sealable shelter comprising an inflatable element (4). The disclosed shelter relates to a portable inflatable shelter, that can be completely environmentally sealed, i.e. airtight and watertight. The shelter may be used for protecting a user from nuclear, biological and il chemical hazards as well as other environmental hazards such as extremes of temperature, pressure and reptile or insect attacks.