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(54) **PROTECTIVE HEADGEAR AND PROTECTIVE ARMOUR AND A METHOD OF MODIFYING  
PROTECTIVE HEADGEAR AND PROTECTIVE ARMOUR**

SCHÜTZENDE KOPFBEDECKUNG UND SCHUTZSCHILD SOWIE VERFAHREN ZUM  
MODIFIZIEREN VON SCHÜTZENDEN KOPFBEDECKUNGEN UND SCHUTZSCHILDEN

CASQUE DE PROTECTION, PLASTRON DE PROTECTION, ET PROCEDE DE MODIFICATION  
DU CASQUE DE PROTECTION ET DU PLASTRON DE PROTECTION

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(56) References cited:

|                        |                        |
|------------------------|------------------------|
| <b>AU-B- 512 331</b>   | <b>DE-A- 2 619 947</b> |
| <b>FR-A- 2 222 034</b> | <b>FR-A- 2 294 659</b> |
| <b>FR-A- 2 387 611</b> | <b>GB-A- 946 473</b>   |
| <b>US-A- 2 769 176</b> | <b>US-A- 2 814 043</b> |
| <b>US-A- 3 142 833</b> | <b>US-A- 3 242 500</b> |
| <b>US-A- 3 350 718</b> | <b>US-A- 3 500 472</b> |
| <b>US-A- 4 006 496</b> | <b>US-A- 4 012 794</b> |
| <b>US-A- 4 081 865</b> | <b>US-A- 4 434 514</b> |
| <b>US-A- 5 014 366</b> |                        |

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## Description

**[0001]** This invention relates to protective headgear, such as safety helmets for use by motor cyclists, pedal cyclists or climbers, as well as in other hazardous sports. It is also relevant in the industrial context, for example factories, on construction sites, defence and military applications or underground and may also have application in other areas where a protective form of headgear is necessary or required, which is effective in reducing or preventing head injury, while being lightweight and unencumbering to the wearer. A particular feature of the present invention is its ability to mimic the characteristics of the human head, in order to provide the desired protection against injury.

**[0002]** The present invention also relates to protective armour, for instance the body armour used by riot police and the armed forces.

**[0003]** Until now all designs for head protection have sought to diffuse and spread the impact of falls or blows by constructing protective helmets of hard materials with a limited degree of elasticity for energy absorption. Interior designs have consisted of webbing support, a variety of foams or a combination of the two, many of which have allowed the head to come into contact with the hard material itself on severe impact. For instance, in US-A-3946441 there is disclosed a safety helmet which comprises a primary shell having tough impact resisting properties and a second outer shell formed from a brittle material which is designed to fracture even upon minor impacts.

**[0004]** Protective armour is also known in the art and in the past one particular use of such armour has been to protect the body when playing sports. In US-A-3500472 there is disclosed a protecting garment having cushioning means which are inserted into pockets on the protective garment and inflated. In use, the garment is designed to restrict any relative movement between the cushioning means and the pocket means when the garment is subjected to impacts.

**[0005]** The present invention takes note of and incorporates most of the protective features of the human head, which of itself provides large energy dissipation and protection against direct and tangential forces. The major features of the human head are:

### The scalp

**[0006]** This is a firm, fibrous, elastic layer with great energy absorbing characteristics. Of particular importance is the fact that it is not attached firmly to the skull, but because of being "fixed" only at the periphery, it may move on the skull by distances of up to one centimetre thus absorbing considerable amounts of energy before it begins to tear. In impacts perpendicular to the surface of the head, its fibrous elasticity allows compression and energy absorption.

### The Skull

**[0007]** The human skull is composed of two layers of dense, compact bone "sandwiching" a layer of spongy cancellous bone (Fig. 1). This provides a hard surface for energy dissipation and absorption whilst allowing a degree of compression or crushing of the cancellous bone with more energy absorption. The cancellous bone may also allow a degree of distortion before any fracture occurs.

### The Cerebro-Spinal Fluid

**[0008]** The fluid surrounding the brain acts as a further energy absorbing element, cushioning the brain in movements within the cranium. Lateral blows or impacts project the brain towards the cranium and the displacement of the incompressible cerebro-spinal fluids acts as a decelerating force.

**[0009]** In one aspect the present invention provides protective headgear comprising:

a shell having an inwardly facing surface which in use faces the head of a user of the headgear and an outwardly facing surface which in use faces away from the head of the user, an outer membrane which overlies at least a portion of the outwardly facing surface of the shell and which is more flexible than the shell, wherein the protective headgear is constructed in such a way that a force applied to an outer surface of the headgear which acts to rotate the headgear and the head of the user can cause the outer membrane to move relative to the shell.

**[0010]** Preferably the membrane is composed of an energy absorbing and compressive material and preferably the material is elastic. Preferably the membrane is connected to the remainder of the protective headgear along a lower edge of the protective headgear and the membrane can extend to allow relative motion between the membrane and the shell.

**[0011]** In one embodiment the membrane comprises a high density foam material. Preferably the shell comprises a carbon fibre composite material.

**[0012]** The headgear can comprise an inner layer which can incorporate a deformable cellular material such as an inner lining member of low density foam. The inner lining member alternatively could comprise a further energy absorbing element in the nature of a flexible sac. The flexible sac can be filled with a liquid of predetermined viscosity which can flow around the sac when the headgear suffers impact in order to damp motion of a head in the headgear relative to the hard shell. The inner liner can comprise cellular material in combination with a fluid filled sac. The fluid filled sac can be subdivided into a plurality of compartments or cells to control fluid displacement within the sac and preferably the

compartments or cells are interconnected with flow regulating passages.

**[0013]** In a preferred embodiment an intermediate layer is interposed between the hard shell and the outer layer, the intermediate layer facilitating relative movement between the shell and outer layer. The intermediate layer may be incorporated integrally in the outer membrane. The intermediate layer may comprise a friction reducing material or lubricant agent which facilitates the movement between the outer layer and the helmet shell.

**[0014]** The membrane preferably overlies the entire outwardly facing surfaces of the shell and is preferably impervious to moisture.

**[0015]** In further embodiments of the invention, the headgear can additionally comprise acoustic or visual protection means and the headgear can also include ventilation means to improve comfort.

**[0016]** In this specification it should be understood that the words outer and inner are used to specify position relative to the hard shell of the headgear.

**[0017]** In a second aspect the present invention provides protective armour comprising:

a first layer of material of a first flexibility having a first surface which in use is presented to receive impact blows, and

a membrane which overlies at least a portion of the first surface of the first layer and which is more flexible than the first layer of material, wherein the protective armour is constructed in such a way that when a force is applied to an outwardly facing surface of the protective armour which has a component tangential to the outer surface, the force can cause the membrane to move relative to the first layer of material.

**[0018]** Preferably the membrane is compressible and elastic and can absorb energy when compressed.

**[0019]** Preferably the membrane is connected to the remainder of the protective armour by elastic connection means which can extend to allow relative motion between the membrane and the first layer.

**[0020]** Preferably the membrane comprises high density foam.

**[0021]** Preferably the protective armour comprises a layer intermediate between the first layer and the membrane, the intermediate layer facilitating relative movement between the membrane and the first layer. Preferably the intermediate layer comprises a lubricant material. Alternatively the intermediate layer has a first surface which can abut the membrane and a second surface which can abut the first surface of the first layer of material, the first and second surfaces of the intermediate layer each having a low coefficient of friction.

**[0022]** Preferably the first layer of material comprises a carbon fibre composite material.

**[0023]** The protective armour can be used as body ar-

mour.

**[0024]** According to a third aspect, the present invention provides protective headgear comprising first and second securing straps for securing the remainder of the head gear on a head of a user, where the first strap can pass under the chin of the user to act as a chin restraint and the second strap can pass around the lower part of the back of the head of the user to act as an occipital restraint.

**[0025]** The present invention further provides a method of modifying existing protective headgear wherein a membrane is attached to the remainder of the headgear to overlie at least a portion of the original outer surface of the protective headgear so as to provide a new outer surface for the protective headgear, the membrane being attached to the remainder of the headgear in such a way that when a force is applied to the outer surface of the membrane which acts to rotate the protective headgear the force can cause the membrane to move relative to the remainder of the headgear.

**[0026]** The present invention additionally provides a method of modifying existing protective armour wherein a membrane is attached to the remainder of the armour to overlie at least a portion of the original outer surface of the protective armour so as to provide a new outer surface for the protective armour, the membrane being attached to the remainder of the armour in such a way that when a force is applied to the outer surface of the membrane which acts tangential to the membrane, the force can cause the membrane to move relative to the remainder of the protective armour.

**[0027]** Preferred embodiments of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 illustrates the structure of the human skull;

Figures 2a and 2b illustrate chin straps for headgear according to the invention;

Figure 3 is a cross-section of a first preferred embodiment of headgear according to the invention;

Figure 4 is a cross-section of a second preferred embodiment of headgear according to the invention;

Figure 5 is a cross-section of a third preferred embodiment of headgear according to the invention.

Figure 6 is a cross-section of a fourth preferred embodiment of headgear according to the invention;

Figure 7 is a cross-section of a fifth preferred embodiment of headgear according to the invention;

Figure 8 is a cross-section of a sixth preferred embodiment of headgear according to the invention;

Figure 9 is a schematic illustration of body armour according to the present invention

Figure 10 is a cross-section through the body armour of Figure 9.

**[0028]** In Figure 3 there can be seen protective headgear in the form of a helmet which has a hard shell 10 and an outer energy absorbing compressible layer 11, resembling the scalp and reproducing its protective function. This layer 11 consists of a fibrous and/or elastic material, resembling carpet tiling or plastic foam. Thick leather would also have some of the envisaged qualities but cost and weight may be determining factors in which case a synthetic material with similar properties would be used. Since the outer soft covering layer 11 could be a porous material it must be rigorously waterproofed as absorbed water would reduce its energy absorbing qualities. This could be achieved by treatment of the material or by the superimposition of a thin but durable layer or by both methods.

**[0029]** To reproduce the energy absorbing qualities of the scalp the attachment of the outer energy absorbing compressible layer 11 to the hard shell 10 is critical. It will be bonded to the hard shell 10 of the helmet around the edge of the hard shell 10, in a way chosen in dependence on the physical characteristics of the materials chosen for the headgear. The layer 11 will be bonded only at the edge of the hard shell 10 in order to allow relative motion between the outer energy absorbing layer 11 and the hard shell 10 in order to mimic the protective movement of the scalp. The outer layer 11 can stretch to allow relative motion. A lubricant 12 between the energy absorbing layer and the shell may be beneficially used.

**[0030]** It is preferred that the hard shell 10 itself is a sandwiched material with hard outer layers sandwiching a deformable inner layer. Otherwise a single layer material of plastic, fibreglass or other appropriate material will be used but with hardness and deformability characteristics matched to the new construction and yielding optimum protection on standard or newly developed testing.

**[0031]** To mimic the fluid suspension provided by the cerebro-spinal fluid, a flexible sac 13, filled with an appropriately viscous liquid will be bonded to the inner surface of the hard shell 10. Since fluid in a unicellular sac would gravitate to the brim, compartmentalisation will be necessary and to allow displacement under impact. Flow control mechanisms between compartments will be included to control flow between the compartments. The flow control mechanism will not allow flow of fluid between compartments in normal use, but will allow flow of fluid between compartments when the helmet is subject to an impact (the interconnection of the compartments allows development of a uniform pressure in all of the compartments, thereby spreading an impact over a large area). The fluid in the layer 13 may be a viscous

or aqueous fluid and will act to damp motion of the helmet relative to the head of a user when the helmet is subject to an impact. The flow control could comprise lines of weakness in walls dividing the compartments, the walls remaining intact to seal off the compartments in normal use, but the lines of weakness breaking to form apertures in the walls (and thus to allow flow of fluid) in impact conditions. An alternative embodiment will be a "bubble pack" type lining, with liquid, liquid and gas combined or solely gas filling.

**[0032]** A thin polystyrene liner bonded to the inner surface of the sac could alternatively be used to maintain the shape of and thus the fluid distribution within the sac in which case compartmentalisation will not be necessarily used.

**[0033]** Figure 6 shows how an outer membrane 30 of closed cell plasticised Polyvinyl Chloride (PVC) can be attached to a carbon fibre composite shell 31 in order to permit relative motion between the membrane 30 and the shell 31. For the sake of simplicity inner layers within the shell 31 (e.g. a head liner) are not shown.

**[0034]** The outer membrane 30 is attached to an inner surface of the shell 31 around the edge of the shell 31 via an intermediary band 60 of a compliant material. An epoxy adhesive is used to bond the intermediary band 60 to the inner surface of the shell 31 around the lower edge. The intermediary band 60 is adhered to the inner surface and then extends down around the lower edge and then upwardly around the exterior of the lower part of the shell 31. The outer membrane 30 is adhered by an adhesive to the part of the intermediary band that overlies the outwardly facing lower edge of the shell 31. The intermediary band 60 will be made of a material of greater compliance than the outer membrane 30. The membrane 30 is attached to the shell 31 only via the intermediary band 60 and thus the remainder of the membrane 30 is free to move relative to the underlying shell 31. Both the membrane 30 and the intermediary band 60 can stretch on application of a force to allow relative motion between the membrane 30 and the shell 31.

**[0035]** A layer 32 of a lubricant gel is enclosed between the membrane 30 and the shell 31 and this facilitates relative movement between the membrane 30 and the shell.

**[0036]** A further embodiment of helmet is illustrated in Figure 7. In this embodiment an outer membrane 40 of polyethylene is attached to the interior of a glass fibre shell 41 via an intermediary band 61 adhered to the bottom edge of the interior of the glass fibre shell 41. The membrane 40 is attached to the shell 41 only via the band 61 thus the membrane 40 is otherwise free to stretch and move relative to the shell 41. The band 61 is composed of a material which is more compliant than the outer membrane 40 and also stretches to allow relative motion. The relative movement is assisted by the interposition of a PTFE layer 42 between the membrane 40 and the shell 41; the surfaces of the PTFE layer hav-

ing a low coefficient of friction.

**[0037]** An additional embodiment of helmet is illustrated in Figure 8. In this embodiment a membrane 50 of ethylene vinyl acetate co-polymers is attached to the interior of a glass reinforced plastic (GRP) shell 51, the membrane 50 being adhered directly to the interior bottom edge of the shell 51. The inwardly facing surface of the membrane 50 is treated to reduce the coefficient of friction of the surface and the outwardly facing surface of the GRP shell is also treated to reduce the coefficient of friction of the surface. Since the membrane 50 is only attached to the shell 51 at the lower edge, the membrane 50 is free to stretch and move relative to the shell 51, assisted by the low coefficient of friction of the abutting surfaces of the membrane 50 and the shell 51.

**[0038]** The inwardly facing surface of the membrane 50 and the outwardly facing surface of the shell 51 in this embodiment can incorporate a lubricant to dispense with the need for an intermediary layer such as a lubricant gel.

**[0039]** Other less preferred materials for the outer membrane include cross-linked high density polyurethane foam and silicon foamed rubber.

**[0040]** Testing has been carried out on embodiments of helmet according to the invention. In each case a standard full faced GRP helmet was tested and then another of the same type of GRP helmet was modified by covering the helmet with a membrane, in accordance with the invention. Each helmet was fitted to a head form with an array of nine accelerometers and then dropped on to a test anvil with an impact surface comprising aluminium oxide paper, 80 grit. The impact velocity was 8.5 m/s and the impact site on the right or left hand side of the helmet.

**[0041]** Very significant reductions were achieved in the maximum tangential force ON the head form in the helmet. Also a moderate decrease in the maximum linear acceleration forces were achieved.

**[0042]** The combination of materials for the headgear will be chosen bearing in mind that the sound insulation qualities of the combination may represent a hazard in motorcycle or cycle applications. It is always possible to provide perforations in the ear area of the headgear.

**[0043]** In military/aeronautical applications additional material or earcups would provide noise protection and additional protection against lateral blows which tend to cause fractures of the base of the skull. Also visual protection and enhancement devices could be incorporated in the helmet and also respiratory devices such as gas masks and air purifiers. The illustrated embodiment in Figure 3 has a fitting band 14.

**[0044]** Since the heat insulation qualities of the described helmets could be high if certain material combinations are chosen, provision must be made for ventilation in appropriate weather conditions. Inlet and outlet ports will be provided with variable control of the air inlet and consideration will be given to the provision of ventilation ports on the vertex in applications where there is no

generated air flow.

**[0045]** In many accidents, particularly in industrial mishaps involving a fall, the helmet is flung off. The retention system is therefore, a critical element of head protection. On each side of the helmet there would be preferably a two point attachment, one in front of and the other behind the central transverse vertical plane. Depending on the shape of the helmet and the application, there would be either a double strap 15 joined to form a chin cup 16 as shown in Figure 2a or a single strap 17, 18 from each point of attachment, the anterior one 17 providing a chin restraint and the posterior 18 an occipital restraint as shown in Figure 2b.

**[0046]** Modifications of the headgear of Figure 3 are shown in Figures 4 and 5. One modification omits the flexible sac 13 and comprises two layers of plastic foam, in combination with a polystyrene liner, either both outside the polystyrene liner (see Figure 5 where two layers of plastic foam 19 and 20 are both outside a polystyrene liner 21) or one outside and the other inside the polystyrene liner (see Figure 4 where one layer of plastic foam 22 is inside a polystyrene liner 23 and one layer of plastic foam 24 is outside the polystyrene liner 23). These foam layers can be either low density or combinations of low and higher density foams.

**[0047]** Severe head injuries continue to occur despite the use of current protective headgear and, in American industry alone, involve national costs amounting to billions of dollars. Many of these injuries result from falls in which the helmet falls off; similarly there are still many motor cycle injuries resulting from the same cause. This is quite apart from those injuries caused by inadequate protection from existing design of head protection.

**[0048]** A major improvement, therefore, will be achieved by conversion of existing hard hat to hats with "soft" outer skins according to the invention, preferably with the provision of effective retention systems. Soft covers and new retention systems designed for attachment to existing headgear are included in the scope of the invention.

**[0049]** Whilst above the present invention is described with reference to its use for protective headgear, the invention can also be applied to protective armour, such as body armour. The same principle of using an overlying membrane can be used. Shown in Figure 9 is protective armour in the form of a breast plate 100 which can be worn in front of a user secured by straps 101.

**[0050]** The breast plate 100 comprises a first layer 102 made of fibre glass (or carbon fibre, a metal or a plastic) which has a first surface 102A in use presented to receive impact blows. The armour has also a compliant elastic membrane 103, for instance of closed cell plasticised Polyvinyl Chloride (or of polyethylene, ethylene vinyl acetate co-polymers, cross linked high density polyurethane foam or silicon foamed rubber). This membrane 103 in use overlies the first surface 102A of the first layer 102. The membrane 103 is more flexible than the first layer 102 and is compressible and elastic and

can absorb energy when compressed.

**[0051]** The membrane 103 is connected to the first layer 102 by an intermediary band 104 of an elastic material.

**[0052]** The intermediary band 104 is adhered around the edge of a face 102B of the first member 102 (the face 102B facing in the opposite direction to the face 102A). The intermediary band 104 extends around the edge of the first member 102 and overlies an edge portion of the surface 102A. The intermediary band 104 is only adhered to the first member 102 on the surface 102B thereof. The membrane 103 is adhered around its periphery to the intermediary band 104.

**[0053]** An intermediary layer 105 of lubricant gel is included between the membrane 103 and the first layer 102 and facilitates relative motion between them. This layer is not essential and could be replaced by a solid layer of a material of a low co-efficient of friction (e.g. a layer of PTFE). Alternatively a lubricant could be incorporated into the inner surface of the membrane 103.

**[0054]** The protective armour is constructed in such a way that when a force is applied to the outwardly facing surface of the membrane 103 which has a component tangential to the outer surface, the force can cause the membrane 103 to move relative to the first layer 102.

**[0055]** The present invention also provides a method of modifying protective armour comprising providing "soft" outer skin to cover an existing plate.

## Claims

### 1. Protective headgear comprising:

a hard shell (10; 31; 41; 51) having an inwardly facing surface which in use faces the head of a user of the headgear and an outwardly facing surface which in use faces away from the head of the user,

an outer membrane (11; 30; 40; 50) of a thickness not greater than the remainder of the headgear which overlies at least a portion of the outwardly facing surface of the shell (10; 31; 41; 51), wherein:

the outer membrane (11; 30; 40; 50) is fixedly attached to the remainder of the headgear only along a lower edge of the hard shell (10; 31; 41; 51) so that the outer membrane (11; 30; 40; 50) can move relative to the hard shell (10; 31; 41; 51) when a force is applied to an outer surface of the headgear which acts to rotate the headgear and the head of the user, characterised in that:

the outer membrane (11; 30; 40; 50) is compressible and elastic and more flexible than the hard shell (10; 31; 41; 51) and the outer membrane (11; 30; 40; 50) can compress in response to the force applied to the headgear and the outer membrane (11; 30; 40; 50) stretches when the said rotating force is applied to the headgear to allow relative mo-

tion between the membrane (11; 30; 40; 50) and the hard shell (10; 31; 41; 51) and can thereby mimic a human scalp in providing protective movement.

2. Protective headgear as claimed in claim 1 wherein the outer membrane (30; 40) is connected to the remainder of the headgear only via an elastic intermediate member (60; 61).

3. Protective headgear as claimed in claim 2 wherein the elastic intermediate member (60; 61) is more compliant than the outer membrane (30; 40).

4. Protective headgear as claimed in any one of the preceding claims wherein the membrane (11; 30; 40; 50) comprises closed cell plasticised polyvinyl chloride.

5. Protective headgear as claimed in any one of claims 1 to 4 wherein the membrane (11; 30; 40; 50) comprises polyethylene.

6. Protective headgear as claimed in any one of claims 1 to 4 wherein the membrane (11; 30; 40; 50) comprises ethylene-vinyl acetate co-polymers.

7. Protective headgear as claimed in any one of the preceding claims wherein the hard shell (10; 31; 41; 51) comprises a carbon fibre composite material.

8. Protective headgear as claimed in any one of the preceding claims comprising additionally a layer (13) of incompressible fluid located in use between the shell (10) and the head of the user and encapsulated in a flexible sac (13).

9. Protective headgear as claimed in claim 8 wherein the flexible sac (13) containing the incompressible fluid is compartmentalised into a plurality of compartments and the flexible sac (13) comprises connection means connecting each compartment to at least one other compartment, the connection means being operable to prevent flow of fluid from one compartment to another until an impact on the protective headgear exceeds a threshold value at which point the connection means allows flow of fluid between the chambers.

10. Protective headgear as claimed in claim 9 wherein the incompressible fluid is a fluid which resists flow between compartments in order to damp motion of the shell (10).

11. Protective headgear as claimed in any one of the preceding claims comprising additionally a layer of low density foam (19; 20; 21; 22; 23; 24) located in use between the shell (10) and the head of the user.

12. Protective headgear as claimed in any one of the preceding claims comprising an intermediate layer (12; 32; 42) interposed between the shell (10; 31; 41) and the membrane (11; 30; 40), the intermediate layer (12; 32; 42) facilitating relative movement between the membrane (11; 30; 40) and the shell (10; 31; 41). 5
13. Protective headgear as claimed in claim 12 wherein the intermediate layer (12; 32) is a layer of lubricant material. 10
14. Protective headgear as claimed in claim 12 wherein the intermediate layer (42) has a first surface which can abut the membrane (40) and a second surface which can abut the shell (41) and the first and second surfaces each have a low coefficient of friction. 15
15. Protective headgear as claimed in any one of the preceding claims wherein the membrane (11; 30; 40; 50) overlies the entire outwardly facing surface of the shell (10; 31; 41; 51). 20
16. Protective headgear as claimed in any one of the preceding claims wherein the membrane (11; 30; 40; 50) is impervious to moisture. 25
17. Protective headgear as claimed in any one of claims 1 to 15 comprising additionally a moisture resistant outer covering overlaying the membrane (11; 30; 40; 50). 30
18. Protective headgear as claimed in any one of the preceding claims comprising additionally acoustic protection means. 35
19. Protective headgear as claimed in any one of the preceding claims comprising additionally visual protection and enhancement means. 40
20. Protective headgear as claimed in any one of the preceding claims comprising additionally ventilation means. 45
21. Protective headgear as claimed in any one of the preceding claims comprising first and second securing straps (17, 18) for securing the headgear on the head of the user, the first strap (17) providing chin restraint and the second strap (18) providing an occipital restraint. 50
22. Protective armour comprising:  
     a first layer of material (102) of a first flexibility having a first surface (102A) which in use is presented to receive impact blows, and  
     a compressible elastic membrane (103) of a thickness not greater than the remainder of the protective armour which overlies at least a portion of the first surface (102A) of the first layer (102) and which is more flexible than the first layer of material (102) and which can move relative to the first layer of material (102), characterised in that:  
     the membrane (103) is fixedly attached to the first layer of material (102) only along an edge of the first layer of material (102) so that when a force is applied to an outwardly facing surface of the protective armour which has a component tangential to the outwardly facing surface, the compressible elastic membrane (103) stretches to allow relative motion between the membrane (103) and the first layer of material (102), and  
     the protective armour includes means (105) to facilitate the relative motion between the membrane (103) and the first surface (102A) of the first layer of material (102) by reducing frictional resistance to relative motion. 55
23. Protective armour as claimed in claim 22 wherein the membrane (103) is connected to the remainder of the protective armour by elastic connection means (104) which can extend to allow relative motion between the membrane (103) and the first layer (102). 60
24. Protective armour as claimed in claim 22 or claim 23 wherein the membrane (103) comprises closed cell plasticised polyvinyl chloride. 65
25. Protective armour as claimed in claim 22 or claim 23 wherein the membrane (103) comprises polyethylene. 70
26. Protective armour as claimed in claim 22 or claim 23 wherein the membrane (103) comprises ethylene-vinyl acetate co-polymers. 75
27. Protective armour as claimed in any one of claims 22 to 26 wherein the means (105) facilitating relative motion between the membrane (103) and the first surface (102A) of the first layer of material (102) comprises a layer (105) intermediate between the first layer (102) and the membrane (103). 80
28. Protective armour as claimed in claim 27 wherein the intermediate layer (105) comprises a lubricant material. 85
29. Protective armour as claimed in claim 27 wherein the intermediate layer (105) has a first surface which can abut the membrane (103) and a second surface which can abut the first surface (102A) of the first layer of material (102), the first and second surfaces of the intermediate layer (105) each having a low coefficient of friction. 90

30. Protective armour as claimed in any one of claims 22 to 29 wherein the first layer of material (102) comprises a carbon fibre composite material.
31. Protective armour as claimed in any one of claims 22 to 30 for use as body armour.
32. A method of modifying existing protective headgear wherein a compressible elastic membrane (11; 30; 40; 50) of a thickness not greater than the existing protective headgear is attached to the remainder of the headgear to overlie at least a portion of the original outer surface of the protective headgear so as to provide a new outer surface for the protective headgear, the membrane (11; 30; 40; 50) being fixedly attached to the remainder of the headgear only along a lower edge of the headgear so that when a force is applied to the outer surface of the membrane which acts to rotate the protective headgear and the head, the membrane (11; 30; 40; 50) stretches to allow relative motion between the membrane (11; 30; 40; 50) and the remainder of the headgear and thereby mimics a human scalp in providing protective movement.
33. A method as claimed in claim 32 wherein the membrane (30; 40) is attached to the remainder of the headgear only via an elastic intermediate member (60; 61) which is more compliant than the membrane (30; 40).
34. A method of modifying existing protective armour wherein a compressible elastic membrane (103) of a thickness not greater than the existing protective armour is attached to the remainder of the armour to overlie at least a portion of the original outer surface of the protective armour so as to provide a new outer surface for the protective armour, the membrane (103) being fixedly attached to the remainder of the armour only along an edge of the armour so that when a force is applied to the outer surface of the membrane (103) which has a component tangential to the membrane (103), the membrane (103) can stretch to allow relative motion between the membrane (103) and the remainder of the protective armour, the method including the step of providing the armour with means (105) to facilitate the relative motion by reducing frictional resistance to relative motion.
35. A method as claimed in claim 34 wherein the membrane (103) is attached to the original protective armour only via an elastic intermediate member (104) which is more compliant than the membrane (103).

## Patentansprüche

- Schützende Kopfbedeckung, umfassend:  
eine Hartschale (10; 31; 41; 51) mit einer nach innen weisenden Fläche, die bei Verwendung zum Kopf eines Verwenders der Kopfbedeckung weist, sowie einer nach außen weisenden Fläche, die bei Verwendung vom Kopf des Verwenders weg weist,  
eine Außenhaut (11; 30; 40; 50), deren Dicke nicht größer ist als der Rest der Kopfbedeckung und die zumindest auf einem Abschnitt der nach außen weisenden Fläche der Schale (10; 31; 41; 51) aufliegt, wobei:  
die Außenhaut (11; 30; 40; 50) nur entlang einem Unterrand der Hartschale (10; 31; 41; 51) fest am Rest der Kopfbedeckung angebracht ist, so daß sich die Außenhaut (11; 30; 40; 50) relativ zur Hartschale (10; 31; 41; 51) bewegen kann, wenn auf eine Außenfläche der Kopfbedeckung eine Kraft ausgeübt wird, die die Wirkung hat, die Kopfbedeckung und den Kopf des Verwenders zu drehen, dadurch gekennzeichnet, daß:  
die Außenhaut (11; 30; 40; 50) komprimierbar und elastisch und flexibler als die Hartschale (10; 31; 41; 51) ist und daß die Außenhaut (11; 30; 40; 50) in Antwort auf die auf die Kopfbedeckung ausgeübte Kraft komprimiert werden kann und sich die Außenhaut (11; 30; 40; 50) streckt, wenn die Drehkraft auf die Kopfbedeckung ausgeübt wird, um eine Relativbewegung zwischen der Haut (11; 30; 40; 50) und der Hartschale (10; 31; 41; 51) zu erlauben, und hierdurch im Vorsehen einer Schutzbewegung eine menschliche Kopfhaut nachahmen kann.
- Schützende Kopfbedeckung nach Anspruch 1, wobei die Außenhaut (30; 40) mit dem Rest der Kopfbedeckung nur über ein elastisches Zwischenelement (60; 61) verbunden ist.
- Schützende Kopfbedeckung nach Anspruch 2, wobei das elastische Zwischenelement (60; 61) dehnbarer ist als die Außenhaut (30; 40).
- Schützende Kopfbedeckung nach einem der vorhergehenden Ansprüche, wobei die Haut (11; 30; 40; 50) geschlossenzelliges plastifiziertes Polyvinylchlorid aufweist.
- Schützende Kopfbedeckung nach einem der Ansprüche 1 bis 4, wobei die Haut (11; 30; 40; 50) Polyethylen aufweist.
- Schützende Kopfbedeckung nach einem der Ansprüche 1 bis 4, wobei die Haut (11; 30; 40; 50) Ethylenvinylacetat-Copolymere aufweist.
- Schützende Kopfbedeckung nach einem der vorhergehenden Ansprüche, wobei die Hartschale (10;



- 31; 41; 51) ein Carbonfaser-Kompositmaterial aufweist.
8. Schützende Kopfbedeckung nach einem der vorhergehenden Ansprüche, die eine zusätzliche Schicht (13) aus nicht komprimierbarem Fluid aufweist, die sich bei Verwendung zwischen der Schale (10) und dem Kopf des Verwenders befindet und in einem flexiblen Beutel (13) eingeschlossen ist.
9. Schützende Kopfbedeckung nach Anspruch 8, wobei der das nicht komprimierbare Fluid enthaltende flexible Beutel (13) in eine Mehrzahl von Kammern gekammert ist und der flexible Beutel (13) ein Verbindungsmittel aufweist, das jede Kammer mit zumindest einer anderen Kammer verbindet, wobei das Verbindungsmittel betreibbar ist, um einen Fluidfluß von einer Kammer in eine andere zu verhindern, bis ein Stoß auf die schützende Kopfbedeckung einen Schwellenwert überschreitet, bei dem das Verbindungsmittel einen Fluidfluß zwischen den Kammern erlaubt.
10. Schützende Kopfbedeckung nach Anspruch 9, wobei das nicht komprimierbare Fluid ein Fluid ist, das eine Strömung zwischen den Kammern hemmt, um die Bewegung der Schale (10) zu dämpfen.
11. Schützende Kopfbedeckung nach einem der vorhergehenden Ansprüche, die zusätzlich eine Schicht aus niedrig dichtem Schaum (19; 20; 21; 22; 23; 24) aufweist, die sich bei Verwendung zwischen der Schale (10) und dem Kopf des Verwenders befindet.
12. Schützende Kopfbedeckung nach einem der vorhergehenden Ansprüche, die eine Zwischenschicht (12; 32; 42) aufweist, die zwischen der Schale (10; 31; 41) und der Haut (11; 30; 40) angeordnet ist, wobei die Zwischenschicht (12; 32; 42) eine Relativbewegung zwischen der Haut (11; 30; 40) und der Schale (10; 31; 41) erleichtert.
13. Schützende Kopfbedeckung nach Anspruch 12, wobei die Zwischenschicht (12; 32) eine Schmiermittelschicht ist.
14. Schützende Kopfbedeckung nach Anspruch 12, wobei die Zwischenschicht (42) eine erste Fläche aufweist, die die Haut (40) stützen kann, sowie eine zweite Fläche, die die Schale (41) stützen kann, und wobei die erste und die zweite Fläche jeweils einen niedrigen Reibkoeffizienten aufweisen.
15. Schützende Kopfbedeckung nach einem der vorhergehenden Ansprüche, wobei die Haut (11; 30; 40; 50) auf der gesamten nach außen weisenden Fläche der Schale (10; 31; 41; 51) aufliegt.
16. Schützende Kopfbedeckung nach einem der vorhergehenden Ansprüche, wobei die Haut (11; 30; 40; 50) feuchtigkeitsundurchlässig ist.
17. Schützende Kopfbedeckung nach einem der Ansprüche 1 bis 15, die zusätzlich eine feuchtigkeitsbeständige Außendecke aufweist, welche auf der Haut (11; 30; 40; 50) aufliegt.
18. Schützende Kopfbedeckung nach einem der vorhergehenden Ansprüche, die zusätzlich ein Schallschutzmittel aufweist.
19. Schützende Kopfbedeckung nach einem der vorhergehenden Ansprüche, die zusätzlich ein Sichtschutz- und -verbesserungsmittel aufweist.
20. Schützende Kopfbedeckung nach einem der vorhergehenden Ansprüche, die zusätzlich ein Lüftungsmittel aufweist.
21. Schützende Kopfbedeckung nach einem der vorhergehenden Ansprüche, die erste und zweite Sicherungsbänder (17, 18) aufweist, um die Kopfbedeckung am Kopf des Verwenders zu sichern, wobei das erste Band (17) eine Kinnhalterung bildet und das zweite Band (18) eine Hinterkopfhalterung bildet.
22. Schutzschild, umfassend:
- eine erste Materialschicht (102) mit einer ersten Flexibilität, die eine erste Fläche (102A) aufweist, die bei Verwendung zur Aufnahme von Stoßschlägen präsentiert wird, und eine komprimierbare elastische Haut (103), deren Dicke nicht größer als der Rest des Schutzschilds ist und die zumindest auf einem Abschnitt der ersten Fläche (102A) der ersten Schicht (102) aufliegt und die flexibler ist als die erste Materialschicht (102) und die sich relativ zur ersten Materialschicht (102) bewegen kann, dadurch gekennzeichnet, daß:
- die Haut (103) nur entlang einem Rand der ersten Materialschicht (102) an der ersten Materialschicht (102) fest angebracht ist, so daß, wenn eine Kraft auf eine nach außen weisende Fläche des Schutzschilds ausgeübt wird, die eine zur nach außen weisenden Fläche tangentielle Komponente aufweist, sich die komprimierbare elastische Haut (103) streckt, um eine Relativbewegung zwischen der Haut (103) und der ersten Materialschicht (102) zu erlauben, und
- das Schutzschild ein Mittel (105) aufweist, um die Relativbewegung zwischen der Haut (103) und der ersten Fläche (102A) der ersten Materialschicht (102) zu erleichtern, indem es den

Reibungswiderstand der Relativbewegung senkt.

23. Schutzschild nach Anspruch 22, wobei die Haut (103) mit dem Rest des Schutzschields durch ein elastisches Verbindungsmittel (104) verbunden ist, das sich dehnen kann, um eine Relativbewegung zwischen der Haut (103) und der ersten Schicht (102) zu erlauben. 5
24. Schutzschild nach Anspruch 22 oder Anspruch 23, wobei die Haut (103) geschlossenzelliges plastifiziertes Polyvinylchlorid aufweist.
25. Schutzschild nach Anspruch 22 oder Anspruch 23, wobei die Haut (103) Polyethylen aufweist. 15
26. Schutzschild nach Anspruch 22 oder Anspruch 23, wobei die Haut (103) Ethylenvinylacetat-Copolymer aufweist. 20
27. Schutzschild nach einem der Ansprüche 22 bis 26, wobei das Mittel (105), welches eine Relativbewegung zwischen der Haut (103) und der ersten Fläche (102A) der ersten Materialschicht (102) erleichtert, eine Schicht (105) aufweist, die zwischen der ersten Schicht (102) und der Haut (103) befindet. 25
28. Schutzschild nach Anspruch 27, wobei die Zwischenschicht (105) Schmiermittel aufweist. 30
29. Schutzschild nach Anspruch 27, wobei die Zwischenschicht (105) eine erste Fläche aufweist, die die Haut (103) stützen kann, und eine zweite Fläche, die die erste Fläche (102A) der ersten Materialschicht (102) stützen kann, wobei die erste und zweite Fläche der Zwischenschicht (105) jeweils einen niedrigen Reibkoeffizienten aufweisen. 35
30. Schutzschild nach einem der Ansprüche 22 bis 29, wobei die erste Materialschicht (102) Carbonfaser-Kompositmaterial aufweist. 40
31. Schutzschild nach einem der Ansprüche 22 bis 30 zur Verwendung als Körperschild. 45
32. Verfahren zum Modifizieren einer vorhandenen schützenden Kopfbedeckung, wobei eine komprimierbare elastische Haut (11; 30; 40; 50), deren Dicke nicht größer als die vorhandene schützende Kopfbedeckung ist, an dem Rest der Kopfbedeckung so angebracht wird, daß sie zumindest auf einem Abschnitt der ursprünglichen Außenfläche der schützenden Kopfbedeckung aufliegt, um eine neue Außenfläche der schützenden Kopfbedeckung vorzusehen, wobei die Haut (11; 30; 40; 50) nur entlang einem Unterrand der Kopfbedeckung an dem Rest der Kopfbedeckung fest angebracht 50

wird, so daß, wenn auf die Außenfläche der Haut eine Kraft ausgeübt wird, die die Wirkung hat, die schützende Kopfbedeckung und den Kopf zu drehen, sich die Haut (11; 30; 40; 50) streckt, um eine Relativbewegung zwischen der Haut (11; 30; 40; 50) und dem Rest der Kopfbedeckung zu erlauben, und hierdurch im Vorsehen einer Schutzbewegung eine menschliche Kopfhaut nachahmt.

33. Verfahren nach Anspruch 32, wobei die Haut (30; 40) am Rest der Kopfbedeckung nur über ein elastisches Zwischenelement (60; 61) angebracht wird, das dehnbarer ist als die Haut (30; 40).
34. Verfahren zum Modifizieren eines vorhandenen Schutzschields, wobei eine komprimierbare elastische Haut (103), deren Dicke nicht größer ist als das vorhandene Schutzschild, an dem Rest des Schields so angebracht wird, daß sie zumindest auf einem Abschnitt der ursprünglichen Außenfläche des Schutzschields aufliegt, um eine neue Außenfläche des Schutzschields vorzusehen, wobei die Haut (103) nur entlang einem Rand des Schields am Rest des Schields fest angebracht wird, so daß, wenn auf die Außenfläche der Haut (103) eine Kraft ausgeübt wird, die eine zur Haut (103) tangentielle Komponente aufweist, sich die Haut (103) strecken kann, um eine Relativbewegung zwischen der Haut (103) und dem Rest des Schutzschields zu erlauben, wobei das Verfahren den Schritt beinhaltet, den Schild mit Mitteln (105) zu versehen, um die Relativbewegung durch Mindern des Reibungswiderstands der Relativbewegung zu erleichtern. 20
35. Verfahren nach Anspruch 34, wobei die Haut (103) an dem ursprünglichen Schutzschild nur über ein elastisches Zwischenelement (104) angebracht wird, das dehnbarer ist als die Haut (103). 35

## Revendications

1. Casque de protection, comprenant :  
 une coque dure (10 ; 31 ; 41 ; 51) comportant une surface donnant vers l'intérieur qui, à l'utilisation, donne sur la tête d'un utilisateur du casque et une surface donnant vers l'extérieur qui, à l'utilisation, donne loin de la tête de l'utilisateur,  
 une membrane externe (11 ; 30 ; 40 ; 50) d'une épaisseur qui n'est pas supérieure au reste du casque qui recouvre au moins une portion de la surface donnant vers l'extérieur de la coque (10 ; 31 ; 41 ; 51), dans lequel :  
 la membrane externe (11 ; 30 ; 40 ; 50) est reliée fixement au reste du casque uniquement le long d'un bord inférieur de la coque dure (10 ; 31 ; 41 ; 51) de manière que la membrane externe (11 ; 30 ; 40 ; 50) puisse se déplacer relativement à la coque 55

dure (10 ; 31 ; 41 ; 51) lorsqu'une force est appliquée sur une surface externe du casque qui a pour effet de faire tourner le casque et la tête de l'utilisateur, caractérisé en ce que :

la membrane externe (11 ; 30 ; 40 ; 50) est compressible et élastique et plus flexible que la coque dure (10 ; 31 ; 41 ; 51) et la membrane externe (11 ; 30 ; 40 ; 50) peut se comprimer en réponse à la force appliquée sur le casque et la membrane externe (11 ; 30 ; 40 ; 50) s'étire lorsque ladite force de rotation est appliquée sur le casque pour permettre un mouvement relatif entre la membrane (11 ; 30 ; 40 ; 50) et la coque dure (10 ; 31 ; 41 ; 51) et peut donc imiter le cuir chevelu d'un être humain dans son mouvement protecteur.

2. Casque de protection selon la revendication 1, dans lequel la membrane externe (30 ; 40) est reliée au reste du casque uniquement via un organe intermédiaire élastique (60 ; 61).
3. Casque de protection selon la revendication 2, dans lequel l'organe intermédiaire élastique (60 ; 61) se déforme davantage que la membrane externe (30 ; 40).
4. Casque de protection selon l'une quelconque des revendications précédentes, dans lequel la membrane (11 ; 30 ; 40 ; 50) comprend un chlorure de polyvinyle plastifié à alvéoles fermés.
5. Casque de protection selon l'une quelconque des revendications 1 à 4, dans lequel la membrane (11 ; 30 ; 40 ; 50) comprend un polyéthylène.
6. Casque de protection selon l'une quelconque des revendications 1 à 4, dans lequel la membrane (11 ; 30 ; 40 ; 50) comprend des copolymères éthylène/acétate de vinyle.
7. Casque de protection selon l'une quelconque des revendications précédentes, dans lequel la coque dure (10 ; 31 ; 41 ; 51) comprend un matériau composite de fibre de carbone.
8. Casque de protection selon l'une quelconque des revendications précédentes, comprenant également une couche (13) de fluide incompressible située, à l'utilisation, entre la coque (10) et la tête de l'utilisateur et encapsulée dans un sac flexible (13).
9. Casque de protection selon la revendication 8, dans lequel le sac flexible (13) contenant le fluide incompressible est compartimenté en une pluralité de compartiments et le sac flexible (13) comprend un moyen de connexion reliant chaque compartiment à au moins un autre compartiment, le moyen de connexion servant à empêcher un écoulement de

fluide d'un compartiment à un autre jusqu'à ce qu'un impact sur le casque de protection excède une valeur seuil, auquel moment le moyen de connexion permet un écoulement de fluide entre les compartiments.

10. Casque de protection selon la revendication 9, dans lequel le fluide incompressible est un fluide qui résiste à un écoulement entre les compartiments afin d'amortir le mouvement de la coque (10).
11. Casque de protection selon l'une quelconque des revendications précédentes, comprenant également une couche de mousse à faible densité (19 ; 20 ; 21 ; 22 ; 23 ; 24) située, à l'utilisation, entre la coque (10) et la tête de l'utilisateur.
12. Casque de protection selon l'une quelconque des revendications précédentes, comprenant une couche intermédiaire (12 ; 32 ; 42) disposée entre la coque (10 ; 31 ; 41) et la membrane (11 ; 30 ; 40), la couche intermédiaire (12 ; 32 ; 42) facilitant un mouvement relatif entre la membrane (11 ; 30 ; 40) et la coque (10 ; 31 ; 41).
13. Casque de protection selon la revendication 12, dans lequel la couche intermédiaire (12 ; 32) est une couche de matériau lubrifiant.
14. Casque de protection selon la revendication 12, dans lequel la couche intermédiaire (42) comporte une première surface qui peut buter contre la membrane (40) et une deuxième surface qui peut buter contre la coque (41) et les première et deuxième surfaces ont chacune un faible coefficient de friction.
15. Casque de protection selon l'une quelconque des revendications précédentes, dans lequel la membrane (11 ; 30 ; 40 ; 50) recouvre la totalité de la surface donnant vers l'extérieur de la coque (10 ; 31 ; 41 ; 51).
16. Casque de protection selon l'une quelconque des revendications précédentes, dans lequel la membrane (11 ; 30 ; 40 ; 50) est imperméable à l'humidité.
17. Casque de protection selon l'une quelconque des revendications 1 à 15, comprenant également un revêtement externe résistant à l'humidité recouvrant la membrane (11 ; 30 ; 40 ; 50).
18. Casque de protection selon l'une quelconque des revendications précédentes, comprenant également un moyen de protection acoustique.
19. Casque de protection selon l'une quelconque des

revendications précédentes, comprenant également un moyen d'amélioration et de protection de la vue.

**20.** Casque de protection selon l'une quelconque des revendications précédentes, comprenant également un moyen de ventilation. 5

**21.** Casque de protection selon l'une quelconque des revendications précédentes, comprenant des première et deuxième brides de fixation (17, 18) pour fixer le casque sur la tête de l'utilisateur, la première bride (17) permettant une retenue au menton et la deuxième bride (18) permettant une retenue à l'occiput. 10 15

**22.** Plastron de protection comprenant :

une première couche de matériau (102) d'une première flexibilité comportant une première surface (102A) qui, à l'utilisation, est destinée à recevoir des impacts, et 20

une membrane élastique compressible (103) d'une épaisseur qui n'est pas supérieure au reste du plastron de protection qui recouvre au moins une portion de la première surface (102A) de la première couche (102) et qui est plus flexible que la première couche de matériau (102) et qui peut se déplacer relativement à la première couche de matériau (102), caractérisé en ce que : 25 30

la membrane (103) est reliée fixement à la première couche de matériau (102) uniquement le long d'un bord de la première couche de matériau (102) de manière que lorsqu'une force est appliquée sur une surface donnant vers l'extérieur du plastron de protection qui a une composante tangentielle à la surface donnant vers l'extérieur, la membrane élastique compressible (103) s'étire pour permettre un mouvement relatif entre la membrane (103) et la première couche de matériau (102), et 35 40

le plastron de protection comprend un moyen (105) pour faciliter le mouvement relatif entre la membrane (103) et la première surface (102A) de la première couche de matériau (102) en diminuant la résistance de friction au mouvement relatif. 45

**23.** Plastron de protection selon la revendication 22, dans lequel la membrane (103) est reliée au reste du plastron de protection par un moyen de connexion élastique (104) qui peut s'étendre pour permettre un mouvement relatif entre la membrane (103) et la première couche (102). 50 55

**24.** Plastron de protection selon la revendication 22 ou la revendication 23, dans lequel la membrane (103)

comprend un chlorure de polyvinyle plastifié à alvéoles fermés.

**25.** Plastron de protection selon la revendication 22 ou la revendication 23, dans lequel la membrane (103) comprend un polyéthylène.

**26.** Plastron de protection selon la revendication 22 ou la revendication 23, dans lequel la membrane (103) comprend des copolymères éthylène/acétate de vinyle.

**27.** Plastron de protection selon l'une quelconque des revendications 22 à 26, dans lequel le moyen (105) facilitant le mouvement relatif entre la membrane (103) et la première surface (102A) de la première couche de matériau (102) comprend une couche (105) intermédiaire entre la première couche (102) et la membrane (103).

**28.** Plastron de protection selon la revendication 27, dans lequel la couche intermédiaire (105) comprend un matériau lubrifiant.

**29.** Plastron de protection selon la revendication 27, dans lequel la couche intermédiaire (105) comporte une première surface qui peut buter contre la membrane (103) et une deuxième surface qui peut buter contre la première surface (102A) de la première couche de matériau (102), les première et deuxième surfaces de la couche intermédiaire (105) ayant chacune un faible coefficient de friction.

**30.** Plastron de protection selon l'une quelconque des revendications 22 à 29, dans lequel la première couche de matériau (102) comprend un matériau composite de fibre de carbone.

**31.** Plastron de protection selon l'une quelconque des revendications 22 à 30 pour utilisation comme plastron pour le corps humain.

**32.** Procédé de modification de casque de protection existant, dans lequel une membrane élastique compressible (11 ; 30 ; 40 ; 50) d'une épaisseur qui n'est pas supérieure au casque de protection existant est fixée au reste du casque pour recouvrir au moins une portion de la surface externe originale du casque de protection afin d'obtenir une nouvelle surface externe pour le casque de protection, la membrane (11 ; 30 ; 40 ; 50) étant reliée fixement au reste du casque uniquement le long d'un bord inférieur du casque de manière que lorsqu'une force est appliquée sur la surface externe de la membrane qui a pour effet de faire tourner le casque de protection et la tête, la membrane (11 ; 30 ; 40 ; 50) s'étire pour permettre un mouvement relatif entre la membrane (11 ; 30 ; 40 ; 50) et le reste du casque et donc imite

le cuir chevelu d'un être humain dans son mouvement protecteur.

- 33.** Procédé selon la revendication 32, dans lequel la membrane (30 ; 40) est fixée au reste du casque uniquement via un organe intermédiaire élastique (60 ; 61) qui se déforme davantage que la membrane (30 ; 40). 5
- 34.** Procédé de modification de plastron de protection existant, dans lequel une membrane élastique compressible (103) d'une épaisseur qui n'est pas supérieure au plastron de protection existant est fixée au reste du plastron pour recouvrir au moins une portion de la surface externe originale du plastron de protection afin d'obtenir une nouvelle surface externe pour le plastron de protection, la membrane (103) étant reliée fixement au reste du plastron uniquement le long d'un bord du plastron de manière que lorsqu'une force est appliquée sur la surface externe de la membrane (103), qui a une composante tangentielle à la membrane (103), la membrane (103) peut s'étirer pour permettre un mouvement relatif entre la membrane (103) et le reste du plastron de protection, le procédé comprenant la phase consistant à doter le plastron d'un moyen (105) pour faciliter le mouvement relatif en diminuant la résistance de friction au mouvement relatif. 10 15 20 25
- 35.** Procédé selon la revendication 34, dans lequel la membrane (103) est fixée au plastron de protection original uniquement via un organe intermédiaire élastique (104) qui se déforme davantage que la membrane (103). 30

35

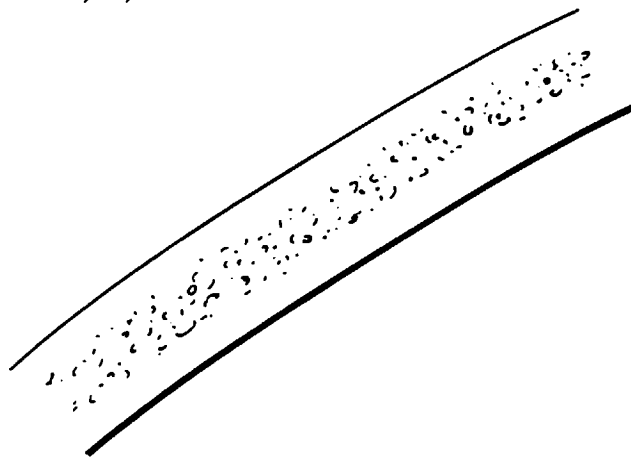
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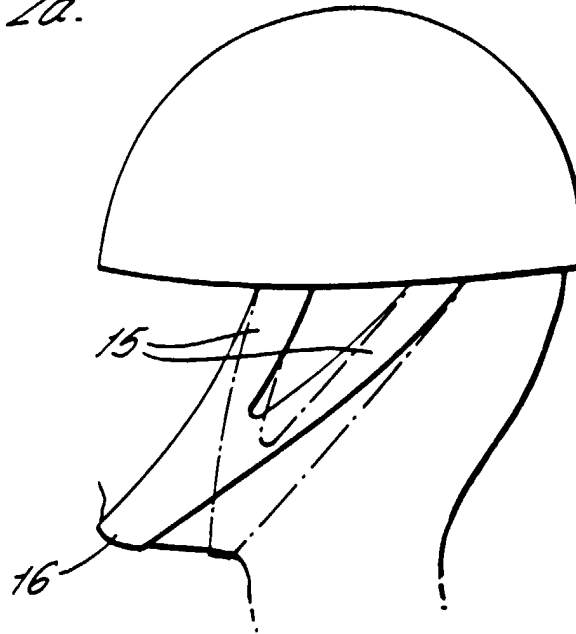
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*FIG. 1.*



*FIG. 2a.*



*FIG. 2b.*

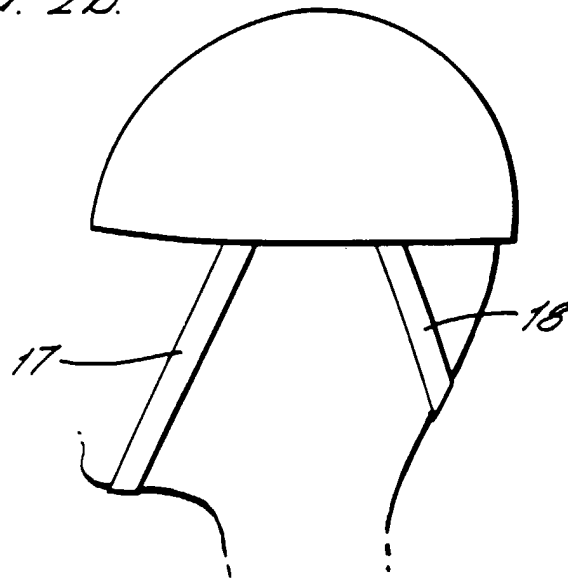


FIG. 3.

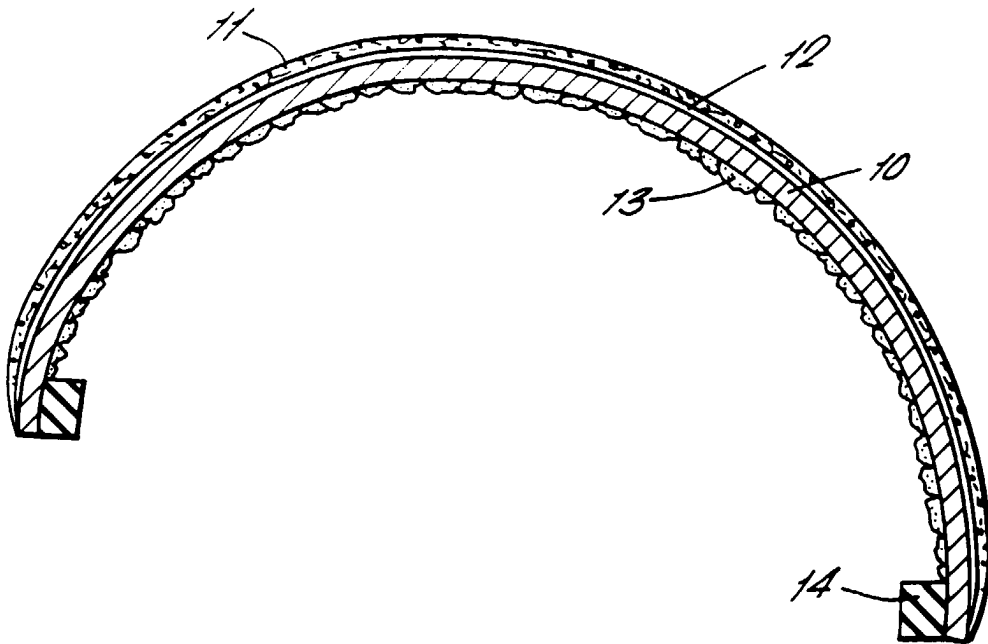




FIG. 4.

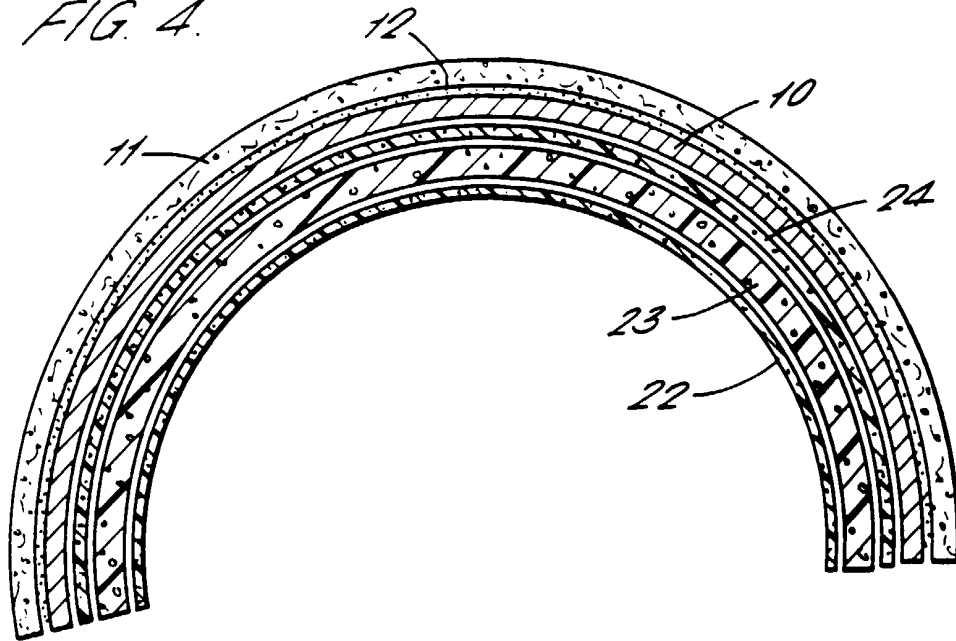
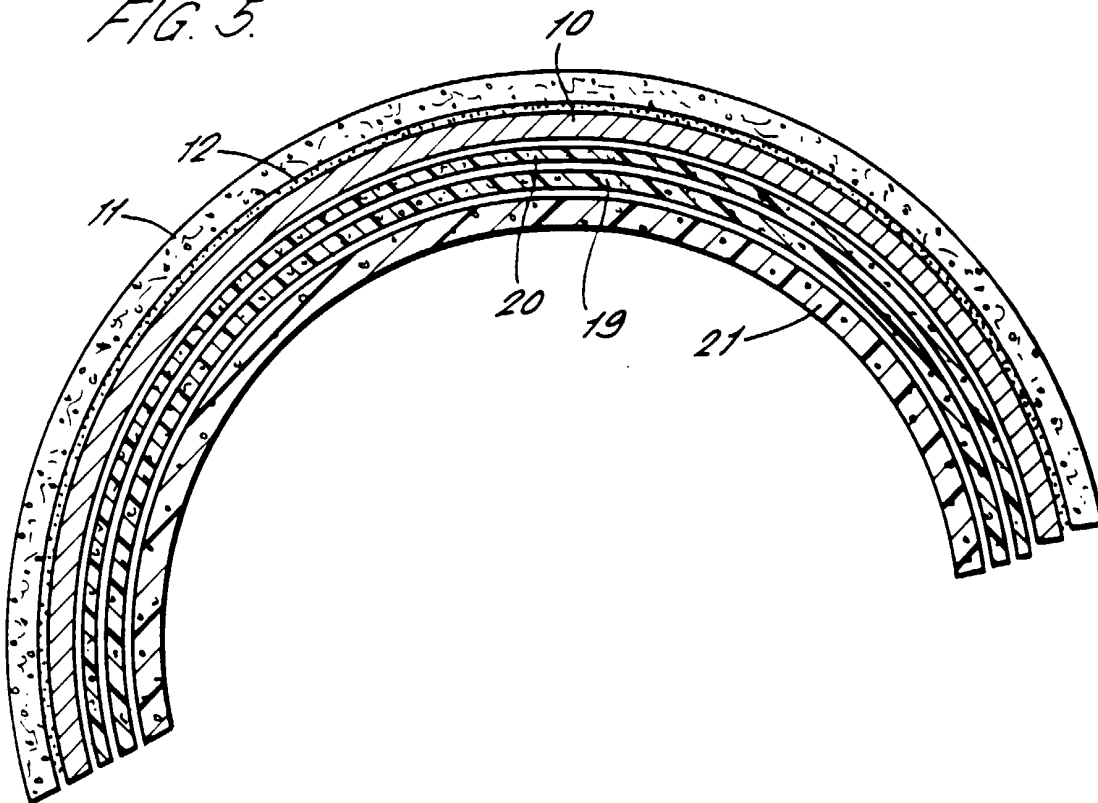


FIG. 5.



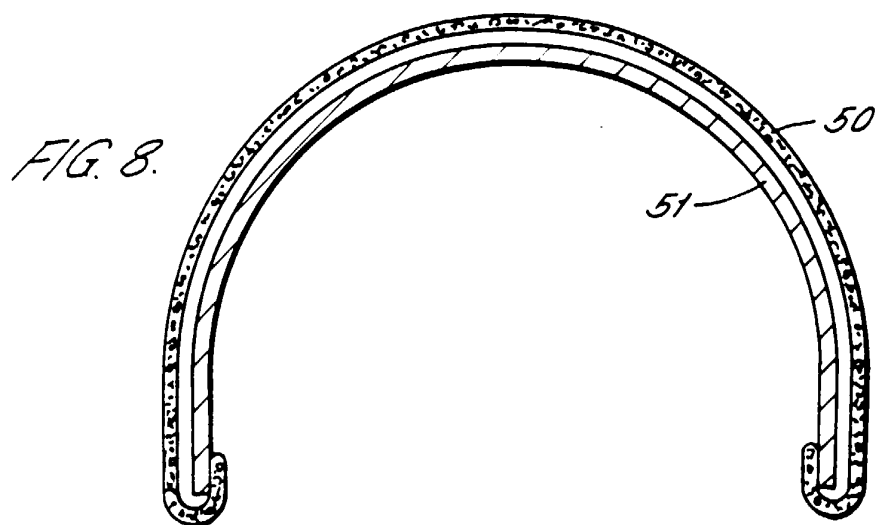
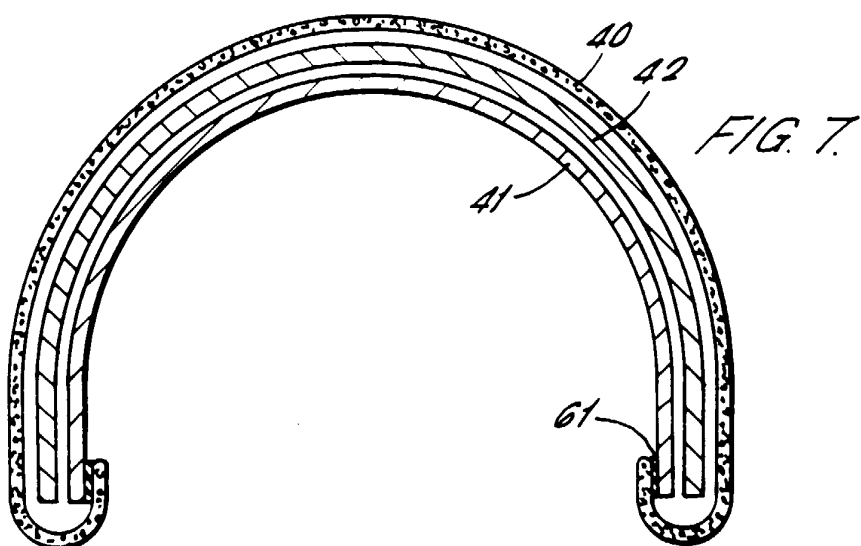
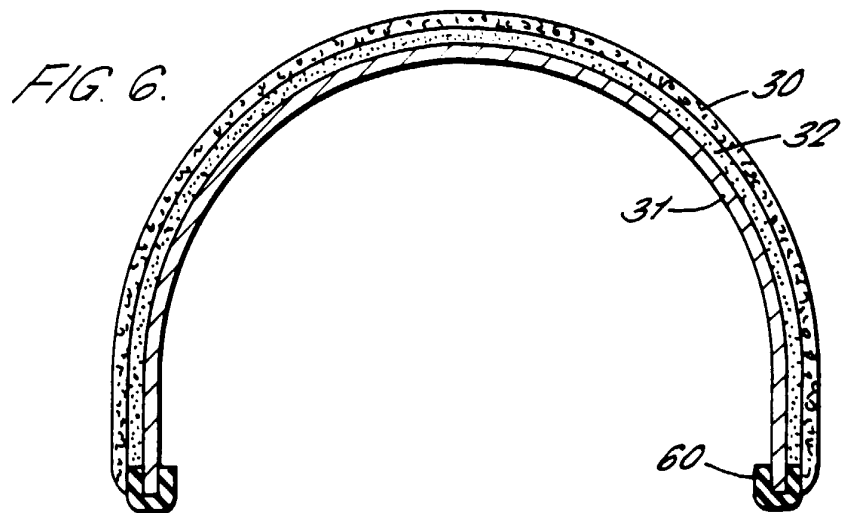


FIG. 9.

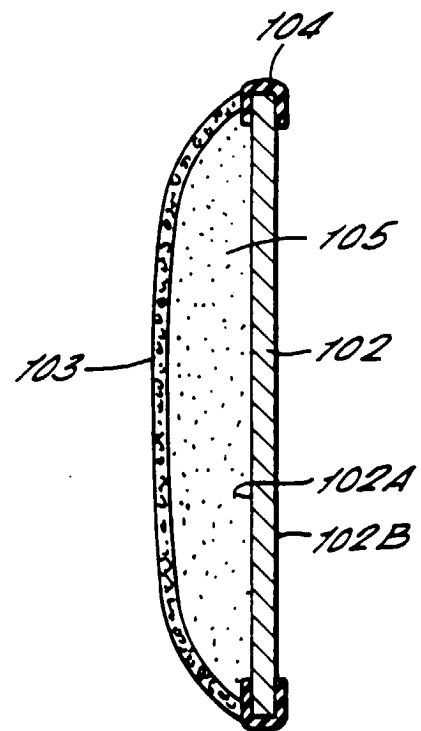
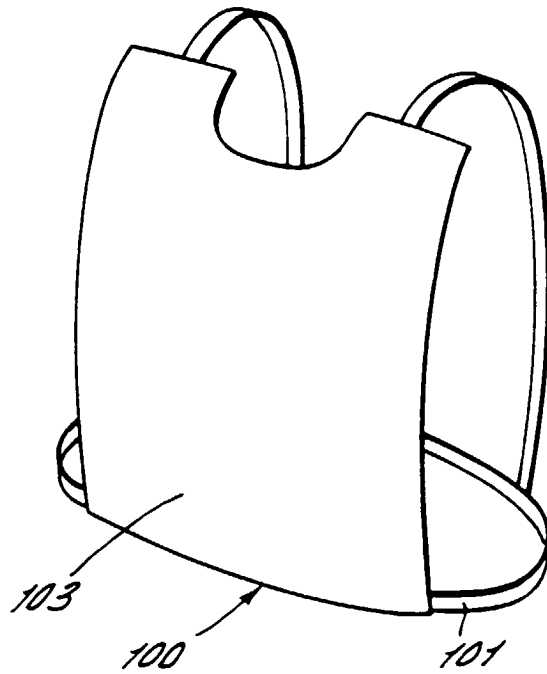


FIG. 10.