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(56) Documents Cited:
GB 2482866 A WO 2006/096941 A1
WO 1999/008557 A1 US 6367090 B1
US 6349416 B1 US 5012533 A

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(54) Title of the Invention: **A helmet**
Abstract Title: **Foldable Helmet**

(57) The helmet comprises a protective shell 10 formed of a flexible expanded polyurethane (EPU) material which defines a cavity to receive the wearers head. The shell is foldable and the helmet further comprises a strap arrangement 11 for fastening the shell to the wearers head. The shell may comprise a plurality of different layers of EPU if different densities or compositions. The shell may comprise of a plurality of fingers extending radially from a locus 18. The fingers may be arranged to have a central finger 12 and symmetrical middle 13L/R and side fingers 14L/R either side of it. The strap arrangement may comprise of a head strap 21, side strap and/or chin strap 20. The head strap may comprise of a first and second strap member 22A/B that may pass through an X shaped retainer 23 behind the wearers head.

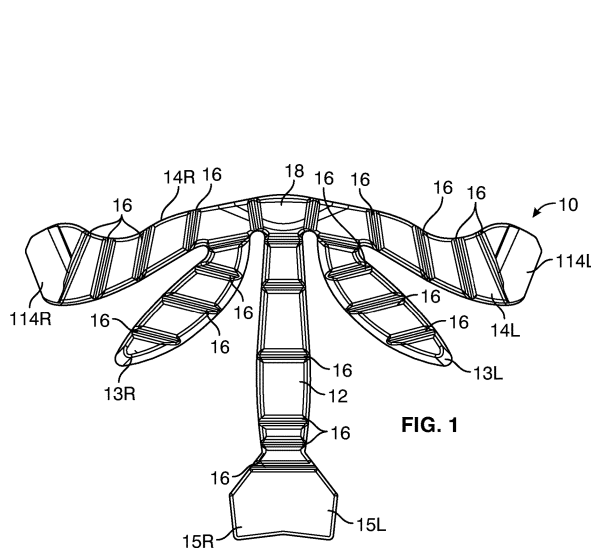


FIG. 1

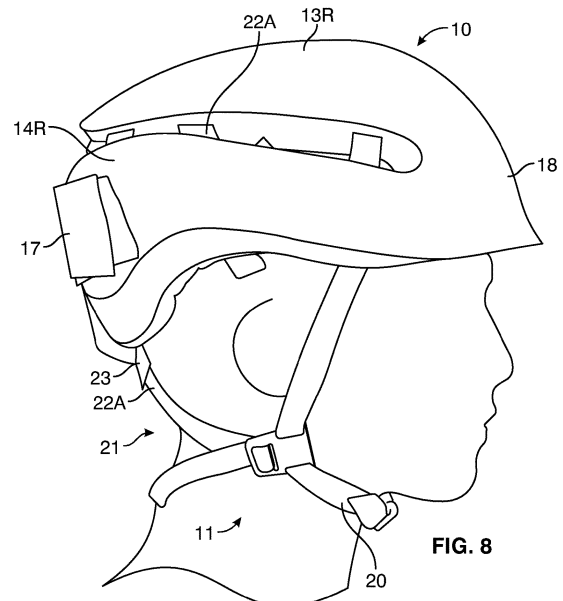
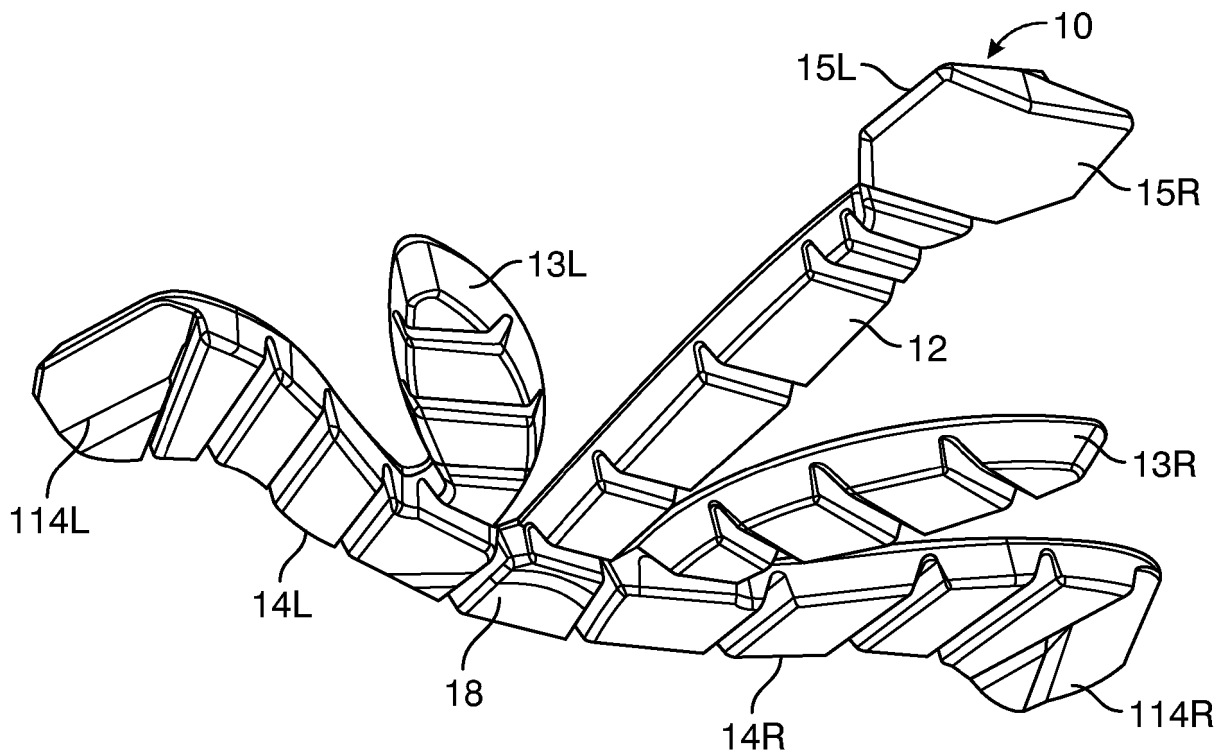
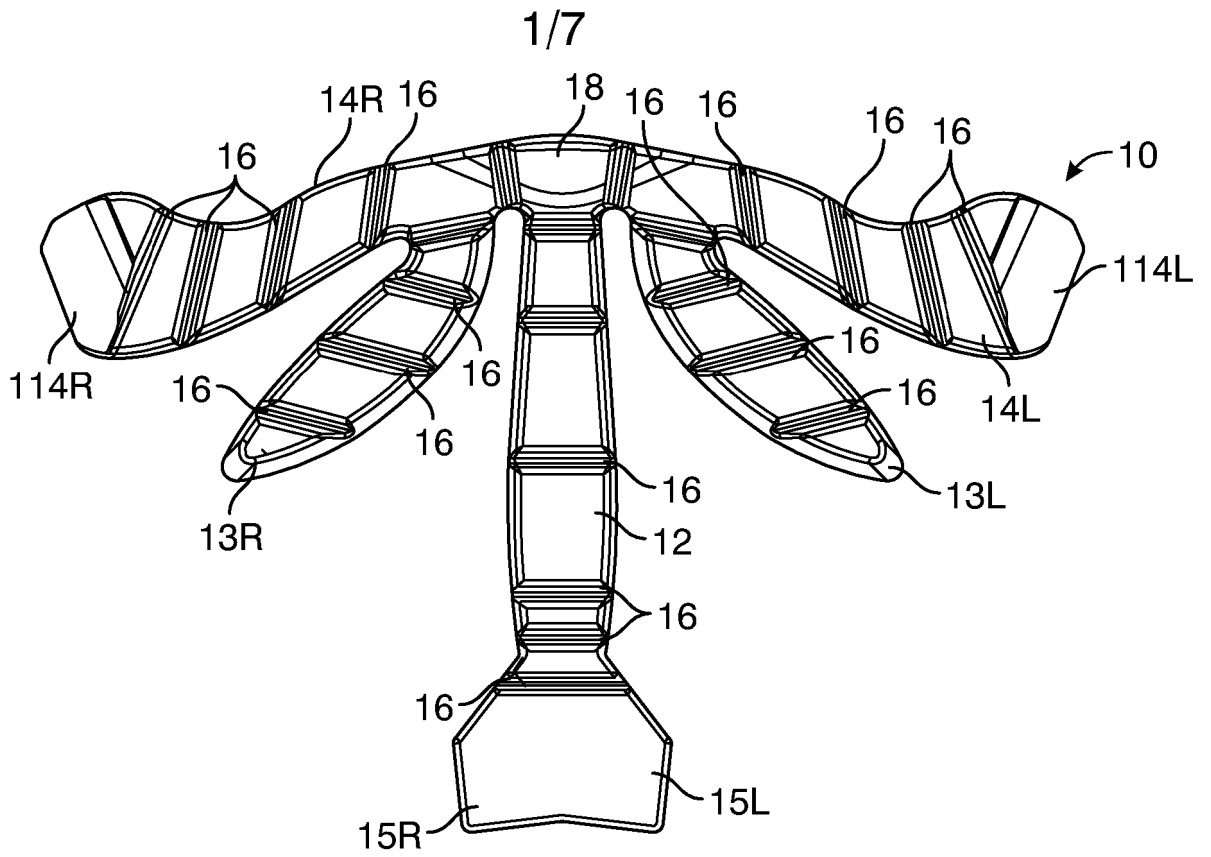


FIG. 8



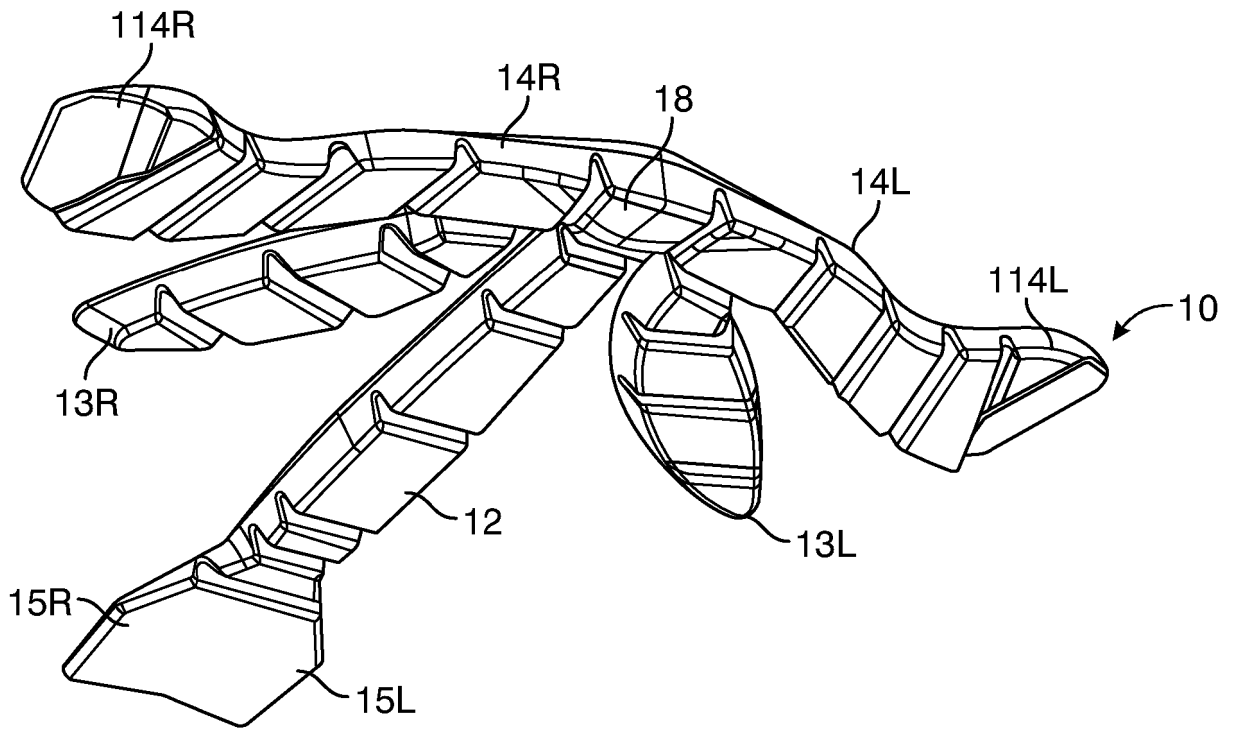


FIG. 3

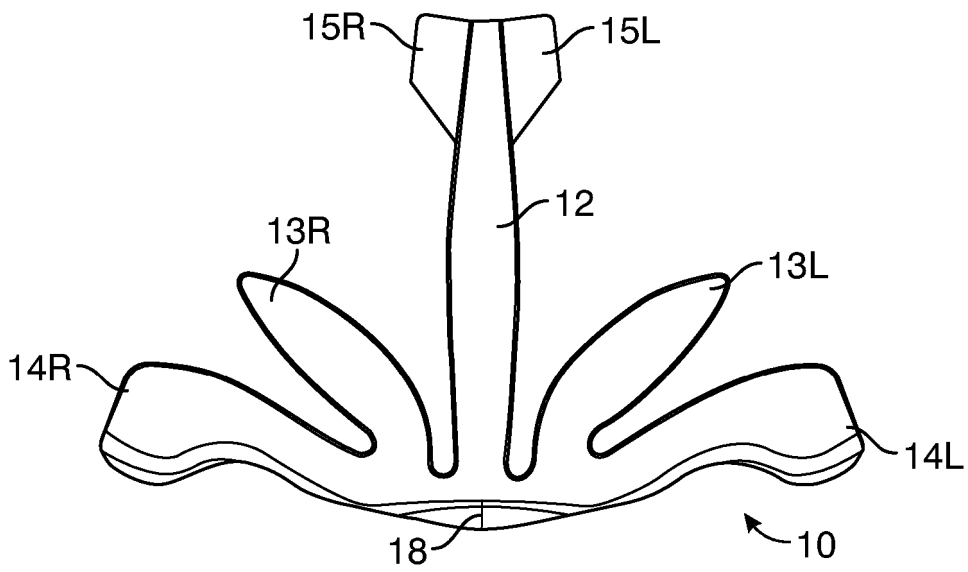


FIG. 4

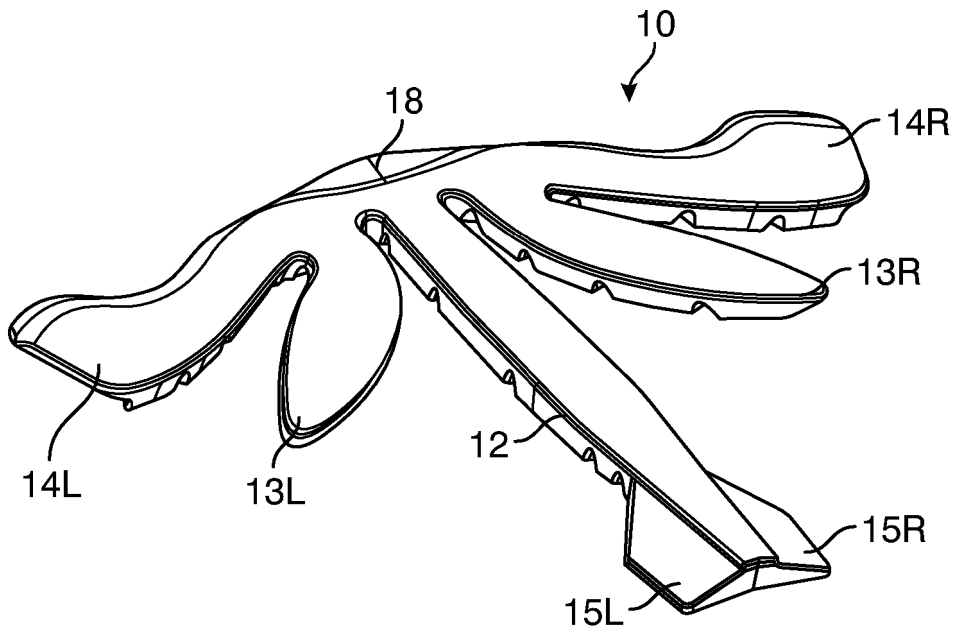


FIG. 5

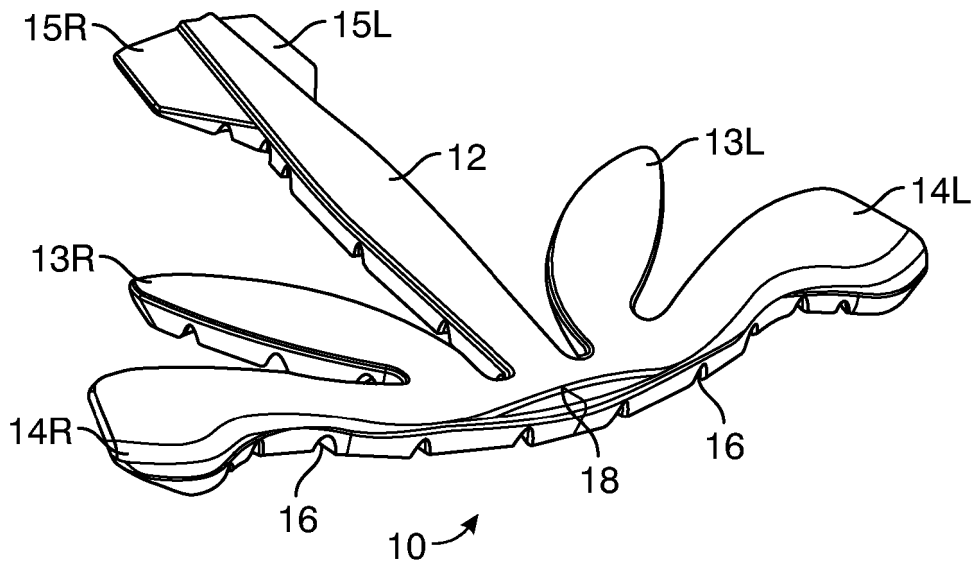


FIG. 6

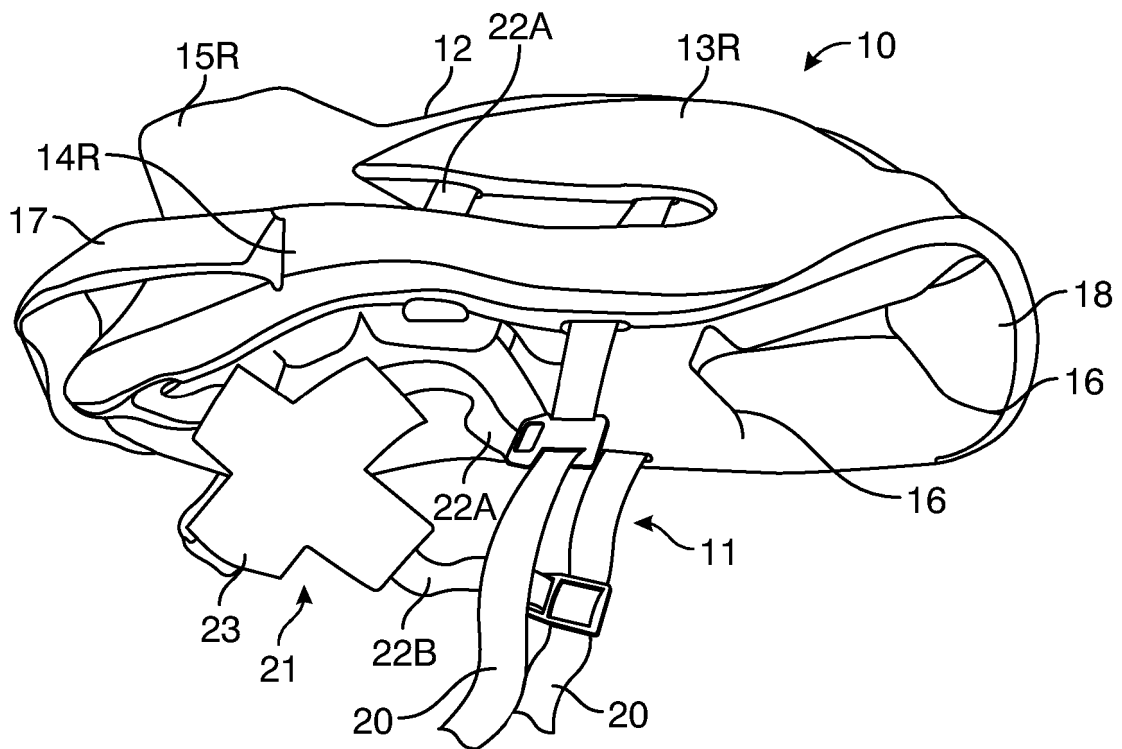


FIG. 7

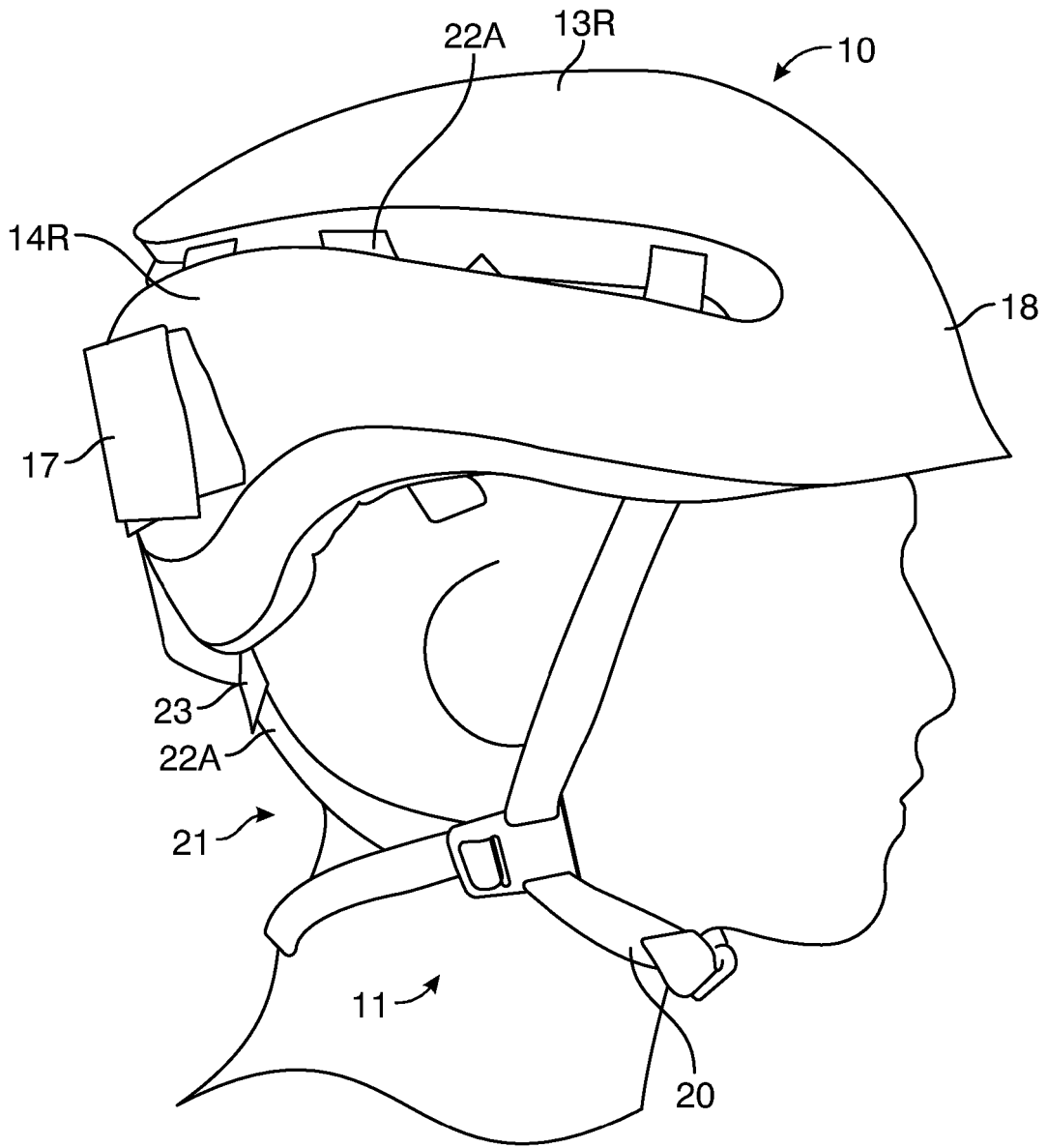


FIG. 8

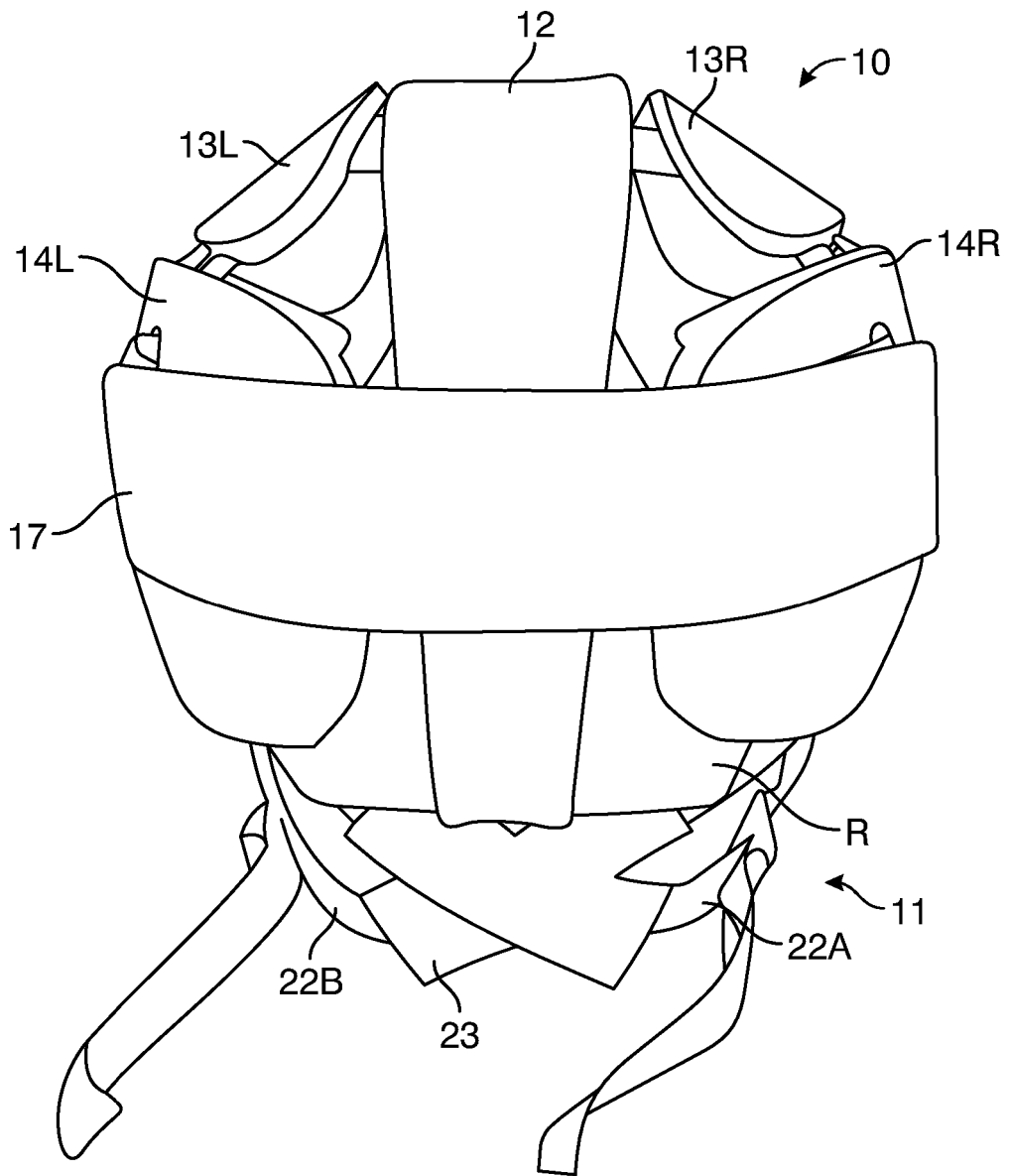


FIG. 9

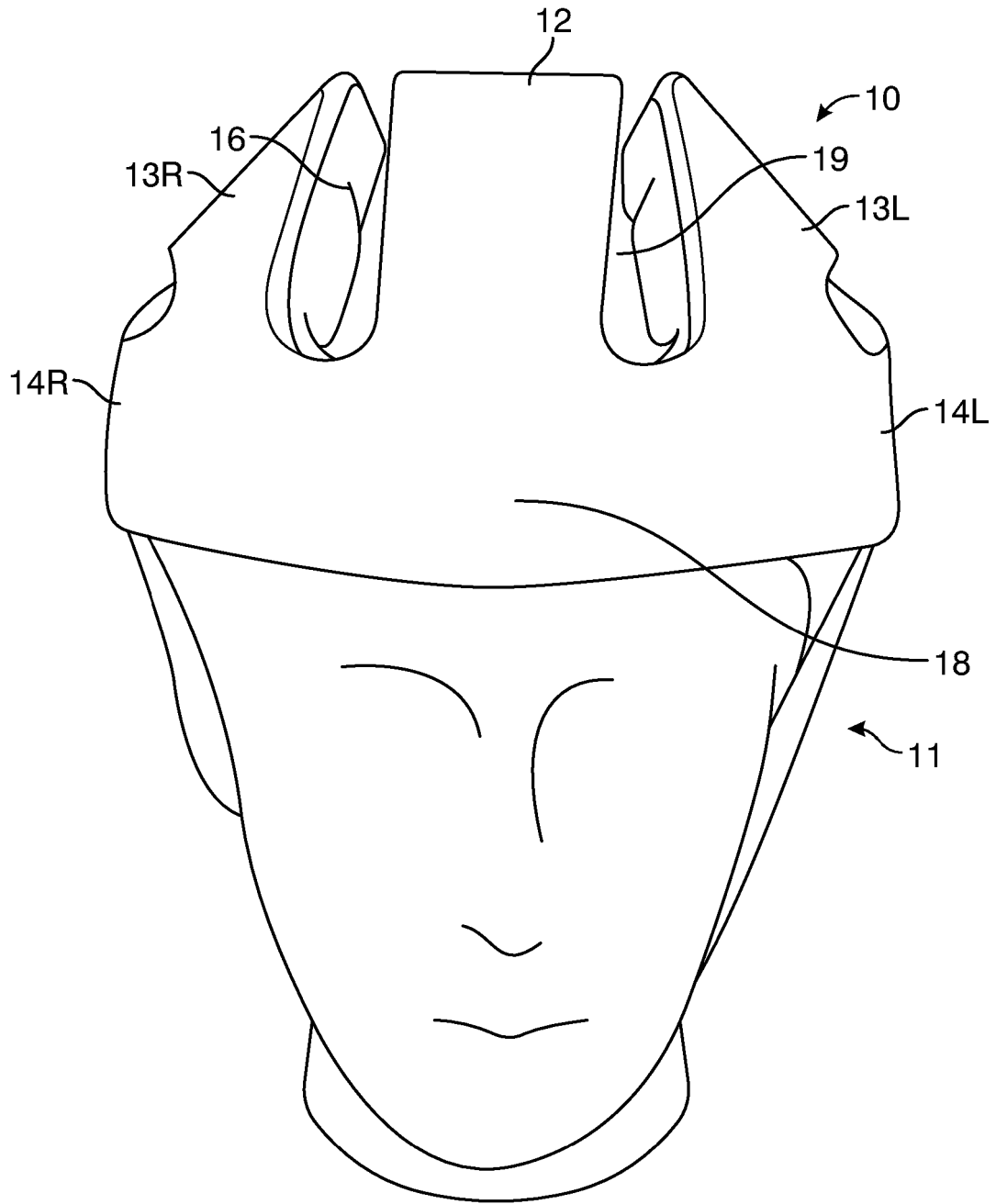


FIG. 10

A HELMET

This invention relates to a helmet and more particularly but not solely to a cycle helmet.

5 There is always the risk of sustaining a head impact whilst participating in sports and activities, such as cycling. Accordingly, the use of protective helmets is widespread to reduce the risk of serious brain injury or even death. Current understanding is that brain injuries in cycle accidents result from the high impact acceleration of the head making the soft brain material slump towards the impact. This creates damaging high pressure at the impact site, and crucially, causes high tearing tensions in the brain on
10 the opposite side from the impact.

More recent research is showing even worse damage can be caused by sudden head rotation, which creates shear stresses and internal tearing around the outside of the brain as its mass catches up with the head rotation.

15

An unprotected head hitting a hard, immovable object, such as another vehicle or the ground, will be forced to change velocity within a couple of millimetres. Most cycle helmet standards assume that a survivable deceleration force is below 250g and known helmets are designed such that the deceleration force in a 20kph impact will
20 be less than 250g if the head can travel at least 6.27mm as it decelerates. Hence, known cycle helmets are designed to do exactly this, by deforming more than 6.27mm under the force of the head decelerating, they provide a cushion that allows the head to travel further and therefore experience lower decelerations.

25 In practice the deceleration is not linear because standard impact absorbing foams increase in resistance the more they are compacted. Most helmet materials therefore need to be around 25mm thick to be able to absorb 12 – 15mm of head movement before the head comes to a complete stop, to achieve a peak acceleration below 250g.

30

Currently cycle helmets are formed of rigid materials, and usually comprise a liner of expanded polystyrene material and rigid shell of plastics material outside for durability and decoration. Expanded polystyrene is used for the liner because it is inexpensive, easy to mould and offers reasonable impact absorption over a wide
35 temperature range.

A problem with this type of helmet is that they are awkward items to carry or store. This is a problem for commuters or business people travelling by bicycle as it is difficult to fit the helmet into any kind of normal day time work bag. Another problem
5 is that it is difficult to make an expanded polystyrene helmet which comfortably fits a range of head shapes. This is mitigated with additional comfort pads or suspended internal adjustable straps.

A further problem is that whilst rigid, crushable liners of expanded polystyrene
10 provide reasonable energy absorption and protection from straight on high speed impacts, the helmets are permanently crushed by an impact and can therefore only provide adequate protection for one impact. Such helmets are also too rigid to provide much absorption at lower speed impacts, which occur more frequently and can still cause brain injuries. Such helmets are also unable to absorb rotational
15 accelerations from oblique impacts, now recognised as the more dangerous cause of serious brain injury.

A solution to these problems would be to make the helmet from a softer, more flexible material. However, the current cycle helmet safety standards, written to suit
20 the strengths of expanded polystyrene, include the requirement to carry out drop tests of helmets at extreme temperatures of -20°C to 50°C . This rules out many better alternatives, that nearly all fail the tests at the upper and lower temperature extremes.

25 With the above problems in mind, we have now devised an improved helmet.

In accordance with the present invention, as seen from a first aspect, there is provided a helmet comprising a protective shell formed of a flexible expanded polyurethane (EPU) material which defines a cavity for receiving the wearer's head,
30 the shell being foldable, the helmet further comprising a strap arrangement for fastening the shell to the wearer's head.

We have found that polyurethane is highly impact absorbent over a wide temperature range, whilst being softer than expanded polystyrene. The material is resiliently
35 flexible to allow the helmet to be folded into or out of shape yet is able to withstand

repeated impacts. When not in use, the helmet can be folded or compressed into a compact condition which enables the helmet to be easily carried, for example in a normal day time work bag.

5 Unlike expanded polystyrene, expanded polyurethane (EPU) material can withstand multiple impacts without significant loss of its impact absorbency. The helmet is thus ideal for children or sports persons, who are more likely to have numerous falls and accidents.

10 Expanded polyurethane (EPU) material, which is more flexible than expanded polystyrene, provides better low speed impact absorption than expanded polystyrene because it reduces accelerations which cause brain injuries.

An advantage of the helmet being flexible is that it can conform to shape and can
15 move around the head more in an oblique impact, potentially reducing the dangerous rotational acceleration on the head.

The shell may be moulded from expanded polyurethane (EPU) material in a flat form, which can then be folded into shape to define the cavity for receiving the wearer's
20 head.

The shell may comprise a plurality of different layers of expanded polyurethane (EPU) material having respective different densities or compositions to create improved impact protection. The outer layer of the shell may comprise an expanded
25 polyurethane (EPU) material which is denser than the inner layer(s) or may be unfoamed or may comprise a smooth skin on the outside to provide a flexible but rugged outer layer for the shell. The inner layer(s) of the shell may comprise an expanded polyurethane (EPU) material which is softer and thicker than the outer layer to provide a more comfortable inner layer.

30

The shell may comprise one or more layers of non-expanded polyurethane (EPU) material. The shell may comprise an inner layer of a non-expanded polyurethane (EPU) material. The shell may comprise an outer layer of non-expanded polyurethane (EPU) material. The shell may comprise both inner and outer layers of
35 non-expanded polyurethane (EPU) material. Additionally, it may be preferable for a

layer of the shell comprising non-expanded polyurethane (EPU) material to be sandwiched between other layers of the shell, where these other layers may be expanded polyurethane (EPU), non-expanded polyurethane, or a combination of the two.

5

The external layer of the shell may comprise a weather proof material. Such a weather proof material is preferably water resistant or, more preferably, completely impermeable. It may also be preferable for the external layer of the shell to comprise anti-bacterial, anti-microbial or similar properties. It may be preferable for the inner
10 layer of the shell to comprise anti-bacterial, anti-microbial or similar properties. It may be preferable for at least one layer of the shell to be treated with an anti-microbial treatment to obtain these properties.

Formations such as channels, cut outs or indents may be formed in the inner surface
15 of the shell to provide fold lines to enable the shell to be folded into a curved shaped by folding in certain directions in order to create the desired folded shape.

The shell may comprise a reinforcing material such as a woven polymer, glass, Kevlar or carbon fibre fabric. The material may be provided as a layer over the entire
20 shell or as one or more discrete regions.

The shell may comprise a plurality of fingers extending radially from a locus. In use the distal ends of the fingers are brought together to form a curved shell which defines the cavity for receiving the wearer's head. The locus of the fingers may form
25 the front of the helmet and a peak may be provided at the front of the helmet.

It may be preferable for at least one finger to contain at least one aperture, allowing the passage of air through the finger to provide ventilation to the user.

30 The shell may comprise a central finger and pair of side fingers extending symmetrically on respective opposite sides of the central finger. In use, the central finger extends over the top of the wearer's head and the side fingers extend around respective sides of the head.

The shell may comprise a pair of middle fingers extending symmetrically on respective opposite sides of the central finger between the latter and the respective side fingers.

- 5 The side fingers may be longer than the middle fingers, the side fingers forming the rim of the shell. The middle fingers are shorter than the central finger.

The distal ends of the side fingers may be detachably interconnected by a strap, for example comprising a hook-and-pile type fastening. The strap enables the diameter
10 of the shell to be adjusted to fit a wide range of head sizes. The strap may also engage the central finger. The strap may also comprise a ratchet mechanism. Any ratchet mechanism may be used as the sole means of adjusting the shell diameter, or in combination with a hook-and-pile type fastening, or in combination with another type of fastener.

15

The distal end of central finger may comprise a pair of wings which extend laterally in respective opposite directions, the thickness of the wings tapering inwardly towards their outer ends to form wedges, the distal ends of the side fingers being correspondingly tapered. In this way when the side fingers are pulled together by the
20 strap, the tapering forces the distal end of the central finger further forward, reducing the effective size of the helmet.

The strap arrangement may engage the middle and/or side fingers to hold them in-situ. The strap arrangement may comprise a side strap portion and/or a chin strap
25 portion which passes through passageways in the fingers to hold them in-situ. Alternatively, the side strap portion and/or the chin strap portion may pass over the middle finger.

The strap arrangement may engage the central finger to hold it in-situ. The strap
30 arrangement may comprise a top strap portion which passes over or through the central finger to bias the central finger downwardly.

The strap arrangement may comprise a chin strap which, in use, passes under the wearer's chin and a head strap which, in use, passes over and behind the wearer's
35 head, preferably through said passageways.

The head strap may comprise first and second head strap members having a first end secured to the shell at a respective side thereof, the straps extending upwardly and converging towards a first point at the central finger where they cross over each other, the straps then extending downwardly, rearwardly and inwardly to a point which, in use, is located behind the wearer's head where the straps cross, the second ends of the strap members being secured to respective sides of the chin strap.

10 The straps cross over each other behind the wearer's head under the wearer's occipital lobe, where they may pass through a former which defines passageways that cross over and hold the strap members in an X-shaped formation and provide greater comfort.

15 The strap arrangement securely holds the shell in situ and prevents it from slumping forwardly or rearwardly in the event of an accident.

The second ends of the strap members may be adjustably secured to respective sides of the chin strap of the assembly, and is preferably secured to the chin strap at a point which, in use, is located under the wearer's ears.

The first ends of the first and second head strap members may be secured to the respective side fingers of the shell at a point which, in use, is preferably located over or behind the wearer's ears.

25 The first and second strap members may provide said side strap portions which engage the middle fingers to hold them in-situ.

The first and second strap members may provide said top strap portion at said first point where they cross over.

30 It will be appreciated that the strap arrangement also has utility with other kinds of helmets in addition to the helmet of the present invention. Thus, in accordance with the present invention, as seen from a second aspect, there is provided a helmet comprising a protective shell and a strap arrangement for fastening the shell to the

wearer's head, the strap arrangement including a head strap comprising first and second head strap members having a first end secured to the shell at a respective side thereof, the straps extending upwardly and converging towards the central of the shell where they cross over each other, the straps then extending downwardly, rearwardly and inwardly to a point which, in use, is located behind the wearer's head where the straps cross, the second ends of the strap members being secured to respective sides of a chin strap of the assembly.

The second ends of the strap members may be adjustably secured to respective sides of a chin strap of the assembly.

The first and second strap members cross over each other behind the wearer's head under the wearer's occipital lobe, where they may pass through an X-shaped retainer to support the straps and to provide greater comfort.

An embodiment of the present invention will now be described by way of an example only and with reference to the accompanying drawings, in which:

Figure 1 is a bottom view of the shell of a foldable cycle helmet in accordance with the present invention, when in its unfolded and as-moulded configuration;

Figure 2 is perspective view from below and the rear of the shell of the helmet of Figure 1;

Figure 3 is perspective view from below and the front of the shell of the helmet of Figure 1;

Figure 4 is a top view of the shell of the helmet of Figure 1;

Figure 5 is perspective view from above and the rear of the shell of the helmet of Figure 1;

Figure 6 is perspective view from above and the front of the shell of the helmet of Figure 1;

Figure 7 is perspective view from below and the right side of the helmet of Figure 1, when in its folded condition;

Figure 8 is a right side view of the helmet of Figure 1, when in use;

5

Figure 9 is a rear view of the helmet of Figure 1, when in use; and

Figure 10 is a front view of the helmet of Figure 1, when in use.

10 Referring to the drawings there is shown a foldable cycle helmet comprising a shell 10 and strap arrangement 11. The shell 10 is formed of expanded polyurethane (EPU) material, for example by moulding. The shell 10 is preferably formed in a flat (unfolded) condition and may comprise a plurality of different layers (not shown) of expanded polyurethane (EPU) material having respective different densities or
15 compositions. The outer layer of the shell 10 may comprise an expanded polyurethane (EPU) material which is denser than the inner layer(s) or may be unfoamed or may comprise a smooth skin on the outside to provide a flexible but rugged outer layer for the shell 10. The inner layer(s) of the shell 10 may comprise an expanded polyurethane (EPU) material which is softer and thicker than the outer
20 layer to provide a more comfortable inner layer.

The shell 10 comprises a plurality of fingers extending radially from a locus 18. The fingers 13L, 13R, 14L, 14R are symmetrical about a central finger 12 and comprise a pair of middle fingers 13L, 13R extending symmetrically on respective opposite sides
25 of the central finger 12 between the latter and respective side fingers 14L, 14R. The side fingers 14L, 14R are longer than the middle fingers 13L, 13R. The middle fingers 13L, 13R are shorter than the central finger 12.

The distal end of central finger 12 comprises a pair of wings 15L, 15R which extend
30 laterally in respective opposite directions, the thickness of the wings 15L, 15R tapering inwardly towards their outer ends to form outwardly facing wedges, the distal ends of the side fingers 14L, 14R are correspondingly tapered to form inwardly facing wedges 114L, 114R.

V-shaped channels 16 are formed in the inner surface of the shell 10 to provide fold lines to enable the shell 10 to be folded into a curved shape by folding the distal ends of the fingers 12, 13L, 13R, 14L, 14R together to form a curved shell 10 which defines a cavity 16 for receiving the wearer's head. The distal ends of the side fingers 14L, 14R are detachably interconnected by a strap 17, for example comprising a hook-and-pile type fastening. The strap 17 enables the diameter of the shell 10 to be adjusted to fit a wide range of head sizes. When the side fingers 14L, 14R are pulled together by the strap 17, their tapered ends slide over the tapered wings 15L, 15R to force the distal end of the central finger 12 further forward, reducing the effective size of the helmet.

The locus 18 of the fingers form the front of the helmet, which may be provided with a peak (not shown). The strap 17 is disposed at the rear of the helmet.

The strap arrangement 11 comprises an adjustable chin strap 20 which, in use, passes under the wearer's chin and a head strap 21 which, in use, passes over and behind the wearer's head. The head strap 21 comprises first and second head strap members 22A, 22B each having a first end secured to respective side fingers 14L, 14R of the shell 10 at a point which, in use, is located over and behind the wearer's ears. The strap members 22A, 22B then extend upwardly and freely through respective channels formed in the distal ends of the middle fingers 13L, 13R to hold the middle fingers 13L, 13R in-situ. The strap members 22A, 22B then converge towards a point over the central finger 12 where they cross over each other, the strap members 22A, 22B then extending downwardly, rearwardly and inwardly to a point which, in use, is located behind the wearer's head where the strap members 22A, 22B cross. An X-shaped retainer 23 supports the strap members 22A, 22B where they cross and provides greater comfort. The second ends of the strap members 22A, 22B are then adjustably secured to respective sides of the chin strap 20.

The strap arrangement 11 securely holds the shell 10 in-situ on the wearer's head and prevents it from slumping forwardly or rearwardly in the event of an accident.

As shown in Figure 7, when not in use, the rear strap 17 can be loosened to allow the fingers to fold apart into a substantially flat condition, so that the helmet can easily be transported and stored.

A helmet in accordance with the present invention is simple and inexpensive in construction yet is foldable and is able to withstand repeated impacts.

CLAIMS

1. A helmet comprising a protective shell formed of a flexible expanded polyurethane (EPU) material which defines a cavity for receiving the wearer's head, the shell being foldable, the helmet further comprising a strap arrangement for fastening the shell to the wearer's head.
5
2. A helmet as claimed in claim 1, in which the shell is moulded from expanded polyurethane (EPU) material in a flat form, which can then be folded into shape to define the cavity for receiving the wearer's head.
10
3. A helmet as claimed in claims 1 or 2, in which the shell comprises a plurality of different layers of expanded polyurethane (EPU) material having respective different densities or compositions.
15
4. A helmet as claimed in claim 3, in which the outer layer of the shell comprises an expanded polyurethane (EPU) material which is denser than the inner layer(s).
20
5. A helmet as claimed in any of claims 1 to 3, in which the outer layer of the shell is un-foamed or comprises a smooth skin.
6. A helmet as claimed in any of claims 3 to 5, in which each inner layer of the shell comprise an expanded polyurethane (EPU) material which is softer and thicker than the outer layer.
25
7. A helmet as claimed in any of claims 1 to 6, in which the shell comprises at least one un-foamed layer
30
8. A helmet as claimed in any preceding claim, in which formations are formed in the inner surface of the shell to provide fold lines to enable the shell to be folded.
- 35 9. A helmet as claimed in any preceding claim, in which the shell comprises a reinforcing material contained within the expanded polyurethane (EPU) material.

10. A helmet as claimed in claim 9, in which the material is provided as a layer over the entire shell or as one or more discrete regions.
- 5 11. A helmet as claimed in any preceding claim, in which the shell comprises a plurality of fingers extending radially from a locus.
12. A helmet as claimed in claim 11, in which the distal ends of the fingers are arranged to be brought together to form a curved shell which defines the
10 cavity for receiving the wearer's head.
13. A helmet as claimed in claims 11 or 12, in which the shell comprises a central finger and pair of side fingers extending symmetrically on respective opposite sides of the central finger.
- 15 14. A helmet as claimed in claim 13, in which the shell comprises a pair of middle fingers extending symmetrically on respective opposite sides of the central finger between the latter and the respective side fingers.
- 20 15. A helmet as claimed in claim 14, in which the side fingers are longer than the middle fingers, the side fingers forming a rim of the shell.
16. A helmet as claimed in claim 14 or 15, in which the middle fingers are shorter than the central finger.
- 25 17. A helmet as claimed in any of claims 13 to 16, in which the distal ends of the side fingers are detachably interconnected by a strap.
- 30 18. A helmet as claimed in any of claims 13 to 17, in which the distal end of central finger comprises a pair of wings which extend laterally in respective opposite directions, the thickness of the wings tapering inwardly towards their outer ends to form wedges, the distal ends of the side fingers being correspondingly tapered.

19. A helmet as claimed in claim 14, in which the strap arrangement engages the middle fingers to hold them in-situ.
- 5 20. A helmet as claimed in claim 19, in which the strap arrangement comprises a side strap portion which passes over or through the middle fingers.
21. A helmet as claimed in claim 13, in which the strap arrangement engages the central finger to hold it in-situ.
- 10 22. A helmet as claimed in claim 21, in which the strap arrangement comprises a top strap portion which passes over or through the central finger to bias the central finger downwardly.
- 15 23. A helmet as claimed in any preceding claim, in which the strap arrangement comprises a chin strap which, in use, passes under the wearer's chin and a head strap which, in use, passes over and behind the wearer's head.
- 20 24. A helmet as claimed in claim 21, in which the head strap comprises first and second head strap members having a first end secured to the shell at a respective side thereof, the straps members extending upwardly and converging towards a first point at the central finger where they cross over each other, the straps members then extending downwardly, rearwardly and inwardly to a point which, in use, is located behind the wearer's head where the straps members cross, the second ends of the strap members being
- 25 secured to respective sides of the chin strap.
25. A helmet as claimed in claim 24, in which the strap members pass through an X-shaped retainer at the point where they cross behind the wearer's head.
- 30 26. A helmet as claimed in claim 24 or 25, in which the second ends of the strap members are adjustably secured to respective sides of the chin strap of the assembly.
- 35 27. A helmet as claimed in any of claims 24 to 26 as appended to claim 13, in which the first ends of the first and second head strap members are secured to the respective side fingers of the shell.

- 5 28. A helmet comprising a protective shell and a strap arrangement for fastening the shell to the wearer's head, the strap arrangement including a head strap comprising first and second head strap members which extend downwardly from the rear of the shell and converge to a point which, in use, is located behind the wearer's head where the straps cross, the strap members being secured to respective sides of a chin strap of the assembly.
- 10 29. A helmet as claimed in claim 28, in which the strap members are adjustably secured to respective sides of a chin strap of the assembly.
- 15 30. A helmet as claimed in claim 28 or 29, in which the strap members pass through a retainer at the point where they cross behind the wearer's head.
- 20 31. A helmet as claimed in any of claims 28 to 30, in which the straps have a first end secured to the shell at a respective side thereof, the straps extending upwardly and converging towards the central of the shell where they cross over each other, the straps then extending downwardly from the rear of the shell and converge to said point behind the wearer's head, the strap members having second ends which are secured to respective sides of the chin strap of the assembly.
- 25 32. A helmet substantially as herein described with reference to the accompanying drawings.



Application No: GB1611751.7

Examiner: Mr Tony Judge

Claims searched: 1-32

Date of search: 9 December 2016

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

| Category | Relevant to claims | Identity of document and passage or figure of particular relevance |
|----------|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| X | 1-23 | US6367090 B1 (IM) Please see figures and column 2, lines 24-36; column 3, lines 55-65; column 4, lines 1-24 and 56-65; column 5, lines 6-53 and column 6, lines 5-28. |
| X | 1, 2, 8-11, 13, 17, 18 and 21-23 | US5012533 A (RAFFLER) Please see figure 5 and column 1, line 60- column 2, line 2; column 2, lines 20-35, 45-56 and 61-68 and column 4, lines 17-32. |
| X | 1-3, 8-13, 17, 18, 21 and 22 | WO2006/096941 A1 (ZLATKO) Please see figures 5 and 6 and page 5, lines 13-15; page 10, lines 20-32; page 11, lines 1-3 and 15-25; page 14, lines 15-20 and page 15, lines 5-6. |
| X | 1, 2, 8 and 11-22 | US6349416 B1 (LAMPE et al) Please see figures 26-29; column 2, lines 30-50; column 6, lines 36-49 and column 7, lines 14-25 and 40-47. |
| X | 1-7, 11-13, 17, 18, 21 and 22 | GB2482866 A (NEOPHITOU) Please see figures; page 1, paragraph 3; page 2, paragraph 2; page 3, paragraph 5 and page 7, paragraph 2. |
| X | 1-3, 5-13, 17, 18 and 21-23 | WO99/08557 A1 (PELLEGRINI) Please see figures and page 3. |

Categories:

| | | | |
|---|-----------------------------------------------------------------------------------------------------------|---|------------------------------------------------------------------------------------------------------------------|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
| Y | Document indicating lack of inventive step if combined with one or more other documents of same category. | P | Document published on or after the declared priority date but before the filing date of this invention. |
| & | Member of the same patent family | E | Patent document published on or after, but with priority date earlier than, the filing date of this application. |

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^X :

Worldwide search of patent documents classified in the following areas of the IPC

A42B

The following online and other databases have been used in the preparation of this search report



WPI, EPODOC

International Classification:

| Subclass | Subgroup | Valid From |
|-----------------|-----------------|-------------------|
| A42B | 0003/32 | 01/01/2006 |
| A42B | 0003/00 | 01/01/2006 |
| A42B | 0003/06 | 01/01/2006 |