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(54) FLEXIBLE MULTI-LAYER HELMET

MEHRSCHICHTIGER FLEXIBLER HELM

CASQUE FLEXIBLE À PLUSIEURS COUCHES

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Description

TECHNICAL FIELD

[0001] Aspects of this document relate generally to helmets including multi-layer designs for improved energy management and methods for making the same. Helmets can be used in any application where providing protection to a user's head is desirable, such as, for example, use in motor sports, cycling, football, hockey, or climbing.

BACKGROUND

[0002] FIG. 1 illustrates a cross-sectional side view of a conventional helmet 10 that comprises an outer shell 12 and a single layer of energy-absorbing material 14. The helmet 10 can be an in-molded helmet for cycling and a hard shell helmet for powersports. The single layer of energy-absorbing material 14 is formed of a relatively rigid single or dual density monolithic material 16, such as expanded polystyrene (EPS). The monolithic rigid design of helmet 10 provides energy dissipation upon impact through deformation of the single layer of energy-absorbing material 14, which does not allow for flex or movement of the helmet 10. A contour of an inner surface 18 of the helmet 10 comprises a generic or standardized surface of a fixed proportion, such as a smooth and symmetrical topography that does not closely align or conform to the proportions and contours of a head 20 of the person wearing the helmet 10. Because heads include different proportions, smoothness, and degrees of symmetry, any given head 20 will include differences from the inner surface 18 of a conventional helmet 10, which can result in pressure points and a gap or gaps 22 between inner surface 18 of helmet 10 and the wearer's head 20. Due to the gaps 22, the wearer may experience shifting and movement of the helmet 10 relative to his head 20, and additional padding or a comfort material might be added between the inner surface 18 of the helmet 10 and the users head 20 to fill the gap 22, and reduce movement and vibration.
US2010299813-A1 discloses a helmet padding including a multi-layered liner including an innermost layer consisting of a comfort liner designed to engage the head of the user, and having an outer surface covered by an inner surface of a relatively low density foam layer. The relatively low density foam layer consists of a first region of relatively uniform thickness with an outer area from which a multiplicity of protuberances extend radially outwardly. The radially outward layer of the inventive padding consists of a layer of relatively high density foam. The outer layer includes a plurality of recesses corresponding to the protuberances of the inner layer and sized to snugly receive the conical protuberances therewithin. The outer surface of the outer foam layer is shaped and configured to engage the outer shell of a helmet in which it is installed.
US2004250340-A1 discloses a protective headguard comprising overlapped inner and outer layers attached so as to permit frictional sliding of at least one area of the outer layer over the inner layer.
EP1388300-A2 discloses a head protecting body for a safety helmet, in which a first liner member for an impact-on-the-head absorbing liner includes a swell for reinforcing at least one region of a forehead region, a left temple region, a right temple region and an occiput region in an overlapping region with respect to a second liner member having a density lower than that of the first liner member, on an overlapping surface side of the first liner member, and the second liner member includes a hollow having a shape substantially corresponding to the swell. According to this head protecting body, despite that the impact-on-the-head absorbing liner is not broken easily more than necessary near a region reinforced with the reinforcing swell, both the maximum acceleration during impact and an HIC can be decreased effectively.
EP1142495-A1 discloses that when shock acts on a helmet which a driver of a motorcycle or the like wears, rotational component as well as advancing component of the shock can be absorbed effectively. It provides a helmet with a shock absorbing liner fitted on an inner side of a shell, a layer of elastic body for absorbing shock having a component directed along an outer surface of the shell is provided between the shell and the shock absorbing liner or between an outer layer of the shock absorbing liner and an inner layer of the shock absorbing liner.
US2012060251-A1 discloses a protective helmet and a method for mitigating or preventing a head injury, in which a shock-absorbing, or shock-absorbing and comfort-providing, inner wearing unit, which can comprise liners, comfort pads, protective pads, nubbed cages and/or strapped wearing units (for example spider-shaped wearing elements, wearing straps, head bands or the like), is divided into a shell-side insert and a head-side insert, which can be counter-rotated (preferably starting from application of a predetermined force) in at least one direction, wherein a sliding surface is provided that assumes the function of a rotational surface, so that the angular acceleration introduced by a blow is drastically reduced or prevented because the head-side insert and the shell-side insert, and thus the head of the wearer and the outer helmet shell, can be counter-rotated quickly and without impediment, preferably in all directions.

SUMMARY

[0003] The present application provides a protective sports helmet in accordance with the claims which follow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The invention will hereinafter be described in conjunction with the appended drawings, where like designations denote like elements, and:

FIG. 1 is a cross-sectional view of a conventional helmet;

FIGs. 2A-2E show various views of a multi-layer helmet;

FIG. 3 is a cross-sectional view of an example of a multi-layer helmet not covered by the current invention;

FIGs. 4A-4C show various view of a layer from a multi-layer liner; and

FIG. 5 is a cross-sectional view of another embodiment of a multi-layer helmet.

DETAILED DESCRIPTION

[0005] This disclosure, its aspects and implementations, are not limited to the specific helmet or material types, or other system component examples, or methods disclosed herein. Many additional components, manufacturing and assembly procedures known in the art consistent with helmet manufacture are contemplated for use with particular implementations from this disclosure. Accordingly, for example, although particular implementations are disclosed, such implementations and implementing components may comprise any components, models, types, materials, versions, quantities, and/or the like as is known in the art for such systems and implementing components, consistent with the intended operation.

[0006] The word "exemplary," "example," or various forms thereof, are used herein to mean serving as an example, instance, or illustration. Any aspect or design described herein as "exemplary" or as an "example" is not necessarily to be construed as preferred or advantageous over other aspects or designs. Furthermore, examples are provided solely for purposes of clarity and understanding and are not meant to limit or restrict the disclosed subject matter or relevant portions of this disclosure in any manner. It is to be appreciated that a myriad of additional or alternate examples of varying scope could have been presented, but have been omitted for purposes of brevity.

[0007] While this disclosure includes of embodiments in many different forms, there is shown in the drawings and will herein be described in detail particular embodiments with the understanding that the present disclosure is to be considered as an exemplification of the principles of the disclosed methods and systems, and is not intended to limit the broad aspect of the disclosed concepts to the embodiments illustrated.

[0008] This disclosure provides a system and method for custom forming protective helmet for a wearer's head, such as a helmet for a cyclist, football player, hockey player, baseball player, lacrosse player, polo player, climber, auto racer, motorcycle rider, motocross racer, skier, snowboarder or other snow or water athlete, sky diver or any other athlete in a sport or other person who is in need of protective head gear. Each of these sports uses a helmet that includes either single or multi-impact rated protective material base that is typically, though not always, covered on the outside by a decorative cover and includes comfort material on at least portions of the inside, usually in the form of padding. Other industries also use protective headwear, such as a construction, soldier, fire fighter, pilot, or other worker in need of a safety helmet, where similar technologies and methods may also be applied.

[0009] FIG. 2A shows a perspective view of a helmet or multi-layer helmet 50. Multi-layer helmet 50 can be designed and used for cycling, power sports or motor sports, and for other applications to provide added comfort, functionality, and improved energy absorption with respect to the conventional helmets known in the prior art, such as helmet 10 shown in FIG. 1. As shown in FIG. 2A, helmet 50 can be configured as a full-face helmet, and is shown oriented top down with a visor 52 positioned at a lower edge of FIG. 2A. The helmet 50 comprises an outer shell 54 and a multi-layer liner 56.

[0010] Outer shell 54 can comprise a flexible, semi-flexible, or rigid material, and can comprise plastics, including ABS, polycarbonate, Kevlar, fiber materials including fiberglass or carbon fiber, or other suitable material. The outer shell 54 can be formed by stamping, thermoforming, injection molding, or other suitable process. While the outer shell 54 is, for convenience, referred to throughout this disclosure as an outer shell, "outer" is used to describe a relative position of the shell with respect to the multi-layer liner 56 and a user's head when the helmet 50 is worn by the user. Additional layers, liners, covers, or shells can be additionally formed outside of the outer shell 54 because the outer shell 54 can be, but does not need to be, the outermost layer of the helmet 50. Furthermore, in some embodiments outer shell 54 can be optional, and as such can be omitted from the helmet 50, such as for some cycling helmets.

[0011] Multi-layer liner 56 can comprise two or more layers, including three layers, four layers, or any number of layers. As a non-limiting example, FIG. 2A shows the multi-layer liner 56 comprising three layers: an outer-layer 58, a middle-layer 60, and an inner-layer 62. Other additional layers, such as a comfort liner layer 64 can also be included. FIG. 2A shows an optional comfort liner layer 64 disposed inside the multi-layer liner 56 and adjacent the inner-layer 62.

[0012] The layers within the multi-layer liner 56 of the helmet 50 can each comprise different material properties to respond to different types of impacts and different types of energy management. Different helmet properties, such as density, hardness, and flexibility, can be adjusted to accommodate different types of impacts and different types of energy management. A helmet can experience different types of impacts that vary in intensity, magnitude, and duration. In some cases, a helmet can be involved in low-energy impact, while in other instances, a helmet can be involved in a high-energy impact. Impacts can include any number of other medium-energy impacts that fall within a spectrum between the low-energy impacts and the high-energy impacts.

[0013] Conventional helmets with single layer liners, such as the helmet 10 from FIG. 1, comprise a single energy management layer that is used to mitigate all types of impacts through a standardized, single, or "one-size-fits-all" approach to energy management. By forming the helmet 50 with the multi-layer liner 56, the multiple layers within the multi-layer liner 56 can be specifically tailored to mitigate particular types of impacts, as described in greater detail below. Furthermore, multiple liner layers can provide boundary conditions at the interfaces of the multiple liner layers that also serve to deflect energy and beneficially manage energy dissipation at various conditions, including low-energy impacts, mid-energy impacts, and high-energy impacts. In some embodiments, multi-layer liner 56 can be formed with one or more slots, gaps, channels, or grooves 66 that can provide or form boundary conditions at the interface between multi-layer liner 56 and the air or other material that fills or occupies the slots 66. The boundary conditions created by slots 66 can serve to deflect energy and change energy propagation through the helmet to beneficially manage energy dissipation for a variety of impact conditions.

[0014] In the following paragraphs, a non-limiting example of the multi-layer liner 56 is described with respect to the outer-layer 58, the middle-layer 60, and the inner-layer 62, as shown, for example, in FIGs. 2A-2E. While the outer-layer 58 is described below as being adapted for high-energy impacts, the middle-layer 60 is described below as being adapted for low-energy impacts, and the inner-layer 62 is described as being adapted for mid-energy impacts, in other embodiments, the ordering or positioning of the various layers could be varied. For example, the outer-layer 58 can also be adapted for low-energy as well as for mid-energy impacts. Furthermore, the middle-layer 60 can be adapted for high-energy impacts as well as for mid-energy impacts. Similarly, the inner-layer 62 can be adapted for high-energy impacts as well as for low-energy impacts. Additionally, more than one layer can be directed to a same or similar type of energy management. For example, two layers of the multi-layer liner can be adapted for a same level of energy management, such as high-energy impacts, mid-energy impacts, or low-energy impacts.

[0015] According to one possible arrangement, the outer-layer 58 can be formed as a high-energy management material and can comprise a material that is harder, more dense, or both, than the other layers within the multi-layer liner 56. A material of the outer-layer 58 can comprise EPS, EPP, Vinyl Nitrile (VN), or other suitable material. In an embodiment, the outer-layer 58 can comprise a material with a density in a range of about 30-90 grams/liter (g/L), or about 40-70 grams/liter (g/L), or about 50-60 g/L. Alternatively, the outer-layer 58 can comprise a material with a density in a range of about 20-50 g/L. By forming the outer-layer 58 with a material that is denser than the other layers, including middle -layer 60 and inner-layer 62, the denser outer-layer 58 can manages high-energy impacts while being at a distance farther from the user's head. As such, less dense or lower-energy materials will be disposed closer to the user's head and will be more yielding, compliant, and forgiving with respect to the user's head during impacts. In an embodiment, the outer-layer 58 can comprise a thickness in a range of about 5-25 mm, or about 10-20 mm, or about 15 mm, or about 10-15 mm.

[0016] The middle-layer 60 is disposed or sandwiched between the outer-layer 58 and the inner-layer 62. The middle-layer 60 is formed of polyester, polyurethane, D30®, Poron® or an air bladder. The middle-layer 60 can comprise a density in a range of about 5-30 g/L, about 10-20 g/L, or about 15g/L. The middle-layer 60 can have a thickness less than a thickness of both the inner-layer 62 and outer-layer 58 (both separately and collectively). In an embodiment, the middle-layer 60 can comprise a thickness in a range of about 3-9 mm, or about 5-7 mm, or about 6mm, or about 4mm.

[0017] The inner-layer 62 can be formed as a medium-energy or mid-energy management material and can comprise a material that is softer, less dense, or both, than the material of other layers, including the outer-layer 58. For example, the inner-layer 62 can be made of an energy absorbing material such as EPS, EPP, VN, or other suitable material. In an embodiment, the inner-layer 62 can be made of EPS with a density in a range of about 20-40 g/L, about 25-35 g/L, or about 30g/L. Alternatively, the inner-layer 62 can be made of EPP with a density of about 30-50 g/L, or about 35-45 g/L, or about 20-40 g/L, or about 40 g/L. Alternatively, the inner-layer 62 can comprise a material with a density in a range of about 20-50 g/L. Forming the inner-layer 62 comprising a density within the ranges indicated above has, as part of multi-layer liner 56, provides better performance during mid-energy impact testing than conventional helmets and helmets without a inner-layer 62 or a mid-energy liner. By forming the inner-layer 62 as being less dense than the outer-layer 58 and more dense than the middle-layer 60, the inner-layer 62 as part of the multi-layer liner 56 can advantageously manage low-energy impacts. In an embodiment, the inner-layer 62 can comprise a thickness in a range of about 5-25 mm, 10-20 mm, or about 10-15 mm.

[0018] An overall or total thickness for the multi-layer liner 56 can comprise a thickness less than or equal to 50 mm, 48 mm, 45 mm, or 40 mm. In some embodiments, an overall thickness of the multi-layer liner 56 can be determined by dividing an available amount of space between the outer shell 54 and the desired position of an inner surface of helmet 50. The division of the overall thickness of multi-layer liner 56 can be accounted for by first allocating a thickness of the middle layer 60 to have a thickness in a range indicated above, such as about 6 mm or 4 mm. Second, a thickness of the outer-layer 58 and a thickness of the inner-layer 62 can be determined based on a material type, such as EPS or EPP as indicated above, and a desired thickness that will accommodate moldability and bead flow of the selected material for formation of the respective layers. A thickness of the outer-layer 58 and the inner-layer 62 can be a same or different thickness, and can be adjusted based on a specific need of a user or a sport specific application and probable impact types that correspond to, or involve, specific energy-levels or ranges.

[0019] A desired performance of multi-layer helmet 50 can be obtained by performance of individual layers specifically adapted for specific types of energy management, such as low-energy, mid-energy, and high-energy, as well as a cumulative of synergistic effect resulting from an interaction or interrelatedness of more than one layer. In some instances, the outer-layer 58 can be configured as described above and can account for a majority, or significant portion, of the energy management in high-energy impacts. In other instances, all of the layers of the multi-layer liner 56, such as the outer-liner 58, the middle-layer 60, and the inner-layer 62, all contribute significantly to energy management in high-energy impacts. In some instances, the middle-layer 60, including the middle-layer 60 formed of EPO, can be configured as described above and can account for a majority, or significant portion, of the energy management in low-energy impacts. In some instances, the inner-layer 62, including the inner-layer 62 formed of EPP or EPS, can be configured as described above and can account for a majority, or significant portion, of the energy management in mid-energy impacts. In other instances, the middle-layer 60 and the inner-layer 62 together, including layers of EPO and EPP, respectively, can be configured as described above, to account for a majority, or significant portion, of the energy management in mid-energy impacts. Or stated differently, a combination of layers comprising EPO and EPP, or other similar materials, can account for a majority, or significant portion, of the energy management in mid-energy impacts.

[0020] In an embodiment, the outer-layer 58 of the multi-layer liner 56 can comprise a high-energy management material comprising EPS with a density in a range of 20-50 g/L. The middle-layer 60 of the multi-layer liner 56 can comprise a mid-energy management material comprising EPP with a density in a range of 40-70 g/L. The inner-layer 62 of the multi-layer liner 56 can comprise a low-energy management material comprising EPO with a density in a range of 10-20 g/L.

[0021] FIG. 2B provides additional detail for an embodiment of multi-layer liner 56 comprising the outer-layer 58, the middle-layer 60, and the inner-layer 62. FIG. 2B provides a perspective view from below the inner surfaces of the outer-layer 58, the middle-layer 60, and the inner-layer 62 in which the of the outer-layer 58, the middle-layer 60, and the inner-layer 62 are disposed in a side-by-side arrangement. The side-by-side arrangement of the outer-layer 58, the middle-layer 60, and the inner-layer 62 is for clarity of illustration, and does not reflect the position or arrangement of the layers within the helmet 50 that will be assumed when the helmet 50 is in operation or ready to be worn by a user. When helmet 50 is worn, or in operation, the outer-layer 58, the middle-layer 60, and the inner-layer 62 are nested one within another, as shown in FIG. 2A.

[0022] At the left of FIG. 2B, outer-layer 58 is shown comprising an inner surface 51. Outer-layer 58 can be substantially solid, as shown, or alternatively, can comprise grooves, slots, or channels extending partially or completely through the outer-layer 58, as discussed in greater detail below with respect to FIG. 4A, to provide greater flexibility to the outer-layer 58. The inner surface 51 of outer-layer 58 can comprise a first movement limiter 55, disposed at a central portion of the inner surface 51. Similarly, at the right of FIG. 2B, the inner-layer 62 is shown comprising an outer surface 53. The inner-layer 62 can be substantially solid and can additionally comprise grooves, slots, or channels 66, as previously shown in FIG. 2A, that can extend partially or completely through the outer-layer 58. Advantages of slots or channels 66 are discussed in greater detail below, with respect to slots 90 and the flex of liner 88 in FIGs. 4A-4C. The outer surface 53 of inner-layer 62 can comprise a second movement limiter 57, disposed at a central portion of the outer surface 53.

[0023] The first movement limiter 55 and second movement limiter 57 can be formed as first and second molded contours, or integral pieces, of outer-layer 58 and inner layer-62, respectively. As a non-limiting example, the first movement limiter 55 can be formed as a recess, void, detent, channel, or groove as shown in FIG. 2B. A perimeter of first movement limiter 55 can comprise a periphery or outer edge 59 that is formed with a curved, squared, straight, undulating, or gear-shape pattern comprising a series or one or more sides, projections, tabs, flanges, protuberances, extensions, or knobs. The second movement limiter 57, can, without limitation, be formed as a projection, tab, flange, protuberance, extension, or knob. Similarly, a perimeter of the second movement limiter 57 can comprise a periphery or outer edge 61 that can be formed with a curved, squared, straight, undulating, or gear-shape pattern comprising a series or one or more sides, projections, tabs, flanges, protuberances, extensions, or knobs.

[0024] The first movement limiter 55 and second movement limiter 57 can be reverse images of one another, and can be mateably arranged so as to be interlocking one with the other. As shown in FIG. 2B, first movement limiter 55 is shown as a recess extending into inner surface 51 of outer-layer 58, and second movement limiter 57 is shown as a projection, extending away from outer surface 53 of inner-layer 62. In an alternative embodiment, the recess-and-projection configuration of the first movement limiter 55 and the second movement limiter 57 can be reversed so that the first movement limiter 55 is formed as a projection and the second movement limiter 57 is formed as a recess or indent. Relative movement, whether translational, rotational, or both, between the outer-layer 58 and the inner-layer 62 can be limited by direct contact, or indirect contact, between first movement limiter 55 and second movement limiter 57. In instances where the multi-layer liner 56 comprises only the outer-layer 58 and the inner-layer 62, direct contact can be made. Alternatively, when the multi-layer liner 56 further comprises a middle-layer 60, the middle layer 60 can serve as an interface disposed between the first movement limiter 55 and the second movement limiter 57. In either event, an amount of rotation can be limited by the size, spacing, and geometry of the first movement limiter 55 and the second movement limiter 57 with respect to each other.

[0025] FIG. 2B shows an embodiment in which the middle-layer 60 is configured to be disposed between, and come in contact with, the first movement limiter 55 and the second movement limiter 57. The middle-layer 60 is shown with a first interface surface 63 and a second interface surface 65. The first interface surface 63 can be curved, squared, straight, undulating, or gear-shaped comprising a series or one or more sides, projections, tabs, flanges, protuberances, extensions, or knobs to correspond to, be a reverse images of, be mateably arranged or interlocking with, first movement limiter 55 or periphery 59. Similarly, the second interface surface 65 can be curved, squared, straight, undulating, or gear-shaped comprising a series or one or more sides, projections, tabs, flanges, protuberances, extensions, or knobs to correspond to, be a reverse images of, be mateably arranged or interlocking with, second movement limiter 57 or periphery 61. An amount of movement between the outer-layer 58 and the inner-layer 62 can also be controlled, limited, or influenced by a configuration and design of the middle-layer 60, including a hardness, springiness, or deformability of the middle-layer 60, as well as by a configuration and design of a size, spacing, and geometry of the first interface surface 63 and the second interface surface 65 with respect to the first rotation limier 55 and the second movement limiter 57, respectively. While a non-limiting example of a relationship or interaction between the first movement limiter 55 and the second movement limiter 57 have been described herein, any number or arrangement of movement limiters and layers can be arranged according to the configuration and design of multi-layer liner 56.

[0026] FIG. 2B also shows a non-limiting example in which middle-layer 60 is formed comprising a plurality of grooves, slots, or channels 66, that extend completely through the middle-layer 60 and align with the grooves 66 formed in inner-layer 62, as previously shown in FIG. 2A. Advantages of slots or channels 66 are discussed in greater detail below with respect to slots 90 and the flex of liner 88 in FIGs. 4A-4C, below. Slots 66 in middle-layer 60 can divide the middle layer into a plurality of panels, wings, tabs, projections, flanges, protuberances, or extensions 67a that can be centrally coupled or connected at a central or top portion of middle-layer 60, such as around fist interface surface 63 and second interface surface 65. Panels 67a can be solid or hollow, and can include a plurality of openings, cut-outs, or holes 68. A number, position, size, and geometry of panels 67a can align with, and correspond to, a number position, size, and geometry of panels 67b formed by slots 66 in inner-layer 62. While FIG. 2A a non-limiting example in which a same number of panels, such as 6 panels, can be formed in the middle-layer 60 and the inner layer 62, any number of suitable panels 67a and 67b, including different numbers of panels 67a and 67b can be formed.

[0027] Different configurations and arrangements for coupling layers of multi-layer liner 56 to each other are contemplated. A way in which layers of multi-layer liner 56 are coupled together can control a relationship between impact forces and relative movement of layers within the multi-layer liner 56. Various layers of multi-layer liner 56, such as outer-layer 58, middle-layer 60, and inner-layer 62, can be coupled or directly attached to one another chemically, mechanically, or both. In some embodiments, coupling occurs only mechanically and without adhesive. The coupling of the various layers of the multi-layer liner 76 can comprise use of adhesives such as glue, or other suitable material, or with mechanical means such tabs, flanges, hook and loop fasteners, or other suitable fastening device. An amount, direction, or speed of relative movement among layers of the multi-layer liner 56 can be affected by how the layers are coupled. Advantageously, relative movement can occur in a direction, to a desired degree, or both, based on the configuration of the multi-layer liner 56. FIGs. 2B and 2D show a non-limiting embodiment in which the inner-layer 62 comprises tabs, flanges 69 formed on the outer surface 53 of inner-layer 62.

[0028] FIG. 2C shows another perspective view of the multi-layer liner 56 from FIGs. 2A and 2B. The multi-layer liner 56 is shown with the outer-layer 58, the middle-layer 60, and the inner-layer 63, nested one within each other and the opening for a user's head within the multi-layer liner 56 oriented in an upwards direction.

[0029] FIG. 2D shows another perspective view of the multi-layer liner 56 from FIGs. 2A-2C showing only the inner-layer 63 nested within the middle-layer 60 without showing the outer-layer 58. Multi-layer liner 56 is shown in a side view with tabs 69 of inner inner-layer 63 interlocking with openings in the middle-layer 60.

[0030] FIG. 2E shows a top perspective view of the multi-layer liner 56 from FIGs. 2A-2D. FIG. 2E shows a winter plug 48 formed of an insulating material made of plastic, foam, rubber, fiber, cloth, or other suitable natural or synthetic material can be formed in a shape that corresponds to, is a reverse images of, or can be mateably arranged or interlocking openings in one or more other layers within the multi-layer liner 56, such as within slots 66 of inner-layer 62. Winter plug 48 can reduce airflow through the helmet 50 and through the multi-layer liner 56 while also increasing insulation and warmth for a user of the helmet 50.

[0031] FIG. 3 shows a cross-sectional view of a helmet or multi-layer helmet 70 not covered by the current invention. Multi-layer helmet 70, like multi-layer helmet 50, can be designed and used for cycling, power sports or motor sports, snow sports, water sports, and for other applications to provide added comfort, functionality, and improved energy absorption and energy management with respect to the conventional helmets known in the prior art, such as helmet 10 shown in FIG. 1. As shown in FIG. 3, helmet 70 can be configured as an in-molded or partially in-molded cycling helmet, a skate style bucket helmet, a snow helmet, or other non-full-face helmet. The helmet 70, like helmet 50, can comprise an outer shell 74 that is similar or identical to outer shell 54. Similarly, multi-layer liner 76 can be similar or identical to multi-layer liner 76. In some examples, outer shell 74 can be optional, such as for some cycling helmets, so that helmet 70 can be formed with the multi-layer liner 76 without the outer shell 74.

[0032] Multi-layer liner 76 can be similar or identical to multi-layer liner 56, and as such can comprise two or more layers, including three layers, four layers, or any number of layers. As a non-limiting example, FIG. 3 shows the multi-layer liner 76 comprising three layers: an outer-layer 78, a middle-layer 80, and an inner-layer 82. The outer-layer 78, the middle-layer 80, and the inner-layer 82 can be similar or identical to the outer-layer 58, the middle-layer 60, and the inner-layer 62, respectively, as described above with respect to FIGs. 2A-2E. As such, the performance and function of the multi-layer liner 76 for energy-management, including management by the layers comprised within the multi-layer liner 76, both individually, collectively, and in various combinations, can also be similar or identical to those from multi-layer liner 56 and its constituent layers.

[0033] As shown in FIG. 3, the middle-layer 80 can be disposed between an entirety of the interface between the outer-layer 78 and the inner-layer 82. Additionally, the middle-layer 80 can be disposed between substantially an entirety of the interface between the outer-layer 78 and the inner-layer 82, such as more than 80% of the interface or more than 90% of the interface. In other examples, and as illustrated in FIG. 5 and described below, a middle-layer can also be disposed between a portion, or less than an entirety, of an interface between the inner and outer-layers. The layers of the multi-layer liner 76 can be coupled to each other, such as the outer-layer 78 and the inner-layer 82 both being coupled to middle-layer 80. The outer-layer 78 and the inner-layer 82 can be coupled or directly attached to opposing inner and outer side of the middle-layer 80, either chemically, mechanically, or both, using adhesives such as glue, or other suitable material, or with mechanical means such tabs, flanges, hook and loop fasteners, or other suitable fastening device.

[0034] By providing the middle-layer 80, such as a thinner middle-layer 80, between one or more layers of the multi-layer liner 76, including between outer-layer 78 and inner-layer 82, the middle-layer 80 can provide or facilitate a desirable amount of relative movement between the outer-layer 78 and the inner-layer 82 during a crash or impact while the helmet 70 is absorbing or attenuating energy of the impact. The relative movement of various layers within the multi-layer liner 76 with respect to the outer shell 74 of the helmet 70 or with respect to the user's head 72 can provide additional and beneficial energy management. An amount of relative movement, whether it be rotational, liner, or translational such as movement made laterally, horizontally, or vertically, can be varied based on how the liner layers are coupled to each other. Relative movement can occur for one or more types of energy management, including low-energy management, mid-energy management, and high-energy management.

[0035] As discussed above with respect to helmet 50 from FIGs. 2A-2E, a desired amount of relative movement among multiple layers of a multi-layer liner can also be provided, or facilitated, by movement limiters. Control of relative movement in helmet 70, as show in FIG. 3, can occur in a manner that is similar or identical to that described above with respect to the first movement limiter 55 and the second movement limiter 57 of helmet 70. Accordingly, FIG. 3 shows outer-layer 78 comprising an inner surface 71, which can further comprise a first movement limiter 75, disposed at a central portion of the inner surface 71. First movement limiter 75 can be similar or identical to the first movement limiter 55, such that the detail recited above with respect to the first movement limiter 55 is applicable to the first movement limiter 75. Similarly, the inner-layer 82 can comprise an outer surface 73 that can further comprise a second movement limiter 77, disposed at a central portion of the outer surface 73. The second movement limiter 77 can be similar or identical to the second movement limiter 57 such that the detail recited above with respect to the second movement limiter 57, and its interaction with one or more other movement limiters, is applicable to the second movement limiter 77 and helmet 70.

[0036] FIG. 3 also shows how the middle-layer 80 can be disposed between, and come in contact with, the first movement limiter 75 and the second movement limiter 77. The middle-layer 80 is shown with a first interface surface 83 and a second interface surface 85. The first interface surface 83 can be similar or identical to first interface surface 63 described above, and second interface surface 85 can be similar or identical to second interface surface 65 described above. An amount of movement between the outer-layer 78 and inner-layer 82 can also be controlled, limited, or influenced by a configuration and design of the middle-layer 80, including a surface finish level of friction, as well as by hardness, springiness, or deformability of the middle-layer 80. An amount of movement between the outer-layer 78 and inner-layer 82 can also be controlled, limited, or influenced by a configuration and design of a size, spacing, and geometry of the first interface surface 83 and the second interface surface 85 with respect to the first rotation limier 75 and the second movement limiter 77, respectively.

[0037] In addition to, and in conjunction with, using movement limiters to provide desired amount of relative movement among multiple layer of a multi-layer liner, different configurations and arrangements for coupling the liner layers to each other can also be used. Various layers of multi-layer liner 76 can be coupled, including directly attached, to each other chemically, mechanically, or both. The coupling of the various layers of the multi-layer liner 76 can comprise use of adhesives such as glue, or other suitable material, or with mechanical means such tabs, flanges, hook and loop fasteners, or other suitable fastening device. An amount, direction, or speed of relative movement among layers of the multi-layer liner 76 can be affected by how the layers are coupled. Advantageously, relative movement can occur in a direction, to a desired degree, or both, based on the configuration of the multi-layer liner 76, such as the middle-layer 80. The middle-layer 80, or another layer of the multi-layer liner 76, can also include slip planes within the multi-layer liner 76 for controlling or directing the relative movement.

[0038] In some examples, layers of multi-layer helmet 70 can be coupled to each other without adhesive, such as with the inner-layer 82 not being bonded with adhesive or glued to the outer-layer 78 and the middle-layer 80. One such example, by way of illustration and not by limitation, is the use of one or more padding snaps 87. The padding snaps 87 can be made of rubber, plastic, textile, elastic, or other springy or elastic material. The padding snaps 87 can couple one or more layers of the multi-layer helmet 70 to each other, to the protective shell 74, or both, by at least one of the padding snaps 87 extending through an opening, hole, or cut-out in the one or more layers of the multi-layer helmet 70. In some examples, one or more layers of the multi-layer helmet 70 can be coupled to a desired location without the padding snaps 87 passing through an opening in that layer. The attachment device can be held at its ends the protective shell and comfort layer by or chemical attachment, such as by an adhesive, or by mechanical attachment. Mechanical attachment can include interlocking, friction, or other suitable method or device. Movement of the one or more layers of the multi-layer helmet 70 can result from a distance or length of the padding snaps 87 in-between the ends of the padding snaps 87 that allows movement, such as elastic movement.

[0039] In some instances, the padding snaps 87 can include a "T" shape, an "I" shape, a "Z" shape, or any other suitable shape that comprises a widened portion at a top, bottom, or both of the padding snap 87 further comprises a narrower central portion. The top widened portion can include a head, tab, or flange, or barbs, an underside of which contacts layers of the multi-layer helmet 70 around the opening in the layer through which the padding snap 87 can pass. Similarly, the bottom widened portion can include a head, tab, flange or barbs that contact an inner portion of the opening in the protective shell for receiving the attachment device. In any event, the padding snap 87 can couple one or more layers of the multi-layer helmet 70 in such a way as to allow a range of motion or relative movement among layers or portion of the helmet 70. The range of motion can be adjusted to a desirable layer amount or distance by adjusting a size, elasticity, or other feature of the padding snap 87. The range of motion can also be adjusted by adjusting a number and position of the padding snaps 87. In an example, each panel, flex panel, or portion of a liner layer separated or segmented by one or more slots can receive, and be coupled to, a padding snap 87. In other examples, a fixed number of padding snaps 87 for the helmet 70, or number of padding snaps 87 per given surface area of the helmet 70 will be used, such as a total of 3, 4, 5, 6, or any suitable number of padding snaps. As such, the padding snaps 87 can allow for a desired amount of sheer force, flexibility, and relative movement among the outer-layer 78, the middle-layer 80, and the inner-layer 82 for better energy management.

[0040] As shown in FIG. 3, a gap or space 84 can exist between an inner surface of inner-layer 82 and a surface of the user's head 72. The gap 84 can extend along an entirety of the interface between user's head 72 and multi-layer liner 76, or along a portion of the interface less than the entirety. The gap 84 can exist as a result of a topography of an individual wearer's head not matching a standardized sizing scheme of helmet 70. As a result, an additional interface layer or layer of comfort padding can be added to the helmet 70 to fill or occupy the space between inner surface 82 of inner-layer 82 and the outer surface or topography of user's head 72.

[0041] As indicated above with respect to multi-layer liner 56, and as is true with multi-layer liner 76, multiple liner layers can provide boundary conditions at the interfaces of the multiple liner layers that serve to deflect energy and beneficially manage energy dissipation at various conditions, including low-energy impacts, mid-energy impacts, and high-energy impacts. In some examples, multi-layer liner 76 can be formed with one or more slots, gaps, channels, or grooves 86 that can provide or form boundary conditions at the interface between multi-layer liner 76 and the air or other material that fills or occupies the slots 86. The boundary conditions created by slots 86 can serve to deflect energy and change energy propagation through the helmet to beneficially manage energy dissipation for a variety of impact conditions.

[0042] FIG. 4A shows a perspective view of a liner layer 88 that can be part of a multi-layer liner for a flexible multilayer helmet such as multi-layer liner 56 or multi-layer liner 76. Liner layer 88 can be formed of any of the materials, and with any of the parameters or densities described above for layers 58, 60, 62, 78, 80, or 82. The liner layer 88 can be formed as any layer within a multiliner layer, including an outer-layer, a middle-layer or intermediate-layer, and as an inner-layer. In some embodiments, liner layer 88 will be formed as an inner-layer, such as inner layer 62 shown in FIG.s. 2A-2E. As such, liner layer 88 can be formed and configured to manage any specific type of impact or types of impacts including low-energy impacts, mid-energy impacts, and high-energy impacts.

[0043] As shown in FIG. 4A, liner layer 88 can comprise a plurality of slots, gaps, channels, or grooves 90 that can be formed partially or completely through the liner layer 88. As shown in FIG. 4A, the slots 90 can extend completely through the liner layer 88, such as from an outer surface 92 of liner layer 88 to and inner surface 94 of the liner layer 88. Slots 90 can be similar or identical to slots 66 and 86 shown in FIGs. 2A and 3, respectively. Slots 90 can be formed in a lateral portion 96 of liner layer 88, in a top 98 portion of liner layer 88, or both. As such, at least a first portion of slots 90 can extend from a bottom edge 100 of liner layer 88 such that a continuous bottom edge 100 of the liner layer 88 forms a crenulated shape that extends along the bottom edge 100 and extends upwards through the lateral portion 96 of the liner layer 88 towards a central portion or the top portion 98 of liner layer 88. In some embodiments, liner layer 88 can further comprise a second portion of slots 90 that can extend from the top portion 98 or centerline of the liner layer 88 downwards towards the bottom edge 100. The second portion of the slots 90 can be formed at the top portion 98 in the form of a plus, star, or other shape with multiple intersecting slots. The first and second portions of slots 90 can also be alternately arranged or interleaved.

[0044] By including slots 90 to create the segmented liner layer 88, the liner layer 88 can, with or without a flexible outer shell, permit flexing, increase energy attenuation, and increase energy dissipation that might not otherwise be present or available. Advantageously, the liner layer 88 comprising slots 90 can provide or from boundary conditions at the interface between the liner layer 88 and the air or other material that fills or occupies the slots 90. The boundary conditions created by slots 90 can serve to deflect energy and change energy propagation through the helmet to beneficially manage energy dissipation at various conditions, including low-energy impacts, mid-energy impacts, and high-energy impacts. Furthermore, the liner layer 88 comprising slots 90 can also provide for adjustment of flex of liner layer 88, including bottom edge 100, to adjust and adapt to a shape of a user's head. Adjustment or flex of liner layer 88 and bottom edge 100 allows for adaptation of a standard sized liner layer 88 to better adapt to, match, and fit, idiosyncrasies of an individual user's head 72 that are not accommodated with conventional helmets 10, as described above in relation to FIG. 1.

[0045] FIG. 4B shows a top plan view of the liner layer 88 being worn by a person with wide and short head 89a. Due to idiosyncrasies of wide and short head 89a, gaps or an offset 91 can exist between the head 89a and the liner layer 88. However, the flex of the liner layer 88 can allow for movement of the liner layer 88, including the bottom edge 100, to provide for adaptation of a standard sized liner layer 88 comprising a standard size to better adapt to, match, and fit, idiosyncrasies of head 89a, including during impacts.

[0046] FIG. 4C shows a top plan view of the liner layer 88 being worn by a person with narrow and long head 89b. Due to idiosyncrasies of narrow and long head 89b, gaps or an offset 91 can exist between the head 89b and the liner layer 88. However, the flex of the liner layer 88 can allow for movement of the liner layer 88, including the bottom edge 100, to provide for adaptation of a standard sized liner layer 88 to better adapt to, match, and fit, idiosyncrasies of head 89b, including during impacts.

[0047] FIG. 5 illustrates a cross-sectional side view of a helmet 110 similar to the cross-sectional side view of helmet 70 shown in FIG. 3. As such, features or elements of helmet 110 that correspond to similar features in helmet 70 can be similar or identical to the corresponding elements such that all the disclosure and discussion presented above with respect to helmet 70 is applicable to helmet 110, unless specifically noted otherwise. For brevity, the details discussed above with respect to helmets 50 and 70 are not repeated here, but can be or are equally applicable to helmet 110, unless stated otherwise. Thus, the outer shell 74 and the multi-layer liner 76 comprising the outer-layer 78, the middle-layer 80, and the inner-layer 82 are analogous to the outer shell 114 and the multi-layer liner 116 comprising the outer-layer 118, the middle-layer 120, and the inner-layer 122, respectively. Similarly, slots, gaps, channels, or grooves 86 are analogous to the slots, gaps, channels, or grooves 126.

[0048] In light of the foregoing, FIG. 5 differs from FIG. 3 in at least two ways. First, the gap 84 between user head 72 and inner-layer 82 present with helmet 70 can be minimized or eliminated in helmet 110 so that an inner surface 122a of inner-layer 122 can contact user head 112, without the presence of a gap. Second and according to the invention, inner-layer 122 in helmet 110 includes a first portion directly attached to middle-layer 120 and a second portion directly attached to outer-layer 118, which is in contrast with the illustration of middle-layer 80 in FIG. 3 that does not directly attach to outer-layer 78.

[0049] With respect to the first difference of helmet 110 not comprising a gap between an inner surface of inner-layer 122 and user head 112, the gap can be avoided, or not created, by forming the topography of the inner surface of inner-layer 122 as a custom formed topography specially fitted to match a topography of user head 112. Accordingly, the custom-fitted multi-layer helmet of FIG. 4, in addition to providing the advantages described above, can also provide a custom fit that yields better comfort and better stability that standard helmets without a custom formed inner topography matching a topography of the user head 112.

[0050] With respect to the second difference of inner-layer 122 in helmet 110 including portions directly attached to both middle-layer 120 and outer-layer 118, coupling or attachment of layers within multi-layer liner 116 can occur similarly to the coupling of layers within multi-layer liner 76. For example, layers within multi-layer liner 116 can be coupled or directly connected chemically, mechanically, or both, using adhesives such as glue, or other suitable material, or with mechanical means such tabs, flanges, hook and loop fasteners, or other suitable fastening devices. As illustrated in FIG. 5, the middle-layer 120 can also be disposed between a portion, or less than an entirety, of an interface between the inner-layer 122 and the outer-layer 118. In an embodiment, a bushing, including a break away bushing, can be used to couple the inner-layer 122 to the outer-layer 118 near a top portion 128 of the helmet 110, which will fit, when worn, over a top portion of the user's head 112. The coupling of inner-layer 122 to outer-layer 118 can provide or facilitate a desirable amount of relative movement between the outer-layer 118 and the inner-layer 122 during a crash or impact while the helmet 1100 is absorbing or attenuating energy of the impact. The relative movement of various layers within the multi-layer liner 1166 with respect to the outer shell 114 of the helmet 110 or with respect to the user's head 112 can provide additional and beneficial energy management. An amount of relative movement, whether it be rotational, liner, or translational such as movement made laterally, horizontally, or vertically, can be varied based on how the liner layers are coupled to each other. Relative movement can occur for one or more types of energy management, including low-energy management, mid-energy management, and high-energy management.

[0051] Different configurations and arrangements for coupling the liner layers to each other are contemplated for controlling a relationship between impact forces and relative movement of the multiple liner layers, which can vary by application. Various layers of multi-layer liner 116 can be coupled, including directly attached, to each other chemically, mechanically, or both. The coupling of the various layers of the multi-layer liner 116 can comprise use of adhesives such as glue, or other suitable material, or with mechanical means such tabs, flanges, hook and loop fasteners, or other suitable fastening device. An amount, direction, or speed of relative movement among layers of the multi-layer liner 116 can be affected by how the layers are coupled. Advantageously, relative movement can occur in a direction, to a desired degree, or both, based on the configuration of the multi-layer liner 116, such as the middle-layer 120. The middle-layer 120, or another layer of the multi-layer liner 116, can also include slip planes within the multi-layer liner 116 for controlling or directing the relative movement.

[0052] According to the invention, the inner-layer 122 is coupled to the middle-layer 120 without adhesive. In some embodiments, various layers of multi-layer liner 116 can be coupled to each other without the use of adhesives. As described above with respect to FIG. 3 and helmet 70, various layers of a multi-layer liner can also be coupled with padding snaps. The above discussion relative to helmet 70 and padding snaps 87 is also applicable to the helmet 110 and the multi-layer liner 116.

[0053] Any combination of the above features can be relied upon to provide the desired helmet performance metrics including low-energy, mid-energy, and high-energy absorption. Features to be adjusted include material properties such as flex, deformation, relative movement (rotational, translational, or both), and various operating conditions such as temperature or any other condition. As appreciated by a person of ordinary skill in the art, any number of various configurations can be created and beneficially applied to different applications according to desired functionality and the needs of various applications. The various configurations can include one or more of the following features as discussed above: (i) proportion adapting fit, (ii) customized fit, (iii) rotational protection, (iv) translation management (v) low-energy management, (vi) mid-energy management, (vii) high-energy management, (viii) energy deflection through changes in boundary conditions, and (ix) increased performance through pairing high and low density materials. In some embodiments, energy absorption through flexing can be achieved by an emphasis or priority on a softer inner-layer in which some low-energy benefit may be realized together with some rotational advantage. In other embodiments, an emphasis or priority on low-energy management can be achieved with more rotational advantage. Variously, specific advantages can be created based on customer or user end use.

[0054] Where the above examples, embodiments, and implementations reference examples, it should be understood by those of ordinary skill in the art that other helmet and manufacturing devices and examples could be intermixed or substituted with those provided. In places where the description above refers to particular embodiments of helmets and customization methods, it should be readily apparent that a number of modifications may be made without departing from the scope of protection that is defined by the appended claims, and that these embodiments and implementations may be applied to other helmet customization technologies as well. Accordingly, the disclosed subject matter is intended to embrace all such alterations, modifications and variations that fall within the scope of protection, as long as they are covered by the appended claims.

Claims

1. A protective sports helmet comprising:

an outer shell (74); and
a multi-layer liner assembly (76) disposed within the outer shell and sized for receiving a wearer's head, wherein the multi-layer liner assembly includes an inner-layer (82), a middle-layer (80), and an outer-layer (78):

the inner-layer (82) positioned between an inner surface (80a) of the middle-layer (80) and the wearer's head (20) and is coupled to said middle-layer without adhesive;

the middle-layer (80) positioned between an outer surface (82b) of the inner-layer (82) and an inner surface (78a) of the outer-layer (78), wherein the middle-layer (80): (i) has a thickness that is less than a thickness of each of the outer-layer (78) and the inner-layer (82), and (ii) includes a material selected from the group consisting of polyester, polyurethane, D30®, Poron® and an air bladder, and wherein a top portion of the multi-layer liner assembly is formed without the middle-layer (80) and is configured to be aligned over a top of the wearer's head; and

the outer-layer (78) disposed adjacent an outer surface (80b) of the middle-layer (80).

2. The protective sports helmet of claim 1, wherein a portion of the inner-layer (82) has a thickness between 5 mm and 25 mm, a portion of the middle-layer (80) has a thickness between 3 mm and 9 mm, and a portion of the outer-layer (78) has a thickness between 5 mm and 25 mm.

3. The protective sports helmet of any of claims 1-2, further comprising at least one padding snap (87) configured to secure the inner-layer (82).

4. The protective sports helmet of any of claims 1-3, wherein the outer shell (74) is flexible.

5. The protective sports helmet of any of claims 1-3, wherein the outer shell (74) is formed of a stamped, thermoformed, or injection molded polycarbonate shell.

6. The protective sports helmet of any of claims 1-5, wherein the outer-layer (78) is coupled to the inner-layer (82) without adhesive.

7. The protective sports helmet of any of claims 1-6, wherein a total thickness of the multi-layer liner (76) is less than or equal to 48 mm.

8. The protective sports helmet of any of claims 1-7, wherein at least a portion of the multi-layer liner assembly is flexible and is segmented to provide gaps between portions of the multi-layer liner assembly.

9. The protective sports helmet of any of claims 1-8, wherein the outer-layer (78) is formed from a high-energy management material.

10. The protective sports helmet of any of claims 1-9, wherein the multi-layer liner (76) includes interfaces between layers of the multi-layer liner (76) with boundary conditions to deflect energy and manage energy dissipation in impacts.

11. The protective sports helmet of any of claims 1-10, wherein a topography of the inner liner layer is custom fitted to match a topography of the wearer's head so that a gap between the wearer's head and the multi-layer liner (76) of the protective sports helmet (70) is reduced or eliminated.

12. The protective sports helmet of any of claims 1-11, wherein the outer layer has an outer interface and the inner-layer has an inner interface, and wherein the inner interface is less than the outer interface.

13. The protective sports helmet of any of claims 1-12, wherein the middle-layer (80) is mechanically coupled to the inner-layer (82) and the outer-layer (78).

14. The protective sports helmet of any of claims 1-13, wherein:

the outer layer (78) is comprised of a material that has a density range of 20-50 g/L;
the middle-layer (80) is comprised of a material that has a density range of 40-70 g/L; and
the inner-layer (82) is comprised of a material that has a density range of 10-20 g/L.

15. The protective sports helmet of any of claims 1-13, wherein:

the inner-layer (82) is formed from a mid-energy management material;
the middle-layer (80) is formed from a low-energy management material; and
the outer-layer (78) is formed from a high-energy management material.

Patentansprüche

1. Ein schützender Sporthelm, der Folgendes beinhaltet:

eine äußere Schale (74); und
eine mehrschichtige Lineranordnung (76), die innerhalb der äußeren Schale angeordnet ist und zum Aufnehmen eines Kopfes des Trägers bemessen ist, wobei die mehrschichtige Lineranordnung eine Innenschicht (82), eine Mittelschicht (80) und eine Außenschicht (78) umfasst:

wobei die Innenschicht (82) zwischen einer inneren Oberfläche (80a) der Mittelschicht (80) und dem Kopf des Trägers (20) positioniert ist und mit der Mittelschicht ohne Klebstoff gekoppelt ist;
wobei die Mittelschicht (80) zwischen einer äußeren Oberfläche (82b) der Innenschicht

(82) und einer inneren Oberfläche (78a) der Außenschicht (78) positioniert ist, wobei die Mittelschicht (80): (i) eine Dicke aufweist, die kleiner als eine Dicke von jeder der Außenschicht (78) und der Innenschicht (82) ist, und (ii) ein Material umfasst, das aus der Gruppe ausgewählt ist, die aus Polyester, Polyurethan, D30®, Poron® und einer Luftblase besteht, und wobei ein oberer Abschnitt der mehrschichtigen Lineranordnung ohne die Mittelschicht (80) gebildet ist und dazu konfiguriert ist, über eine Oberseite des Kopfs des Trägers ausgerichtet zu werden; und

wobei die Außenschicht (78) neben einer äußeren Oberfläche (80b) der Mittelschicht (80) angeordnet ist.

2. Schützender Sporthelm gemäß Anspruch 1, wobei ein Abschnitt der Innenschicht (82) eine Dicke zwischen 5 mm und 25 mm aufweist, ein Abschnitt der Mittelschicht (80) eine Dicke zwischen 3 mm und 9 mm aufweist und ein Abschnitt der Außenschicht (78) eine Dicke zwischen 5 mm und 25 mm aufweist.

3. Schützender Sporthelm gemäß einem der Ansprüche 1-2, der ferner mindestens ein Polsterungsschnappelement (87) beinhaltet, das dazu konfiguriert ist, die Innenschicht (82) zu sichern.

4. Schützender Sporthelm gemäß einem der Ansprüche 1-3, wobei die äußere Schale (74) flexibel ist.

5. Schützender Sporthelm gemäß einem der Ansprüche 1-3, wobei die äußere Schale (74) aus einer gestanzten, thermogeformten oder spritzgegossenen Polycarbonatschale gebildet ist.

6. Schützender Sporthelm gemäß einem der Ansprüche 1-5, wobei die Außenschicht (78) mit der Innenschicht (82) ohne Klebstoff gekoppelt ist.

7. Schützender Sporthelm gemäß einem der Ansprüche 1-6, wobei eine Gesamtdicke des mehrschichtigen Liners (76) kleiner als oder gleich 48 mm ist.

8. Schützender Sporthelm gemäß einem der Ansprüche 1-7, wobei mindestens ein Abschnitt der mehrschichtigen Lineranordnung flexibel ist und segmentiert ist, um Lücken zwischen Abschnitten der mehrschichtigen Lineranordnung bereitzustellen.

9. Schützender Sporthelm gemäß einem der Ansprüche 1-8, wobei die Außenschicht (78) aus einem Hochenergie-Management-Material gebildet ist.

10. Schützender Sporthelm gemäß einem der Ansprüche 1-9, wobei der mehrschichtige Liner (76) Grenzflächen zwischen Schichten des mehrschichtigen Liners (76) mit Randbedingungen umfasst, um bei Aufprällen Energie abzulenken und Energiedissipation zu managen.

11. Schützender Sporthelm gemäß einem der Ansprüche 1-10, wobei eine Topographie der inneren Linerschicht maßgenau ist, um mit der Topographie des Kopfs des Trägers übereinzustimmen, sodass eine Lücke zwischen dem Kopf des Trägers und dem mehrschichtigen Liner (76) des schützenden Sporthelms (70) reduziert oder eliminiert wird.

12. Schützender Sporthelm gemäß einem der Ansprüche 1-11, wobei die Außenschicht eine äußere Grenzfläche aufweist und die Innenschicht eine innere Grenzfläche aufweist, und wobei die innere Grenzfläche kleiner als die äußere Grenzfläche ist.

13. Schützender Sporthelm gemäß einem der Ansprüche 1-12, wobei die Mittelschicht (80) mit der Innenschicht (82) und der Außenschicht (78) mechanisch gekoppelt ist.

14. Schützender Sporthelm gemäß einem der Ansprüche 1-13, wobei:

die Außenschicht (78) aus einem Material besteht, das eine Dichte im Bereich von 20-50 g/L aufweist;
die Mittelschicht (80) aus einem Material besteht, das eine Dichte im Bereich von 40-70 g/L aufweist; und
die Innenschicht (82) aus einem Material besteht, das eine Dichte im Bereich von 10-20 g/L aufweist.

15. Schützender Sporthelm gemäß einem der Ansprüche 1-13, wobei:

die Innenschicht (82) aus einem Mittelenergie-Management-Material gebildet ist;
die Mittelschicht (80) aus einem Niedrigenergie-Management-Material gebildet ist; und
die Außenschicht (78) aus einem Hochenergie-Management-Material gebildet ist.

Revendications

1. Un casque de protection pour sport comprenant :

une coque externe (74) ; et
un ensemble doublure multicouche (76) disposé à l'intérieur de la coque externe et dimensionné pour recevoir la tête d'un porteur, l'ensemble doublure multicouche comprenant une couche interne (82), une couche médiane

(80) et une couche externe (78) :

la couche interne (82) étant positionnée entre une surface interne (80a) de la couche médiane (80) et la tête (20) du porteur et est couplée à ladite couche médiane sans adhésif ;
la couche médiane (80) est positionnée entre une surface externe (82b) de la couche interne (82) et une surface interne (78a) de la couche externe (78), où la couche médiane (80) : (i) a une épaisseur qui est inférieure à l'épaisseur de chacune parmi la couche externe (78) et la couche interne (82), et (ii) comprend un matériau choisi dans le groupe constitué par du polyester, du polyuréthane, du D30®, du Poron® et une poche à air, et où une partie supérieure de l'ensemble doublure multicouche est formée sans la couche médiane (80) et est configurée pour être alignée sur le dessus de la tête du porteur ; et
la couche externe (78) est disposée adjacente à une surface externe (80b) de la couche médiane (80).

2. Le casque de protection pour sport de la revendication 1, où une partie de la couche interne (82) a une épaisseur comprise entre 5 mm et 25 mm, une partie de la couche médiane (80) a une épaisseur comprise entre 3 mm et 9 mm, et une partie de la couche externe (78) a une épaisseur comprise entre 5 mm et 25 mm.

3. Le casque de protection pour sport de l'une quelconque des revendications 1-2, comprenant en outre au moins un organe d'encliquetage de rembourrage (87) configuré pour fixer la couche interne (82).

4. Le casque de protection pour sport de l'une quelconque des revendications 1-3, où la coque externe (74) est flexible.

5. Le casque de protection pour sport de l'une quelconque des revendications 1-3, où la coque externe (74) est formée d'une coque en polycarbonate estampée, thermoformée ou moulée par injection.

6. Le casque de protection pour sport de l'une quelconque des revendications 1-5, où la couche externe (78) est couplée à la couche interne (82) sans adhésif.

7. Le casque de protection pour sport de l'une quelconque des revendications 1-6, où une épaisseur totale de la doublure multicouche (76) est inférieure ou égale à 48 mm.

8. Le casque de protection pour sport de l'une quelconque des revendications 1-7, où au moins une partie de l'ensemble doublure multicouche est flexible et est segmentée pour aménager des espaces entre des parties de l'ensemble doublure multicouche.

9. Le casque de protection pour sport de l'une quelconque des revendications 1-8, où la couche externe (78) est formée à partir d'un matériau de gestion d'énergie élevée.

10. Le casque de protection pour sport de l'une quelconque des revendications 1-9, où la doublure multicouche (76) comprend des interfaces entre les couches de la doublure multicouche (76) avec des conditions limites pour dévier l'énergie et gérer la dissipation d'énergie lors des impacts.

11. Le casque de protection pour sport de l'une quelconque des revendications 1-10, où une topographie de la couche de doublure interne est ajustée de façon personnalisée pour correspondre à une topographie de la tête du porteur de sorte qu'un espace entre la tête du porteur et la doublure multicouche (76) du casque de protection pour sport (70) est réduit ou supprimé.

12. Le casque de protection pour sport de l'une quelconque des revendications 1-11, où la couche externe a une interface externe et la couche interne a une interface interne, et où l'interface interne est plus petite que l'interface externe.

13. Le casque de protection pour sport de l'une quelconque des revendications 1-12, où la couche médiane (80) est couplée mécaniquement à la couche interne (82) et à la couche externe (78).

14. Le casque de protection pour sport de l'une quelconque des revendications 1-13, où :

la couche externe (78) est constituée d'un matériau qui a une plage de densité de 20-50 g/L ;
la couche médiane (80) est constituée d'un matériau qui a une plage de densité de 40-70 g/L ; et
la couche interne (82) est constituée d'un matériau qui a une plage de densité de 10-20 g/L.

15. Le casque de protection pour sport de l'une quelconque des revendications 1-13, où :

la couche interne (82) est formée à partir d'un matériau de gestion d'énergie intermédiaire ;
la couche médiane (80) est formée à partir d'un matériau de gestion à faible énergie ; et
la couche externe (78) est formée à partir d'un matériau de gestion d'énergie élevée.

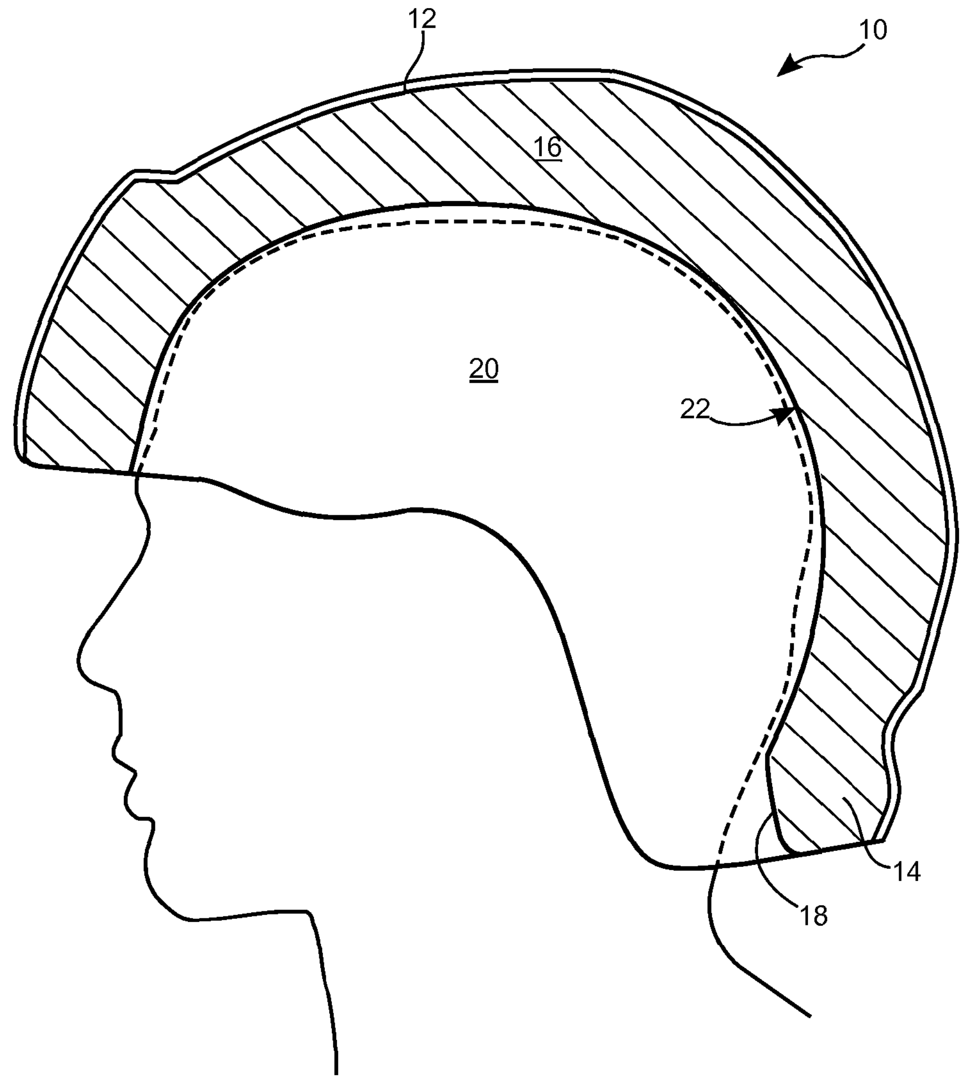


FIG. 1

-- Prior Art --

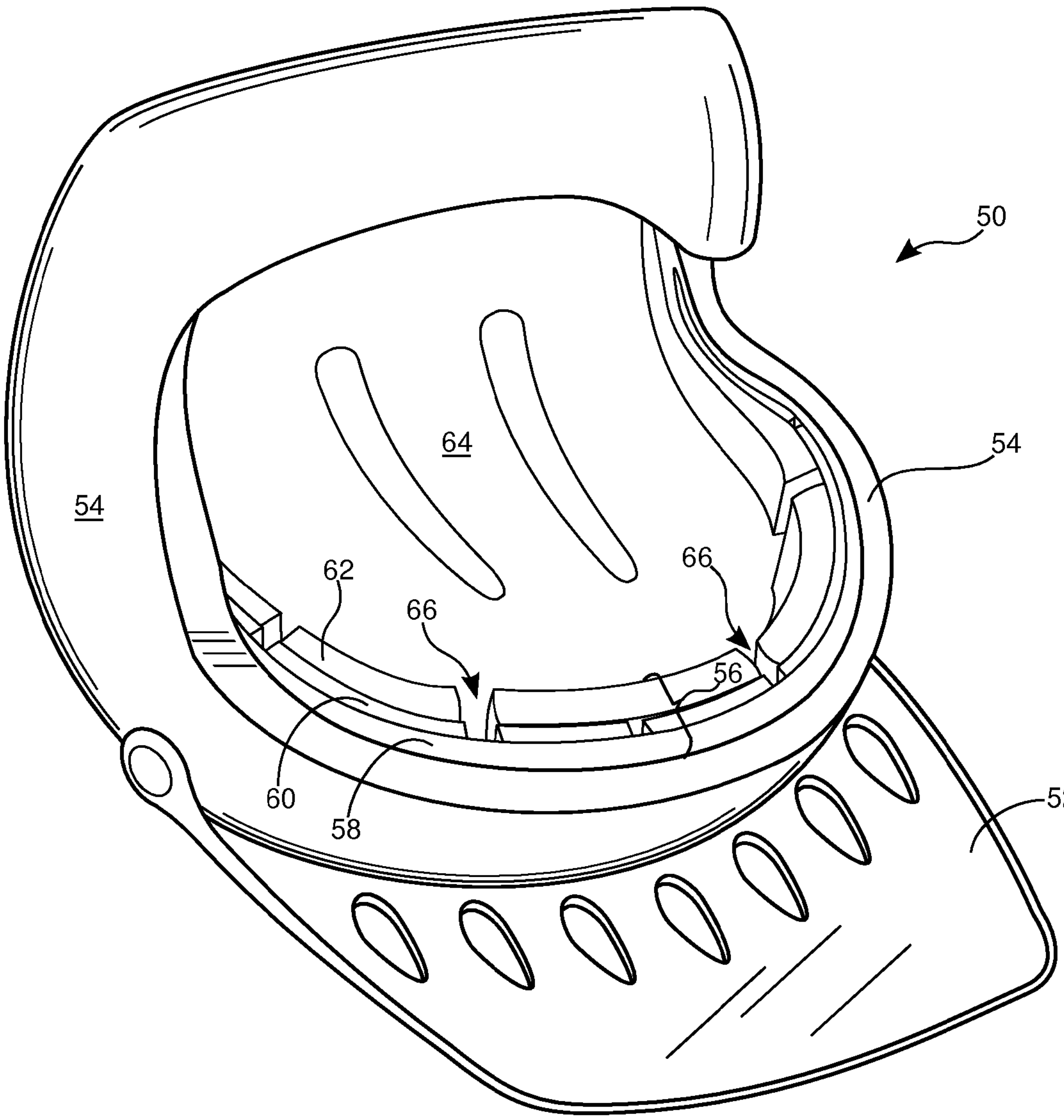


FIG. 2A

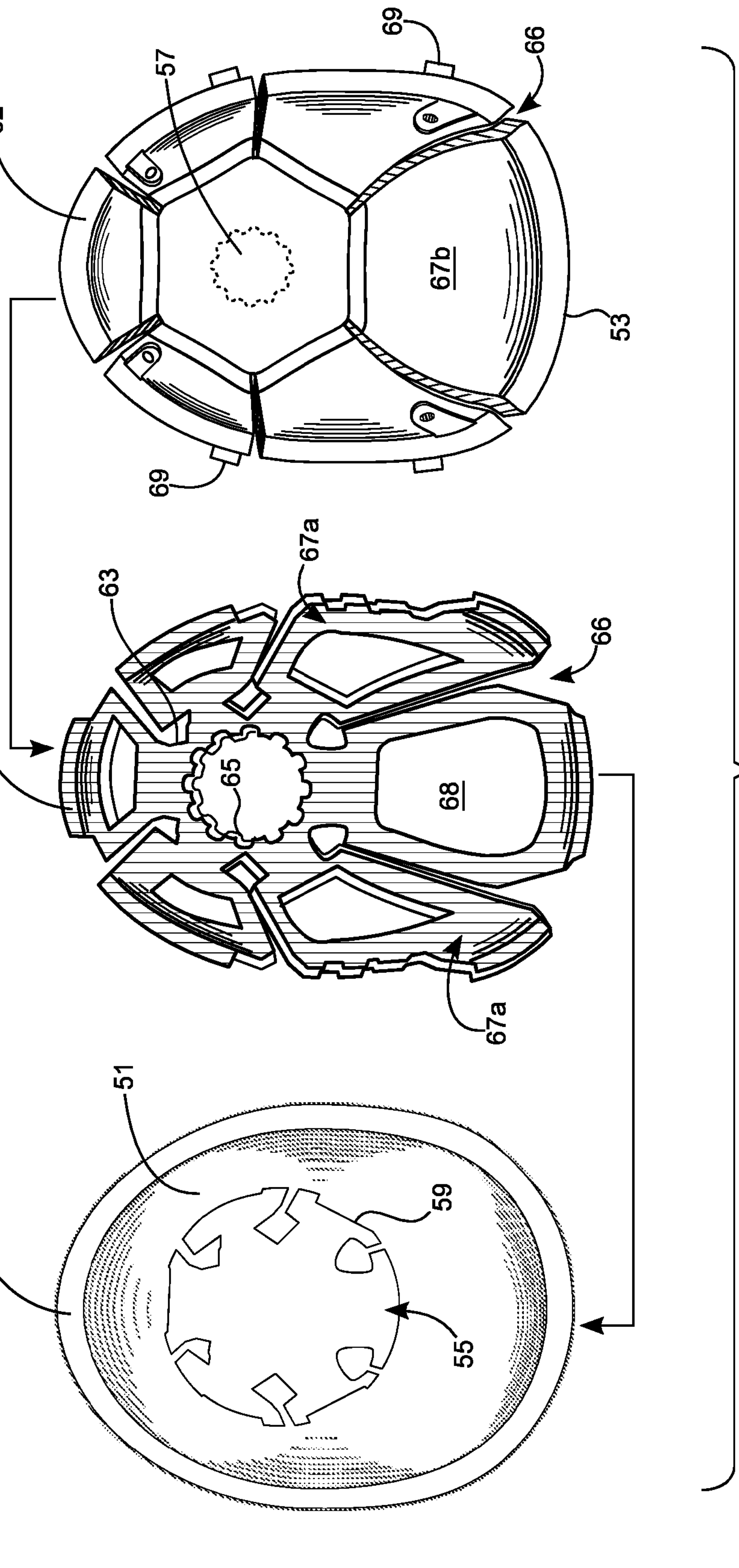


FIG. 2B

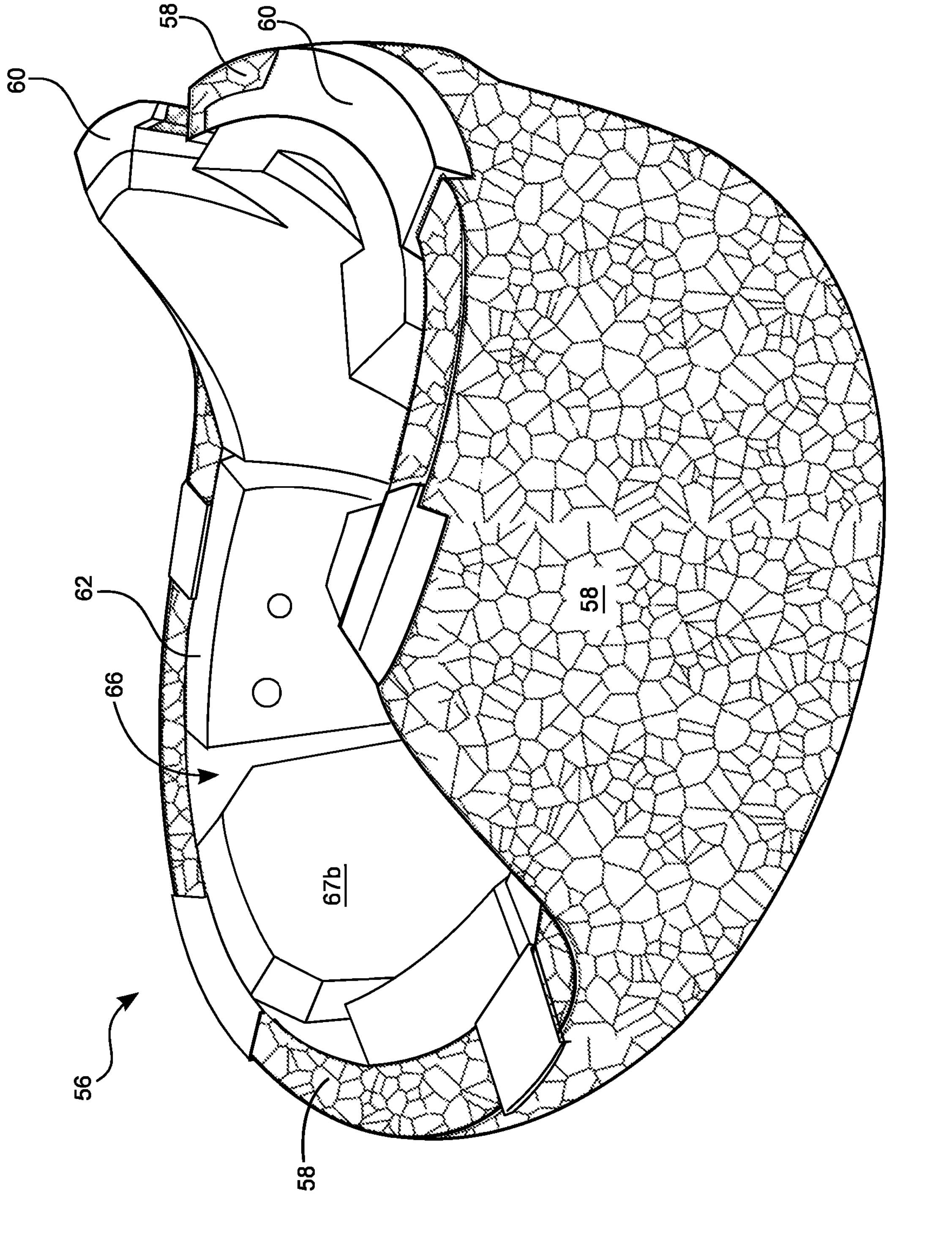


FIG. 2C

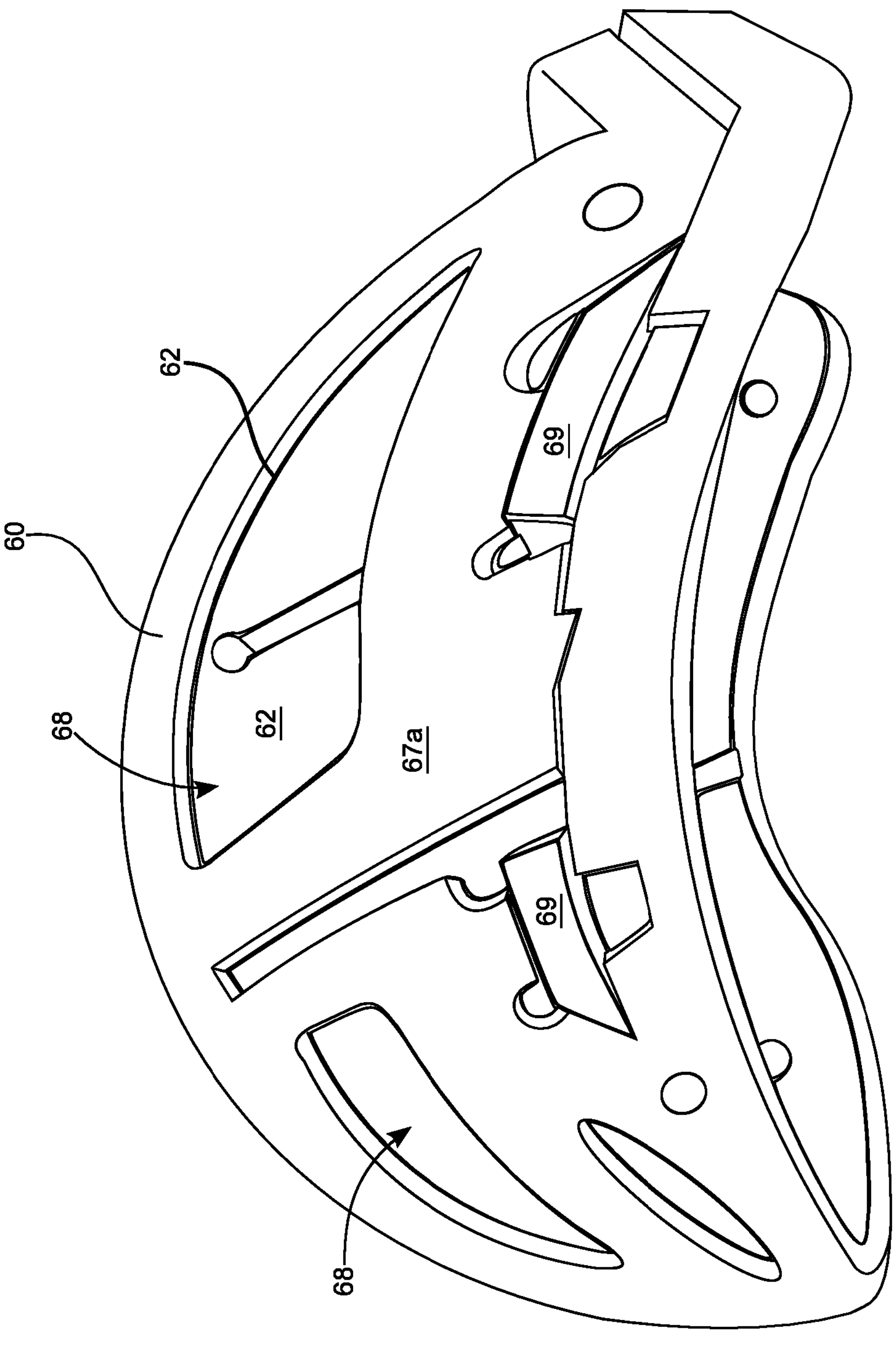


FIG. 2D

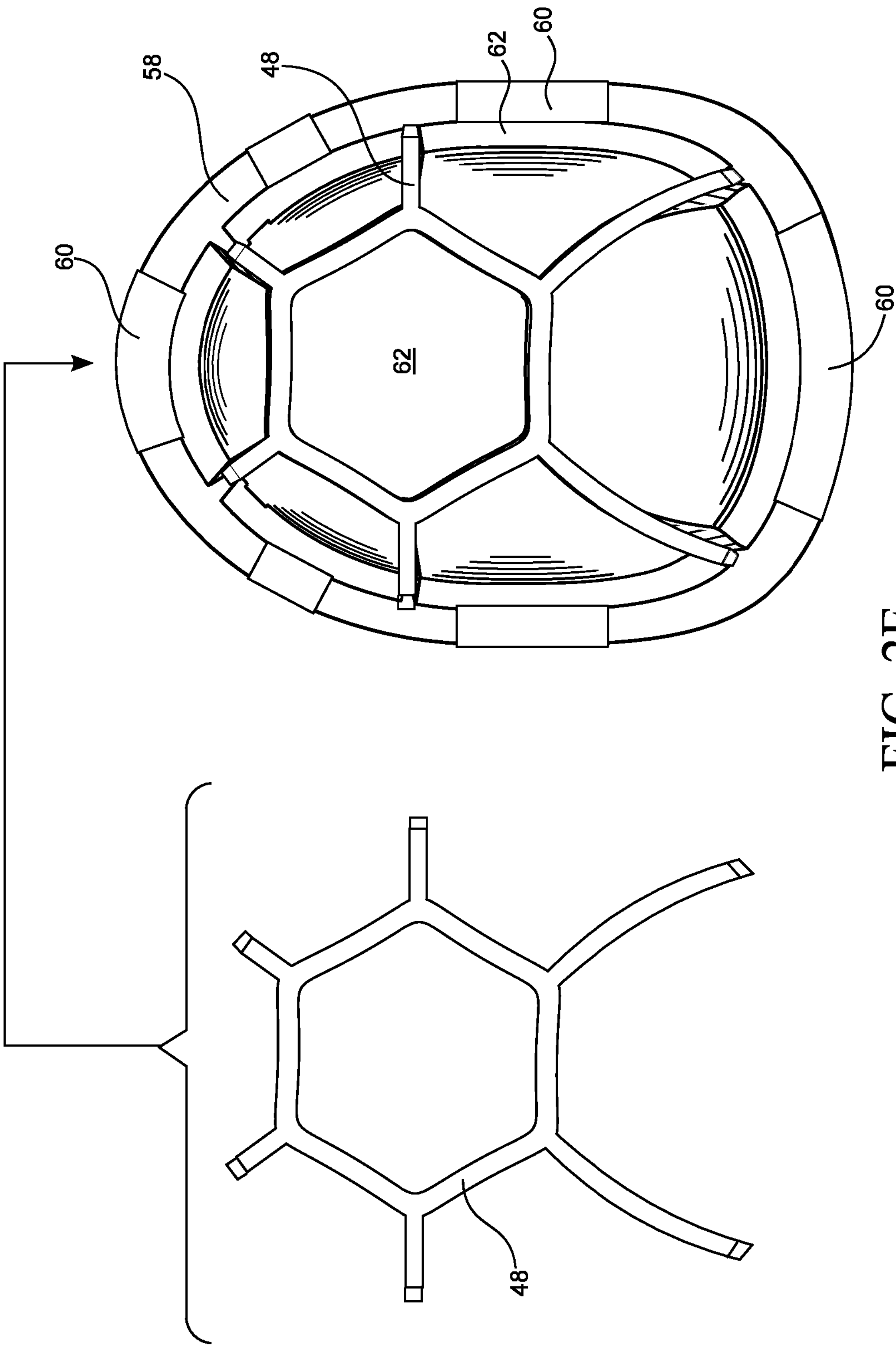
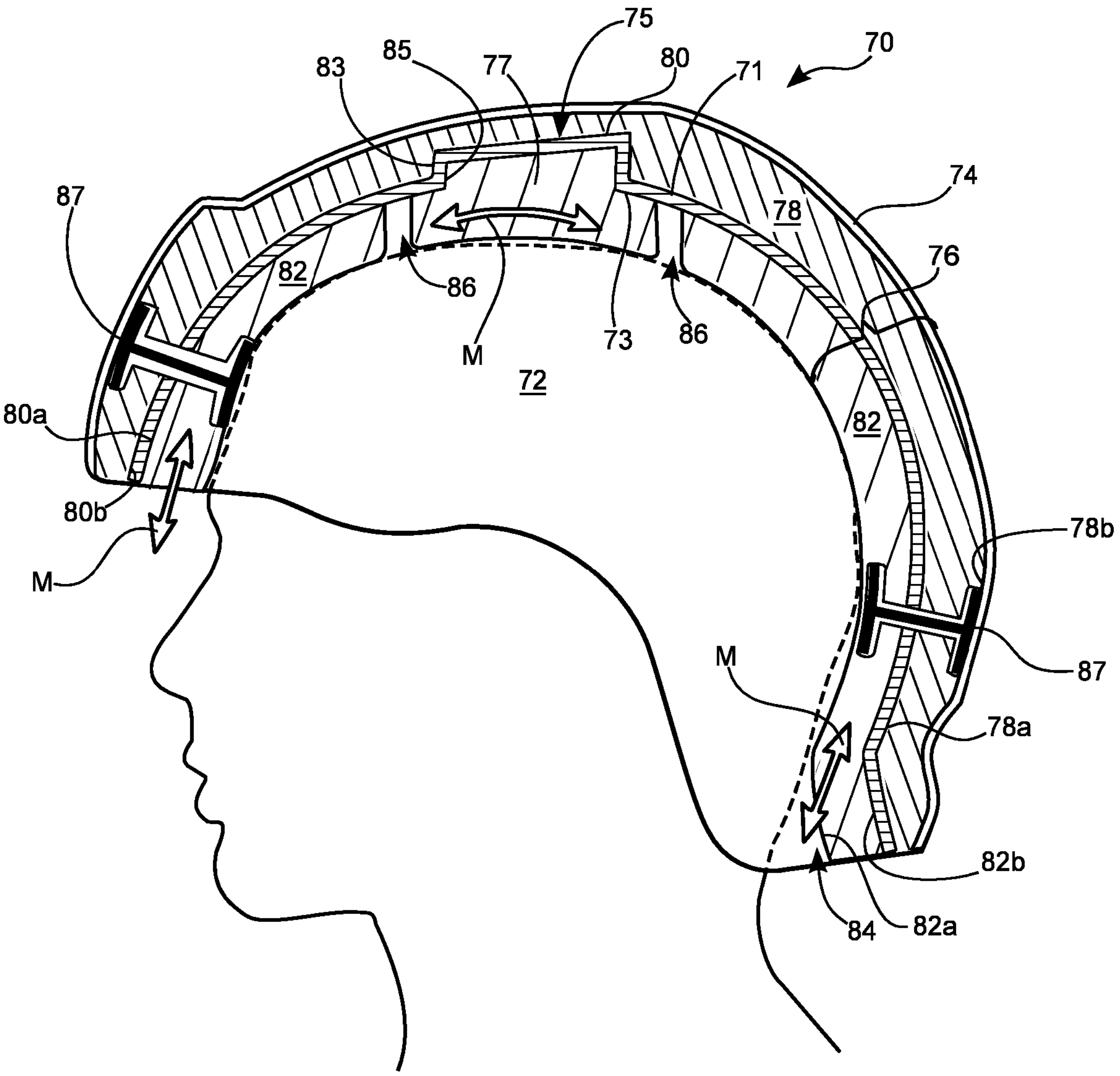


FIG. 2E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M
78a
82b
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82a

FIG. 3

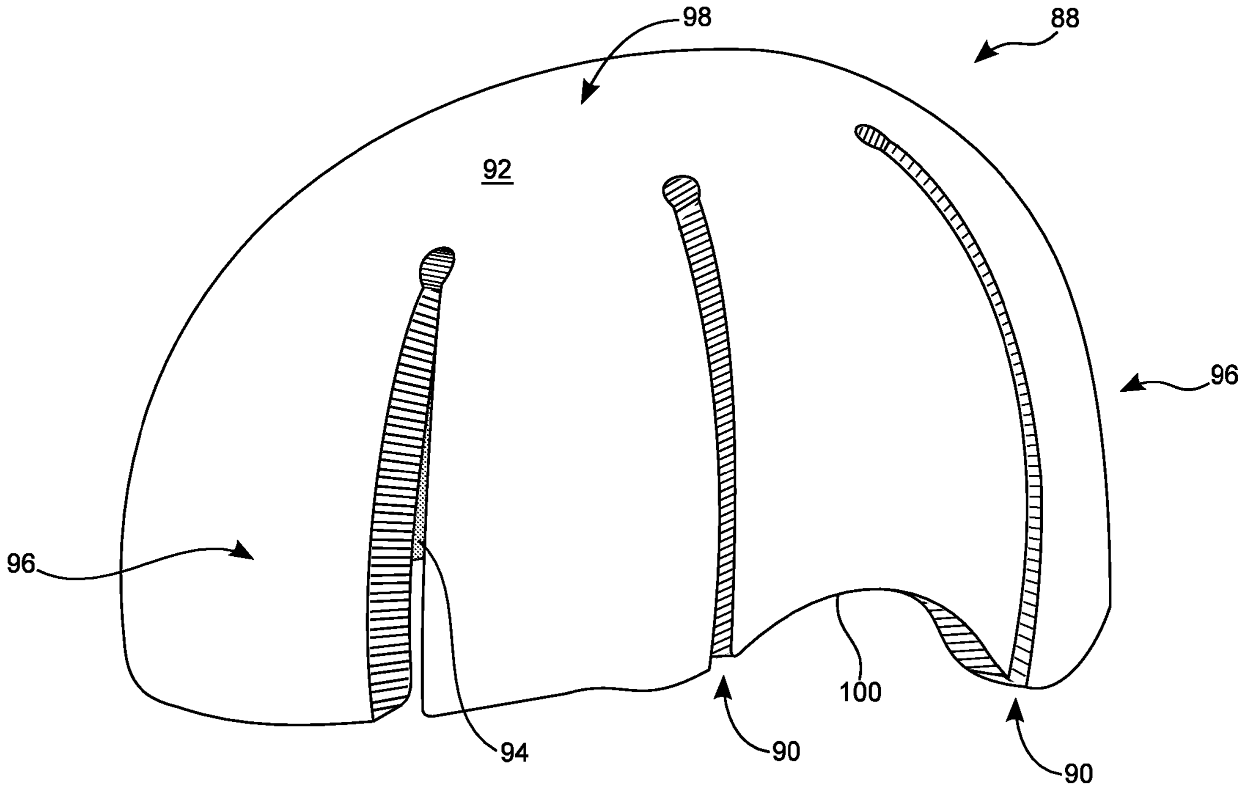


FIG. 4A

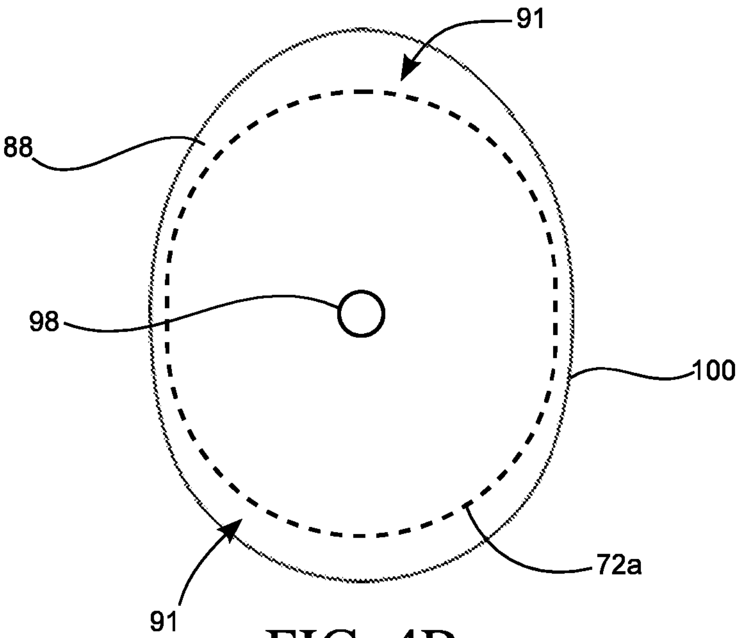


FIG. 4B

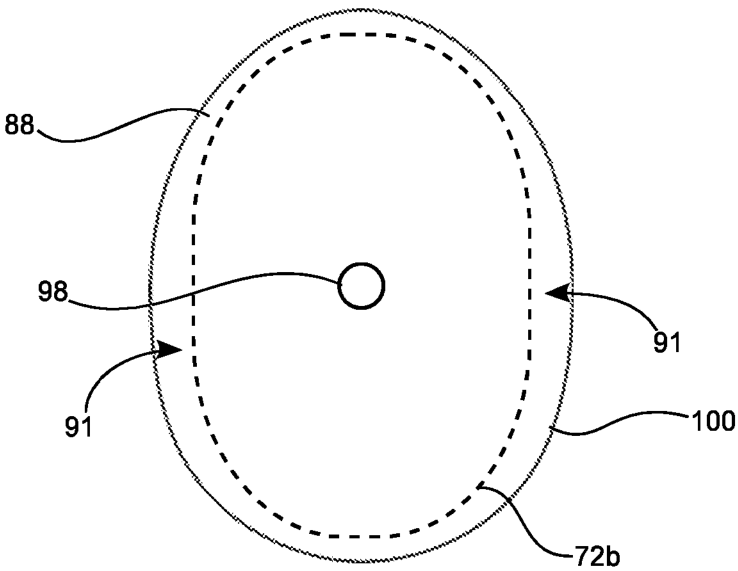
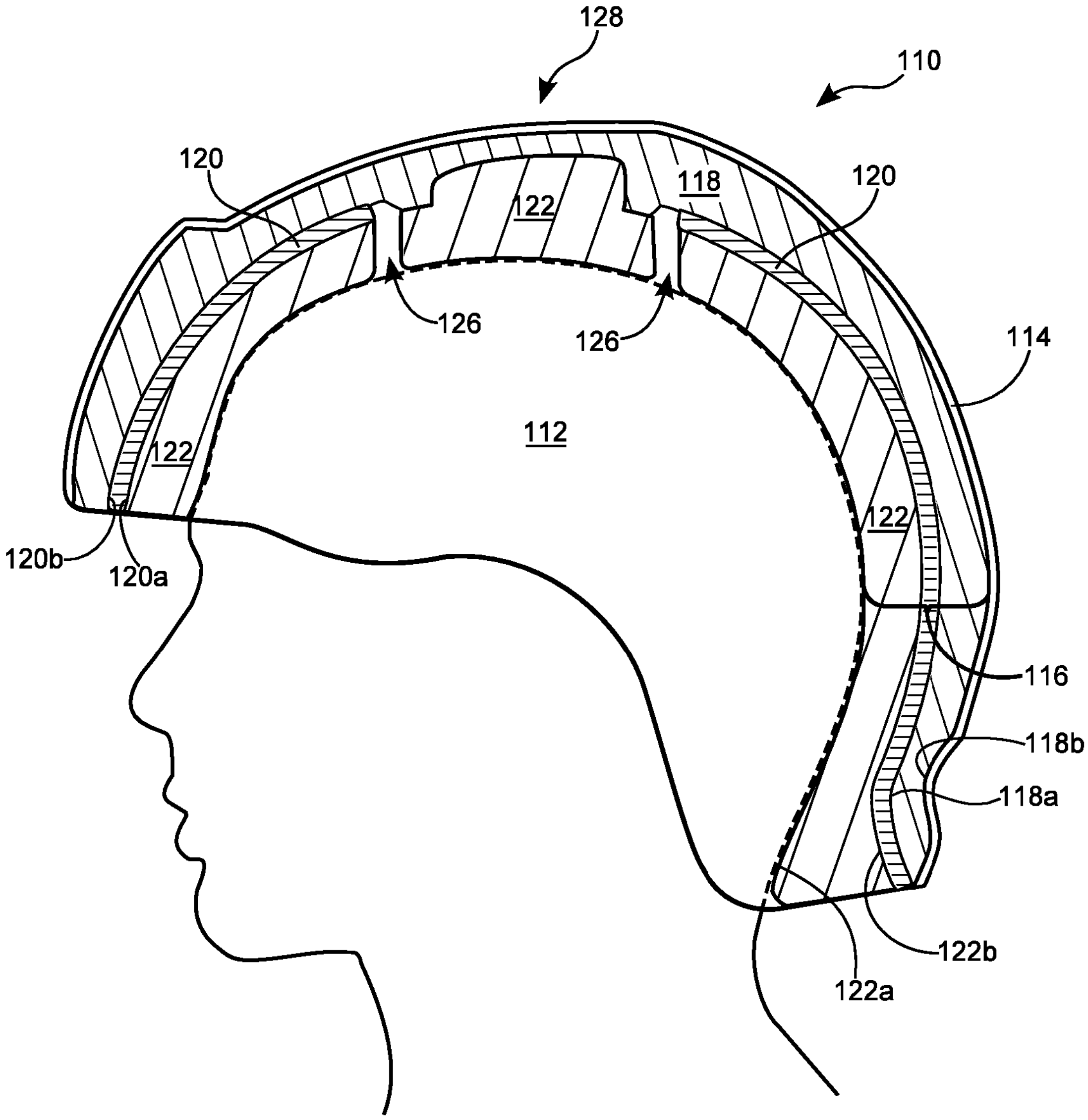


FIG. 4C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122a

FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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