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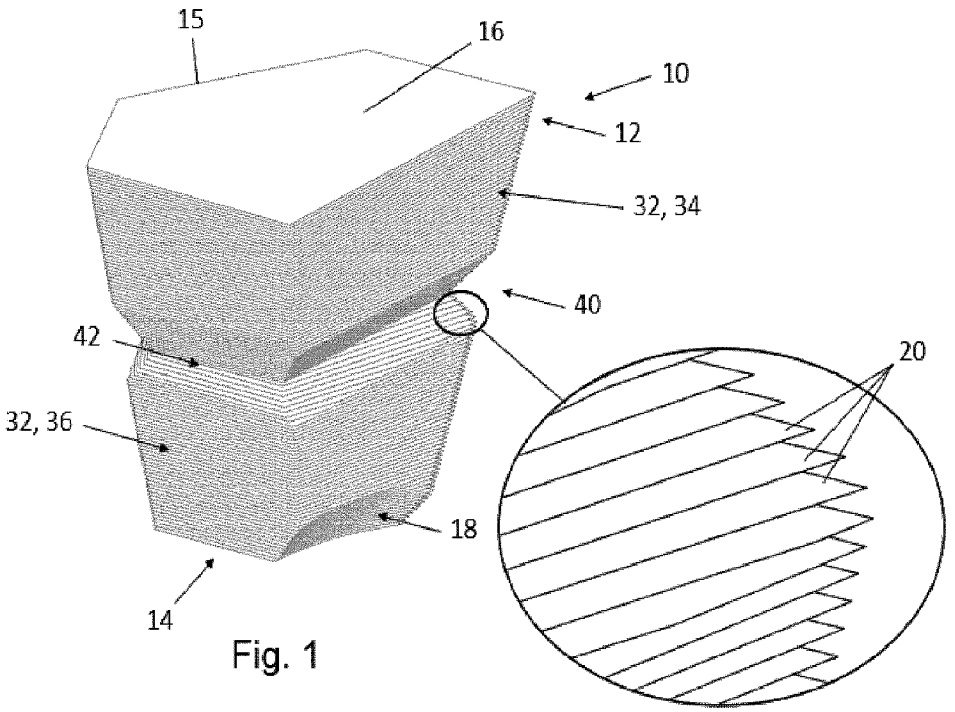

Fig. 1

Fig. 1A

(57) Abrégé/Abstract:
A cushion pad connectable to a garment for providing protection thereto is provided. The cushion pad includes a plurality of layers formed of strings disposed in a manner to define a repeating pattern, with the plurality of layers being stacked on one another to define one or more cells along a thickness of the cushion pad. A protective garment comprising a support structure to which the cushion pads are connectable is also provided.

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Abstract:

A cushion pad connectable to a garment for providing protection thereto is provided. The cushion pad includes a plurality of layers formed of strings disposed in a manner to define a repeating pattern, with the plurality of layers being stacked on one another to define one or more cells along a thickness of the cushion pad. A protective garment comprising a support structure to which the cushion pads are connectable is also provided.

CUSHION PADS AND RELATED SYSTEMS

TECHNICAL FIELD

[001] The technical field generally relates to protective gear and equipment, and more specifically relates to a helmet provided with a liner made of cushion pads.

BACKGROUND

[002] Contact sports, and more specifically multi-contact sports, generally involve collisions and, in some cases, repeated collisions. Nonlimitative examples of multi-contact sports include American football and hockey. Repeated collisions, especially proximate the head, the neck and/or the shoulder regions can result in serious injuries. While helmets and other protective gear and applications for the body and/or items have evolved greatly over the years in an attempt to provide optimum protection, there is still a general need for improvements.

SUMMARY

[003] According to an aspect, a cushion pad connectable to a garment for providing protection thereto is provided. The cushion pad includes a plurality of layers formed of strings disposed in a manner to define a repeating pattern, with the plurality of layers being stacked on one another to define one or more cells along a thickness of the cushion pad.

[004] According to a possible embodiment, the repeating pattern is defined in each layer of the plurality of layers.

[005] According to a possible embodiment, the repeating pattern is defined by at least two adjacent layers of the plurality of layers.

[006] According to a possible embodiment, the repeating pattern includes a lattice pattern, a honeycomb pattern, a hexagonal pattern or a combination thereof.

[007] According to a possible embodiment, the plurality of layers comprises a first section and a second section, and wherein the strings of the first section of the plurality of

layers define a first repeating pattern, and the strings of the second section of the plurality of layers define a second repeating pattern.

[008] According to a possible embodiment, the first repeating pattern and the second repeating pattern are configured to provide respective impact absorption behaviors.

[009] According to a possible embodiment, the first section and the second section are stacked one on top of another.

[0010] According to a possible embodiment, the strings of the first section define the lattice pattern, and the strings of the second section define the honeycomb pattern.

[0011] According to a possible embodiment, at least some of the one or more cells are shaped and configured to reversibly deform.

[0012] According to a possible embodiment, the strings of at least some of the plurality of layers are aligned with the strings of another one of the plurality of layers to form substantially straight cells.

[0013] According to a possible embodiment, the strings of at least some of the plurality of layers are offset relative to the strings of one or more adjacent layers.

[0014] According to a possible embodiment, the strings of at least some of the plurality of layers are axially offset in at least one direction relative to the strings of one or more adjacent layers, rotationally offset relative to the strings of one or more adjacent layers, or a combination thereof.

[0015] According to a possible embodiment, the strings of at least some of the plurality of layers are rotationally offset by between about 1 degree and 359 degrees relative to the strings of one or more adjacent layers.

[0016] According to a possible embodiment, at least some of the plurality of layers are substantially planar and parallel to one another.

[0017] According to a possible embodiment, at least some of the plurality of layers are substantially planar and angled relative to one another.

[0018] According to a possible embodiment, at least some of the plurality of layers are non-planar.

[0019] According to another aspect, a helmet is provided. The helmet includes an outer shell defining a cavity for receiving a head of a person; a support structure coupled to the outer shell and positioned within the cavity, the support structure comprising a web of support material positioned in a spaced-apart relation relative to the outer shell and defining a plurality of openings; and a plurality of cushion pads provided within respective openings of the web of support material, the plurality of cushion pads forming a liner of the helmet, where each cushion pad comprises an outer cushion section extending between the outer shell and the web of support material and an inner cushion section extending within the cavity on an opposite side of the web of support material relative to the outer cushion section.

[0020] According to a possible embodiment, the cushion pads are manufactured using an additive manufacturing process.

[0021] According to a possible embodiment, the cushion pads are manufactured using a 3D printing process.

[0022] According to another aspect, a protective garment having a surface provided with a support structure is provided. The protective garment includes a plurality of cushion pads connectable to the support structure and adapted to form a liner of the protective garment, each cushion pad comprising an outer cushion section extending between the surface of the protective garment and support structure, and an inner cushion section extending opposite the outer cushion section on an opposite side of the support structure.

[0023] According to a possible embodiment, each cushion pad comprises a plurality of layers formed of segments defining a repeating pattern, and wherein the plurality of layers are stacked to define cells along a thickness of the cushion pad.

[0024] According to a possible embodiment, the repeating pattern is defined in each layer of the plurality of layers.

[0025] According to a possible embodiment, the repeating pattern is defined by at least two adjacent layers of the plurality of layers.

[0026] According to a possible embodiment, the repeating pattern includes a lattice pattern, a honeycomb pattern, a hexagonal pattern or a combination thereof.

[0027] According to a possible embodiment, the plurality of layers comprises a first section and a second section, and wherein the segments of the first section of the plurality of layers define a first repeating pattern, and the segments of the second section of the plurality of layers define a second repeating pattern.

[0028] According to a possible embodiment, the first repeating pattern and the second repeating pattern are configured to provide respective impact absorption behaviors.

[0029] According to a possible embodiment, the first section and the second section are stacked one on top of another.

[0030] According to a possible embodiment, the first section includes layers defining the lattice pattern, and the second section includes layers defining the honeycomb pattern.

[0031] According to a possible embodiment, at least some of the one or more cells are shaped and configured to reversibly deform.

[0032] According to a possible embodiment, the segments of at least some of the plurality of layers are aligned with the segments of another one of the plurality of layers to form substantially straight cells.

[0033] According to a possible embodiment, the segments of at least some of the plurality of layers are offset relative to the segments of one or more adjacent layers.

[0034] According to a possible embodiment, the segments of at least some of the plurality of layers are axially offset in at least one direction relative to the segments of one or more adjacent layers, rotationally offset relative to the segments of one or more adjacent layers, or a combination thereof.

[0035] According to a possible embodiment, the segments of at least some of the plurality of layers are rotationally offset by between about 1 degree and 359 degrees relative to the segments of one or more adjacent layers.

[0036] According to a possible embodiment, at least some of the plurality of layers are substantially planar and parallel to one another.

[0037] According to a possible embodiment, at least some of the plurality of layers are substantially planar and angled relative to one another.

[0038] According to a possible embodiment, at least some of the plurality of layers are non-planar.

[0039] According to a possible embodiment, the protective garment includes a helmet.

[0040] According to another aspect, a protective cushion pad is provided. The protective cushion pad includes a plurality of layers formed of strings disposed to define a repeating pattern, with the plurality of layers being stacked on each other to define one or more cells along a thickness of the cushion pad.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] Figure 1 is a perspective view of a cushion pad according to an embodiment.

[0042] Figure 1A is an enlarged view of a portion of the cushion pad shown in Figure 1, showing a plurality of layers stacked relative to one another, in accordance with an embodiment.

[0043] Figure 2 is a bottom perspective view of the cushion pad shown in Figure 1.

[0044] Figure 3 is a top view of a section of the cushion pad, showing a repeating lattice pattern, according to an embodiment.

[0045] Figure 3A is an enlarged view of a portion of the lattice pattern shown in Figure 3, showing a cell according to an embodiment.

[0046] Figure 4 is a top view of a section of the cushion pad, showing a repeating honeycomb pattern, according to an embodiment.

[0047] Figure 5 is a top view of the cushion pad, showing a first section having the repeating lattice pattern and a second section having the repeating honeycomb pattern stacked on one another, according to an embodiment.

[0048] Figure 6 is a perspective view of a helmet fitted on a head of a person.

[0049] Figure 7 is a perspective view of a helmet having an inner liner formed from a plurality of cushion pads, according to an embodiment.

[0050] Figure 8 is a front view of the helmet shown in Figure 7.

[0051] Figure 9 is a sectional view of the helmet shown in Figure 8, showing a plurality of cushion pads provided along the inner surface of the helmet.

[0052] Figure 10 is a perspective view of a support structure adapted to hold the plurality of cushion pads within the helmet, according to an embodiment.

[0053] Figures 11 and 12 are front and side views of the support structure shown in Figure 10, showing support members extending from a web of material, according to an embodiment.

[0054] Figures 13 to 15 are possible embodiments of a position of the support structure relative to the cushion pads.

[0055] Figures 16 to 18 illustrate a possible embodiment of the different configurations of the cushion pads adapted to be inserted in a helmet.

[0056] Figure 19 to 21 are schematic representations of layers being formed one on top of another in a substantially planar manner, according to an embodiment.

[0057] Figures 22 and 23 are schematic representations of layers being formed one on top of another in a multi-planar manner, according to an embodiment.

[0058] Figure 24 to 26 are schematic representations of layers being formed one on top of another in a substantially non-planar manner, according to an embodiment.

[0059] Figure 27 to 30 are representations of segments being disposed to form layers in different layering sequences according to possible embodiments.

DETAILED DESCRIPTION

[0060] As will be explained below in relation to various embodiments, the present disclosure describes devices, systems and methods for forming protective gear, such as padding for use in various equipment and/or systems. The padding can be used as part of a helmet to improve shock absorption, among other advantages.

[0061] More particularly, the present disclosure relates to a protective helmet, and corresponding parts, which includes a protective structure lining an inner surface thereof to provide protection to the head of the wearer. The protective structure can include an array of cushion pads designed to improve performance of the helmet, such as increasing shock absorption, for example, thereby reducing potential risks and injuries to the wearer. The helmet can further be provided with a coating provided on the exterior surface of the outer shell adapted to increase the friction coefficient between the helmet and another item contacting the helmet, such as a second helmet. For example, during a football game, helmets often contact, and slide off one another. It is noted that increasing the friction coefficient along the exterior surface of the helmets can reduce the sliding motion, which can in turn reduce the risk for injuries.

[0062] The protective structure (e.g., the cushion pads) can be positioned in a predetermined configuration within the helmet using a support structure secured to the inner surface of the helmet. The support structure can be shaped and adapted to hold the cushion pads in respective configurations along the interior of the helmet. In some implementations, the support structure includes a sling connectable to the helmet shell in a spaced-apart relation relative to the head of the wearer. The sling, and corresponding parts, define a plurality of apertures in which the cushion pads can be positioned. The cushion pads can include cushion sections having respective shapes, sizes, configurations and/or properties. In some embodiments, the cushion pad includes a pair of cushion sections coupled to one another, or integrally formed together, to form the

cushion pad, which can be installed within an aperture of the sling for positioning the cushion pad within the helmet. As will be described further below, the cushion sections define an interface region therebetween shaped and adapted to cooperate with the sling to secure the cushion pad within the corresponding aperture of the sling.

[0063] At least one of the cushion sections of the cushion pads can be manufactured using digital fabrication techniques, which may include computer numerical control (CNC) and/or an additive manufacturing process, such as 3D printing, for example. As mentioned above, the cushion sections can include respective shapes, sizes, configurations and/or properties. For example, a cushion section can be formed of a plurality of layers stacked on one another, where each layer has a predetermined pattern, such as a lattice pattern, a honeycomb pattern, or any other suitable pattern(s) or combination thereof. The layers can be stacked substantially vertically and aligned relative to each other such that the structure of the cushion section is relatively uniform throughout a thickness thereof. The aligned layers can form the honeycomb configuration throughout the thickness of the cushion section, for example. Alternatively, or additionally, the layers can be misaligned, axially and/or rotationally, relative to one another. The misaligned layers can be stacked to form the lattice configuration throughout the thickness of the cushion section, among other possible configurations.

[0064] With reference to Figures 1 to 2, a cushion pad 10 according to a possible embodiment is illustrated. As will be described further below, the cushion pad 10 can be integrated as part of various devices and/or systems to provide protection (e.g., shock absorbance) to the device, the system and/or the person(s) using or operating the device or system. The cushion pad 10 can have any suitable overall geometry and/or size adapted to provide protection. For example, in this embodiment, the cushion pad 10 has a cross-sectional shape having five (5) sides so as to form a generally pentagonal shape (see Figure 1). However, it is appreciated that the cushion pad 10 can have any suitable number of sides such as three (3) to form a triangular cross-sectional shape, four (4) to form a rectangular cross-sectional shape, etc. In some embodiments, the cushion pad 10 tapers inwardly along its height (e.g., from a top end 12 to a bottom end 14 thereof) such that the outer perimeter and the cross-sectional area of the cushion pad 10 is smaller proximate the bottom end relative to proximate the top end.

[0065] In some embodiments, the cushion pad 10 can be manufactured using an additive manufacturing process, which may include 3D printing and/or similar techniques. As used herein, it should be understood that the expression "additive manufacturing" refers to a manufacturing process where hardware is operated to deposit material, layer upon layer, in predetermined and/or desired geometric shapes. The hardware can use data from a computer-aided-design (CAD) software or one or more 3D object scanners to operate and form the desired object. It is noted that additive manufacturing processes adds material (e.g., layers) to create the object, such as the cushion pad 10. It is also noted that, by contrast, an object created by traditional means often requires the removal of material through milling, machining, carving, shaping and/or other means, such as injection moulding, compression moulding, etc.. The cushion pad 10 can be created via any suitable subset of additive manufacturing, such as via 3D printing or via rapid prototyping, for example. In some embodiments, the cushion pad 10 can be further worked on (e.g., polished) using non-additive manufacturing processes, such as those listed above.

[0066] The cushion pad 10 is created using relatively resilient material such that forces applied thereto can deform the cushion pad as it absorbs at least a portion of those forces to provide protection to the device, the system and/or the person(s) using or operating the device or system. Of note, the deformation of the cushion pad is generally reversible. For example, the cushion pad may be in a "deformed" or "compressed" configuration when a force is applied to the cushion pad or when energy is absorbed by the cushion pad, and the cushion pad may be in a "relaxed" or "original" configuration when no force is applied to the cushion pad or after the energy is released from the cushion pad. It should also be noted that the cushion pad described herein can be configured for single impact applications, where the pad deforms permanently to absorb forces/energy.

[0067] Still referring to Figures 1 to 2, and more specifically to Figure 1A, the cushion pad 10 includes a plurality of layers 20 successively bonded to an adjacent layer 20 in order to form the three-dimensional object, i.e., the cushion pad 10. Each layer can have substantially the same shape, although their size can vary. As described above, each subsequent layer can have a greater or smaller outer perimeter than a previous layer while keeping the same shape (e.g., the pentagonal shape seen in Figure 1). In some

embodiments, each layer can be formed of relatively straight segments (e.g., strings or cords of material), such as the outer perimeter 15 of the pentagonal shape of the top layer 16 seen in Figure 1. Alternatively, or additionally, one or more layers 20 can include curved segments which can be adapted to form a recessed region of the formed 3D object. For example, and as seen in Figures 1 and 2, the cushion pad 10 includes a recessed region 18 proximate the bottom end 14 thereof, where a plurality of adjacent layers includes a curved segment. It should be noted that the cushion pad 10 can include straight outer walls, sectioned outer walls, curved outer walls, or a combination thereof. In some embodiments, the recessed portion 18 (or at least a portion thereof) may be conformal. In some embodiments, the bottom end 14 may also be entirely or at least partially conformal. In some embodiments, the top end 12 may also be entirely or at least partially conformal.

[0068] Although Figures 1 to 2 illustrate each layer 20 as a substantially complete and solid layer, it should be noted that each layer can include a specific geometry defined across the layer. With reference to Figures 3 to 5, in addition to Figures 1 to 2, in some embodiments, each layer 20 can be formed with a repeating pattern across said layer. For example, one or more layers 20 can be formed with a lattice configuration (seen in Figure 3) where a first set of segments 22 of a given layer are positioned parallel to one another across the layer, and where a second set of segments 24 of the same layer are position parallel to one another and perpendicularly relative to the first set of segments 22 across the layer. It is appreciated that the lattice configuration defines a plurality of cells 30 across the layer, where each cell 30 is formed from a pair of adjacent segments of each set of segments 22, 24. It is noted that each cell 30 of a given layer can have the same dimensions, for example, when the segments of each set of segments are provided at regular intervals across the layer. Alternatively, the segments can be provided at irregular intervals (e.g., larger and/or smaller intervals) across the layer such that the cells 30 have varying dimensions and shapes.

[0069] In some embodiments, each layer 20 may include a network of lines. In some embodiments, the network of lines may include a first set of spaced-apart lines and a second set of spaced-apart lines, and the first set and the second set of spaced-apart lines may be integrally formed. The first set and the second set of spaced-apart lines may be orthogonal one with respect to another. Of course, the first set and the second set of

spaced-apart lines may define another angle than a right angle. For example, the angle between the first set and the second set of spaced-apart lines may be included in a closed interval extending from 0 to 180. In some embodiments, each layer 20 may be aligned with a subsequent layer 20. In this configuration, the cushion pad 10 includes a plurality of aligned layers 20 and each layer 20 may be said to be in phase one with respect to another.

[0070] In other embodiments, each layer 20 may be misaligned with a subsequent layer 20. In this configuration, the cushion pad 10 includes a plurality of misaligned layers 20 and each layer 20 may be said to be de-phased one with respect to another. In some embodiments, a spacing between two subsequent lines may be constant or substantially constant over the layer 20. The two subsequent lines may be part of the first set and/or the second set of spaced-apart lines. In this configuration, the period of the layer 20 may be said to be constant and the layer 20 may be characterized as being "periodic". In other embodiments, a spacing between two subsequent lines may be different or substantially different over the layer 20. The two subsequent lines may be part of the first set and/or the second set of spaced-apart lines. In this configuration, the period of the layer 20 may be said to be non-constant and the layer 20 may be characterized as being "non-periodic". It should be noted that the properties of the cushion pad 10 and the layers 20, which may include, for example and without being limitative, alignment, dephasing, change in thickness, and many others are selected and/or optimized to modify and/or improve the overall mechanical properties of the cushion pad 10, and the item incorporating such a cushion pad 10.

[0071] It should be understood that each cell 30 also has a thickness, and that said thickness can correspond to the thickness of the layer on which the cells 30 are defined. It should thus be noted that a plurality of layers can be aligned with one another to increase the thickness of the cells 30. In such embodiments, the cells 30 of each layer 20 is aligned with a corresponding cell 30 of a previous layer such that the cells 30 are generally straight and have a thickness substantially corresponding to a cumulative thickness of the aligned layers. It is noted that, if the layers are aligned throughout the cushion pad 10, the thickness of the cells 30 substantially correspond to a thickness of the cushion pad 10. In alternate embodiments, the layers 20 can be created so as to be offset relative to adjacent

layers (i.e, layers above and/or below) throughout the cushion pad 10. The layers can be offset relative to one another by any suitable manner. For example, each subsequent layer can be axially offset following a direction of the segments from either sets of segments (e.g., along directions A or B as illustrated in Figure 3A). As such, it should be understood that the thickness of the cells increases and that the cells are at least partially slanted throughout a portion of the cushion pad. In other embodiments, it is appreciated that the layers can be axially offset relative to one another following any other suitable direction, such as any direction between directions A and B seen in Figure 3A.

[0072] Alternatively, or additionally, the layers can be rotationally offset relative to a previous and/or subsequent layer. For example, any given layer can be rotated by any suitable angle (e.g., 5, 10, 25, 30, 50, 100, 120, 150, 200 or 300 degrees, etc.) relative to a previously formed layer, thus creating a web of segments throughout the cushion pad 10. In some embodiments, it should be noted that rotating a layer includes rotating the layer in a plane substantially parallel to the plane in which is formed a previous layer. As such, although being offset (e.g., axially, rotationally, or a combination thereof), each layer remains substantially parallel to the other layers of the cushion pad 10.

[0073] As seen in Figures 27 to 30, in some embodiments, the layers can be deposited one on top of another according to a layering sequence. For example, a first layer can be formed with segments 22 extending in a first direction, and a second layer can be deposited/formed on top of the first layer with segments 24 extending in a second direction perpendicular from the first direction, and so on. In other words, each layer is rotated by about 90 degrees relative to the previous layer. This sequence can be referred to as a 1:1 layering sequence (shown in Figure 27), where one (1) layer is formed in a first direction followed by one (1) layer in another direction. It is appreciated that the layering sequence can include any other suitable variations, such as a 2:2 layering sequence (shown in Figure 28), where two (2) layers are formed in a first direction followed by two (2) layers in another direction, or a 1:2 layering sequence (shown in Figure 29), a 2:1 layering sequence, a 3:1 layering sequence (shown in Figure 30), a 1:3 layering sequence, etc.

[0074] It should also be noted that the layering sequence can include layers formed with segments extending in additional directions, such as a third, a fourth direction and/or any suitable number of additional directions. In these embodiments, the layering sequence can

be a:b:c, where "a" corresponds to the number of layers with segments extending in the first direction (e.g., 1, 2, 3, etc.), "b" corresponds to the number of layers with segments extending in the second direction (e.g., 1, 2, 3, etc.), and "c" corresponds to the number of layers with segments extending in the third direction (e.g., 1, 2, 3, etc.), and so on for any suitable number of layers in a given direction and/or any suitable number of directions. In some embodiments, a single layer can include segments extending in more than a single direction. For example, a single layer can include a lattice pattern, or a honeycomb pattern, where segments extend in at least two different directions in the same layer.

[0075] In some embodiments, the layers 20 can be substantially planar, e.g., formed in respective planes, as illustrated in Figures 19 to 23. The segments of the layers 20 can be deposited on a substantially flat base 21 and built off of each other. As such, each plane, and therefore each layer 20, can be substantially parallel to other planes (shown in Figures 19 to 21). However, in other embodiments, each layer 20 can be angled relative to other layers 20 (Figures 22 and 23) such that the layers can include respective 3D orientations. In addition, it should be noted that at least some of the layers 20 can be non-planar, as illustrated in Figures 24 to 26. The segments of the layers 20 can be deposited on a curved base 23 and subsequently built off of each other to create non-planar layers 20. As such, and for example, bottom layers of cushion pads used in helmets can be planar, non-planar (e.g., curved) or multi-planar (e.g., formed of a plurality of planar layers angled relative to one another), such as to better conform to the shape of a user's head at different locations within the helmet. The cushion pads can therefore have sections of substantially planar layers combined with sections of non-planar layers and/or multi-planar layers. Alternatively, the entire pad can be made of multi-planar, non-planar or planar layers. It is appreciated that the non-planar layers can be different (e.g., different curvatures) from one another within the same pad and/or from one pad to another.

[0076] Now referring to Figure 4, the cushion pad 10, or at least a section thereof, can include cells 30 disposed so as to form a honeycomb pattern across the corresponding layer. In this embodiment, each layer can be positioned relative to adjacent layers in any suitable configuration, such as those previously described (e.g., axially and/or rotationally offset).

[0077] In some embodiments, the cushion pad 10 is formed of a plurality of cushion sections 32, where each cushion section is formed of any suitable number of layers having any suitable configuration(s). For example, a first cushion section can be formed of relatively aligned layers forming generally straight cells 30. Another cushion section can be formed of axially offset layers, while yet another cushion section is formed of rotationally offset layers. It should also be noted that each cushion section 32, having their respective configurations of layers, can have respective resiliencies. In other words, one cushion section can be configured to greatly deform (e.g., for increased comfort) while another cushion section can be configured to only slightly deform (e.g., for increased force absorption). It should be noted that the layers can deform purely vertically, purely horizontally, at least partially vertically and/or horizontally, rotationally, according to a shear deformation or a combination thereof. It is also noted that a section of the cushion pad 10 having a repeating lattice pattern (seen in Figure 3) acts differently under pressure than a section having another configuration, such as a repeating honeycomb pattern (seen in Figure 4). For instance, a lattice pattern can provide additional control on multidirectional impact absorption behavior as compared to other patterns, such as solid foam, for example. In some embodiments, the cushion pad 10 can include one or more sections having a honeycomb patterns and one or more sections having a lattice pattern.

[0078] Referring back to Figures 1 and 2, in addition to Figure 5, the cushion pad 10 can include a pair of cushion sections 32, such as an outer cushion section 34 and an inner cushion section 36. In this embodiment, the outer cushion section 34 includes a plurality of generally aligned layers 20 having a honeycomb pattern, whereas the inner cushion section 36 includes a plurality of generally aligned layers 20 having a lattice pattern. As previously mentioned, the cushion pad 10 can be used to protect devices, systems and/or the person(s) using or operating such devices and/or systems. The inner and outer cushion sections 34, 36 can thus be configured provide shock absorption, improve protection and/or improve comfort. The cushion pad 10 can be used in combination with other similar cushion pads to form an array of cushion pads 10 adapted to create a lining for devices or systems, such as sporting equipment, for example.

[0079] In this embodiment, and with reference to Figures 1 and 2, each cushion pad 10 can include an intermediate region 40 defined between the outer and inner cushion

sections 34, 36. As seen in Figures 1 and 2, the intermediate region 40 can include tapered portions of the outer and inner cushion sections 34, 36 defining a groove 42 around a perimeter of the cushion pad 10. As will be described further below, the cushion pad 10 can be installed in a support structure, where components of the support structure are adapted to engage the cushion pad along the groove 42. The cushion pad 10 can therefore be secured on the support structure (herein referred to as a "sling"), where the wider sections thereof on either side of the groove 42 at least partially prevent removal of the cushion pad 10 from the support structure.

[0080] With reference to Figures 6 to 9, in some embodiments, the cushion pad 10 is part of an array of cushion pads forming a liner 45 for a helmet 50. In the illustrated embodiments, the helmet 50 corresponds to a football helmet, although it should be noted that other helmets and/or other types of equipment can include a liner 45 formed of a plurality of cushion pads 10. The helmet 50 includes an outer shell 52 having an outer surface 54 and an inner surface 56, where the inner surface 56 defines a cavity 55 of the helmet 50 for receiving the head (H) of a person. The outer shell 52 also defines a front opening 57 enabling the person to see in front of him/her/them, with the helmet 50 being provided with a facemask 58 connected to the outer shell 52 for at least partially protecting the wearer's face (e.g., nose, mouth, eyes, etc.). It is appreciated that the outer shell 52 further includes a bottom opening 59 enabling a person's head to engage the cavity from below. It should be noted that, in other embodiments, the helmet 50 can be provided with a visor (e.g., instead of, or in addition to the facemask) coupled to the outer shell 52 and being pivotable between open and closed positions for respectively opening and closing the front opening 57.

[0081] The cushion pads 10 are illustratively provided along the inner surface 56 of the outer shell 52 such that the pads are positioned between the wearer's head and the outer shell 52 when wearing the helmet 50. It is appreciated that the cushion pads 10 can have respective shapes, sizes, configurations or a combination thereof, based on its position along the inner surface 56, among others. Each cushion pad 10 can also be installed within the cavity 55 so as to position the outer cushion section 34 proximate the outer shell 52 (e.g., connected to the inner surface 56) and position the inner cushion section 36 within the cavity 55 to be positioned adjacent the head of a person wearing the helmet 50.

As seen in Figure 9, the inner cushion section 36 of each cushion pad 10 can cooperate to generally conform to a shape of a person's head.

[0082] As seen in Figures 10 to 12, in addition to Figures 6 to 9, the helmet can include a support structure 60 adapted to support the cushion pads 10 within the cavity 55 along the inner surface 56 of the helmet shell 52. The support structure 60 can be shaped and adapted to support each cushion pad 10 individually, i.e., independently from the other cushion pads 10. In this embodiment, the cushion pads 10 can be removably installed on the support structure 60, thereby enabling the removal of one or more cushion pads 10 for maintenance, replacement or repositioning, among others. As will be described further below, the support structure 60 can be removably coupled to the outer shell 52 and is positioned so as to be spaced from a head of the person wearing the helmet 50 and spaced from the inner surface 56.

[0083] In some embodiments, the support structure 60 can include a sling 62 connectable to the outer shell 52 and being shaped and sized to support the cushion pads 10. More specifically, the sling 62 can be made of a web of material 64 defining a plurality of openings 65 for receiving the cushion pads 10. In this embodiment, the sling 62 includes a generally continuous edge 63, and each one of the openings 65 is complementarily shaped relative to one or more of the cushion pads 10 such that the cushion pad fits snugly within the corresponding opening 65. The sling 62 can conform to the shape of the outer shell 52, where the edge 63 is positioned along the edges of the front opening 57 and bottom opening 59. The sling 62 can include any suitable number of openings 65, such as two, four, ten, twenty or fifty openings, which can correspond to the number of cushion pads 10 installed within the helmet 50. In some embodiments, the sling 62 includes an axis of symmetry (S) where the openings 65 on a right side of the sling 62 are mirrored on a left side thereof. However, it is appreciated that other configurations are possible, such as having only a portion of the sling being mirrored on the right and left sides, or such as having no symmetry between the right and left sides, for example.

[0084] In some embodiments, the continuous edge 63 may be engineered to alter the general profile of the same. For example, the continuous edge 63 may include variations in thickness, shape and/or topology, and is generally designed to enhance or generally

improve the overall properties of the sling 62. Of note, the generally continuous structure 63 may have a different structure than the material forming the sling 62.

[0085] Referring back to Figures 1 and 2, with continued reference to Figures 10 to 12, in this embodiment, the web of material 64 is adapted to engage each cushion pad 10 along the groove 42 defined along the intermediate region 40 thereof. The cushion pad 10 can engage a corresponding one of the openings 65 until the inner cushion section 36 is provided on a first side of the sling 62, and the outer cushion section 34 is provided on a second opposite side of the sling 62. The resiliency of the cushion pad 10 can enable deformation thereof for insertion within the opening 65. Once in the desired position, where the web of material 64 is provided along the groove 42, the cushion pad 10 is released and reverts to an initial shape and size. The outer and inner cushion sections 34, 36 can at least partially extend over the sling 62 (e.g., over the web of material surrounding the cushion pad) such that the cushion pad is at least partially secured within the opening 65. Each cushion pad 10 is installed in the sling 62 in a similar manner so as to form a protective lining which can be installed within protective gear, such as along the inner surface of the helmet 50.

[0086] With reference to Figures 10 to 12, the sling 62 can include support members 66 adapted to be connected to the outer shell 52, such as to the inner surface thereof. In some embodiments, the support members 66 can be fastened to the inner surface using any suitable method, such as mechanical fasteners, adhesive, interference fit, among other possibilities. The support members 66 can be adapted to position the web of material 64 in a spaced-apart relation relative to the inner surface 56 of the outer shell 52. It is appreciated that the cushion pads 10 can thus be positioned within the cavity, with the outer cushion section 34 extending between the outer shell 52 and the sling 62, and the inner cushion section 36 extending within the cavity, such as between the sling 62 and the head of the person wearing the helmet 50. In this embodiment, the support members 66 include spacers 68 extending outwardly from the web of material 64 at various locations around the sling 62, and connection pads 70 provided at a distal end of the spacers 68. The connection pads 70 are connectable to the outer shell 52, with the spacers 68 positioning the web of material 64 in the spaced-apart position relative to the outer shell 52, as previously described.

[0087] In this embodiment, the components of the sling 62 (e.g., the web of material 64 and/or the support members 66) can be made of resilient material adapted to enable relative movement between the components of the sling, between the sling and the outer shell 52 and/or between the sling and the cushion pads. For example, the application of a force on the outer shell 52 can push the support members 66 inwardly (e.g., towards the web of material 64) enabling compression of the outer cushion section 34 to absorb at least a portion of the applied force. It is noted that the inner cushion section 36, along with the web of material 64, can simultaneously deform to further absorb some of the applied force.

[0088] In some embodiments, the sling is made from a plastic material or rubber. It is noted that the sling can be manufactured via a similar process to the cushion pads (e.g., additive manufacturing).

[0089] In the illustrated embodiments, the sling 62 is positioned substantially in the middle of the cushion pads 10, with the inner and outer cushion sections being relatively the same size as one another. However, it is appreciated that other configurations are possible. As seen in Figures 13 to 15, the cushion pads 10 can be provided with grooves provided proximate a bottom end and/or a top end thereof, so as to position the sling accordingly, e.g., proximate the bottom end (Figure 13) or proximate the top end (Figure 15). In alternate embodiments, the helmet (or protective garment) can be provided with two or more slings 62, where each sling is adapted to hold respective sets of cushion pads 10 within the helmet, and where each sling can be provided at respective heights along the cushion pads 10 they are holding. Other embodiments are possible, as will be understood by a person of ordinary skill in the art.

[0090] Now turning to Figures 16 to 18, there is illustrated an embodiment of the configuration or distribution of the cushion pads 10 within a helmet structure. It should be noted that the material density may vary from one cushion pad 10 to another, or between different regions of the helmet structure. More specifically, different types of cushion pads 10 may be provided at different locations of the helmet structure. Two cushion pads 10 of different types will generally have a least one different property, which may include, for example, density, stiffness, behavior, geometry, and the weight. In some embodiments, cushion pads 10 having a predetermined weight may be provided at given

locations of the helmet structure, depending on the mechanical requirements of the respective helmet portions. The size of the individual cells forming the cushion pad 10 may also vary. For example, each cell may have a dimension substantially equal to 3 mm, 4 mm, 5 mm or 6 mm. It should be readily understood that these values serve an illustrative purpose only.

[0091] It should be appreciated from the present disclosure that the various implementations of the helmet, and corresponding components, provide several advantages over conventional devices and/or apparatus in that it provides additional protection against collisions, such as those suffered by the helmets of football players, for example.

[0092] The present disclosure may be embodied in other specific forms without departing from the subject matter of the claims. The described example implementations are to be considered in all respects as being only illustrative and not restrictive. For example, in the embodiments described herein, the cushion pads are used to provide a liner within a football helmet. However, it is noted that other types of gear or equipment can be provided with such cushion pads, such as, for example and without being limitative, plastron, chest pad, shoulder pad, knee pad, elbow pad, back protector pad, neck protector pad, neck roll, pad collar and neck guard.

[0093] In some embodiments, the connection pads 70 allows a relative movement of the sling 62 with respect to the other components of the helmet, *i.e.*, independently of the movement of the outer shell 52 or the head of the user. The mechanical properties of the connection pads 68,70 are designed or selected to achieve a targeted mobility, and allow a relative movement of the sling 62.

[0094] The present disclosure intends to cover and embrace all suitable changes in technology. The scope of the present disclosure is, therefore, described by the appended claims rather than by the foregoing description. The scope of the claims should not be limited by the implementations set forth in the examples, but should be given the broadest interpretation consistent with the description as a whole.

[0095] As used herein, the terms “coupled”, “coupling”, “attached”, “connected”, or variants thereof as used herein can have several different meanings depending in the

context in which these terms are used. For example, the terms coupled, coupling, connected, or attached can have a mechanical connotation. For example, as used herein, the terms coupled, coupling, or attached can indicate that two elements or devices are directly connected to one another or connected to one another through one or more intermediate elements or devices via a mechanical element depending on the particular context.

[0096] In the present disclosure, an embodiment is an example or implementation of the perforation blade. The various appearances of "one embodiment," "an embodiment" or "some embodiments" do not necessarily all refer to the same embodiments. Although various features may be described in the context of a single embodiment, the features may also be provided separately or in any suitable combination. Conversely, although the helmet and related components may be described herein in the context of separate embodiments for clarity, it may also be implemented in a single embodiment. Reference in the specification to "some embodiments", "an embodiment", "one embodiment", or "other embodiments", means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least some embodiments, but not necessarily in all embodiments.

[0097] In the above description, the same numerical references refer to similar elements. Furthermore, for the sake of simplicity and clarity, namely so as to not unduly burden the figures with several references numbers, not all figures contain references to all the components and features, and references to some components and features may be found in only one figure, and components and features of the present disclosure which are illustrated in other figures can be easily inferred therefrom.

[0098] In addition, although the optional configurations as illustrated in the accompanying drawings comprises various components and although the optional configurations of the helmet and related components as shown may consist of certain geometrical configurations as explained and illustrated herein, not all of these components and geometries are essential and thus should not be taken in their restrictive sense, i.e. should not be taken as to limit the scope of the present disclosure. It is to be understood that other suitable components and cooperations thereinbetween, as well as other suitable geometrical configurations may be used for the implementation and use of the robot cell,

and corresponding parts, as briefly explained and as can be easily inferred herefrom, without departing from the scope of the disclosure.

CLAIMS

1. A cushion pad connectable to a garment for providing protection thereto, the cushion pad comprising:

   a plurality of layers formed of strings disposed in a manner to define a repeating pattern, with the plurality of layers being stacked on one another to define one or more cells along a thickness of the cushion pad.

2. The cushion pad of claim 1, wherein the repeating pattern is defined in each layer of the plurality of layers.

3. The cushion pad of claim 1, wherein the repeating pattern is defined by at least two adjacent layers of the plurality of layers.

4. The cushion pad of any one of claims 1 to 3, wherein the repeating pattern includes a lattice pattern, a honeycomb pattern, a hexagonal pattern or a combination thereof.

5. The cushion pad of any one of claims 1 to 4, wherein the plurality of layers comprises a first section and a second section, and wherein the strings of the first section of the plurality of layers define a first repeating pattern, and the strings of the second section of the plurality of layers define a second repeating pattern.

6. The cushion pad of claim 5, wherein the first repeating pattern and the second repeating pattern are configured to provide respective impact absorption behaviors.

7. The cushion pad of claim 5 or 6, wherein the first section and the second section are stacked one on top of another.

8. The cushion pad of any one of claims 5 to 7, wherein the strings of the first section define the lattice pattern, and the strings of the second section define the honeycomb pattern.

9. The cushion pad of any one of claims 1 to 8, wherein at least some of the one or more cells are shaped and configured to reversibly deform.

10. The cushion pad of any one of claims 1 to 9, wherein the strings of at least some of the plurality of layers are aligned with the strings of another one of the plurality of layers to form substantially straight cells.

11. The cushion pad of any one of claims 1 to 10, wherein the strings of at least some of the plurality of layers are offset relative to the strings of one or more adjacent layers.

12. The cushion pad of any one of claims 1 to 11, wherein the strings of at least some of the plurality of layers are axially offset in at least one direction relative to the strings of one or more adjacent layers, rotationally offset relative to the strings of one or more adjacent layers, or a combination thereof.

13. The cushion pad of claim 12, wherein the strings of at least some of the plurality of layers are rotationally offset by between about 1 degree and 359 degrees relative to the strings of one or more adjacent layers.

14. The cushion pad of any one of claims 1 to 13, wherein at least some of the plurality of layers are substantially planar and parallel to one another.

15. The cushion pad of any one of claims 1 to 14, wherein at least some of the plurality of layers are substantially planar and angled relative to one another.

16. The cushion pad of any one of claims 1 to 15, wherein at least some of the plurality of layers are non-planar.

17. A helmet comprising:

an outer shell defining a cavity for receiving a head of a person;

a support structure coupled to the outer shell and positioned within the cavity, the support structure comprising a web of support material

positioned in a spaced-apart relation relative to the outer shell and defining a plurality of openings; and

a plurality of cushion pads provided within respective openings of the web of support material, the plurality of cushion pads forming a liner of the helmet, where each cushion pad comprises an outer cushion section extending between the outer shell and the web of support material and an inner cushion section extending within the cavity on an opposite side of the web of support material relative to the outer cushion section.

18. The helmet of claim 17, wherein the cushion pads are manufactured using an additive manufacturing process.

19. The helmet of claim 17 or 18, wherein the cushion pads are manufactured using a 3D printing process.

20. A protective garment having a surface provided with a support structure, comprising :

a plurality of cushion pads connectable to the support structure and adapted to form a liner of the protective garment, each cushion pad comprising an outer cushion section extending between the surface of the protective garment and support structure, and an inner cushion section extending opposite the outer cushion section on an opposite side of the support structure.

21. The protective garment of claim 20, wherein each cushion pad comprises a plurality of layers formed of segments defining a repeating pattern, and wherein the plurality of layers are stacked to define cells along a thickness of the cushion pad.

22. The protective garment of claim 20 or 21, wherein the repeating pattern is defined in each layer of the plurality of layers.

23. The protective garment of claim 20 or 21, wherein the repeating pattern is defined by at least two adjacent layers of the plurality of layers.

24. The protective garment of any one of claims 20 to 23, wherein the repeating pattern includes a lattice pattern, a honeycomb pattern, a hexagonal pattern or a combination thereof.

25. The protective garment of any one of claims 20 to 24, wherein the plurality of layers comprises a first section and a second section, and wherein the segments of the first section of the plurality of layers define a first repeating pattern, and the segments of the second section of the plurality of layers define a second repeating pattern.

26. The protective garment of claim 25, wherein the first repeating pattern and the second repeating pattern are configured to provide respective impact absorption behaviors.

27. The protective garment of claim 25 or 26, wherein the first section and the second section are stacked one on top of another.

28. The protective garment of any one of claims 25 to 27, wherein the first section includes layers defining the lattice pattern, and the second section includes layers defining the honeycomb pattern.

29. The protective garment of any one of claims 20 to 28, wherein at least some of the one or more cells are shaped and configured to reversibly deform.

30. The protective garment of any one of claims 20 to 29, wherein the segments of at least some of the plurality of layers are aligned with the segments of another one of the plurality of layers to form substantially straight cells.

31. The protective garment of any one of claims 20 to 30, wherein the segments of at least some of the plurality of layers are offset relative to the segments of one or more adjacent layers.

32. The protective garment of any one of claims 20 to 31, wherein the segments of at least some of the plurality of layers are axially offset in at least one direction relative to the segments of one or more adjacent layers, rotationally offset relative to the segments of one or more adjacent layers, or a combination thereof.

33. The protective garment of claim 32, wherein the segments of at least some of the plurality of layers are rotationally offset by between about 1 degree and 359 degrees relative to the segments of one or more adjacent layers.

34. The protective garment of any one of claims 20 to 33, wherein at least some of the plurality of layers are substantially planar and parallel to one another.

35. The cushion pad of any one of claims 20 to 34, wherein at least some of the plurality of layers are substantially planar and angled relative to one another.

36. The protective garment of any one of claims 20 to 35, wherein at least some of the plurality of layers are non-planar.

37. The protective garment of any one of claims 20 to 36, wherein the protective garment includes a helmet.

38. A protective cushion pad comprising:

a plurality of layers formed of strings disposed to define a repeating pattern, with the plurality of layers being stacked on each other to define one or more cells along a thickness of the cushion pad.

39. The protective cushion pad of claim 36, further comprising any one feature of any one of claims 1 to 16.

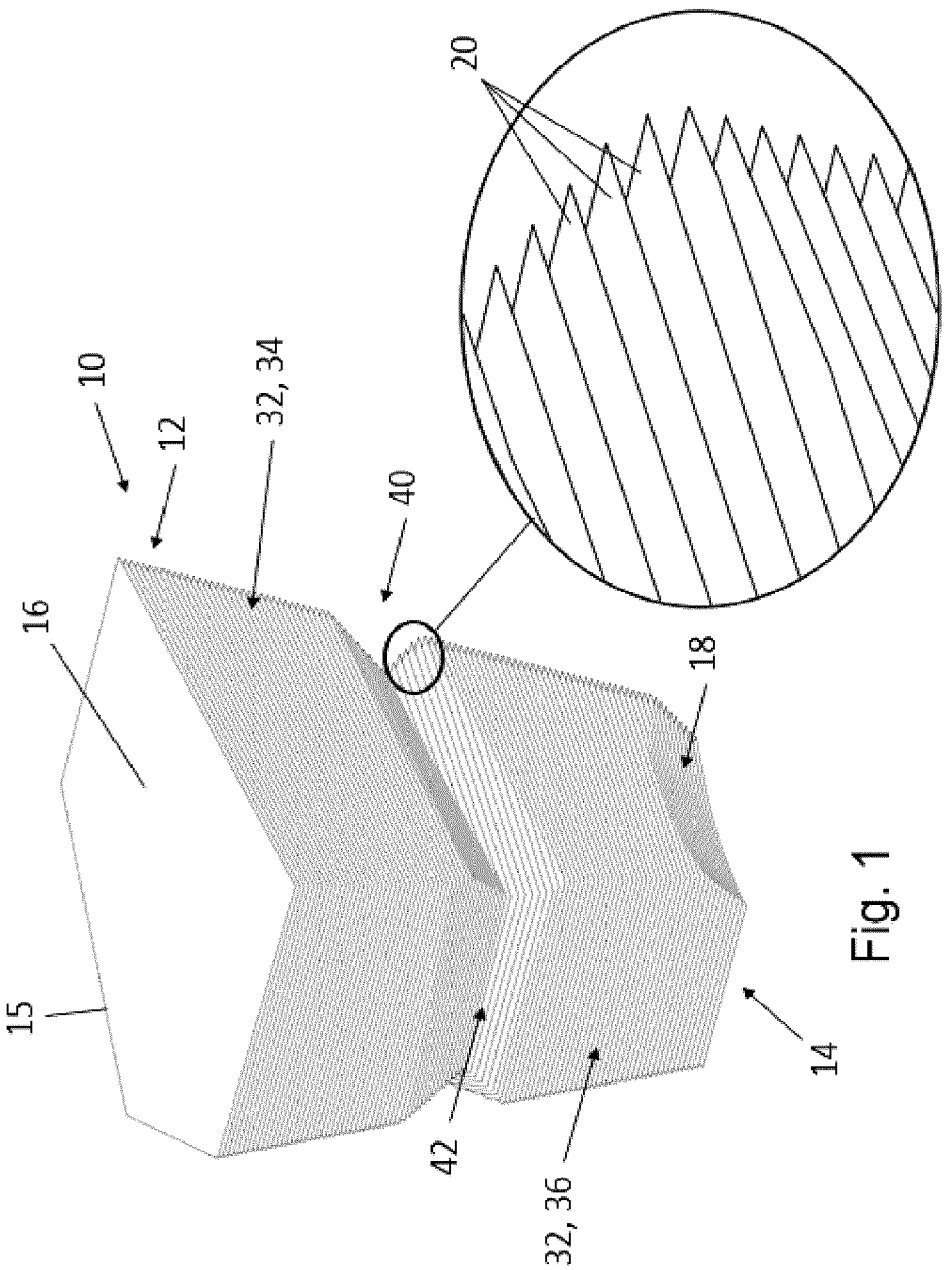

Fig. 1

Fig. 1A

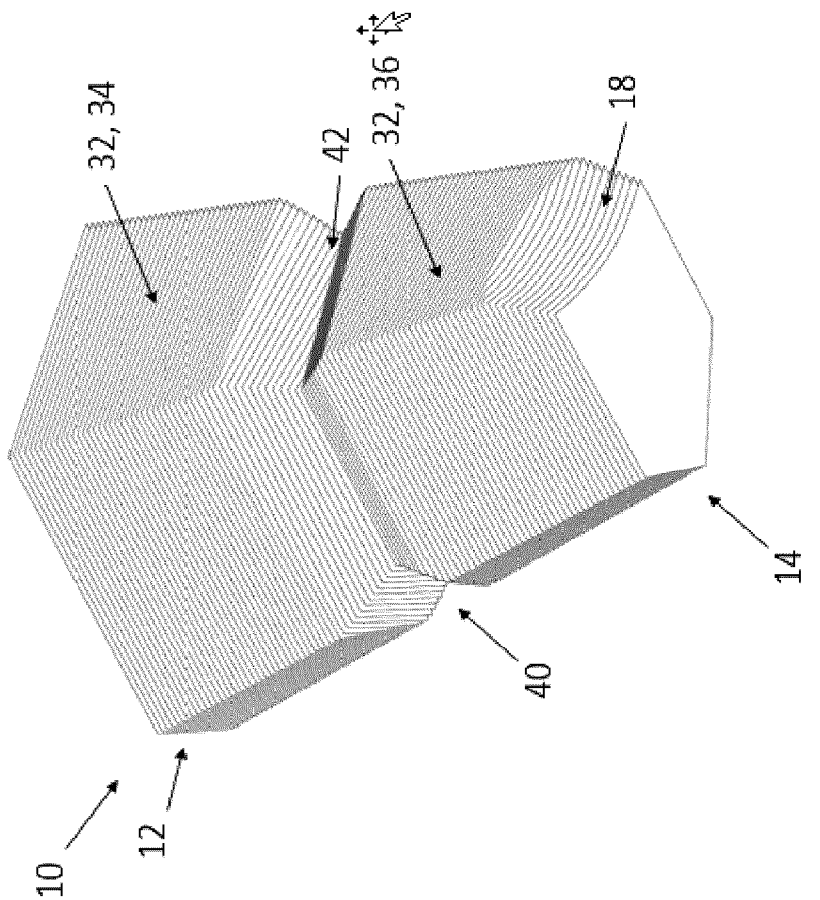

Fig. 2

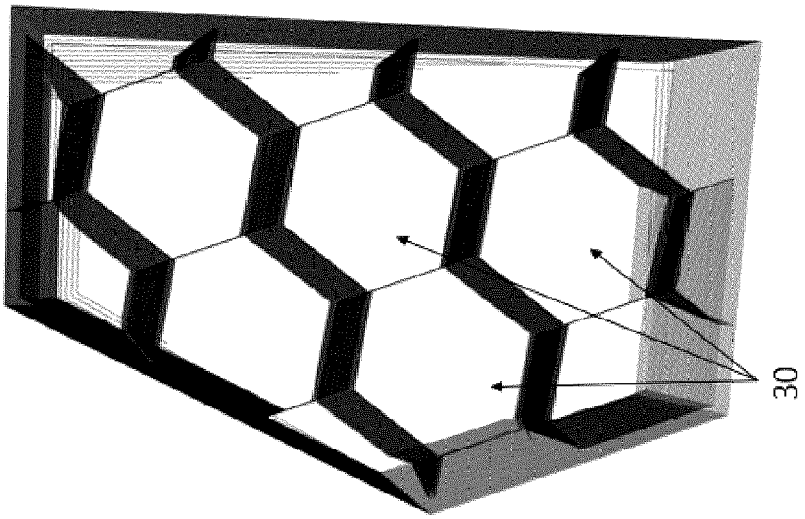

Fig. 4

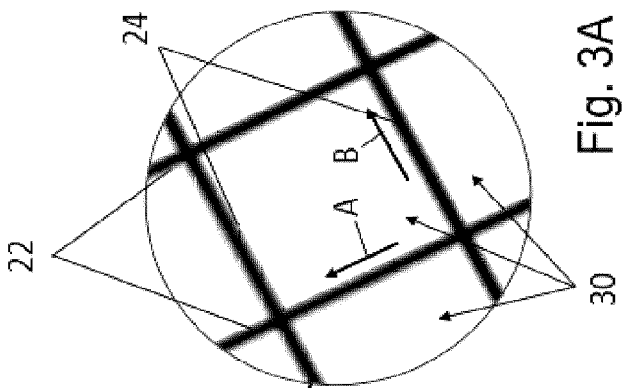

Fig. 3A

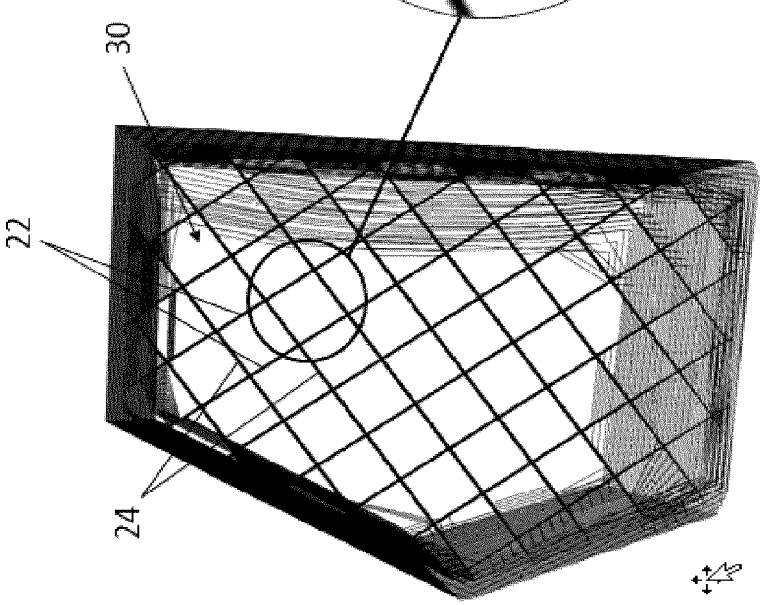

Fig. 3

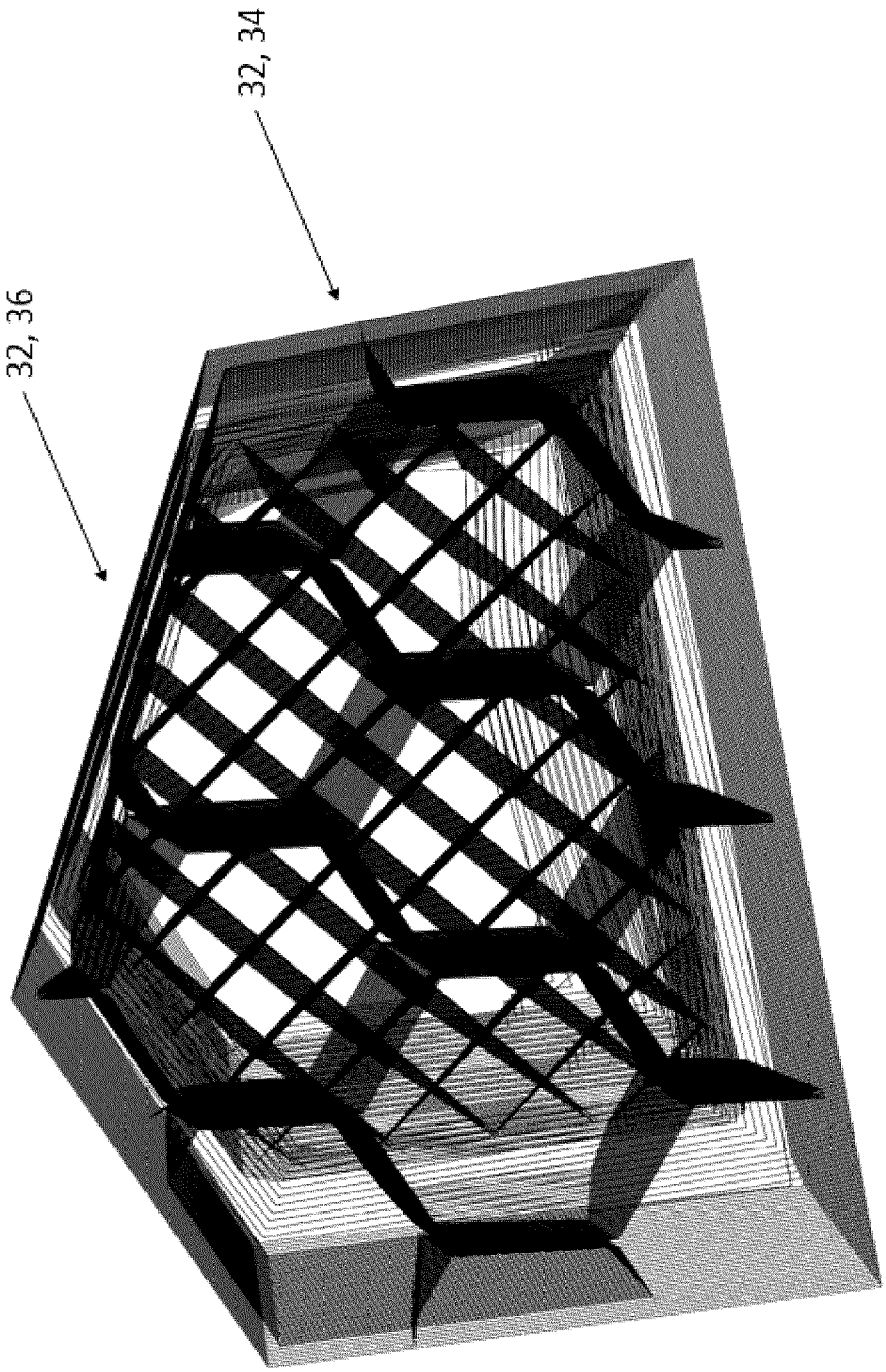

Fig. 5

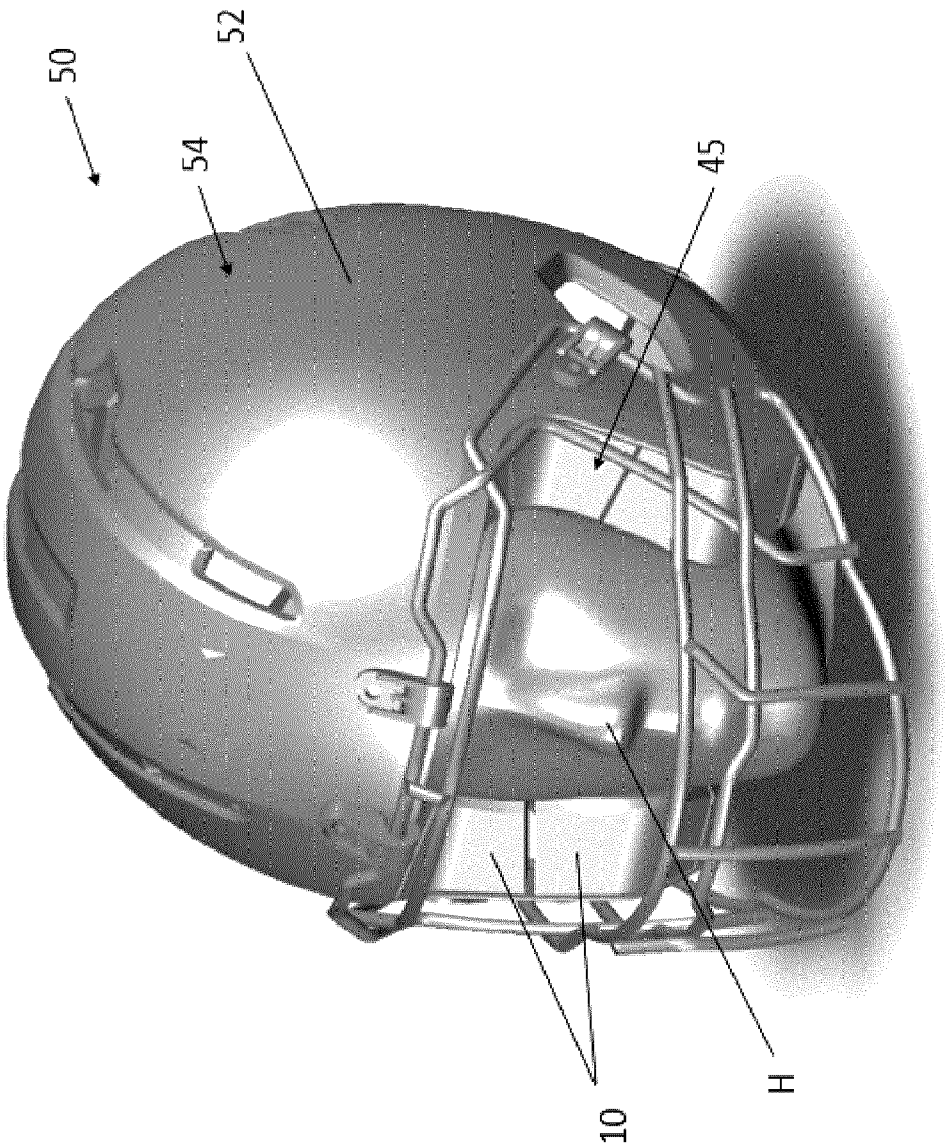

Fig. 6

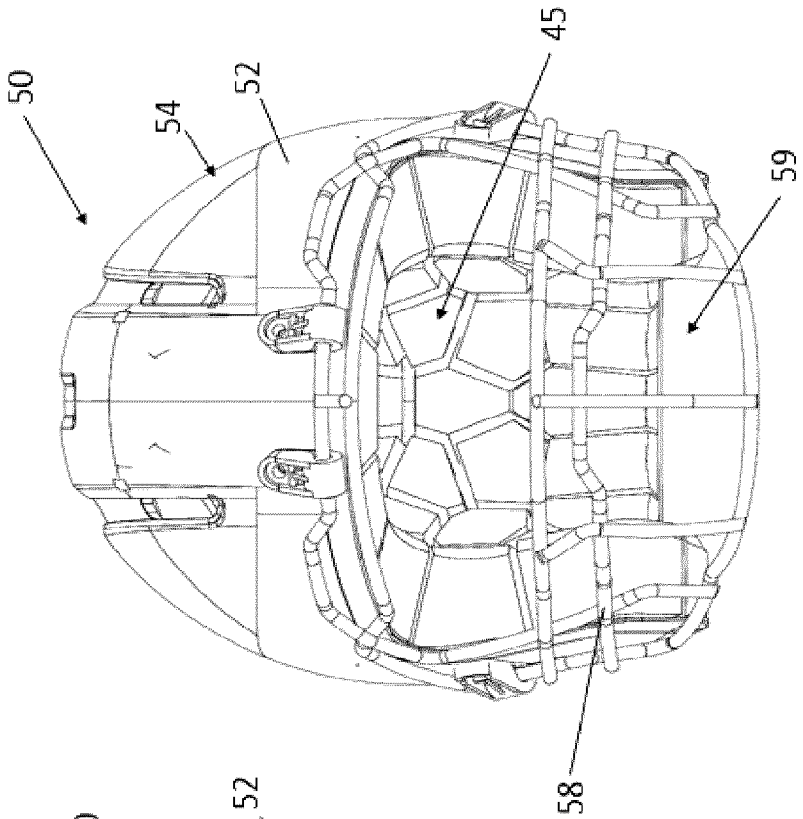

Fig. 8

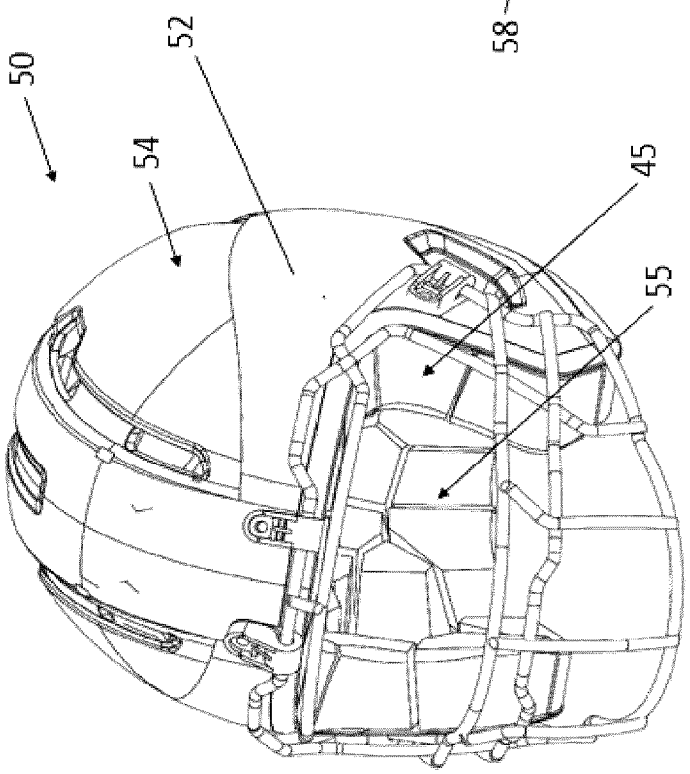

Fig. 7

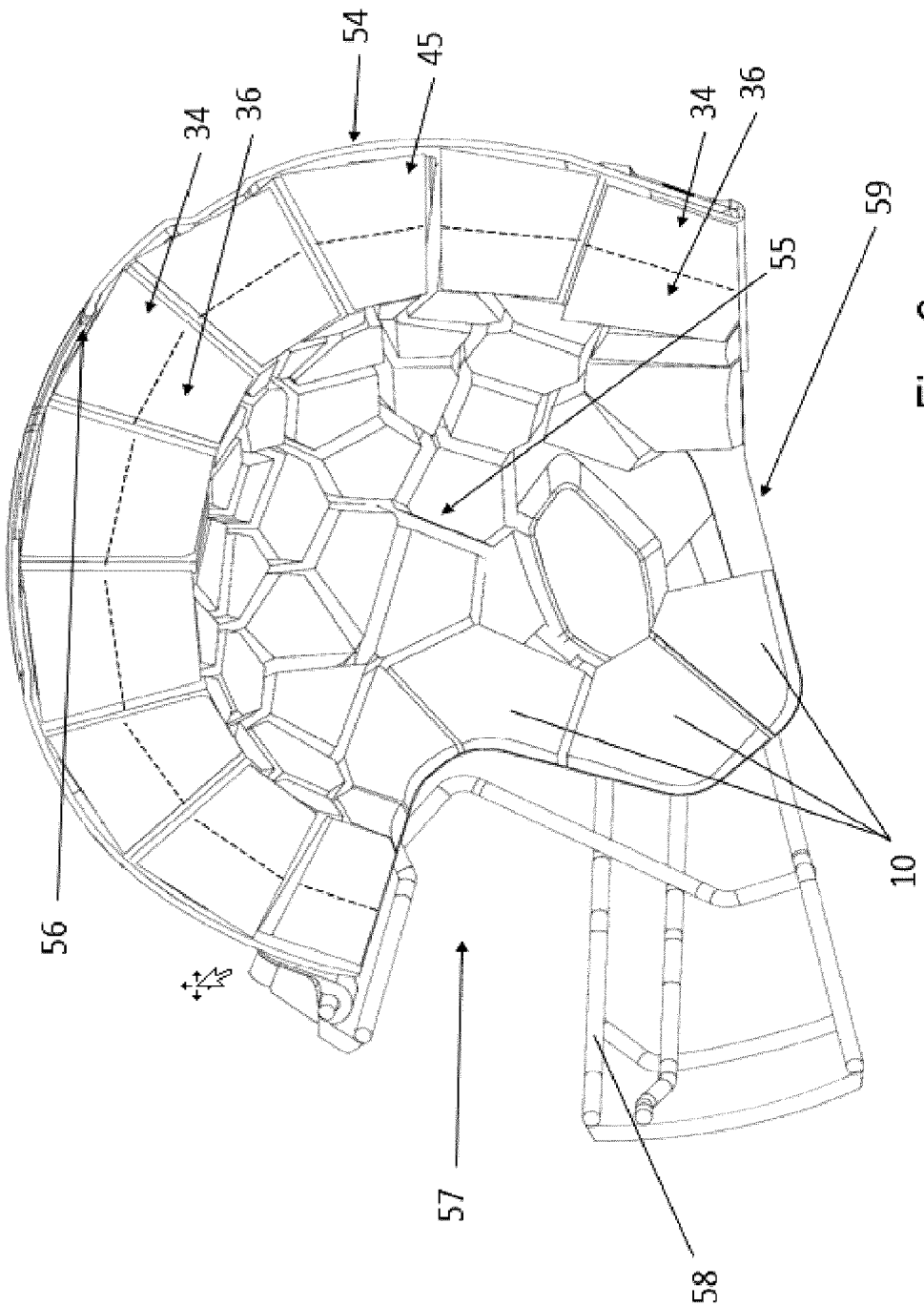

Fig. 9

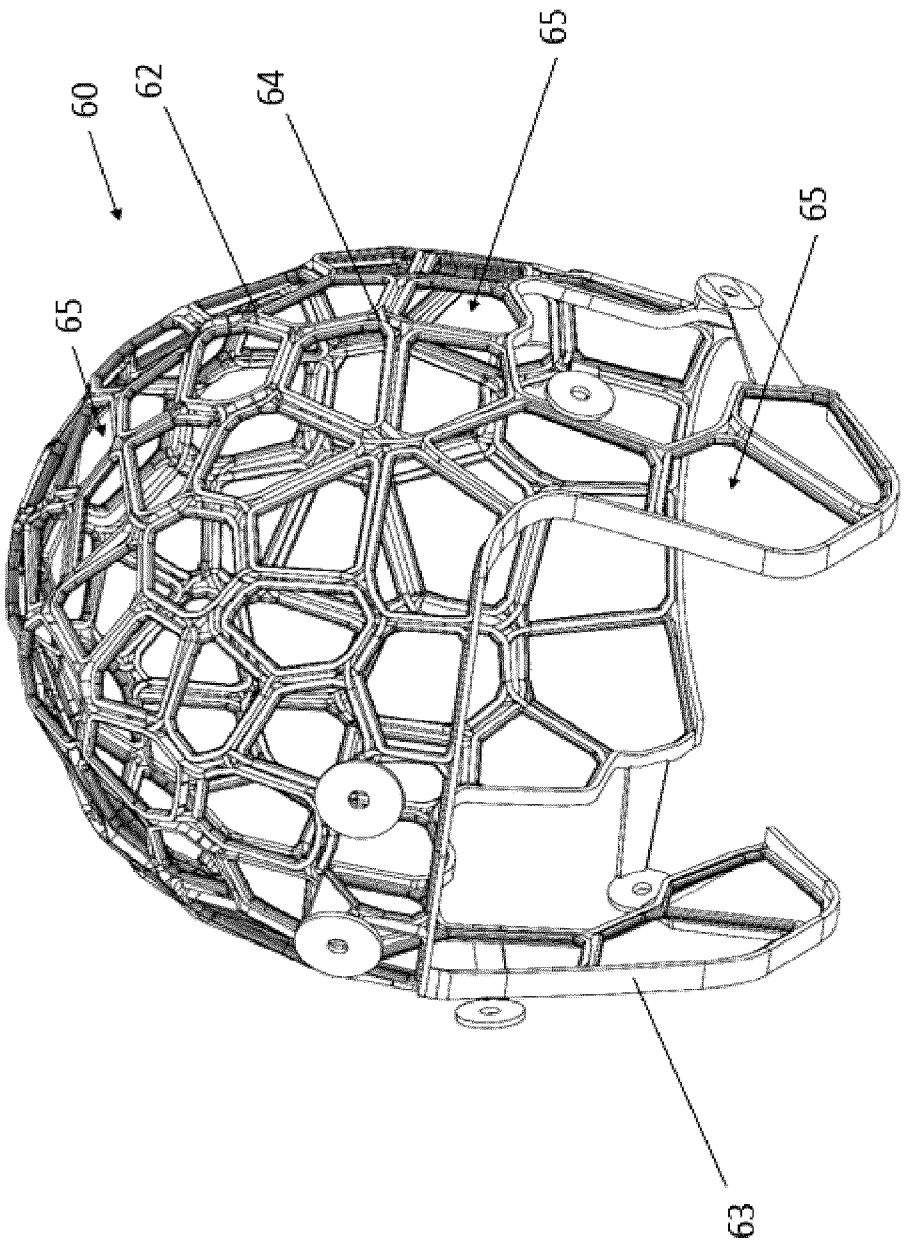

Fig. 10

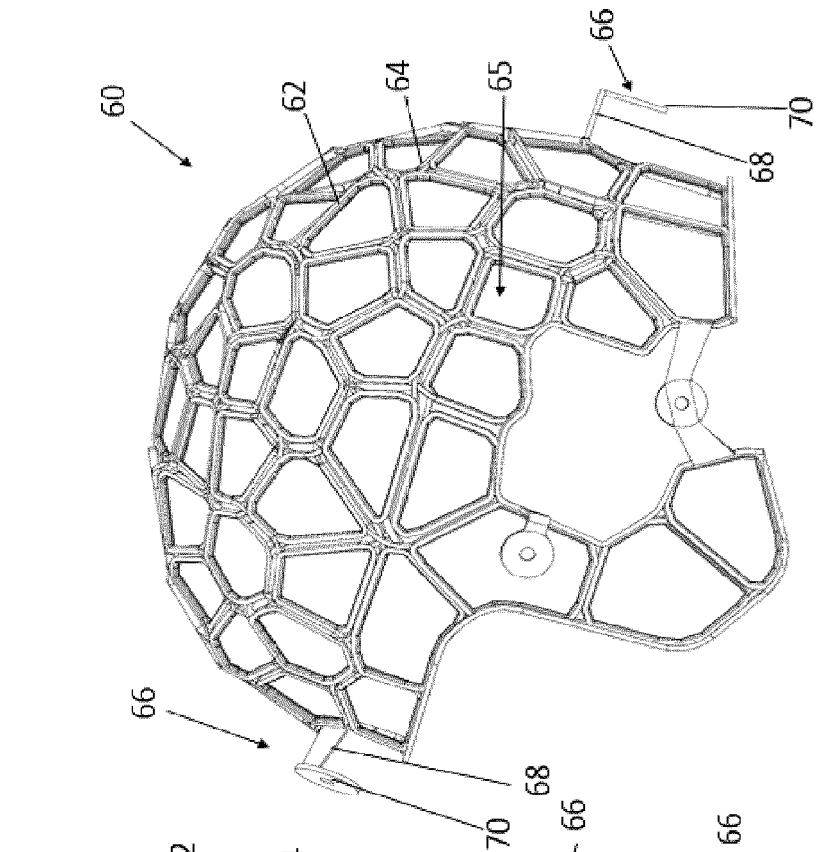

Fig. 12

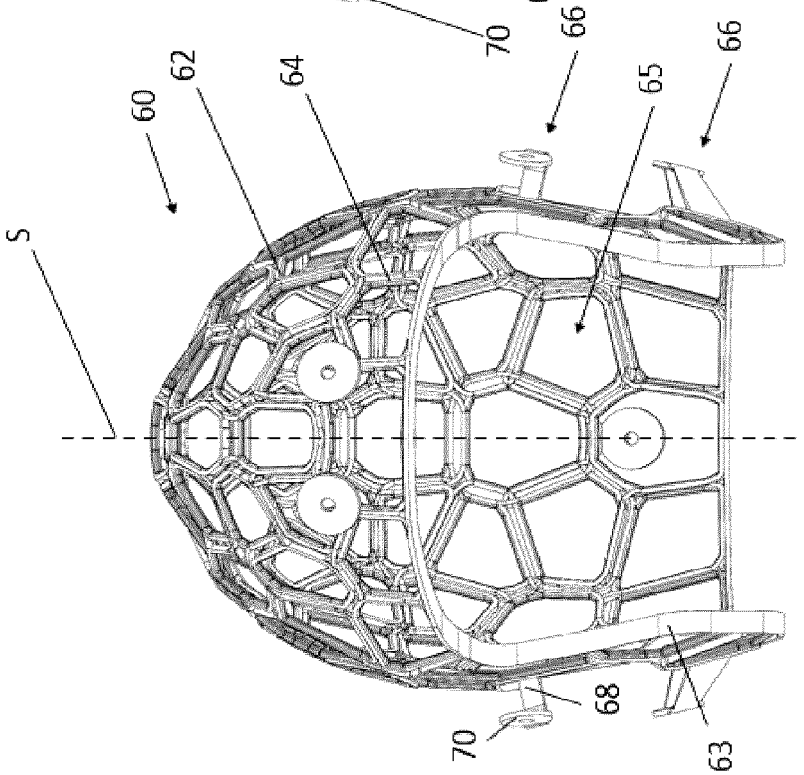

Fig. 11

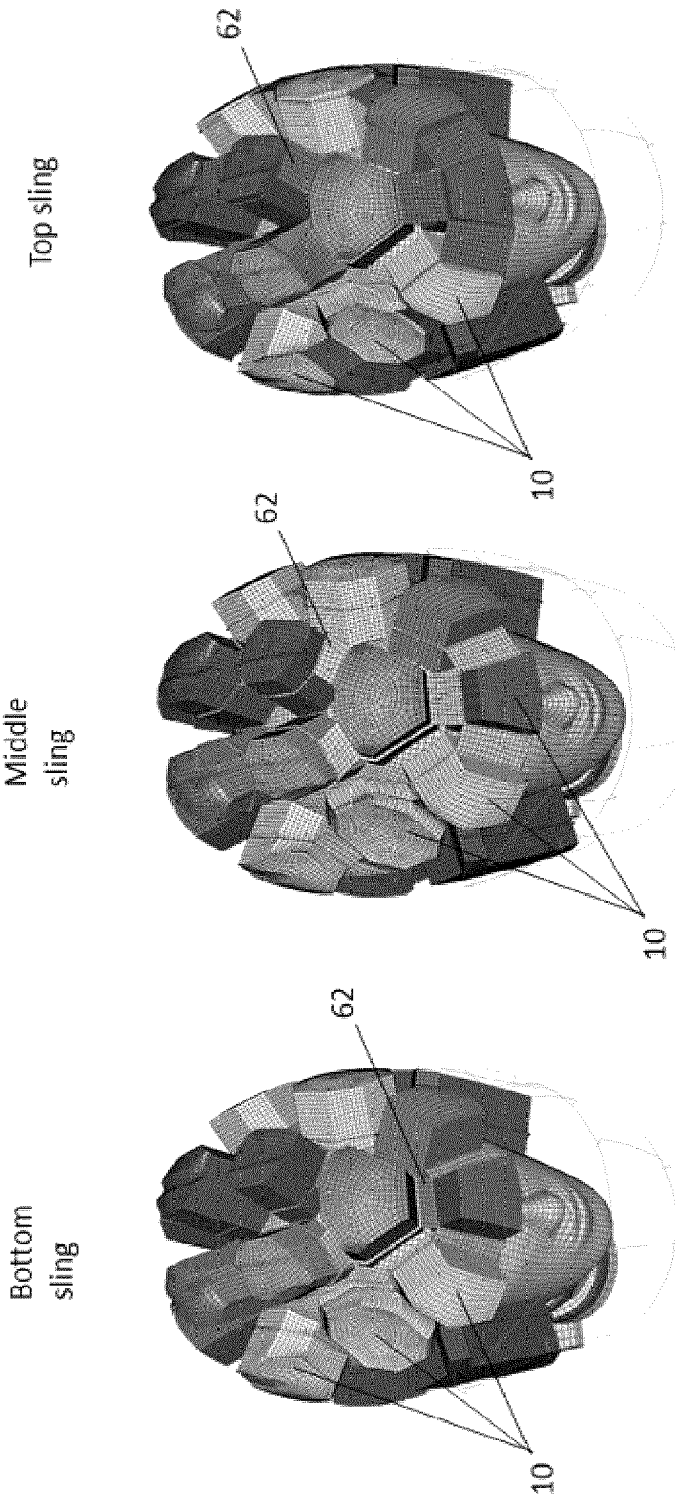

Fig. 13

Fig. 14

Fig. 15

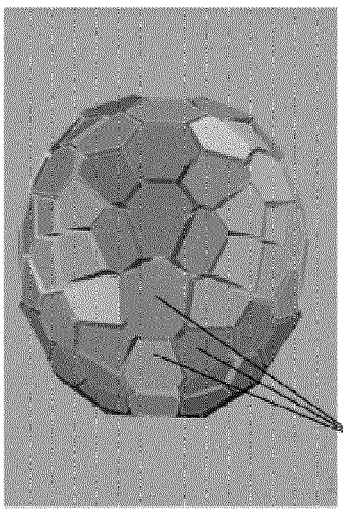

Fig. 18

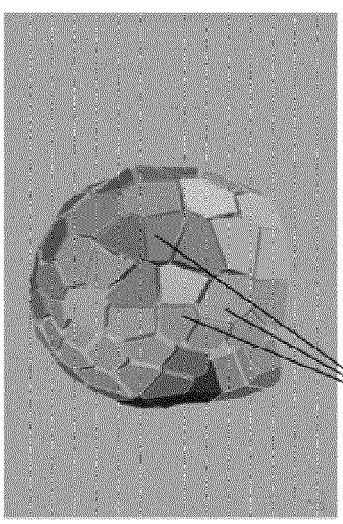

Fig. 17

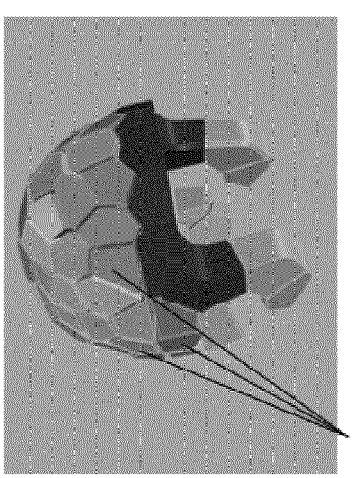

Fig. 16

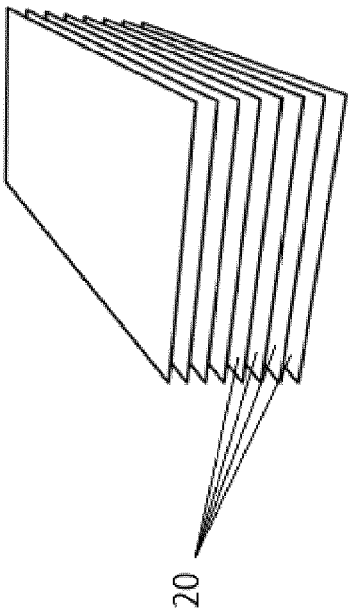

Fig. 20

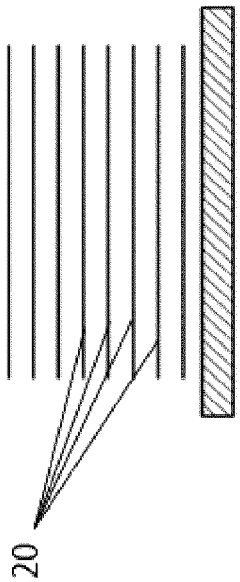

Fig. 21

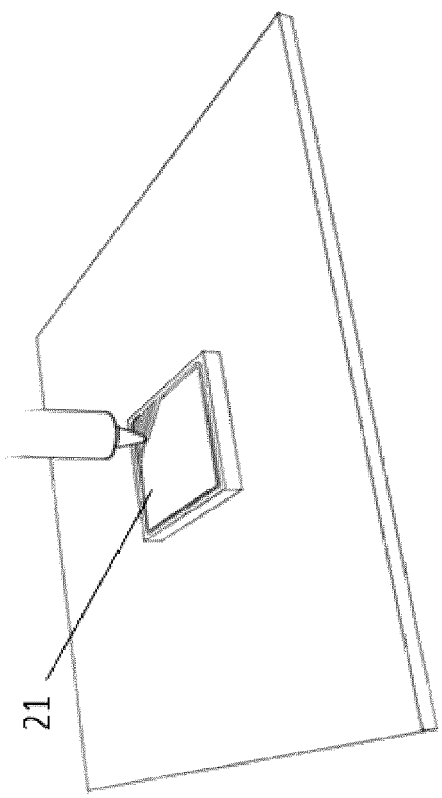

Fig. 19

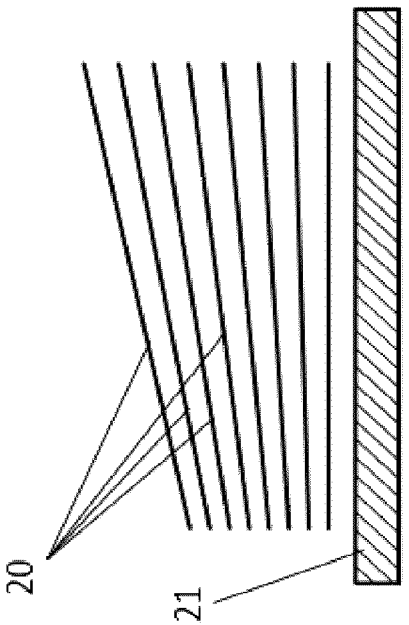

Fig. 23

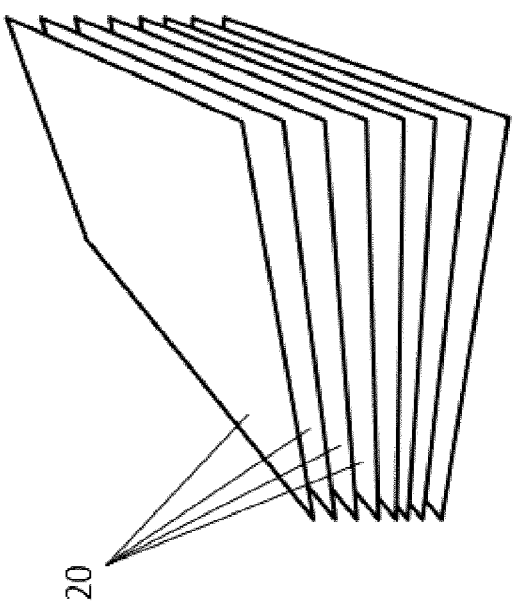

Fig. 22

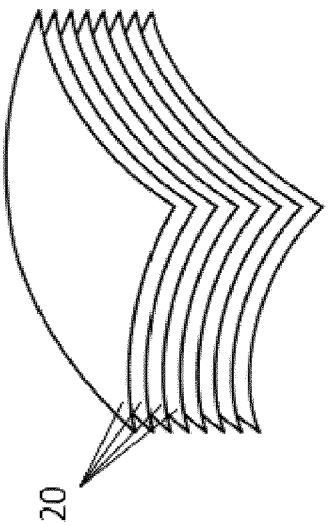

Fig. 25

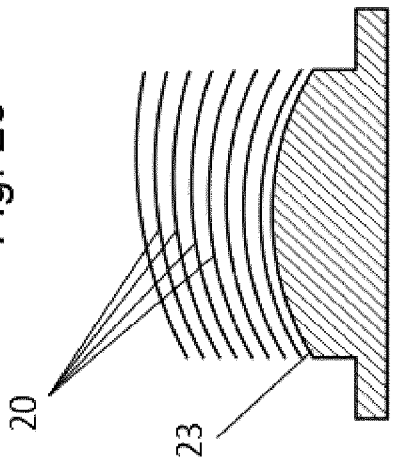

Fig. 26

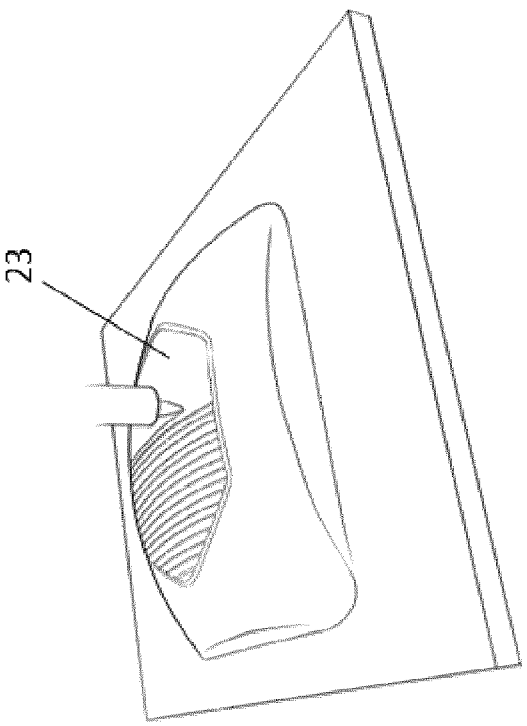

Fig. 24

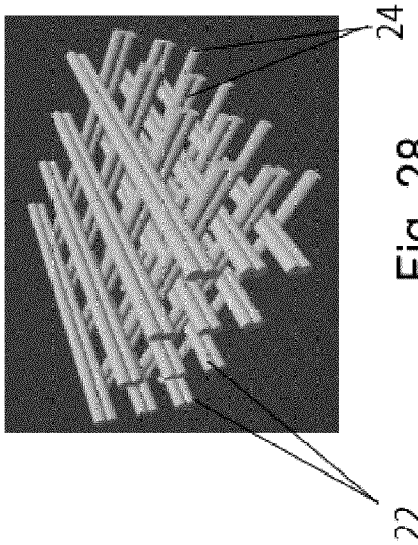

Fig. 28

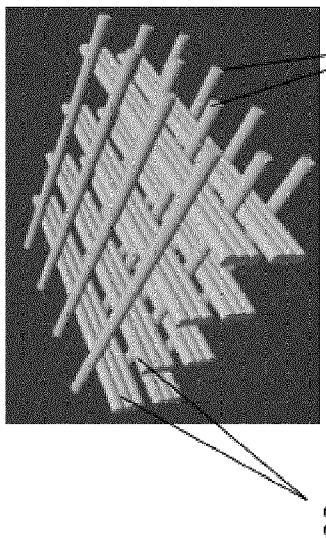

Fig. 30

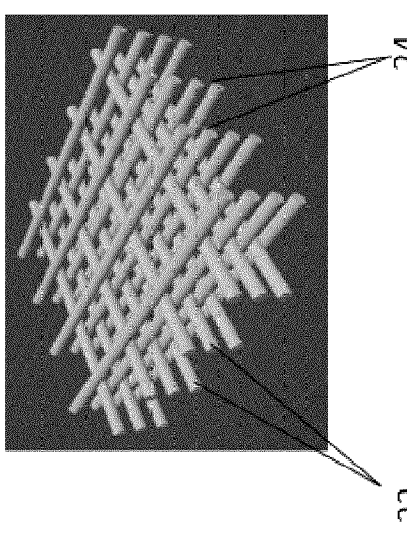

Fig. 27

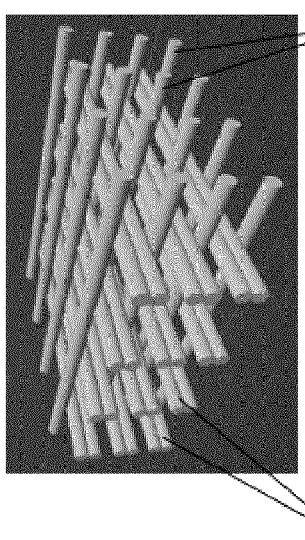

Fig. 29

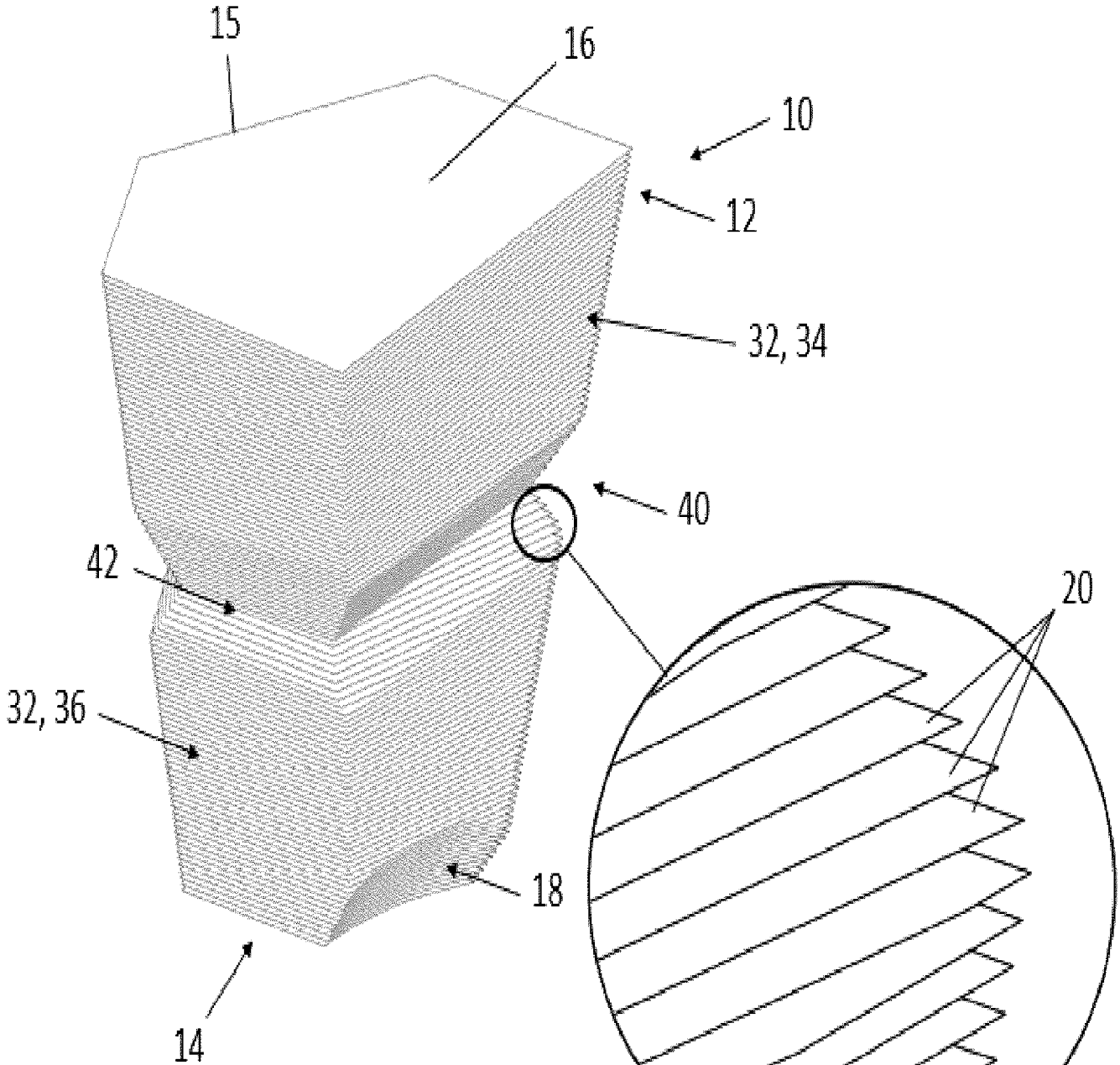

Fig. 1

Fig. 1A