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(54) **HELMET**

HELM

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(56) References cited:
EP-A1- 3 838 043
US-A1- 2015 047 110
US-B1- 10 834 987

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Description

TECHNICAL FIELD

[0001] The present invention relates to the field of helmets with cellular energy-absorbing structures. In particular, the present invention relates to helmets using layered structures.

BACKGROUND ART

[0002] In the state of the art some helmet solutions using cellular energy-absorbing structures are known. These kinds of structures have excellent properties in terms of impact energy absorption with respect to traditional polymeric foam materials. Despite this, the foam allows to obtain fascinating shapes and is still easier to mould with respect to the cellular structures. Therefore, many solutions employing these kinds of energy-absorbing structures combine the use of foam liners and cellular structures.

[0003] An example in this sense is disclosed in the patent US10834987. This document relates to a helmet comprising a plurality of cellular liners that are retained within respective recesses of a polymer foam shell without the necessity of using additional fasteners or adhesive, and discloses the preamble of claim 1. Substantially, the cellular liner of this document is sized to fit snug within the recess and is retained within the recess as a friction fit with the shell or foam of the recesses. According to this document fasteners are useless and discouraged. Despite the cellular liner being retained in the foam shell, during an oblique impact to the helmet, the cellular liner slides over a barrier layer arranged on the polymer shell and simultaneously it in-plane compresses. Therefore, the risk that during an impact the cellular liner gets out the polymer shell is high and, in this case, the head of the wearer is exposed to serious risks.

[0004] Similarly to the previous prior art document, the patent EP3473122 relates to a solution wherein a foam liner configured to support a cellular insert and, during an impact, the foam liner acts as a stop that helps to prevent the insert from sliding out of the cycling helmet. In addition, this solution uses an insert cover which helps prevent the insert removal. This insert cover is arranged on the foam liner to traverse the entire interior perimeter of the helmet for protecting the user's head from the abrasive surface of the insert. Indeed, cellular energy absorbing structures can have interior edges that are somewhat abrasive and uncomfortable if in direct contact with skin. For this reason, the insert cover of this document is arranged only over the interface between the insert and the foam liner, to avoid this kind of problem.

[0005] In this solution, the insert cover is not a fastener used to lock the insert to the foam liner, but a system for improving the comfort of the helmet and preventing a manipulation of the helmet. Substantially, this solution limits the problem of the previously mentioned document US108349872, but it does not avoid an insert leakage, because during an impact the insert pad in-plane compresses and deforms, reducing its size. Consequently, the peripheral containment is not enough to avoid the release of the cellular insert from the foam liner during an oblique impact, exposing the wearer to risks.

[0006] None of the available solutions provides helmets comprising cellular energy-absorbing inserts that are fastened to the shell of the helmet, guaranteeing a firm connection between shell and cellular inserts during an impact regardless of the shell shape. This firm connection is required in particular during an oblique impact and presently known solutions do not guarantee that the cellular energy-absorbing insert does not come disconnected from the shell, nullifying its advantages and exposing the wearer to serious risks.

[0007] Moreover, all available solutions disclose helmets having cellular energy-absorbing inserts spanning across the at least one vent of the helmet, which reduce or alter ventilation.

[0008] Furthermore, since cellular energy-absorbing materials are more expensive with respect to foams, none of the available solutions suggests minimizing the usage of cellular energy-absorbing inserts for realizing a cheaper helmet, without affecting their safety.

[0009] Finally, none of the available solutions simplify the helmet construction and assembly.

SUMMARY

[0010] Said and other inconvenients of the state of the art are now solved by a helmet comprising: a shell having at least one vent; one or more inserts of a cellular energy-absorbing material having a curved shape; and one or more retainers crossing the one or more inserts from side to side and fixed to the shell at opposing sides of the insert for constraining it to the shell. The one or more retainers are shaped so as to laterally and inwardly trap the one or more inserts. A helmet so conceived allows to connect the insert/s in a stable manner to the shell, avoiding any release of the insert/s during an impact event, in particular during an oblique impact to the helmet. Moreover, this helmet allows simplification of assembly and allows smaller cellular inserts with a consequent reduction in costs.

[0011] Advantageously, the one or more inserts can be arranged inside the shell so as to leave the at least one vent free. This kind of solution maximizes the ventilation of the wearer's head, without detriment to the level of protection provided by the helmet.

[0012] Preferably, one or more retainers can be fixed to the shell so as to not span across said at least one vent. In this way, the vents are completely free and no obstacles are present in the vents.

[0013] In particular, the one or more retainers can comprise a plurality of first connectors, preferably snap-pins, configured to reversibly engage respective second connectors, preferably snap-baskets, attached to the shell.

These kinds of connectors allow a connection/disconnection of the retainer/s to the shell.

[0014] Advantageously, the cellular energy absorbing material of the one or more inserts can comprise a plurality of interconnected open cells configured to absorb energy by plastic deformation in response to a longitudinal compressive load applied to said cells. This kind of cellular material provides excellent results in terms of energy-absorption and is very light weight. Preferably each cell can comprise a tube having a sidewall and a longitudinal axis, and the cells are connected to each other through their sidewalls. This feature enables the production of a sheet of interconnected side-by-side cells.

[0015] In particular, at least part of the longitudinal axes of the cells can be normal to an inner surface of the shell over which the one or more inserts are arranged. This arrangement of cells maximizes the absorption of the normal component of an impact.

[0016] Preferably, the helmet can also comprise a low frictional layer arranged over the shell in correspondence of the one or more inserts. This layer allows a translation of the insert reducing translational and angular accelerations of the brain that can be very dangerous for the wearer's health. This feature contributes to improve the helmet behaviour of absorbing the tangential component of an impact.

[0017] Advantageously, the one or more retaining elements can support one or more connecting means, like Velcro coins, for connecting a comfort liner to the rest of the helmet. These connecting means allow a simple, stable and fast positioning/removal of the comfort liner in/from the helmet.

[0018] In particular, the one or more retainers can be deformable and can exhibit a bending stiffness that is comparable or less than the insert/s' compressive stiffness. Due to this behaviour of the retainer/s, during an impact, the retainers do not act as rigid beams but simply follow the deformation of the insert/s without opposing resistance.

[0019] Advantageously, the shell can comprise a plurality of shoulders defining one or more places wherein respective one or more inserts are accommodated to prevent a global displacement of the respective insert. These shoulders allow to keep the insert in position both during the assembly and during the use of the helmet. In particular, in case of an oblique impact, the insert in-plane compresses and deforms against the shoulder/s, but it remains coupled to the shell thanks to the retainer/s.

[0020] Preferably, the inserts can be three or more and extend in a front-rear direction. At least one insert is arranged on a left-side of the shell, at least one insert is arranged on a right-side of the shell and at least one insert is arranged on a top-side of the shell. Left and right inserts allow to protect temporal lobes of the brain, while the top insert allows to protect frontal, parietal and occipital lobes.

[0021] Preferably, the shell is a deformable shell that can be made of a foam material, for having a cheaper helmet. Alternatively, the shell can comprise a lattice structure, preferably a 3D printed lattice structure that allows to achieve better energy-absorbing performances.

[0022] In this particular case, the shell can comprise longitudinal and transverse ribs arranged so as to form vents. This architecture of the shell maximizes the strength of the deformable shell and allows perspiration and air flow.

[0023] Advantageously, the helmet can also comprise an upper skin configured to cover at least in part an upper and outer surface of the shell, and/or a lower skin configured to cover at least in part a lower and outer surface of the shell. The upper skin contributes, together with the shell and the inserts, to absorb the energy of an impact. The lower skin allows a customization of the helmet and protects the shell from lateral/lower impacts.

[0024] In an embodiment, the shell can also comprise one or more recesses shaped for accommodating additional insert/s. These additional inserts contribute to the impact energy absorption.

[0025] In an alternative embodiment to the deformable shell, the shell can be a hard shell, that is rigid and more suitable for work helmets.

[0026] These and other advantages will be better understood thanks to the following description of different embodiments of said invention given as non-limitative examples thereof, making reference to the annexed drawings.

DRAWINGS DESCRIPTION

[0027] In the drawings:

Fig. 1 shows an isometric view of a first embodiment helmet according to the present invention viewed from below;

Fig. 2 shows a top view of a first embodiment helmet according to the present invention;

Fig. 3 shows a side view of a first embodiment helmet according to the present invention;

Fig. 4 shows a bottom exploded view of a first embodiment helmet according to the present invention;

Fig. 5 shows a detailed view of the connectors of the helmet according a first embodiment of the present invention;

Fig. 6 shows an isometric bottom view of a first embodiment helmet according to the present invention wherein the inserts are removed;

Fig. 7 shows a top view of a second embodiment helmet of the present invention;

Fig. 8 shows a front view of a second embodiment helmet of the present invention;

Fig. 9 shows a side view of a second embodiment helmet of the present invention;

Fig. 10 shows a bottom view of a second embodiment helmet of the present invention;

Fig. 11 shows longitudinal cross-sectional view of

the helmet according to the second embodiment;
Fig. 12 shows an exploded view of a second embodiment helmet according to the present invention;
Fig. 13 shows a bottom view of a third embodiment helmet according to the present invention;
Fig. 14 shows an exploded view of a third embodiment helmet according to the present invention;
Fig. 15 shows longitudinal cross-sectional view of a third embodiment helmet according to the present invention;
Fig. 16 shows a detailed view of the connectors of a third embodiment helmet according to the present invention.

DETAILED DESCRIPTION

[0028] The following description of one or more embodiments of the invention refers to the annexed drawings. The same reference numbers indicate equal or similar parts. The object of the protection is defined by the annexed claims. Technical details, structures or characteristics of the solutions here-below described can be combined with each other in any suitable way.

[0029] With the reference number 1 is represented a helmet according to the present invention. In particular, Figs. 1-6 depict a first embodiment of the helmet and Figs. 7-12 depict a second embodiment of the helmet, Figs. 13-16 depict a third embodiment of the helmet.

[0030] The main components of the helmet 1 are the shell 2, the insert/s 3 and the retainer/s 4, as shown in the figures. These components will be detailed in the following.

[0031] The helmets 1 of the present invention comprise a head retention system (not represented). This retention system is configured to maintain the helmet 1 over the head of the wearer.

[0032] In the first and second embodiments, the shell 2 is preferably a body made of a polymeric foam, like EPS (Expanded Polystyrene) or EPP (Expanded Polypropylene), thus a deformable shell 2. Alternatively, the shell 2 is a hard shell like that of the third embodiment. In a further alternative embodiment (not shown), the shell 2 comprises a lattice structure. In the first and second embodiments, the shell is deformable, while in the third embodiment the shell is more rigid.

[0033] This shell 2 has an outer surface that can be subdivided in an upper outer surface 12 and a lower outer surface 11, and an inner surface 17.

[0034] This shell 2 generally provides the overall size and appearance of the helmet, as shown in Figs. 12 and 14.

[0035] The insert 3 comprises a cellular energy-absorbing material that performs better than traditional foam materials in terms of energy-absorption, in particular in terms of absorption of compressive impact energy.

[0036] The insert 3 is made of a plurality of interconnected open cells 16. These cells 16 are configured to absorb energy by plastic deformation in response to a longitudinal compressive load.

[0037] Each cell 16 comprises a tube having a sidewall and a longitudinal axis. The cells 16 are interconnected via their sidewalls.

[0038] Initially, the insert 3 is flat and subsequently is curved. The flat insert (not shown) is like a tile/brick of interconnected cells having parallel longitudinal axes. The flat insert is cut to the required dimensions and then is curved. The flat insert normally has a constant thickness.

[0039] The flat insert can be curved via thermoforming or manually if it has synclastic or monoclastic behaviours. The insert 3 can thus assume a single-curved shape or a double-curved shape.

[0040] The cells 16 of the insert 3 are preferably tubes. The tubes depicted in the figures have circular cross-sections. Alternatively, the cross-section of the cells/tubes 16 can be a square, a hexagon, a non-uniform hexagon, a re-entrant hexagon, a chiral truss, a diamond, a triangle or an arrowhead. In particular, the cross-section of the cells/tubes 16 can be shaped so that the insert 3 exhibits a monoclastic or synclastic behaviour. Alternatively, the cells 16 can be the cells of a lattice structure.

[0041] Almost all cells 16 of the inserts 3 have longitudinal axes that are normal to the inner surface 17 of the shell 2. In this way the energy absorption is improved.

[0042] The cells 16 can be welded to each other via their sidewalls. Alternatively, the cells 16 can be bonded by means of adhesive layers interposed between adjacent sidewalls. The cells 16 can be connected so as to minimize the gap between adjacent tubes. Alternatively, the cells 16 can be monolithically extruded or 3D printed so as to share sidewalls.

[0043] When the cells 16 have a circular cross-section, the outer diameter of the circular cross-section can range between 2,5 and 8 mm, and the wall thickness of said cells 16 can range between 0,05 and 0,3 mm. According to these dimensional values, the energy absorption of insert 3 is optimized. Furthermore, these values allow you to have a very light helmet 1.

[0044] The insert 3 has a thickness between 15 and 40 mm.

[0045] In a particular embodiment (not shown), the insert 3 can comprise an upper and/or lower sheet layer. Said sheet layer can be a polymeric fabric, or a film, firmly attached to the front edges of said open cells 16 through a heat-activated adhesive. When a load is applied, the fabric spreads the energy on a plurality of cells 16, even if the load is applied punctually. The heat-activated adhesive can be a thermoset polyester web film adhesive.

[0046] The inserts 3 are connected to the shell 2 by means of retainers 4.

[0047] The retainers 4 are shaped to follow the shape of the inner side of the insert/s 3.

[0048] These retainers 4 cross the inserts 3 where they are flatter, thus in a direction that is perpendicular to direction in which the insert 3 curves. Where the insert 3 is flatter, the retainers 4 can easily overlap and cross the

inserts 3 from side to side for tying it to the shell 2. Moreover, the surface of contact between the portion of the retainer 4 crossing the insert 3 and the insert 3 itself is maximized. For example, in the first and second embodiments, the inserts 3 are curved in a front-back direction and almost flat in a left-right direction, therefore the retainers 4 cross the inserts 3 in a left-right direction.

[0049] If the insert 3 is not very curved, the retainer 4 can also run in all directions. In the third embodiment of Figs. 13-16, the retainer 4 crosses the insert 3 in the direction wherein the insert 3 is flatter, thus the left-right direction of the helmet 1 and in the direction wherein the insert 3 has a bigger curvature, thus the front-back direction of the helmet 1.

[0050] Each retainer 4 comprises means to connect it to the shell 2 in a reversible or irreversible manner.

[0051] Each retainer 4 is coupled to the shell 2 so that, for each insert 3, one coupling point lies on one side of the insert 3 and another coupling point lies on the other side of the insert 3. Each insert 3 is thus constrained to the shell 2 at two opposing sides via the retainer 4 that crosses it.

[0052] The retainers 4 are configured to not oppose resistance in case of an impact. For this reason, the retainers 4 are deformable and exhibit a stiffness in bending that is comparable to or inferior to the compressive stiffness of the inserts 3. In this way, in case of a compression of the helmet due to an impact, the retainers 4 do not act as rigid beams, and they follow the compressive deformation of the insert 3. The retainers 4 are preferably made of a polymer like nylon or polyethylene. Alternatively, the retainers 4 are made of an elastomeric material, so to exert a clamping force that pushes the insert/s 3 against the inner surface 17 of the shell 2.

[0053] With the term "opposite sides" or "opposing sides", reference is made to the lateral sides of the insert 3.

[0054] With reference to the first embodiment of Figs. 1-6, the shell 2 comprises a plurality of ribs 15 that are arranged longitudinally and transversally. The longitudinal ribs 15L cross the transverse ribs 15T. On the upper portion of the helmet 1, said longitudinal and transverse ribs 15L,15T form a sort of mesh, and the empty spaces of this mesh define the vents 5 of the helmet 1, as shown in Figs. 2,3 and 6. The same architecture is present in the second embodiment, as shown in Figs. 7,8,9 and 12.

[0055] The shape of the shell 2 can vary, indeed the overall shapes of the helmets of the two embodiments are different, as shown in Figs. 3 and 9.

[0056] The inner side of the shell 2 is shaped so as to form shoulders 7, as shown in Figs. 4, 5, 6, 11. The shoulders 7 are arranged so as to define at least a place 6, thus a zone/portion, wherein respective insert 3 can be arranged. The shoulders 7 can be niches or protrusions of the shell 2, as shown in Fig. 6. A place 6 is defined by neighbour shoulders 7.

[0057] In correspondence of said places 6, the shell 2 is thinner with respect to the rest of the helmet 1. On these thin portions of the shell 2, the inserts 3 are arranged.

[0058] The insert 3 is overlaid to one of these thin portions of the shell 2 and faces inwardly. The thin portions can have a thickness of 5-6 mm.

[0059] The inserts 3 are arranged in respective places 6 of the shell 2 and the shoulders 7 also facilitate the positioning of the inserts 3 during the helmet assembly. The shoulders 7 even provide geometrical constraints to lateral movements of the inserts 3.

[0060] The shell 2 so conceived has a less complex shape, in particular on its inner side. Therefore, if shell 2 is made of foam like that of first and second embodiments, the mould used for achieving this shape requires less pieces and consequently the manufacturing of this kind of shell 2 is quicker and cheaper.

[0061] The retainers 4 of first and second embodiments comprise snap-pins 13 that are configured to reversibly engage with corresponding snap-baskets 14. These snap-baskets 14 are preferably embedded in the foam of the shell 2, as shown in Fig. 5 and 11. When the snap-pins 13 enter in respective snap-baskets 14, the retainer 4 remains firmly connected to the shell 2. Vice versa, the snap-pins 13 can be extracted from the snap-baskets 14 for detaching the retainer 4. Alternatively, the first connectors and the second connectors are designed to provide a permanent and irreversible connection.

[0062] Each retainer 4 has more snap-pins 13 and consequently the shell 2 has more snap-baskets 14. Each snap-pin 13 corresponds to a snap-basket 14.

[0063] As represented in Fig. 1, 4, 6, 10, 11, the retainers 4 run in a transverse direction, while the inserts 3 develop in a longitudinal direction.

[0064] In the first embodiment, the inserts 3,3' are five. Three inserts 3 are connected through retainers 4 while two additional inserts 3' are accommodated in respective recesses 19 in the shell 2, as shown in Figs. 4 and 6. These additional inserts 3' are shaped so to be flush with the inner surface 17 of the shell 2, when they are accommodated in said recesses 19.

[0065] The inserts 3 of the first embodiment are arc-shaped slices that are bonded to the shell 2 through two retainers 4. One retainer 4 is arranged in the front portion of the helmet 1, while the second one is arranged in the central-rear portion of the helmet 1.

[0066] Each retainer 4 crosses more inserts 3, alternating portions connected to the shell 2 to portions overlapping and crossing the inserts 3.

[0067] Each retainer 4 is shaped to block the lateral and inward movements of the insert 3. Substantially, the retainer 4 overlaps in part the insert 3 both over the inner side and over the lateral sides. In a particular embodiment, the retainer/s 4 only prevent/s inward movements.

[0068] For this reason, the retainer 4 can be shaped like a squared-curve, as shown in Fig. 4.

[0069] In an alternative embodiment (not shown), the retainer 4 is flat so as to prevent only inward movements. In this case, the height of the shoulders 7 are substantially

equal to the thickness of the insert 3.

[0070] Normally, the thickness of the inserts 3 is higher than the height of shoulders 7, because they are elements that come into play before the shoulders 7 during an impact. Therefore, the retainers 4 have said zig-zag shape. Vice versa, if the shoulders 7 are flush with the inserts 3, the retainers 4 are flat elements. In this case, the retainer 4 only traps inwardly the one or more inserts 3.

[0071] As shown in Fig. 12, the helmet 1 also comprises an upper skin 9 which lies on an upper and outer surface 11 of the shell 2 and a lower skin 10 which lies on a lower and outer surface 12 of the shell 2.

[0072] The inserts 3 are arranged in the shell 2 so as to leave the vents 5 free, as shown in Figs. 7, 8, 10. The vents 5 are free if observed frontally, as the top vents of Fig. 7.

[0073] Also, the retainers 4 are arranged so as to not span across the vents 5. In this way, since both the inserts 3 and the retainers 4 fall outside the vents 5, the ventilation is maximized.

[0074] The second embodiment of Figs. 8-12 is substantially equal to the first embodiment of Figs. 1-7 with the exception that first embodiment has five inserts 3,3' of which two encased in the shell 2 and three retained through retainers 4, while the second embodiment has four inserts 3 all retained through retainers 4. So, all features of the first embodiment are valid also for the second embodiment.

[0075] In the first embodiment, one insert 3 is arranged on a left-side of the shell 2 together with an additional insert 3', and, in a symmetrical manner, one insert 3 is arranged on a right-side of the shell 2 together with an additional insert 3'. Finally, an insert 3 is arranged on a top-side of the shell 2 along a centerline.

[0076] In the second embodiment, two inserts 3 are arranged on the left side of the shell 2 and two inserts 3 are arranged on the right side of the shell 2. Two of said couples face the top portion of the helmet 1, while the other one faces the side portion of the helmet 1.

[0077] During an orthogonal impact, the cells 16 of the inserts 3 plastically buckle absorbing a great quantity of the impact energy. The rest of the impact is absorbed by the shell 2 and by the skins 9,10.

[0078] During an oblique impact to the helmet 1 the insert 3 slides over the shell 2, in particular when the shell 2 comprises a low frictional layer 8, and presses against one or more shoulders 7 of the shell 2. Therefore, the insert 3 in-plane compresses and deforms absorbing the tangential component of the oblique impact. Despite this deformation, the insert 3 remains in place thanks to the retainer/s 4.

[0079] The retainers 4 tie the inserts 3 to the shell 2 independently from their deformations. Therefore, the present solution is safer and more reliable than those known in the art. The inserts 3 can slide over the shell 2 without becoming disconnected from it.

[0080] The shell 2 can comprise a thin low frictional layer 8, for example a coating of a semi-rigid polymer. This low frictional layer 8 creates a barrier over which the insert 3 can slide. The low frictional layer is arranged directly over the inner surface 17 of the shell 2, in correspondence with the inserts 3, as shown in Fig. 11.

[0081] As schematically shown in Fig. 1, the helmet 1 comprises a comfort liner 20, that is represented through a transparent grey portion that covers the area wherein the shell 2 and the inserts 3 are arranged, except those portions having vents 5.

[0082] The comfort liner 20 is connected to the rest of the helmet 1 through connecting means.

[0083] As Fig. 1 depicts, each retainer 4 comprises more Velcro™ coins 18 arranged on the portions crossing the inserts 3. The hooks of Velcro™ coins 18 inwardly protrude from these portions of the retainers 4 and easily connect to the synthetic/natural fabric of the comfort liner 20.

[0084] The Velcro coins 18 are attached through an adhesive layer to the retainers 4. In this way, the comfort liner 20 can be easily attached to the shell 2 and simultaneously under the inserts 3.

[0085] The third embodiment of Figs. 13-16 is a work helmet 1, while the helmets depicted in Figs. 1-12 are bike helmets 1.

[0086] The work helmet 1 of the third embodiment has an outer hard shell, made of a rigid plastic, like ABS, HDPE or polypropylene, and an inner insert 3 arranged in the top area of the helmet 1.

[0087] The insert 3 is caged by a retainer 4 that crosses the insert 3 along perpendicular directions. In particular, the retainer 4 crosses the insert 3 in the front-back direction and in the left-right direction, but other directions are possible.

[0088] The retainer 4 is connected to the shell 2 at its ends. At each end, the retainer 4 has a first connector, that is a slot 13', as shown in Fig. 16. Vice versa, the shell 2 comprises second connectors, that in this case are pins 14' protruding from the shell 2.

[0089] The retainer 4 is shaped so as to cross the insert from side to side and it's shaped like a cage. In this way, the lateral and inward movements of the insert 3 are prevented.

[0090] Normally, the work helmets are configured to protect the wearer from objects that fall from a height, so along a vertical direction. For this reason, the insert 3 is arranged in the top area of the helmet 1. For the same reason, the insert 3 is not subject to strong lateral movements, therefore, in this embodiment, the retainer 4 acts more as a trap for the insert 3.

[0091] Even in this embodiment, the retainer 4 can comprise Velcro™ coins (not shown) for connecting a comfort liner (not shown). Otherwise, the helmet 1 comprises a suspension harness system.

[0092] The helmet 1 of the third embodiment has an insert 3 arranged outside the vents 5, therefore the vents 5 are not obstructed by the insert 3.

[0093] Even in this case, the retainers 4 are softer than

the insert 3, in order to not oppose resistance in case of a compression due to an impact.

[0094] Concluding, the invention so conceived is susceptible to many modifications and variations all of which fall within the scope of the invention as defined by the appended claims.

Legend of reference signs:

[0095]

1	helmet
2	shell
3	insert
4	retainer
5	vent
6	place
7	shoulder of the shell
8	low frictional layer
9	upper skin
10	lower skin
11	upper and outer surface of the shell
12	lower and outer surface of the shell
13	snap-pin
14	snap-basket
15L	longitudinal rib of the shell
15R	transverse rib of the shell
16	cell
17	inner surface of the shell
18	Velcro™ coin
19	recess
20	comfort liner
L	longitudinal direction insert
T	transverse direction insert

Claims

1. Helmet (1) comprising:

- a shell (2) comprising at least one vent (5);
- one or more inserts (3) of a cellular energy-absorbing material having a curved shape; and being **characterised by**
- one or more retainers (4) crossing the one or more inserts (3) from side to side and fixed to the shell (2) at opposing sides of each insert (3) for constraining it to the shell (2), the one or more retainers (4) are shaped so as to laterally and inwardly trap the one or more inserts (3).

2. Helmet (1) according to claim 1, wherein the one or more inserts (3) are arranged inside the shell (2) so as to leave said at least one vent (5) free.

3. Helmet (1) according to claim 1 or 2, wherein one or more retainers (4) are fixed to the shell (2) so as to not span across said at least one vent (5).

4. Helmet (1) according to any one of preceding claims, wherein the one or more retainers (4) comprise a plurality of first connectors, preferably snap-pins (13), configured to reversibly engage respective second connectors, preferably snap-baskets (14), attached to the shell (2).

5. Helmet (1) according to any one of preceding claims, wherein cellular energy absorbing material of the one or more inserts (3) comprises a plurality of interconnected open cells (16) configured to absorb energy by plastic deformation in response to a longitudinal compressive load applied to said cells (16), preferably each cell (16) comprises a tube having a sidewall and a longitudinal axis, and the cells (16) are connected to each other through their sidewalls.

6. Helmet (1) according to claim 5, wherein at least part of the longitudinal axes of the cells (16) are normal to an inner surface (17) of the shell (2) on which the one or more inserts (3) are arranged.

7. Helmet (1) according to any one of preceding claims, also comprising a low frictional layer (8) arranged over the shell (2) in correspondence of the one or more inserts (3).

8. Helmet (1) according to any one of preceding claims, wherein the one or more retaining elements (4) support one or more connecting means, like Velcro coins (18), for connecting a comfort liner (20) to the rest of the helmet (1).

9. Helmet (1) according to any one of preceding claims, wherein the one or more retainers (4) are deformable and exhibit a bending stiffness that is comparable to or less than the compressive stiffness of the insert/s (3).

10. Helmet (1) according to any one of preceding claims, wherein the shell (2) comprises a plurality of shoulders (7) defining one or more places (6) wherein respective one or more inserts (3) are accommodated to prevent a global lateral displacement of the respective insert (3).

11. Helmet (1) according to any one of preceding claims, wherein the inserts (3) are three or more and extend in a front-back direction; at least one insert (3) is arranged on a left-side of the shell (2), at least one insert (3) is arranged on a right-side of the shell (2) and at least one insert (3) is arranged on a top-side of the shell (2).

12. Helmet (1) according to any one of preceding claims, wherein the shell (2) is a deformable shell made of a foam material or comprising a lattice structure.

13. Helmet (1) according to claim 12, wherein the shell (2) comprises longitudinal and transverse ribs (15,15L) arranged to form vents (5).

14. Helmet (1) according to claim 12 or 13, also comprising an upper skin (9) configured to cover at least in part an upper and outer surface (11) of the shell (2), and/or a lower skin (10) configured to cover at least in part a lower and outer surface (12) of the shell (2).

15. Helmet (1) according to any one of claims 12 to 14, wherein the shell (2) comprises one or more recesses (19) shaped for accommodating additional insert/s (3').

16. Helmet (1) according to any one of claims 1 to 11, wherein the shell (2) is a hard shell.

Patentansprüche

1. Helm (1) umfassend:

- eine Schale (2), die mindestens eine Entlüftung (5) umfasst;
- ein oder mehrere Einsätze (3) aus einem zellulären energieabsorbierenden Material mit gebogener Form; und **gekennzeichnet durch**
- eine oder die mehreren Halter (4), die den einen oder die mehreren Einsätze (3) von einer Seite zur anderen kreuzen und an gegenüberliegenden Seiten jedes Einsatzes (3) an der Schale (2) befestigt sind, um ihn an der Schale (2) festzuhalten, der eine oder die mehreren Halter (4) so geformt sind, dass sie den einen oder die mehreren Einsätze (3) seitlich und nach innen festhalten.

2. Helm (1) nach Anspruch 1, bei dem der/die Einsatz(e) (3) innerhalb der Schale (2) so angeordnet sind, dass die mindestens eine Entlüftung (5) frei bleibt.

3. Helm (1) nach Anspruch 1 oder 2, wobei ein oder mehrere Halteelemente (4) so an der Schale (2) befestigt sind, dass sie sich nicht über die mindestens eine Entlüftung (5) erstrecken.

4. Helm (1) nach einem der vorhergehenden Ansprüche, wobei das/die eine oder die mehreren Halter (4) mehrere erste Konnektoren, vorzugsweise Druckstifte (13), umfassen, die so ausgebildet sind, dass sie reversibel in jeweilige zweite Konnektoren eingreifen, vorzugsweise Druckkörbe (14), an der Schale (2) befestigt.

5. Helm (1) nach einem der vorhergehenden Ansprüche, wobei das zelluläre energieabsorbierende Material des einen oder der mehreren Einsätze (3) eine Vielzahl miteinander verbundener offener Zellen (16) umfasst, die so konfiguriert sind, dass sie Energie durch plastische Verformung als Reaktion auf eine Längsbewegung absorbieren Bei einer Druckbelastung, die auf die Zellen (16) ausgeübt wird, besteht vorzugsweise jede Zelle (16) aus einem Rohr mit einer Seitenwand und einer Längsachse, und die Zellen (16) sind durch ihre Seitenwände miteinander verbunden.

6. Helm (1) nach Anspruch 5, bei dem zumindest ein Teil der Längsachsen der Zellen (16) normal zu einer Innenfläche (17) der Schale (2) ist, auf der sich der oder die Einsätze (3) befinden angeordnet sind.

7. Helm (1) nach einem der vorhergehenden Ansprüche, außerdem umfassend eine reibungsarme Schicht (8), die über der Schale (2) entsprechend dem einen oder den mehreren Einsätzen (3) angeordnet ist.

8. Helm (1) nach einem der vorhergehenden Ansprüche, wobei das eine oder die mehreren Halteelemente (4) ein oder mehrere Verbindungsmittel, wie Klettverschlüsse (18), zum Verbinden eines Komfortfutters (20) mit dem Rest tragen den Helm (1).

9. Helm (1) nach einem der vorhergehenden Ansprüche, bei dem das/die Halteelement(e) (4) verformbar sind und eine Biegesteifigkeit aufweisen, die mit der Drucksteifigkeit der Einlage(n) (3) vergleichbar oder geringer ist als diese.

10. Helm (1) nach einem der vorhergehenden Ansprüche, bei dem die Schale (2) mehrere Schultern (7) aufweist, die eine oder mehrere Stellen (6) definieren, in denen jeweils der eine oder die mehreren Einsätze untergebracht sind (3), um insgesamt eine seitliche Bewegung des jeweiligen Einsatzes (3) zu verhindern.

11. Helm (1) nach einem der vorhergehenden Ansprüche, wobei die Einsätze (3) drei oder mehr sind und sich von vorne nach hinten erstrecken; mindestens ein Einsatz (3) auf einer linken Seite der Schale (2) angeordnet ist, mindestens ein Einsatz (3) auf einer rechten Seite der Schale (2) angeordnet ist und mindestens ein Einsatz (3) auf angeordnet ist eine Oberseite der Schale (2).

12. Helm (1) nach einem der vorhergehenden Ansprüche, wobei die Schale (2) eine verformbare Schale aus einem Schaumstoffmaterial ist oder eine Gitterstruktur aufweist.

13. Helm (1) nach Anspruch 12, wobei die Schale (2)

Längs- und Querrippen (15,15L) aufweist, die zur Bildung der Entlüftung (5) angeordnet sind.

14. Helm (1) nach Anspruch 12 oder 13, außerdem umfassend eine obere Haut (9), die so konfiguriert ist, dass sie zumindest teilweise eine obere und äußere Oberfläche (11) der Schale (2) bedeckt, und/oder eine untere Haut (10) konfiguriert, um zumindest teilweise eine untere und äußere Oberfläche (12) der Schale (2) abzudecken.

15. Helm (1) nach einem der Ansprüche 12 bis 14, bei dem die Schale (2) eine oder mehrere Nischen (19) aufweist, die zur Aufnahme eines oder mehrerer zusätzlicher Einsätze (3') dienen.

16. Helm (1) nach einem der Ansprüche 1 bis 11, wobei die Schale (2) eine Hartschale ist.

Revendications

1. Casque (1) comprenant :

- une coque (2) comprenant au moins une ouverture (5) ;
- un ou plusieurs inserts (3) en un matériau cellulaire absorbant l'énergie ayant une forme incurvée; et étant **caractérisé par**
- un ou plusieurs éléments de retenue (4) traversant le ou les inserts (3) d'un côté à l'autre et fixent à la coque (2) sur les côtés opposés de chaque insert (3) pour le retenir à la coque (2), le un ou plusieurs éléments de retenue (4) sont formés pour garder latéralement et vers l'intérieur le ou les inserts (3).

2. Casque (1) selon la revendication 1, dans lequel le ou les inserts (3) sont disposés à l'intérieur de la coque (2) de manière à laisser libre ledit au moins une ouverture (5).

3. Casque (1) selon la revendication 1 ou 2, dans lequel un ou plusieurs éléments de retenue (4) sont fixés à la coque (2) de manière à ne pas s'étendre sur ledit au moins une ouverture (5).

4. Casque (1) selon l'une quelconque des revendications précédentes, dans lequel le ou les éléments de retenue (4) comprennent une pluralité de premiers connecteurs, de préférence des broches à pression (13), configurés pour s'engager de manière réversible dans respectifs seconds connecteurs, de préférence des paniers à pression (14), fixé à la coque (2).

5. Casque (1) selon l'une quelconque des revendications précédentes, dans lequel le matériau cellulaire absorbant l'énergie du ou des inserts (3) comprend une pluralité de cellules ouvertes interconnectées (16) configurées pour absorber de l'énergie par déformation plastique en réponse à une charge longitudinal de compression appliquée auxdites cellules (16), de préférence chaque cellule (16) comprend un tube ayant une paroi latérale et un axe longitudinal, et les cellules (16) sont reliées les unes aux autres par leurs parois latérales.

6. Casque (1) selon la revendication 5, dans lequel au moins une partie des axes longitudinaux des alvéoles (16) sont normaux à une surface interne (17) de la coque (2) sur laquelle le ou les inserts (3) sont disposés.

7. Casque (1) selon l'une quelconque des revendications précédentes, comprenant également une couche à faible frottement (8) disposée sur la coque (2) en correspondance du ou des inserts (3).

8. Casque (1) selon l'une quelconque des revendications précédentes, dans lequel le ou les éléments de retenue (4) supportent un ou plusieurs moyens de liaison, comme des pièces Velcro (18), pour relier une doublure de confort (20) au reste du le casque (1).

9. Casque (1) selon l'une quelconque des revendications précédentes, dans lequel le ou les éléments de retenue (4) sont déformables et présentent une rigidité à la flexion comparable ou inférieure à la rigidité à la compression du ou des inserts (3).

10. Casque (1) selon l'une quelconque des revendications précédentes, dans lequel la coque (2) comprend une pluralité d'épaules (7) définissant un ou plusieurs endroits (6) dans lesquels sont respectivement logés les un ou plusieurs inserts (3) pour empêcher un déplacement latéral global de l'insert (3) respectif.

11. Casque (1) selon l'une quelconque des revendications précédentes, dans lequel les inserts (3) sont au nombre de trois ou plus et s'étendent selon une direction avant-arrière; au moins un insert (3) est disposé sur un côté gauche de la coque (2), au moins un insert (3) est disposé sur un côté droit de la coque (2) et au moins un insert (3) est disposé sur un côté supérieur de la coque (2).

12. Casque (1) selon l'une quelconque des revendications précédentes, dans lequel la coque (2) est une coque déformable réalisée dans un matériau mousse ou comportant une structure en treillis.

13. Casque (1) selon la revendication 12, dans lequel la coque (2) comprend des nervures longitudinales et

transversales (15,15L) agencées pour former les ouvertures (5).

14. Casque (1) selon la revendication 12 ou 13, comprenant également une peau supérieure (9) configurée pour recouvrir au moins en partie une surface supérieure et externe (11) de la coque (2), et/ou une peau inférieure (10) configuré pour recouvrir au moins en partie une surface inférieure et extérieure (12) de la coque (2).

15. Casque (1) selon l'une quelconque des revendications 12 à 14, dans lequel la coque (2) comprend un ou plusieurs niches (19) conforment pour accueillir un ou des inserts supplémentaires (3').

16. Casque (1) selon l'une quelconque des revendications 1 à 11, dans lequel la coque (2) est une coque dure.

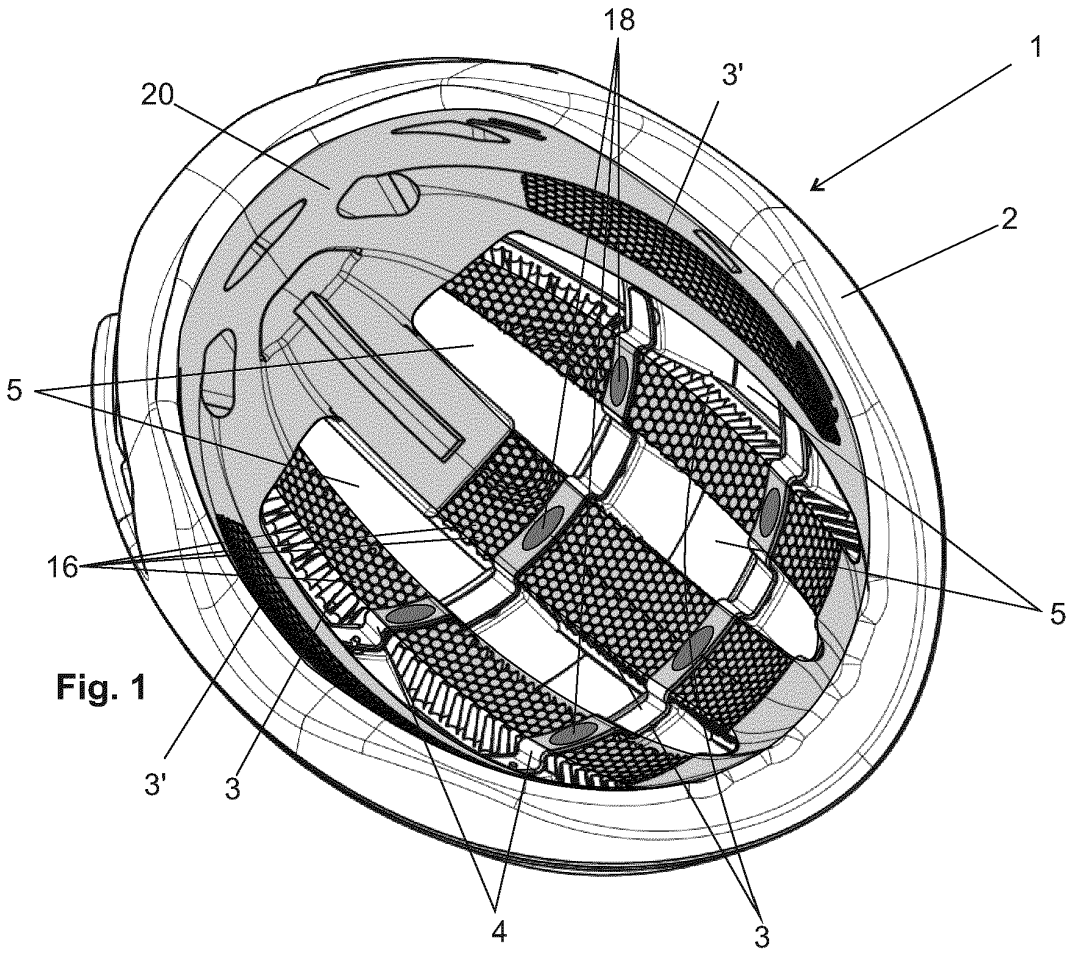


Fig. 1

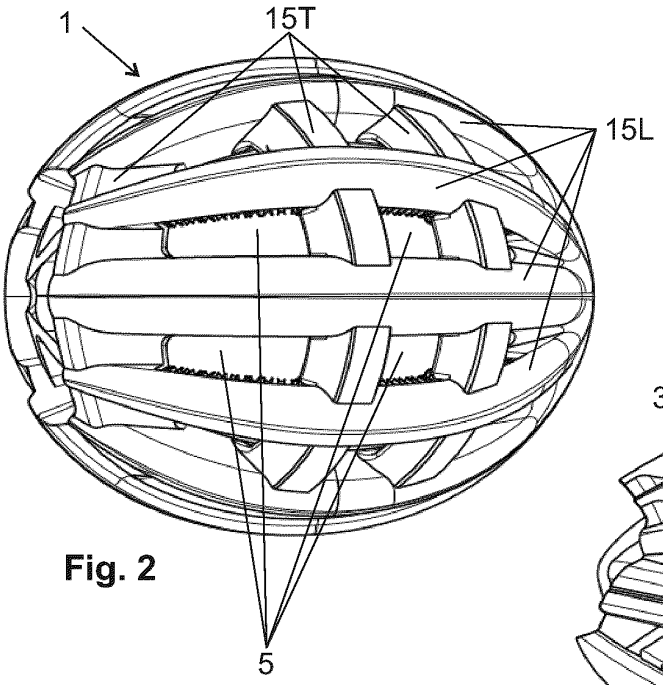


Fig. 2

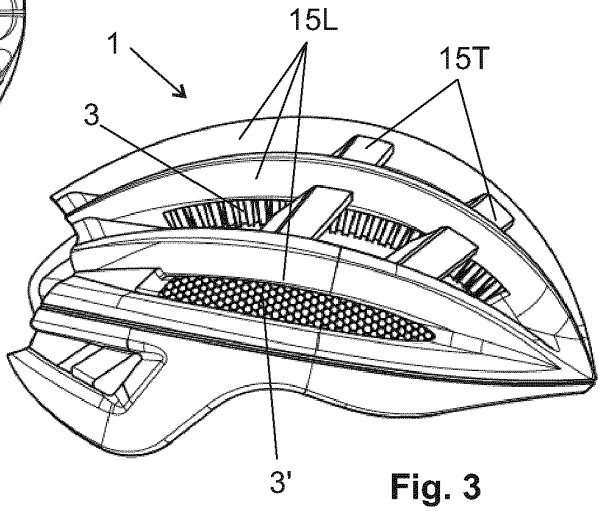


Fig. 3

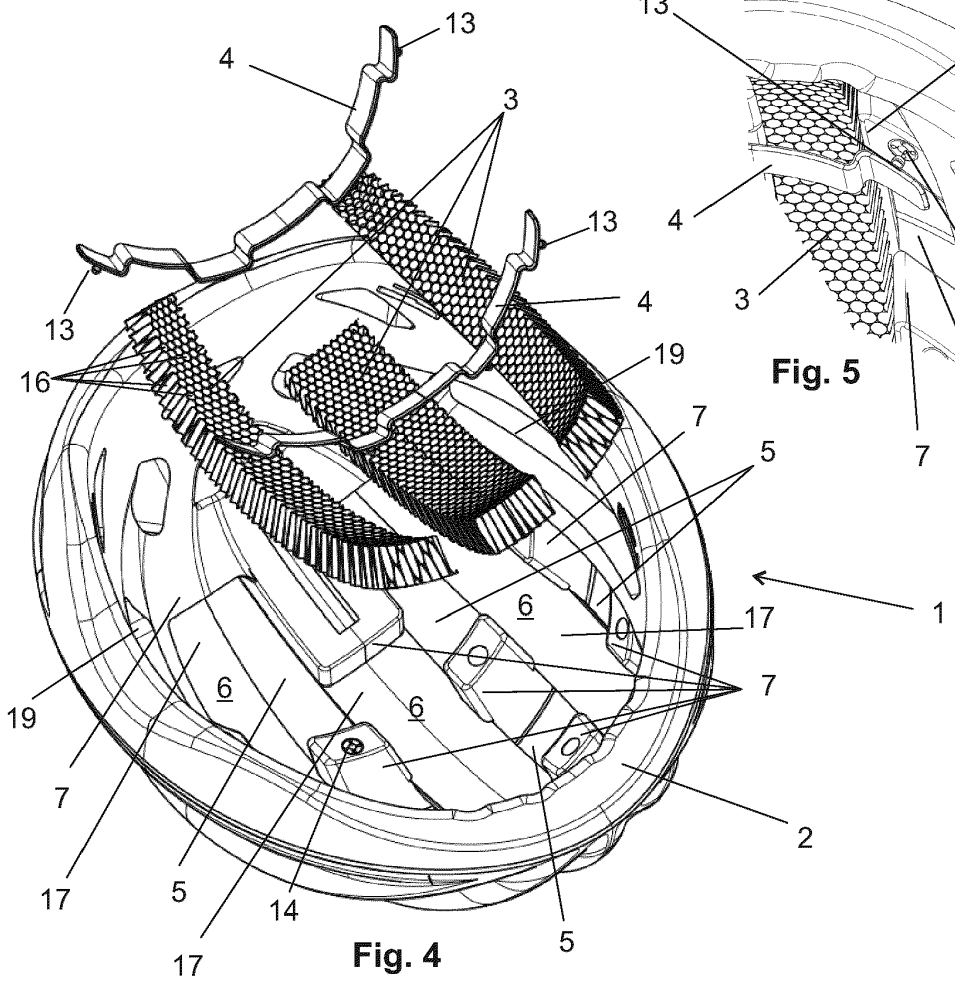


Fig. 4

Fig. 5

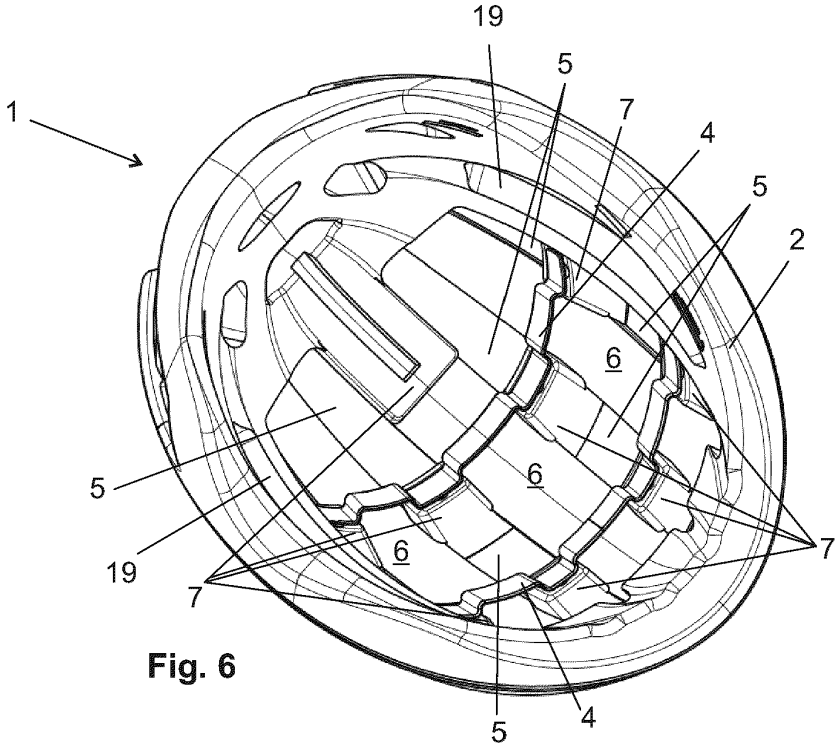


Fig. 6

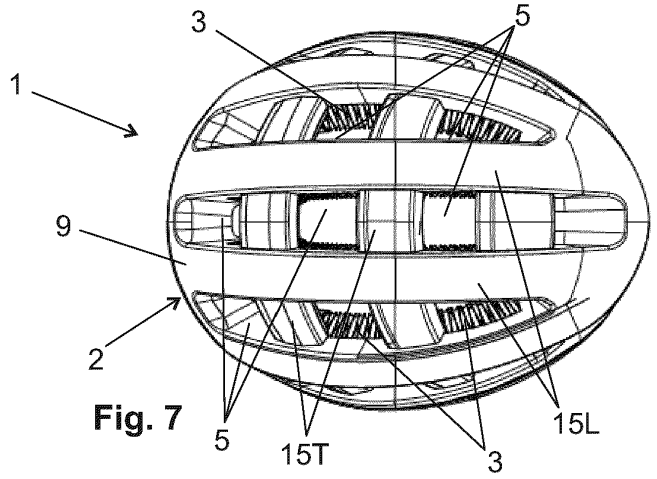


Fig. 7

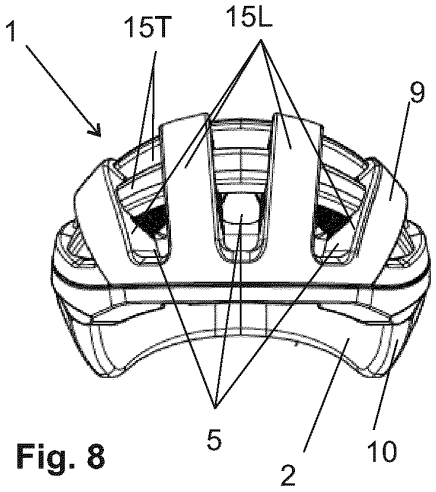


Fig. 8

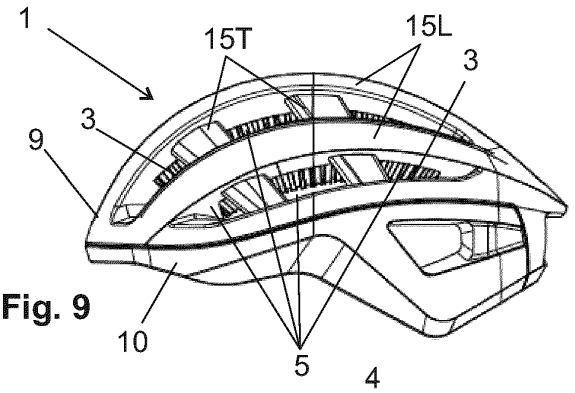


Fig. 9

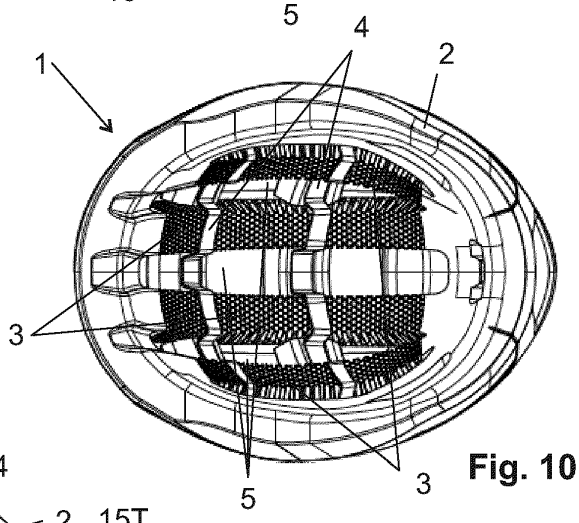


Fig. 10

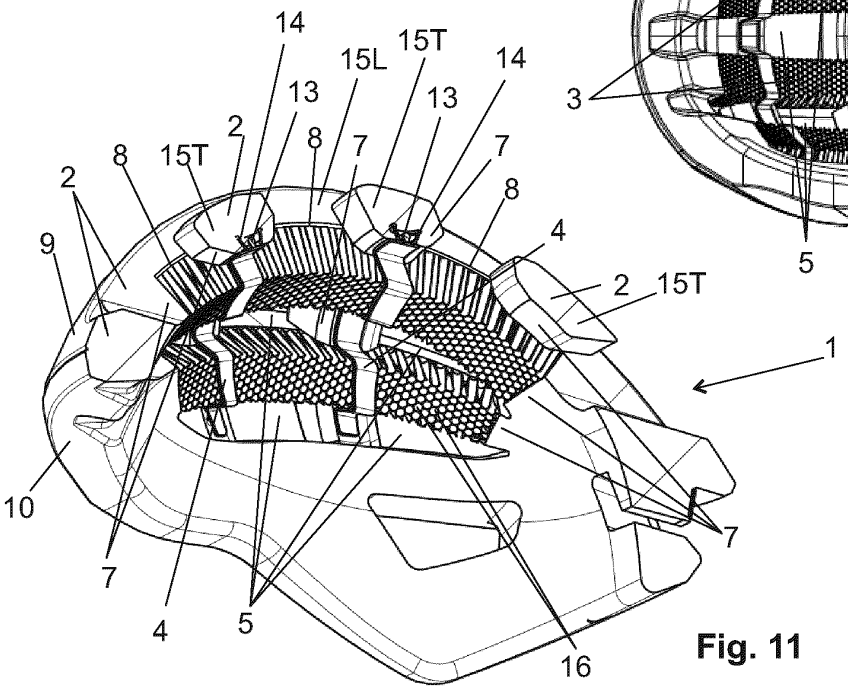


Fig. 11

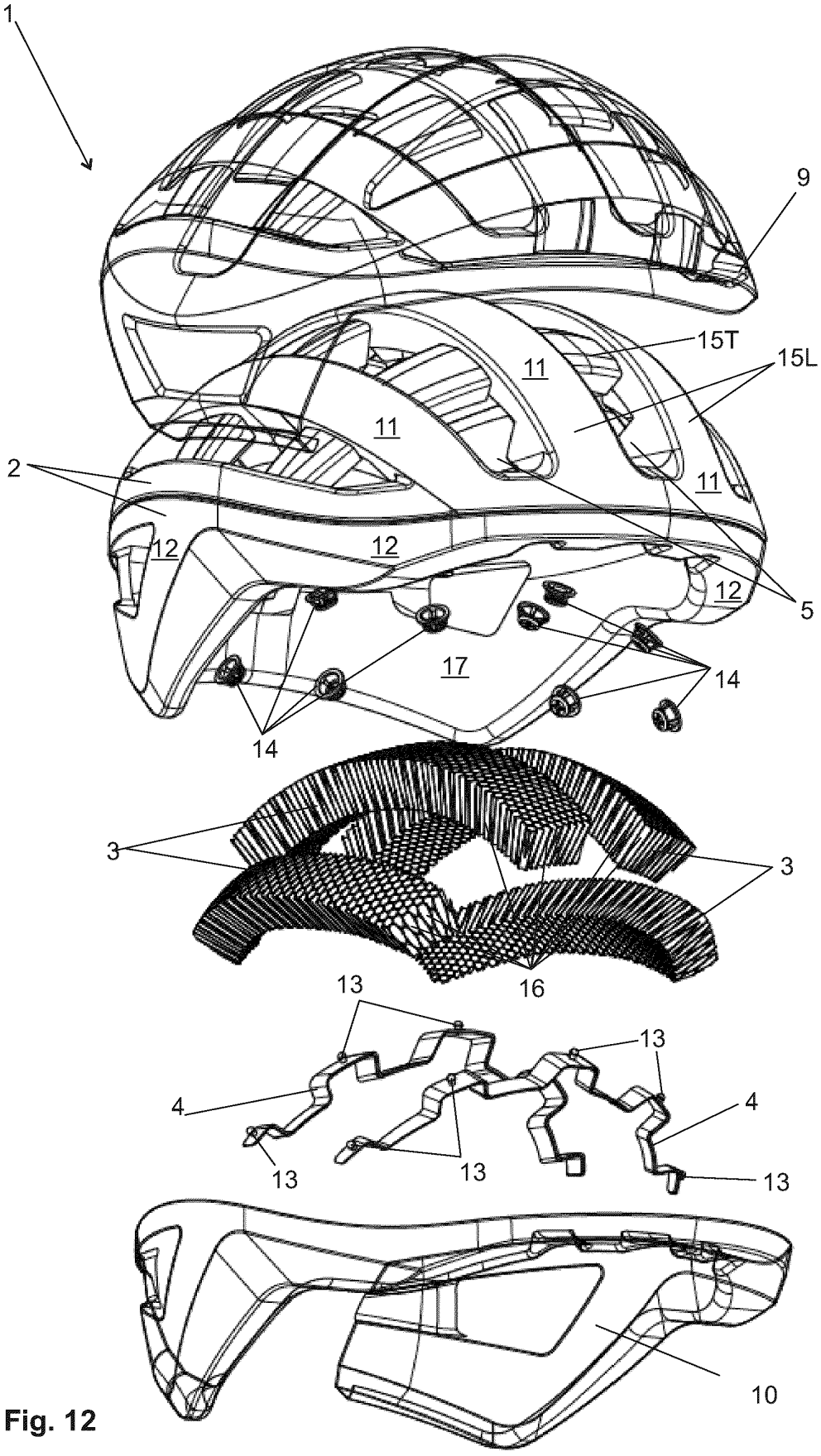


Fig. 12

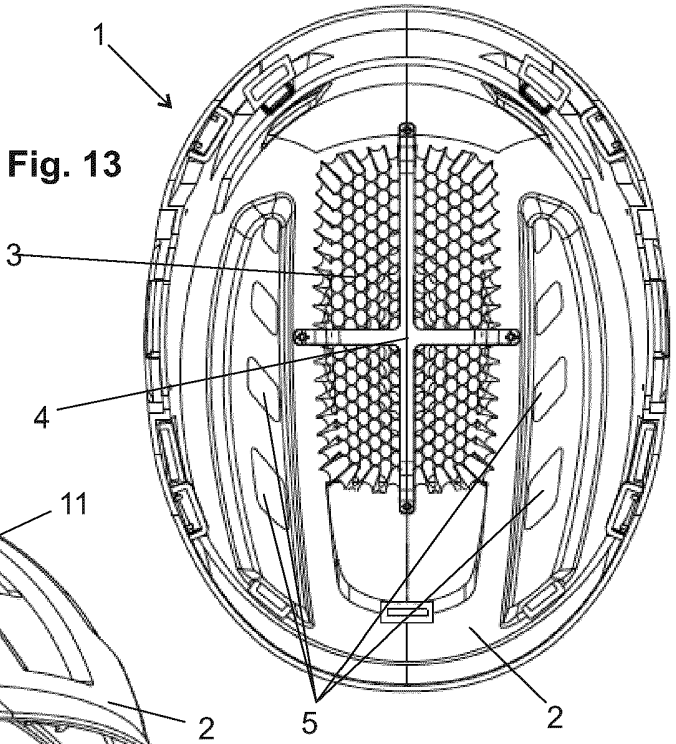


Fig. 13

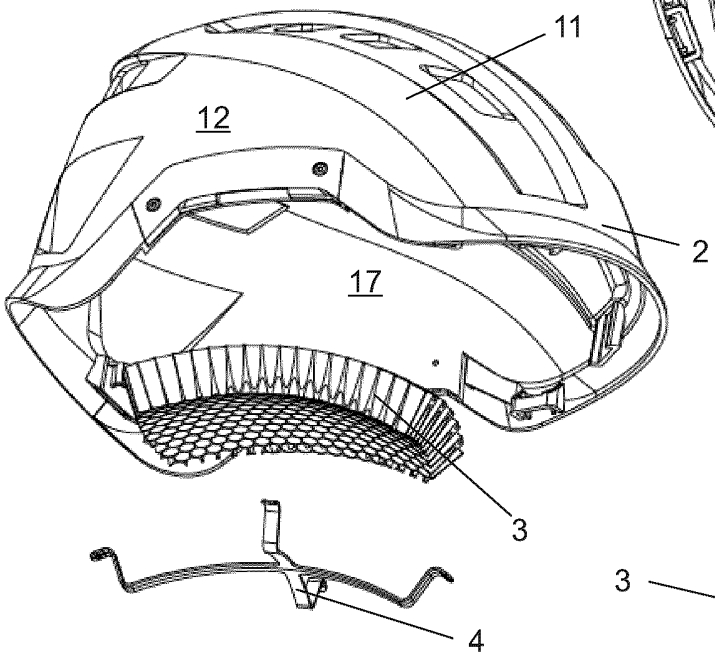


Fig. 14

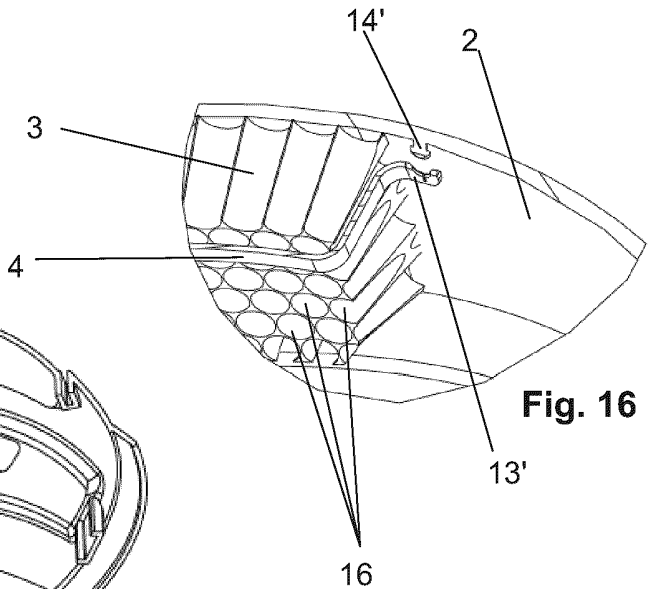


Fig. 16

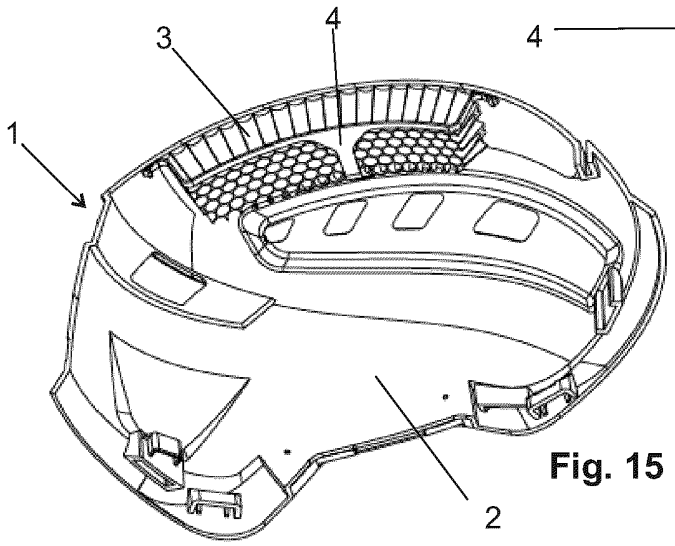


Fig. 15

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 10834987 B **[0003]**
- EP 3473122 A **[0004]**
- US 108349872 B **[0005]**