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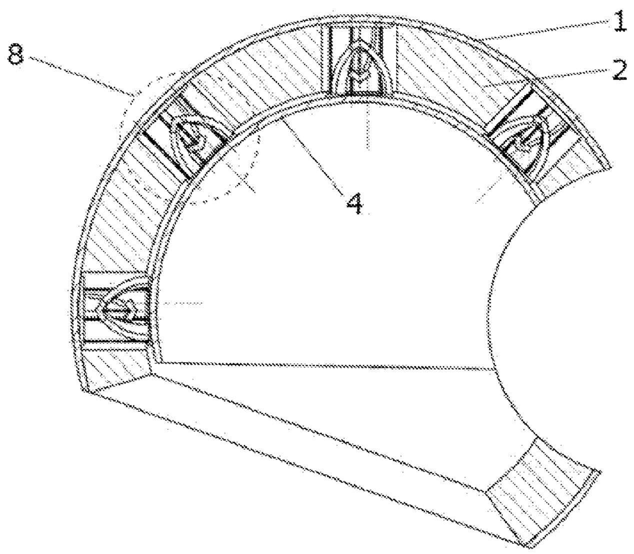

Fig. 3

(57) Abstract: The object of the invention is a helmet with a multi-directional suspension system and a procedure for assembling a connection between an outer shell (1) and an inner shell (4) of such a helmet. The helmet comprises the inner shell (4) of the helmet and the outer shell (1) of the helmet, which are movably connected to each other using suspension connectors (8). The suspension connector (8) comprises two opposite parts, each of which comprises a base (5) and a bracket (6) extending therefrom, wherein the top of the bracket (6) of the first part is closer to the base (5) of the second part than the top of the bracket (6) of the second part. The parts of the suspension connector (8) are connected by flexible suspensions (7). The tops of the brackets (6) are connected by at least one flexible suspension (7) and the edge parts of the bases (5) by at least three flexible suspensions (7).

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Helmet with a multi-directional suspension system and a procedure for assembling the helmet

Technical Field

The invention relates to the field of health protection, specifically to a helmet for protecting the head from injury capable of absorbing also rotational forces generated during a fall, such as helmets for motorists, cyclists, and others.

Background of the Invention

Head injuries are a major danger when practicing motor, cycling, equestrian, or other sports. Statistics show that a high-quality and properly fitted helmet reduces the risk of fatal injury by almost 40 % for motorcyclists, and in case of severe injury even more than 70 %. About 37 % of the cyclists killed would have survived had they been using a helmet properly.

As the human brain has shear properties comparable to gel, it is more sensitive to rotational movement than linear movement. Brain tissue stretches due to the relative movement of parts of the brain during rotation. Today’s motorcycle helmets are subject to safety standards that are designed primarily for protection from linear impact forces. However, this is due to change in the future, and measurements of the rotational forces acting on the head in the helmet during impact will be included in the testing during homologation. In the current state of the art, helmets are known that solve this problem in a certain way.

One variant may be a helmet according to the application US20200022443 A1. Here, the inner part is suspended on strips on the outer part, which however allows movement of the parts only at a certain angle and range and does not guarantee effective dissipation of forces during impact.

EP2854584 A1, on the other hand, describes a helmet with a central layer of honeycomb material which, in the event of an impact, is capable of absorbing both linear and rotational forces, but only through deformation of the material, or destruction of the helmet, and not through the relative movement of the inner and outer layers of the helmet.

Another variant may be a helmet according to US20140208486 A1 or US9439469 B2 that comprises shock absorbers between the inner and outer layers formed of elastic materials such as rubber parts or springs. All these connections between the inner and outer layers absorb the impact force by means of connectors based on soft elastic absorbers by deforming the material. The connector thus transmits the shear stress itself, although it absorbs it to a certain extent.

The most well-known option is the helmet described in the document EP2440082 B1, where there is a low-friction sliding layer between the outer and inner parts and the two parts are connected by elastic connectors. This creates another plastic insert that acts as a shear plane between the head and the helmet. However, due to the construction thereof, this layer only allows 10–15 mm movement during oblique impacts and does not mitigate linear impacts. These must be fully dispersed by a traditional EPS (expanded polystyrene) layer.

However, especially in some low-energy impacts, the EPS layer cannot deform properly due to its high density. This problem has already been solved by implementing multiple EPS layers, but this still does not solve the angular impacts that cause the rotational movement.

Therefore, it would be suitable to present a helmet solution that improves the dissipation effect, especially for the rotational, but also for the linear, component of the forces, and that increases the comfort of use.

Summary of the Invention

The above shortcomings are to a certain extent eliminated by a helmet with a multi-directional suspension system comprising an outer helmet shell and an inner helmet shell and at least three suspension connectors, where each suspension connector comprises two opposite parts, wherein a first part of the suspension connector is connected to the first one of the inner helmet shell or the outer helmet shell and a second part of the suspension connector is connected to the second one of the inner helmet shell or the outer helmet shell, wherein each part of the suspension connector comprises a base and at least one bracket extending therefrom in a direction towards the base of the opposite part, where the bases are connected by at least three flexible suspensions and the tops of the brackets are connected by at least one flexible suspension, wherein the top of the bracket of the first part is closer to the base of the second part than the top of the bracket of the second part, wherein the length of the flexible suspensions is adapted such that the flexible suspensions are in a tensioned state. From a physical point of view, it is clear that all the flexible suspensions must be in a tensioned state for the suspension connector to function.

Each part of the connector comprises a base and a bracket, wherein the first end of the bracket is connected to the base and the second end extends out from the base and is terminated by the top of the bracket. The bracket is an elongated element that can be thought of as an arm or beam. The base may take various shapes, wherein preferably it is a shape having a round plan, a convex surface towards the outer shell of the helmet and a concave surface towards the inner shell of the helmet. Other base shapes can be used, such as a triangle or another polygon, oval, etc., wherein the base surfaces may be flat or slightly convex or concave.

By incorporating suspension connectors based on the principle of tensegrity, optimal absorption of the forces acting on the user’s head during impact is achieved. These findings are based on an analysis of motorcycle accidents and a study of bridge structures. Energy absorption is more reliable here than in the case of other available helmets. Parts of the connectors are made of a rigid material, connected to each other by flexible suspensions such that the forces acting on the entire connector system are balanced and the system is rigid but elastic at the same time. In this way, it is to a certain extent similar to the system of a living organism, which, thanks to the connection of the rigid parts by flexible connectors that form a prestressed system, is able to balance mechanical impulses from the outside.

Prestressing of the tensile elements by force ensures tractive forces in all loaded states while the structure remains elastic. When tangential forces are applied at helmet impact, the forces are absorbed by the flexibility and/or elasticity of the suspension and, if the limit force is exceeded, by the destruction of the entire connector.

The tensegrity connector allows for wider movement between the outer and inner shell, while at the same time it can dissipate linear impacts to a certain extent by stretching the flexible suspensions in the suspension connectors. A tensegrity-based helmet is the solution for the new helmet standards, where the helmet should induce an angular acceleration of less than 5000 rad/s^2 at an angular impact of 5 m/s with BrIC (brain injury criterion; a parameter indicating the probability of a severe brain injury based on the angular velocity and acceleration applied in the accident) of less than 0,6, but at the same time, for linear impacts of 5,2 m/s, the HIC (head injury criterion; a parameter indicating the probability of a severe head injury based on the time and forces applied in the accident) it should not exceed 2400.

The indirect connection between the inner and outer shell allows the outer shell to rotate independently before the movement is transferred to the inner shell and subsequently to the head and brain in the event of a tangential impact. The indirect connection is realized by a special helmet structure where the inner and outer shells are connected only by tensegrity connectors and at least one of the rigid parts of the helmet is not attached to the soft central part. This feature allows relative rotation between the outer and inner layers of the helmet, provided that the individual parts of the helmet are at least similar in shape. At the same time, the connectors hold the structural integrity of the helmet. This connection reduces the rotational acceleration of the head when it hits an obstacle.

One of the advantages of the present invention is the possibility of using the system in virtually any type of helmet, since the use of the suspension system by means of tensegrity connectors does not require the exact spherical shape of the individual parts of the helmet as is the case with prior art variants.

Between the inner side of the outer shell of the helmet and the outer side of the inner shell of the helmet there is arranged a central part of soft material adapted to absorb the impact forces comprising pockets for the suspension connectors, wherein the central part is rigidly connected to the inner shell of the helmet or to the outer shell of the helmet. This layer has the potential to improve the dissipation of the linear force components acting on the user’s head in the event of an accident. The central part is most often made of a layer of expanded polystyrene with pockets for the suspension connectors, wherein the pockets are wider compared to the suspension connectors to allow movement between the inner and outer shell of the helmet.

There is a free space between the central part of the helmet and the inner shell or outer shell of the helmet. In case the central part is connected to the outer shell, there is a free space between the central part and the inner shell. In case the central part is connected to the inner shell, there is a free space between the central part and the outer shell. This arrangement allows the mutual movement of the inner and outer shell and, above all, ensures that the first part of the forces is absorbed by the suspension connector and only in the second phase are the forces absorbed by the soft central part.

The flexible suspensions connecting the bases of the suspension connector are anchored at the edge of the bases, wherein by the edge of the base is meant any point on the base surface the distance of which from the connector axis is greater than 70 % of the shortest distance from the connector axis to the edge of the base surface, thus achieving the balancing of the tensile forces within the connector and thus maximum stability of the connector.

The procedure for assembling a connection between the inner and outer shell of the helmet comprises, first of all, the step of manufacturing the suspension connector, which comprises firstly manufacturing the first and second parts of the suspension connector and then connecting the first and second parts of the suspension connector by means of flexible suspensions, within which the stress of the suspensions is also adjusted, thereby completing the suspension connector. A suitable way of manufacturing them is, for example, 3D printing, which allows for the manufacture of more complex structures. The steps of manufacturing the suspension connector are repeated depending on the number of suspension connectors needed to make the helmet. In the following step, the first bases of the suspension connectors are rigidly connected to the first one of the inner shell of the helmet or the outer shell of the helmet. The connection is realized by a glue, fusion, or suitable fasteners. The second shell of the helmet is then positioned and the second bases of the suspension connectors are rigidly connected to the second one of the inner shell of the helmet or outer shell of the helmet, again by means of a glue, fusion, or other suitable fasteners. The glue can be applied either to the bases of the connectors or to the appropriate areas of the shell of the helmet. From a functional point of view, it is irrelevant whether the connector is first connected to the inner or outer shell. However, the shape of the helmet can be a limiting factor, where, for example, in the case of integral helmets it is possible that the inner shell with the connectors applied could not be inserted into the outer shell due to the dimensions of the individual parts.

In the case of the manufacture of a helmet with a soft central part applied in a fluid form, the manufacturing procedure includes the steps of applying the central part of the helmet before the step of connecting the first bases of the suspension connectors to the first one of the inner shell of the helmet or the outer shell of the helmet, where models simulating the shape of the suspension connectors adapted to define the space for the suspension connectors at the areas where the real connectors will subsequently be located are placed on the inner shell of the helmet or the outer shell of the helmet, and, for example, EPS or other material of the central part of the helmet is applied. The application is done by spraying or applying a fluid material, which is then cured or hardened with appropriate agents. The models have the same shape as the connector with adequate clearance to allow the real connector to move as desired. The size of the difference between the width of the connector model and the width of the real connector depends on the set stiffness of the suspension, the length of the suspension, and the stiffness of the individual parts of the connector. After application or curing of the central part, the connector models are removed and the procedure as described above continues.

In the case of the manufacture of a helmet with a central soft part in the form of an inserted prefabricated component, the central part of the helmet is connected to the inner shell of the helmet or the outer shell of the helmet using gluing, fusion, or fasteners before the step of connecting the first bases of the suspension connectors to the first one of the inner shell of the helmet or the outer shell of the helmet.

Description of Drawings

A summary of the invention is further clarified using exemplary embodiments thereof, which are described with reference to the accompanying drawings, in which:

fig. 1 shows a vertical section through a helmet without the suspension connectors of this invention,

fig. 2 shows a front view of the inner shell of the helmet with the suspension connectors,

fig. 3 shows a vertical section through the helmet with the suspension connectors,

fig. 4 shows a suspension connector in an embodiment with one bracket on each part of the connector,

fig. 5 shows a suspension connector in an embodiment with three connected brackets on each part of the connector.

Exemplary Embodiments of the Invention

The basic embodiment is a helmet for motorcyclists.

The helmet comprises an outer shell 1, a soft central part 2 with pockets 3 for suspension connectors 8, an inner shell 4, and the suspension connectors 8 connecting the inner shell 4 and the outer shell 1. In Fig. 1, a section through the helmet without the suspension connectors 8 can be seen, in Fig. 3, the helmet already has the suspension connectors 8. The central part 2 is inseparably connected to the outer rigid shell 1, whether using gluing, in-mold technique, or fasteners such as rivets. It is also not directly connected to the inner rigid shell 4. There is a free space between them, allowing movement between the shells 1, 4 of the helmet. The central part 2 is formed by injection molding EPS foam on the inner side of the outer shell 1 of the helmet with models of the suspension connectors placed at the locations where the real connectors 8 will be glued in later. The models are then removed, leaving pockets 3 in the central part 2 for the placement of the suspension connectors 8.

Alternatively, a helmet consisting of only the outer shell 1 and the inner shell 4 without the soft central part 2 can be used, where the absorption of the impact forces, both rotational and linear, will be provided only by the tensegrity suspension connectors 8. Similarly, a helmet can be used where the soft central part 2 will be inseparably connected to the inner shell 4 of the helmet, and the free space will be between the central part 2 and the outer shell 1. The width of the free space depends on the size of the suspension connector 8 and the length and elasticity of the suspensions 7.

The material of the soft central part 2 is preferably expanded polystyrene, alternatively expanded polypropylene, expanded polyurethane, foam polymers, or mixtures of said polymers may be used, depending on the helmet manufacturing technology used. The thickness of the central part 2 is chosen according to the use of the helmet such that the ability to absorb the impact forces is sufficient, and the height of the suspension connector 8 depends on it.

The material of the inner shell 1 and outer shell 4 may be polycarbonate, carbon fiber reinforced plastic, glass fiber reinforced plastic, Kevlar, molded plastics, acrylonitrile butadiene styrene, and others, depending on the helmet manufacturing technology used. The function of this rigid part is to protect the head mechanically during impact, and above all to prevent foreign bodies from penetrating the helmet. The inside of the helmet can be equipped with padding for a proper fit on the user’s head.

For the desired protective effect of the helmet, at least three suspension connectors 8 are used. One near each ear area, one in the back of the occipital area. Preferably, more connectors 8 spread over the helmet surface can be used (in the case of integral helmets also in the chin protection area), taking into account the fact that a larger number of connectors 8 reduces the volume of the central part 2, which absorbs the linear components of the impact. By optimizing the number of the connectors 8 and the stiffness of the suspensions 7, and therefore their maximum tensile strength, it is possible to optimize the helmet’s ability to absorb linear/rotational movement. This also allows for the adjustment of the price of the helmet, where e.g., a larger number of connectors 8 with a thinner, less expensive suspension 7 may be cheaper than a smaller number of connectors 8 with a more expensive suspension 7 with better parameters for the application.

The connector 8 based on the principle of tensegrity comprises the following basic components – two rigid parts with brackets 6 and flexible suspensions 7, as can be seen in Fig. 4 and Fig. 5. The first and second rigid parts are connected by flexible suspensions 7. The rigid part comprises a base 5 of a lenticular or semilenticular shape and an integral bracket 6, which is connected at one end to the base 5 and the other end faces outwardly from the base and is terminated by the top of the bracket 6. The bracket 6 has a straight shape and extends from the base 5 towards the opposite base 5 at an angle of less than 90°, or may take different shapes, for example the letter L or J. In embodiments with one bracket 6 on each part of the connector 8, the tops of the brackets 6 are preferably located in an axis passing through the center of the first and second bases 5 of the connector 8.

The base 5 of the connector 8 can take different shapes. Preferably it is a shape having a round plan, a convex surface towards the outer shell 1 of the helmet and a concave surface towards the inner shell 4 of the helmet. Other shapes of the base 5 can be used, such as a triangle or another polygon, oval, etc., wherein the surfaces of the base 5 may be flat or slightly convex or concave.

The connector 8 may also comprise several pairs of brackets 6, always opposite each other. The opposite brackets 6 are also connected to each other by the flexible suspensions 7 and the individual pairs of the brackets 6 are positioned axially symmetrically with respect to the base of the connector 8. Another alternative is brackets 6 connected by more than one flexible suspension 7.

The flexible suspensions 7 may be made of wire (metallic, non-metallic, organic, synthetic), fiber (synthetic, glass, carbon, aramid), or micro-chain (metallic, synthetic). The rigid part of the connector 8 must be made of a rigid material (for example, 3D printed plastic HP PA12-Hewlet Packard Polyamide 12, HP PA 12 GB-Hewlet Packard Polyamide 12 Glass Beads). The attachment of the suspension 7 to the bases 5 allows the relative angle between the axis of the suspension and the normal vector of the base 5 to be changed. From a physical point of view, the suspension 7 can only work in a tensioned state. However, due to the specific shape, the whole connector 8 is structurally integral in shear (tangential stress) and in compression (normal stress). Further loss of energy can be ensured by gradual destruction of the part of the connector 8.

The stiffness of the connector 8 can be adjusted by the stress of the suspension 7. The connection between the rigid parts and the suspension 7 can be made by drilling an opening in the rigid part, threading the suspension 7 through the opening and securing it with a knot and/or glue on the other side, or by securing it with a screw or plug or other stop.

Another option how the connector 8 can be realized is to create rigid parts interleaved with each other by means of 3D printing. The rigid part has a base 5 which is subsequently glued into the inner shell 1 or outer shell 4 of the helmet. Three brackets 6 extend from the base 5 and connect in the space in front of the base 5. The first part of the connector 8 is of identical shape and is interleaved in the second part such that a tensegrity formation can be formed, i.e., the junction of the three brackets 6 of the bottom part is inserted in the space between the brackets 6 of the upper part. Manufacture using 3D printing eliminates the need to laboriously assemble the parts, as the parts can be printed directly interleaved. In the case of another method of manufacture, the base 5 and the element of the connected brackets 6 are manufactured separately and subsequently connected, e.g., by gluing, fusion, or fasteners. The parts are further connected by suspensions 7 at the place of the connection of the three brackets 6 and at the edge parts of the bases 5. Other variants of the tensegrity suspensions are also possible.

The procedure for assembling the connection between the inner shell 4 and the outer shell 1 of the helmet comprises, first of all, the manufacture of the suspension connector 8. First, a first and a second part of the suspension connector 8 is manufactured, for example by 3D printing. Each part of the connector 8 comprises a base 5 and a bracket 6 extending therefrom. The first and second parts of the suspension connector 8 are connected by means of flexible suspensions 7, wherein the tension of the suspensions 7 is adjusted at the same time. This completes the suspension connector 8. The steps of manufacturing the suspension connector 8 are repeated depending on the number of the suspension connectors 8 needed to manufacture the helmet.

In a subsequent step, the first bases 5 of the suspension connectors 8 are rigidly connected to the inner shell 4 of the helmet. The connection is realized by a glue, fusion, or suitable fasteners. The outer shell 1 of the helmet is then placed and the second bases 5 of the suspension connectors 8 are rigidly connected to the outer shell 1 of the helmet, again by means of a glue, fusion, or other suitable fasteners. The glue can be applied either to the bases 5 of the connectors 8 or to the appropriate areas of the shell 1, 4 of the helmet. Alternatively it is possible to connect the first bases 5 to the outer shell 4 of the helmet, then position the inner shell 4 of the helmet and connect the second bases 5 of the connectors 8 thereto.

In the case of the manufacture of a helmet with the central soft part 2 applied in a fluid form, the steps of applying the central part 2 of the helmet are included in the manufacturing procedure before the step of connecting the first bases 5 of the suspension connectors 8 to the inner shell 4 of the helmet. Models of the suspension connectors 8 adapted to define the space for the suspension connectors 8 at the locations where the real connectors 8 will subsequently be located are placed on the inner shell 4 of the helmet, and e.g., EPS or other material of the central part 2 of the helmet is applied. The application is done by spraying or applying a fluid material, which is then cured or hardened with appropriate agents. The models have the same shape as the connector 8 with adequate clearance to allow the real connector 8 to move as desired. The size of the difference between the width of the model of the connector 8 and the width of the real connector 8 depends on the set stiffness of the suspension 7, the length of the suspension 7, and the stiffness of the individual parts of the connector 8. After application or curing of the central part 2 the models of the connectors 8 are removed and the procedure as described above continues.

In the case of the manufacture of a helmet with the central soft part 2 in the form of an inserted prefabricated component, the central part 2 of the helmet is connected to the inner shell 4 of the helmet (alternatively the outer shell 1 of the helmet) by gluing, fusion, or fasteners before the step of connecting the first bases 5 of the suspension connectors 8 to the inner shell 4 of the helmet.

The properties of the helmet in terms of its protective capabilities can be changed by adjusting the stiffness of the connector 8, or by using a suspension 7 with a different stiffness or with a non-linear characteristic in terms of the dependence of the force on the extension of the suspension 7. The change will result in a different stiffness/rotational stiffness of the connection between the inner shell 1 and the outer shell 4 of the helmet. A softer connector 8 is more preferable in applications where lighter impacts are expected.

Helmet with multi-directional suspension is characterized by the ability to absorb rotational and linear forces at the same time. The absorption of rotational forces is particularly desirable in the case of motorcyclist injuries.

Industrial Applicability

The absorption properties of the suspension connector can be changed by the choice of the suspension, its elasticity, and length. This makes the principle also applicable in applications for helmets designed for other sports such as equestrianism, cycling, etc. Different sports are characterized by different injury mechanisms and therefore require different helmet parameters.

List of Reference Numbers

1 - Outer shell of the helmet

2 - Central part of the helmet

3 - Pocket for a suspension connector

4 - Inner shell of the helmet

5 - Base of the rigid part of the connector

6 - Bracket

7 - Suspension

8 - Connector

CLAIMS

1. A helmet with a multi-directional suspension system comprising an outer shell (1) of the helmet and an inner shell (4) of the helmet and at least three suspension connectors (8), **characterized in that** each suspension connector (8) comprises two opposite parts, wherein a first part of the suspension connector (8) is connected to the first one of the inner shell (4) of the helmet or the outer shell (1) of the helmet and a second part of the suspension connector (8) is connected to the second one of the inner shell (4) of the helmet or the outer shell (1) of the helmet, wherein each part of the suspension connector (8) comprises a base (5) and at least one bracket (6) extending therefrom in a direction towards the base (5) of the opposite part, where the bases (5) are connected by at least three flexible suspensions (7) and the tops of the brackets (6) are connected by at least one flexible suspension (7), wherein the top of the bracket (6) of the first part is closer to the base (5) of the second part than the top of the bracket (6) of the second part, wherein the length of the flexible suspensions (7) is adapted such that all the flexible suspensions (7) are in a tensioned state.

2. The helmet with a multi-directional suspension of claim 1, **characterized in that** the first end of the bracket (6) is connected to the base (5) and the second end extends outwardly from the base (5) and is terminated by the top of the bracket (6).

3. The helmet with a multi-directional suspension system of claims 1 and 2, **characterized in that** between the inner side of the outer shell (1) of the helmet and the outer side of the inner shell (4) of the helmet is arranged a central part (2) of the helmet adapted to absorb impact forces that comprises pockets (3) for the suspension connectors (8), wherein the central part (2) of the helmet is rigidly connected to the inner shell (4) of the helmet or to the outer shell (1) of the helmet.

4. The helmet with a multi-directional suspension system of claim 4, **characterized in that** there is a free space between the central part (2) of the helmet and the inner shell (4) of the helmet or the outer shell (1) of the helmet.

5. The helmet with a multi-directional suspension system of claims 1 to 4, **characterized in that** the flexible suspensions (7) connecting the bases (5) of the suspension connector (8) are anchored at the edge of the bases (5), wherein the edge of the base (5) means any point of the surface of the base (5) distance of which from the axis of the suspension connector (8) is greater than 70 % of the shortest distance from the axis of the suspension connector (8) to the edge of the surface of the base (5).

6. A procedure for assembling a connection between the inner shell (4) and the outer shell (1) of the helmet with a multi-directional suspension system of claims 1 to 5, **characterized in that** it comprises the successive steps:

   a) manufacture of the suspension connector (8) comprising

      a step of manufacturing the first and second part of the suspension connector (8), and further

      a step of connecting the first and second parts of the suspension connectors (8) by means of flexible suspensions (7), during which the stress of the flexible suspensions (7) is adjusted,

      wherein the steps of manufacturing the suspension connector (8) are repeated depending on the number of the suspension connectors (8) required to connect the inner shell (4) and the outer shell (1) of the helmet;

   b) a rigid connection of the first bases (5) of the suspension connectors (8) to the first one of the inner shell (4) of the helmet or the outer shell (1) of the helmet;

   c) a rigid connection of the second bases (5) of the suspension connectors (8) to the second one of the inner shell (4) of the helmet or the outer shell (1) of the helmet.

7. The procedure for assembling a connection between the inner shell (4) and the outer shell (1) of the helmet with a multi-directional suspension system of claim 6, **characterized in that** prior to the step of connecting the first bases (5) of the suspension connectors (8) to the first one of the inner shell (4) of the helmet or the outer shell (1) of the helmet,

models imitating the shape of the suspension connectors (8) are placed on the inner shell (4) of the helmet or on the outer shell (1) of the helmet, adapted to define the space for the suspension connectors (8),

then the central part (2) of the helmet is applied to the inner shell (4) of the helmet or the outer shell (1) of the helmet,

and the models imitating the shape of the suspension connectors (8) are removed.

8. The procedure for assembling a connection between the inner shell (4) and the outer shell (1) of the helmet with a multi-directional suspension system of claim 6, **characterized in that** prior to the step of connecting the first bases (5) of the suspension connectors (8) to the first one of the inner shell (4) of the helmet or the outer shell (1) of the helmet, the central part (2) of the helmet is connected to the inner shell (4) of the helmet or the outer shell (1) of the helmet.

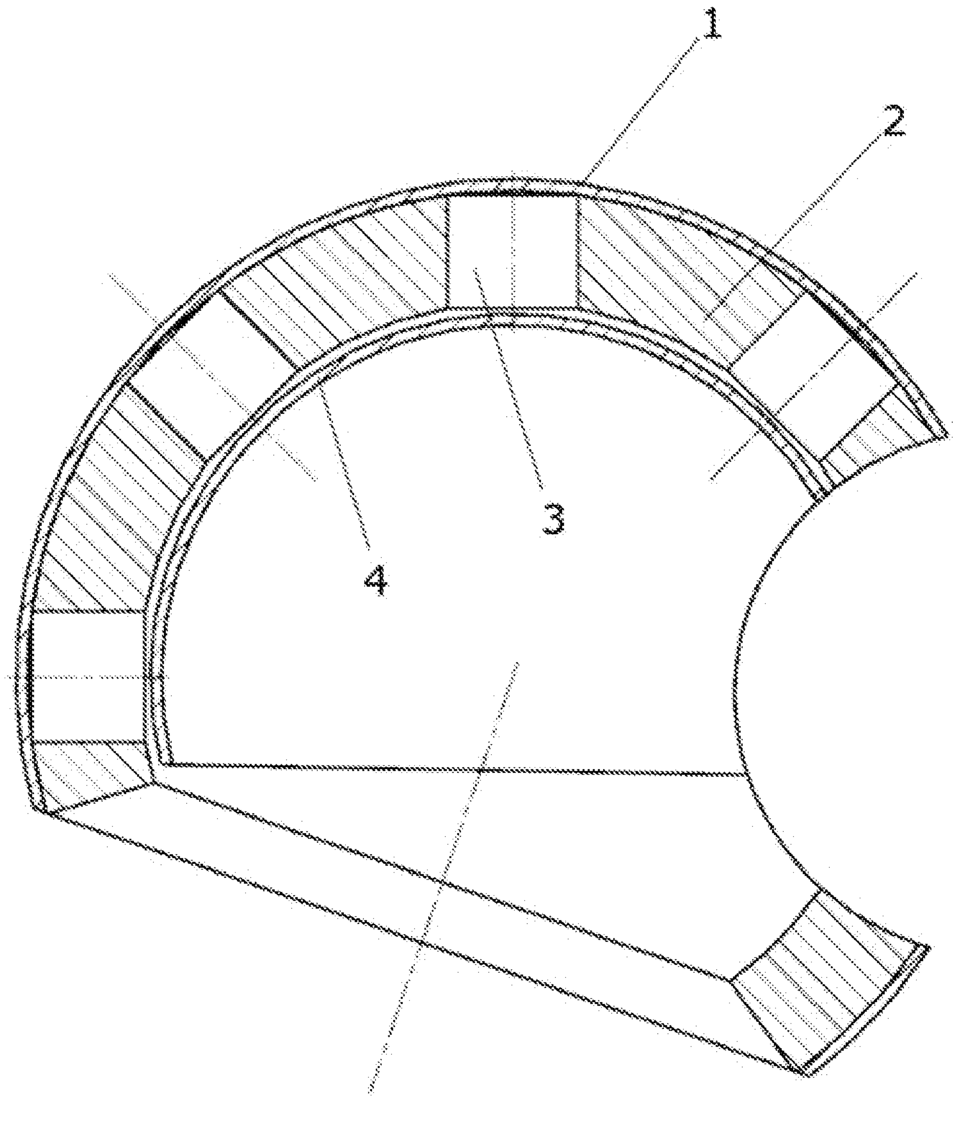

Fig. 1

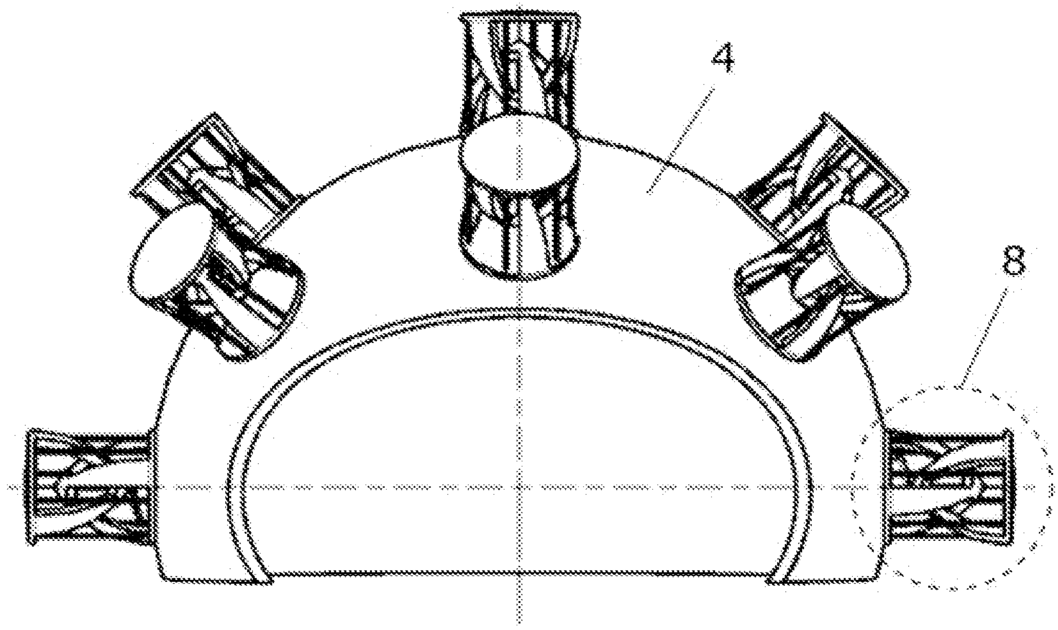

Fig. 2

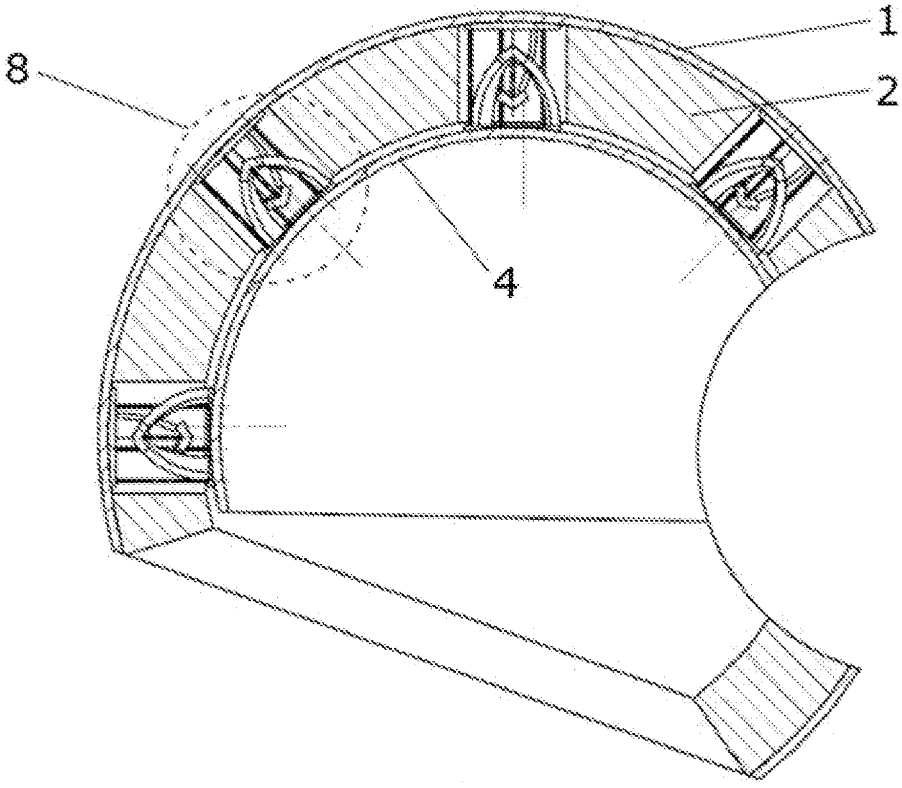

Fig. 3

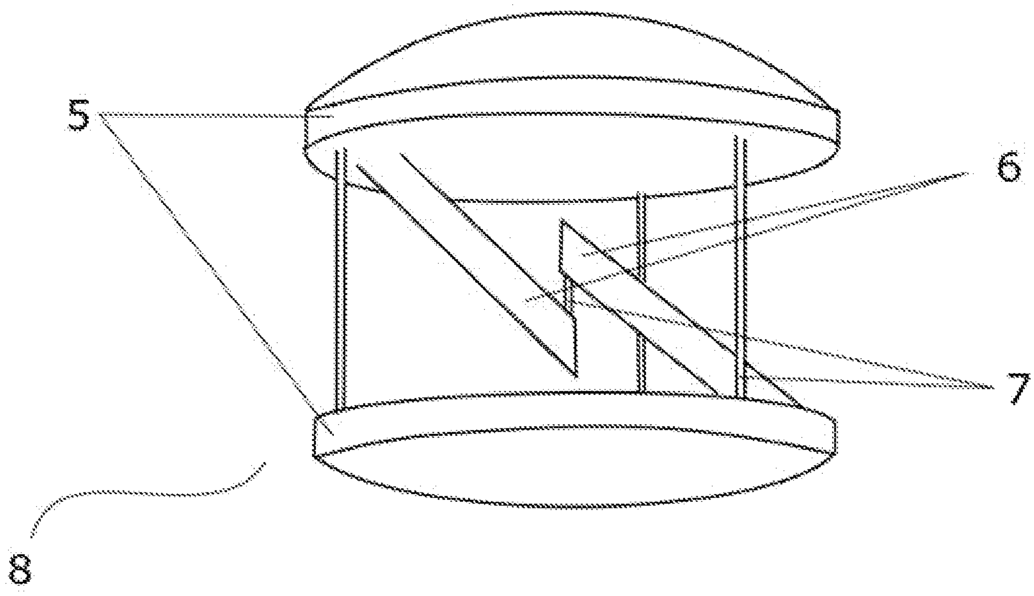

Fig. 4

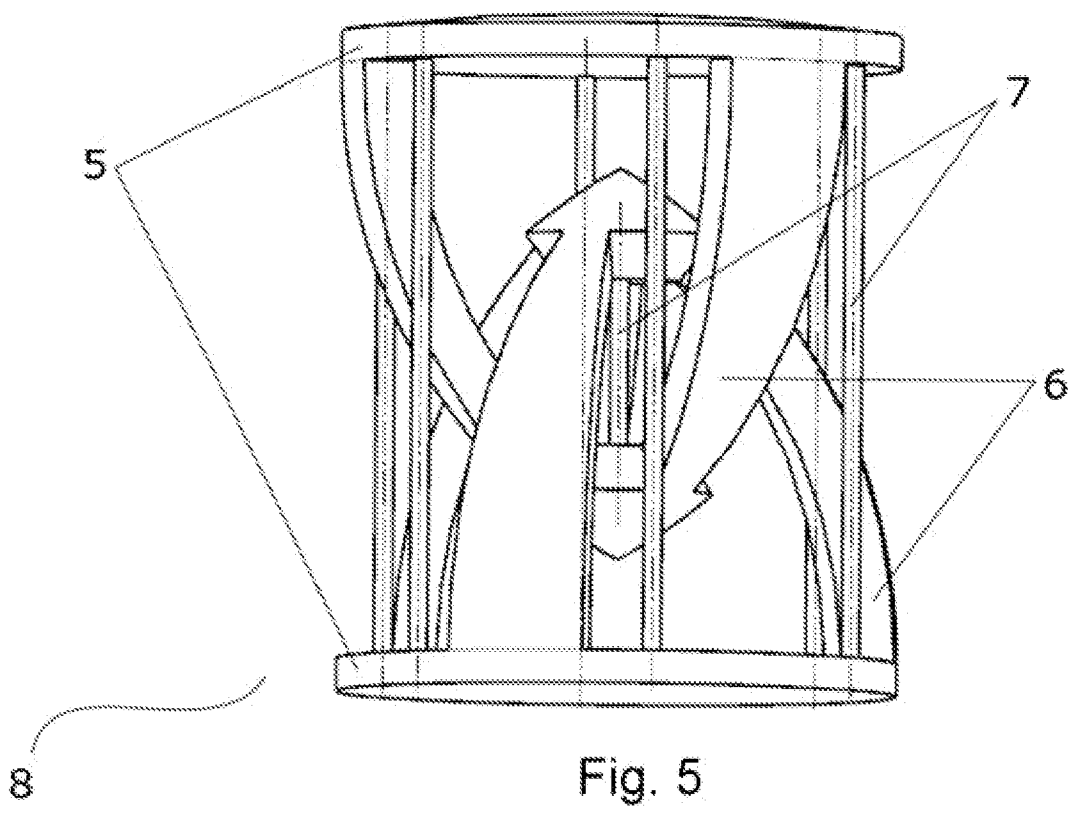

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/CZ2022/050066

A. CLASSIFICATION OF SUBJECT MATTER
INV. A42B3/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A42B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2018/000186 A1 (BROWN JEFFREY W [US]) 4 January 2018 (2018-01-04) paragraphs [0023] - [0029]; figures 2,7	1-8
A	US 2019/242110 A1 (RIMOLI JULIAN JOSE [US]) 8 August 2019 (2019-08-08) paragraphs [0062], [0092] - [0094]; figure 4	1-8

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 October 2022	10/11/2022

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	D'Souza, Jennifer

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/CZ2022/050066

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2018000186 A1	04-01-2018	NONE	
US 2019242110 A1	08-08-2019	US 2019242110 A1	08-08-2019
		WO 2018068056 A1	12-04-2018