(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 893 824 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
06.10.2021 Bulletin 2021/40

(21) Application number: **15250001.3**

(22) Date of filing: **07.01.2015**

(51) Int Cl.:
A41D 13/05 *(2006.01)* ***A41D 31/00*** *(2019.01)*

(54) **Method of making body protection apparatus**

Verfahren zur Herstellung von Körperschutzvorrichtung

Procédé de fabrication d'un appareil de protection du corps

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **10.01.2014 GB 201400470**

(43) Date of publication of application:
15.07.2015 Bulletin 2015/29

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- **None**

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EP 2 893 824 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a method of fabricating a body protection apparatus for absorbing the energy of an impact.

[0002] Devices for protecting the human body against injury are known. For example, it is known to provide a back protector for motorcyclists such that, in the event of an accident or a fall, injuries to a rider's spine can be reduced or eliminated.

[0003] The requirements for a spine protector of this type may be identified as follows. The device should be resilient, in that it should retain its shape so as to remain at its required location and so as to retain its mechanical integrity. However, upon receiving an impact of sufficient energy, the device should absorb this energy. Furthermore, in order to be useable in most environments, the device should be breathable to facilitate heat transfer, to ensure that a user does not become too hot and uncomfortable.

[0004] According to an aspect of the present invention, there is provided a method of fabricating a body protection apparatus for absorbing the energy of an impact, characterised by the steps of: constructing an internal planar structure from a plurality of open cells, wherein said cells are tubular open cells configured to deform under load, by extruding a plurality of tubes, each with an internal circumference of a first material and an outer circumference of a second material, in which the second material has a lower melting point than the inner material, the outer diameter of said tubes being between 2mm and 9mm, cutting said extruded tubes into short tubes, each having a length of between 10mm and 25mm, arranging said short tubes in close packed arrays, and heating said tubes to weld them together; and arranging an outer layer of a flexible sheet material to overlie a surface of said internal planar structure, wherein the outer layer of flexible material is held in place relative to the internal planar structure such that the outer layer of flexible material increases the area of energy absorption under impact.

[0005] The invention will now be described by way of example only with reference to the accompanying drawings, of which:

Figure 1 shows a body protection apparatus;
Figure 2 shows an internal planar structure of the apparatus identified in Figure 1;
Figure 3 shows an example of an outer layer of flexible sheet material;
Figure 4 shows an alternative view of the apparatus identified in Figure 1;
Figure 5 shows the apparatus in an outer cover for attachment to a user;
Figure 6 shows the apparatus of Figure 1 deployed within a jacket;
Figure 7 illustrates the apparatus of Figure 1 in use;
Figure 8 shows a first stage in a method of fabricating a body protection assembly;
Figure 9 shows a second stage in said assembly;
Figure 10 shows a third stage in said assembly;
Figure 11 shows an alternative jacket with pockets for receiving protection devices; and
Figure 12 shows a glove with pockets for receiving protection devices.

Figure 1

[0006] A body protection apparatus **101** is shown in Figure 1, for protecting a human body from injury due to an impact. The apparatus has an internal planar structure **102** defining the shape of the apparatus. The internal planar structure is therefore substantially rigid but does allow a degree of flexibility. Thus, in an embodiment, pressure may be applied to a bottom **103** of the apparatus and to a top **104** of the apparatus resulting in a degree of curvature being introduced. In this way, when fitted, the apparatus will flex to a degree in order to accommodate the particular shape of a user and to accommodate user movements.

[0007] An outer layer of a flexible sheet material **105** is provided having a shape defined by the internal planar structure. The internal planar structure **102** is itself made up from a plurality of cells. Cells at the position of an impact region deform to absorb kinetic energy. In addition, the outer layer of the flexible sheet material draws additional cells into the impact region. In this way, the outer layer extends the size of the impact region so as to increase the number of cells that absorb the kinetic energy. It is then possible for the apparatus to absorb a substantial degree of kinetic energy before the overall integrity of the apparatus breaks down.

Figure 2

[0008] Internal planar structure **102** is shown in Figure 2. Region **201** is shown enlarged at **202**. In this embodiment, cells, such as cell 203, are tubes, with each tube being welded to at least one other tube. A material of this type is described in European patent publication EP 1 694 152 (US 8,082,599).

[0009] In this embodiment, each cell comprises a tube and the tubes are arranged in close packed arrays, such that the gap between adjacent tubes is minimised. Each tube has a diameter of between two millimetre and nine millimetre (2mm - 9mm) and a thickness of between zero point one millimetre and zero point seven five millimetre (0.10mm - 0.75mm). A typical tube length is between ten millimetre and twenty five millimetre (10mm - 25mm). In this configuration, a progressive buckling failure mode is achieved and a global fracture is avoided if a sufficient number of the tubes are included in the process of material deformation.

[0010] In previous applications of the material, it is known to encase the material within a solid outer shell, such as that provided by a motorcyclist's helmet. In this way, the integrity of the apparatus is maintained by the

outer shell and the presence of the outer shell ensures that the impact region is extended over a substantially large number of collapsing cells. In the present embodiment, such a shell is not available and the rigidity and structure of the apparatus are provided by the cellular material itself.

[0011] Experiments have shown that when used alone, the material may fracture upon the application of a relatively modest impact; given that the progressive buckling property is not observed. However, further experiments have shown that by the inclusion of an outer layer of a flexible sheet material, it is possible to bring a sufficient number of collapsing cells within the influence of the impact, thereby dissipating impact energy without causing a catastrophic failure.

[0012] Thus, in an embodiment, the cells are tubes and each tube is welded to at least one other tube. However, in alternative embodiments, alternative structures could be deployed, such as a honey-comb structure, provided that progressive buckling occurs upon impact and the region of buckling is extended by the presence of the planar structure.

Figure 3

[0013] An example of an outer layer **301** of a flexible sheet material is shown in Figure 3. In an embodiment, the flexible material covers the upper or outer face of the apparatus; this being the impact side of the apparatus. In an alternative embodiment, flexible material of the type shown in Figure 3 covers both the front face and the rear face of the internal planar structure.

[0014] In an embodiment, a layer of adhesive **302** is provided between the internal planar structure and the flexible material. Thus, in an embodiment, a sub-assembly of the apparatus will be constructed as a plurality of layers. A first layer **301** provides a rear flexible material face that is covered by a layer of adhesive **302**. The internal planar structure **102** is then applied, followed by a further layer of adhesive and a front flexible material cover.

Figure 4

[0015] In an embodiment, a subassembly **404** (constructed from the plurality of layers previously described) is surrounded by an outer rim **402**. In an embodiment, the outer rim **402** is constructed from a plastics material and is configured to hold the edges of the layers in place.

[0016] In an embodiment, an edge **402** is chamfered, as shown in Figure 1.

[0017] In an embodiment, the flexible material **301** is a breathable material, knitted or woven from a yarn. Thus, in this way, at modest expense, it is possible to produce an assembly that has the required mechanical properties, while at the same time presenting holes for breathability and heat transfer.

[0018] In an alternative embodiment, the outer layer **301** is a flexible plastic sheet material. To facilitate heat transfer, the flexible sheet material **301** is provided with a plurality of holes **403**. In an embodiment, the holes are as large as possible, to enhance breathability, while maintaining sufficient material to retain the required mechanical characteristics.

[0019] In the example shown in Figure 4, the overall shape of the apparatus has been configured to allow the apparatus to be deployed for protection against spinal injury. In this application, a vertical axis **404** is positioned over the spine of a user and a horizontal axis **405** is placed at the position of the shoulders.

Figure 5

[0020] In an embodiment, the apparatus of Figure 4 may be surrounded by an outer cover **501** and the assembly may include attachments **502** for attaching the apparatus into position over the spine of a user. In an embodiment, the attachments may take the form of shoulder straps **502** and a waist belt **503.** In the example of Figure 5, the apparatus is totally self contained and its functionality is directed exclusively towards providing protection.

Figure 6

[0021] In an alternative configuration, the apparatus of Figure 4 may be included at a location **601** within a jacket **602**. The apparatus may be included during the manufacture of the jacket **602** or the jacket **602** may be provided with a pocket allowing the apparatus to be inserted and, if necessary, subsequently removed or replaced.

[0022] The example of Figure 6 shows the apparatus deployed in a motorcyclist's jacket **602**. However, it should be appreciated that the apparatus could be included in many other forms of clothing, such as clothing for off road cycling or skiing. In many of these sporting applications, it is appreciated that the devices should be lightweight, flexible and breathable; while at the same time exhibiting sufficient strength in order to absorb energy when an impact occurs. Further examples are described with reference to Figures 8 to 12.

***Figure** 7*

[0023] The configuration illustrated in Figure 6 facilitates a method for protecting a body while receiving an impact. As shown in Figure 7, a user has fallen from a motorcycle **701** resulting in the user making impact with tarmac **702**. The resulting accident could leave the user severely injured but the impact has been received at the position of the body protection apparatus.

[0024] In response to this, the body protection apparatus absorbs kinetic energy by deforming cells at the position of a region of energy absorption. The apparatus is configured to draw-in additional cells into the region of energy absorption. Thus, in this way, the outer layer ex-

tends the size of the impact region so as to increase the number of cells that absorb kinetic energy.

[0025] The cells form a solid planar structure that defines the shape of the body protection apparatus. In addition, the planar structure has an impact surface in contact with an outer layer of flexible material having a shape defined by the solid structure to perform the step of extending the impact region, thereby drawing-in additional cells.

[0026] It should be appreciated that following an impact of the type shown in Figure 7, plastic deformation to the solid planar structure occurs due to the progressive buckling of the cells. In many applications, an apparatus strong enough to absorb an impact of this type would tend to be uncomfortable and introduce further problems in terms of heat dissipation. However, in an embodiment, a user's body may experience satisfactory heat transfer due to the outer layer being constructed from a breathable material. As shown in Figure 4, this breathability may be achieved by the presence of a plurality of holes in the sheet material.

*Figure **8***

[0027] A method of fabricating a body protection assembly is shown in Figures 8 through 10 and alternative applications for the assembly are illustrated in Figures 11 and 12.

[0028] To fabricate the assembly, an internal structure 801 is constructed from a plurality of cells, such that the structure is configured to deform in an area of energy absorption upon receiving an impact.

[0029] The internal structure is constructed by extruding tubes with an internal circumference of a first material and an outer circumference of a second material, in which the second material has a lower melting point than the inner material. Predetermined lengths of the extruded tubes are then cut and arranged into the planar structure of Figure 8. Heat is then applied to melt a portion of the outer circumferences without melting respective inner circumferences. In this embodiment, further machining is performed in order to create a chamfered edge **802.**

[0030] The tubes have an outer diameter of between two millimetre and nine millimetre (2mm - 9mm) and each tube may have a thickness of less than seven hundred and fifty micrometre (**750**μm).

Figure 9

[0031] Having constructed the internal structure **802**, an outer layer of a flexible material **901** is attached to the internal structure. The purpose of the outer layer of flexible material is to bring more of the cells into a region of energy absorption when an impact occurs, thereby increasing the area of energy absorption.

Figure 10

[0032] An assembly of layers, consisting of a first flexible material, a layer of adhesive, the internal structure, a further layer of adhesive and a second flexible material is surrounded by an outer rim **1001** of a plastics material. The outer rim holds the layers of the assembly in place and maintains the overall mechanical integrity of the apparatus.

[0033] The apparatus shown in Figure 10 may be produced to various sizes, facilitating many different types of application. The apparatus of Figure 10 may be seen as a general purpose protector, suitable for application in various places; unlike the protector of Figure 4 that has been designed for a specific type of application.

Figure 11

[0034] An alternative jacket **1101** is shown in Figure 11. The jacket has been constructed with a plurality of pockets configured to receive protection devices of the type shown in Figure 10.

Figure 12

[0035] A glove **1201** is shown in Figure 12, again including pockets for receiving protection devices of the type shown in Figure 10. Thus, it can be seen, that the size of the protection device shown in Figure 10 may vary significantly, thereby allowing deployment in many different configurations.

Claims

1. A method of fabricating a body protection apparatus (101) for absorbing the energy of an impact, **characterised by** the steps of:
constructing an internal planar structure (102, 801) from a plurality of open cells configured to deform under load, by:

extruding a plurality of tubes, each with an internal circumference of a first material and an outer circumference of a second material, in which the second material has a lower melting point than the inner material, the outer diameter of said tubes being between 2mm and 9mm,
cutting said extruded tubes into short tubes, each having a length of between 10mm and 25mm,
arranging said short tubes in close packed arrays, and
heating said tubes to weld them together; and
arranging an outer layer of a flexible sheet material (105, 301) to overlie a surface of said internal planar structure;
wherein the outer layer of flexible material is held

in place relative to the internal planar structure such that the outer layer of flexible material increases the area of energy absorption under impact.

2. A method according to claim 1, further including the step of providing an outer rim to hold said outer layer to the edges of said internal planar structure.

3. A method according to either of claims 1 or 2, further including the step of attaching said outer layer to said internal planar structure.

4. A method according to claim 3, wherein said step of attaching said outer layer to said internal planar structure comprises the step of adhering said outer layer to said internal planar structure using a layer of adhesive.

5. A method according to any of claims 1 to 4, further including the steps of:

obtaining attachments suitable for attaching the body protection apparatus into position over the spine of a user; and
attaching said attachments to said body protection apparatus.

6. A method according to any of claims 1 to 5, wherein said step of arranging said outer layer includes arranging it to overlie both a front and a rear surface of said internal planar structure.

7. A method according to any of claims 1 to 6, wherein said flexible material is a breathable material knitted or woven from a yarn.

8. A method according to any of claims 1 to 6, wherein said flexible material is a plastic sheet material.

9. A method according to claim 8, wherein said outer layer of plastic sheet material defines a plurality of holes.

Patentansprüche

1. Verfahren zum Herstellen einer Körperschutzvorrichtung (101) zum Absorbieren der Energie eines Aufpralls, **gekennzeichnet durch** die Schritte:
Konstruieren einer inneren planaren Struktur (102, 801) aus einer Vielzahl von offenen Zellen, die dazu konfiguriert sind, sich unter Last zu verformen, **durch**:

Extrudieren einer Vielzahl von Rohren, jedes mit einem Innenumfang aus einem ersten Material und einem Außenumfang aus einem zweiten Material, wobei das zweite Material einen niedrigeren Schmelzpunkt als das Innenmaterial hat, wobei der Außendurchmesser der Rohre zwischen 2 mm und 9 mm beträgt,
Schneiden der extrudierten Rohre in kurze Rohre, die jeweils eine Länge zwischen 10 mm und 25 mm aufweisen,
Anordnen der kurzen Röhren in dicht gepackten Arrays, und
Erhitzen der Rohre, um sie miteinander zu verschweißen; und
Anordnen einer äußeren Schicht aus einem flexiblen Blattmaterial (105, 301), um über einer Oberfläche der inneren ebenen Struktur zu liegen;
wobei die äußere Schicht aus flexiblem Material relativ zu der inneren ebenen Struktur an Ort und Stelle gehalten wird, so dass die äußere Schicht aus flexiblem Material den Bereich der Energieabsorption bei einem Aufprall vergrößert.

2. Verfahren nach Anspruch 1, das des Weiteren den Schritt des Bereitstellens eines äußeren Rands umfasst, um die äußere Schicht an den Kanten der inneren ebenen Struktur zu halten.

3. Verfahren nach einem der Ansprüche 1 oder 2, das ferner den Schritt des Anbringens der äußeren Schicht an der inneren ebenen Struktur umfasst.

4. Verfahren nach Anspruch 3, wobei der Schritt des Anbringens der äußeren Schicht an der inneren ebenen Struktur den Schritt des Anklebens der äußeren Schicht an die innere ebene Struktur unter Verwendung einer Klebstoffschicht umfasst.

5. Verfahren nach einem der Ansprüche 1 bis 4, ferner umfassend die Schritte:

Erhalten von Befestigungen, die zum Befestigen der Körperschutzvorrichtung in Position über der Wirbelsäule eines Benutzers geeignet sind; und
Anbringen der Anbauteile an der Körperschutzvorrichtung.

6. Verfahren nach einem der Ansprüche 1 bis 5, wobei der Schritt des Anordnens der äußeren Schicht das Anordnen derselben umfasst, um sowohl eine vordere als auch eine hintere Oberfläche der inneren ebenen Struktur zu überlagern.

7. Verfahren nach einem der Ansprüche 1 bis 6, wobei das flexible Material ein atmungsaktives Material ist, das aus einem Garn gewirkt oder gewebt ist.

8. Verfahren nach einem der Ansprüche 1 bis 6, wobei

das flexible Material ein Kunststofffolienmaterial ist.

9. Verfahren nach Anspruch 8, wobei die äußere Schicht aus Kunststofffolienmaterial eine Vielzahl von Löchern definiert.

Revendications

1. Procédé de fabrication d'un appareil de protection corporelle (101) pour absorber l'énergie d'un impact, **caractérisé par** les étapes consistant à :
construire une structure plane interne (102, 801) à partir d'une pluralité de cellules ouvertes configurées pour se déformer sous charge, en :

extruder une pluralité de tubes, chacun avec une circonférence interne d'un premier matériau et une circonférence externe d'un deuxième matériau, dans lesquels le deuxième matériau a un point de fusion inférieur à celui du matériau interne, le diamètre externe desdits tubes étant compris entre 2 mm et 9 mm ,
découper lesdits tubes extrudés en tubes courts, chacun ayant une longueur comprise entre 10 mm et 25 mm,
disposer lesdits tubes courts en rangées serrées, et
chauffer lesdits tubes pour les souder ensemble; et
disposer une couche externe d'un matériau en feuille flexible (105, 301) pour recouvrir une surface de ladite structure plane interne;
dans lequel la couche externe de matériau flexible est maintenue en place par rapport à la structure plane interne de telle sorte que la couche externe de matériau flexible augmente la zone d'absorption d'énergie sous impact.

2. Procédé selon la revendication 1, comprenant en outre la phase consistant à fournir un rebord externe pour maintenir ladite couche externe aux bords de ladite structure plane interne.

3. Procédé selon l'une ou l'autre des revendications 1 ou 2, comprenant en outre la phase de fixation de ladite couche externe à ladite structure plane interne.

4. Procédé selon la revendication 3, dans lequel ladite phase de fixation de ladite couche externe sur ladite structure plane interne comprend la phase de collage de ladite couche externe sur ladite structure plane interne à l'aide d'une couche d'adhésif.

5. Procédé selon l'une quelconque des revendications 1 à 4, comprenant en outre les étapes consistant à:

obtenir des fixations appropriées pour attacher l'appareil de protection corporelle en position sur la colonne vertébrale d'un utilisateur ; et
attacher lesdits accessoires audit appareil de protection corporelle.

6. Procédé selon l'une quelconque des revendications 1 à 5, dans lequel ladite phase de disposer ladite couche externe comprend de placer celle-ci pour recouvrir à la fois une surface avant et une surface arrière de ladite structure plane interne.

7. Procédé selon l'une quelconque des revendications 1 à 6, dans lequel ledit matériau flexible est un matériau respirant tricoté ou tissé à partir d'un fil.

8. Procédé selon l'une quelconque des revendications 1 à 6, dans lequel ledit matériau flexible est un matériau en feuille plastique.

9. Procédé selon la revendication 8, dans lequel ladite couche externe de matériau en feuille plastique définit une pluralité de trous.

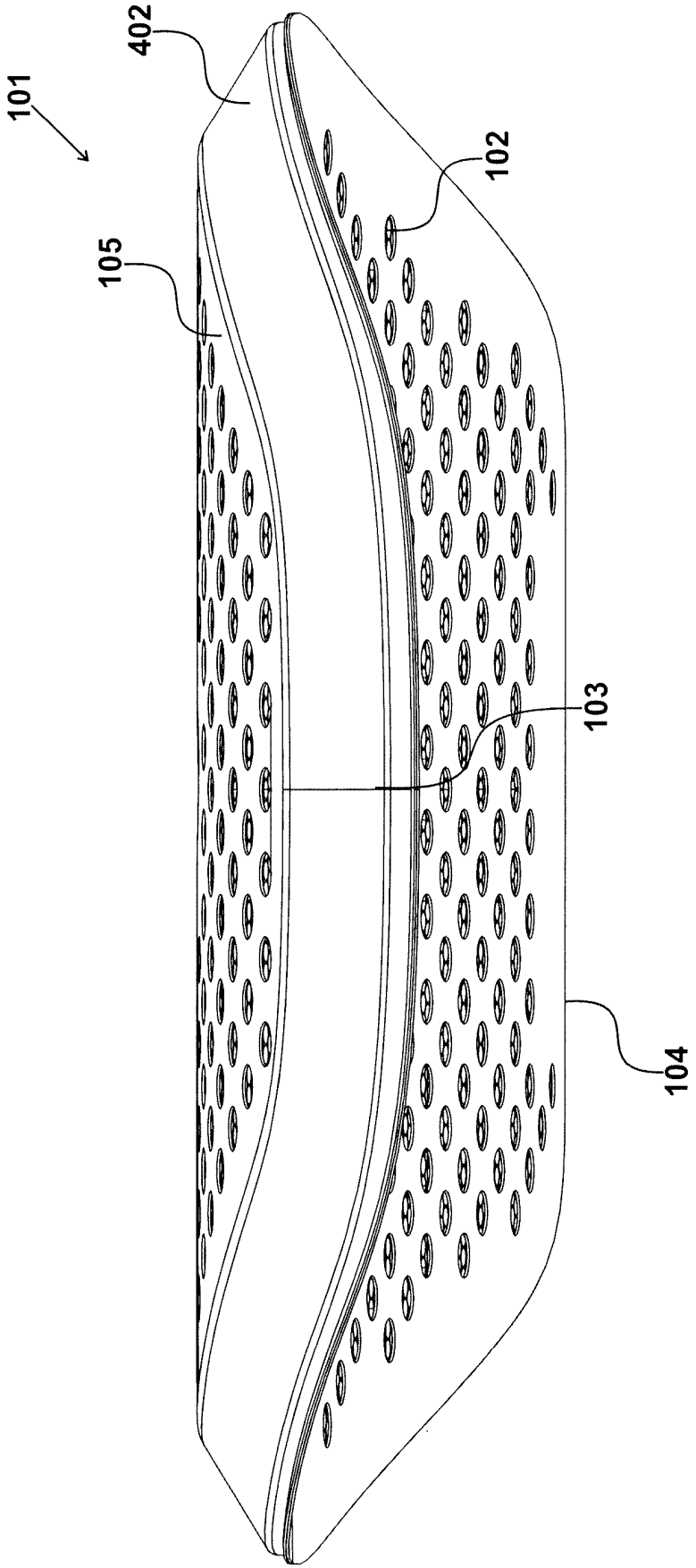

Fig. 1

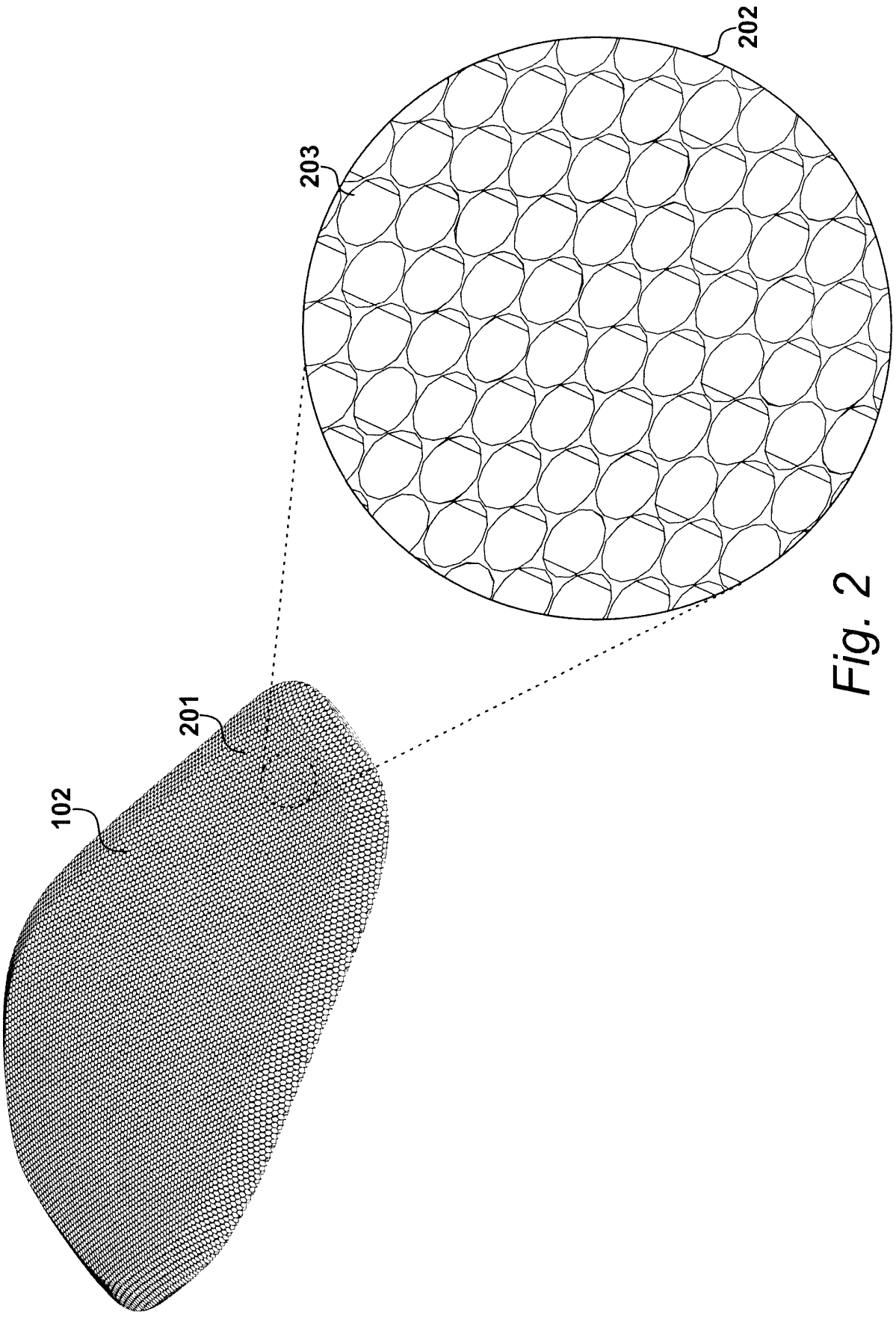

Fig. 2

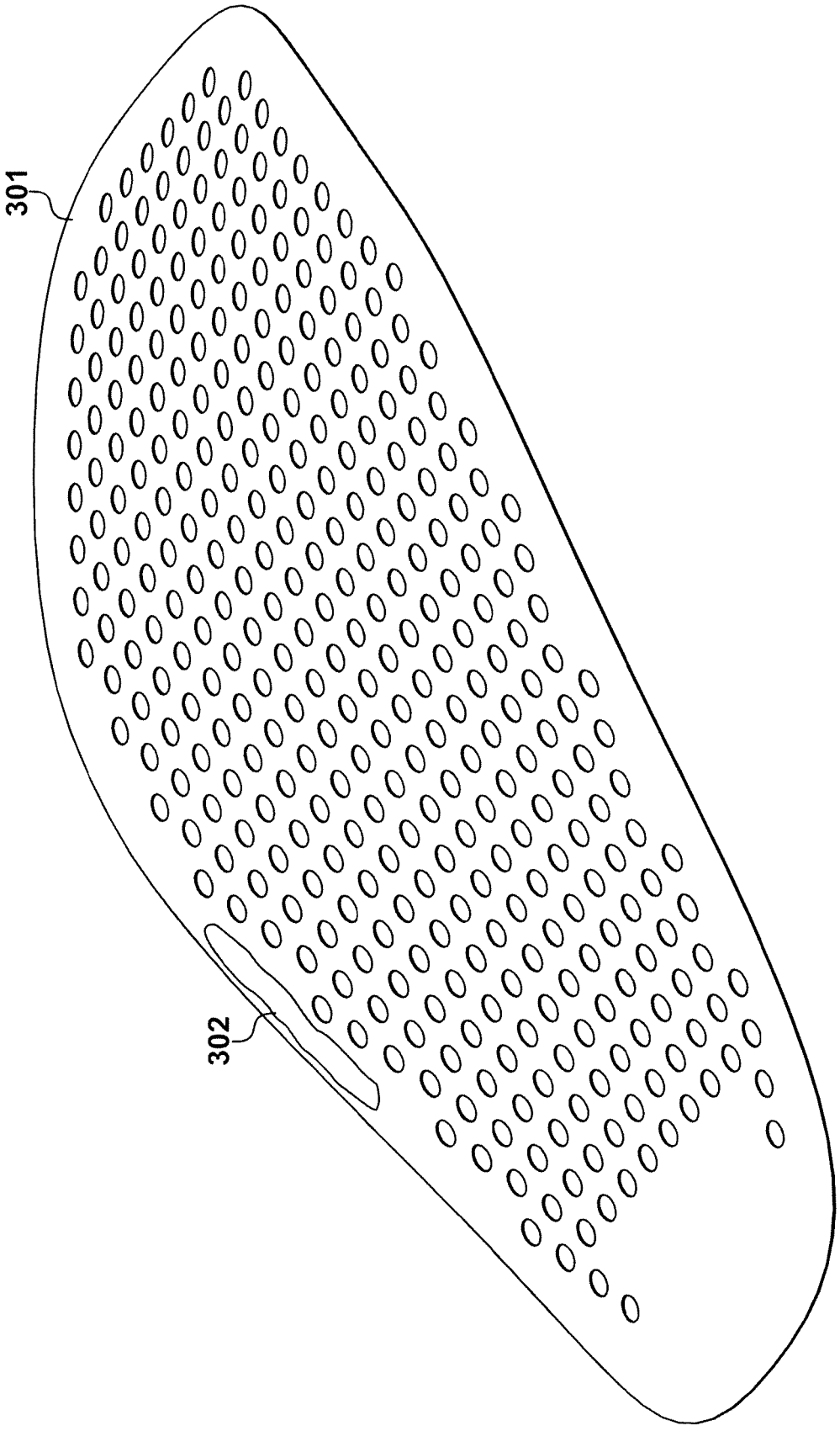

Fig. 3

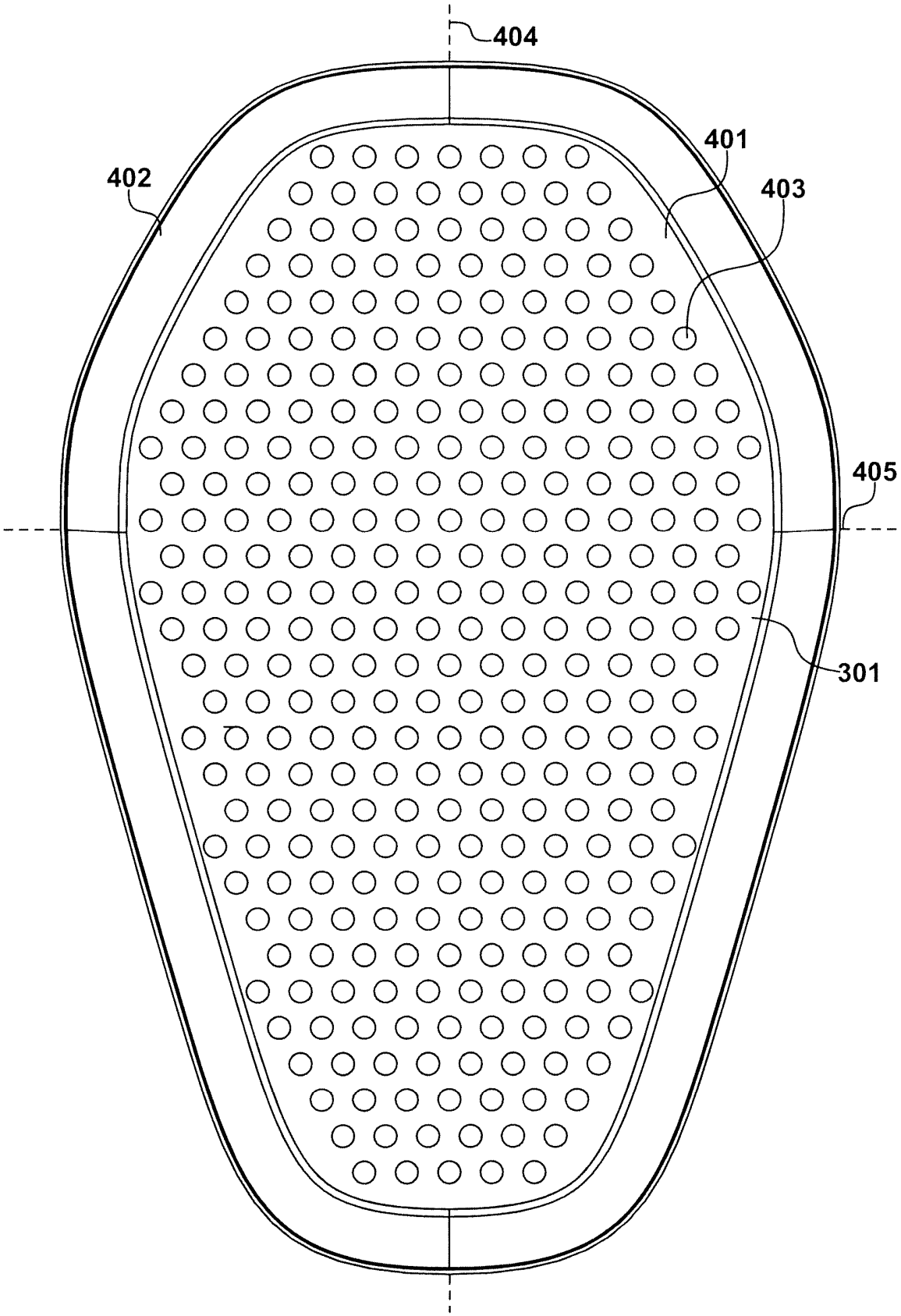

Fig. 4

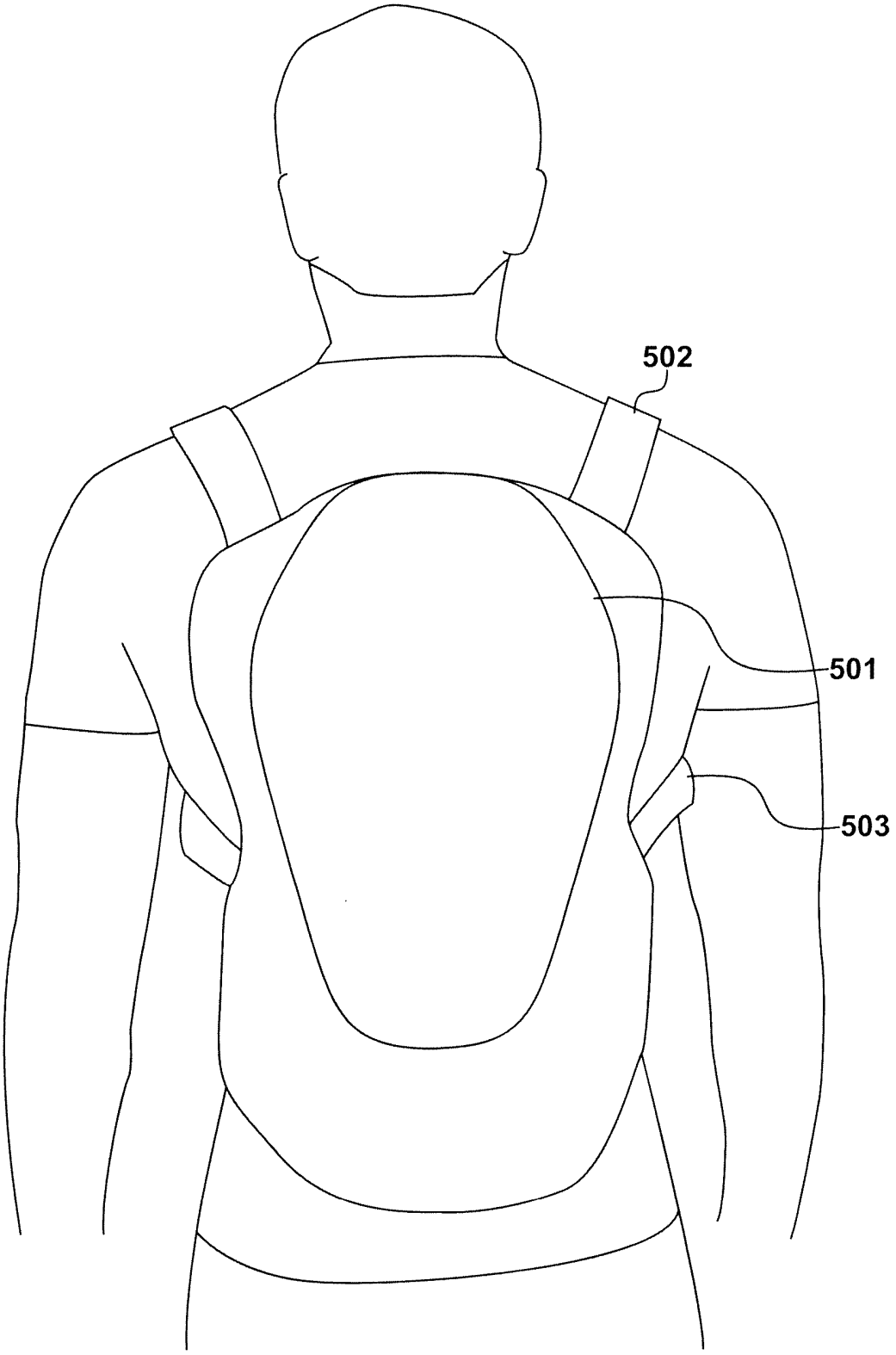

Fig. 5

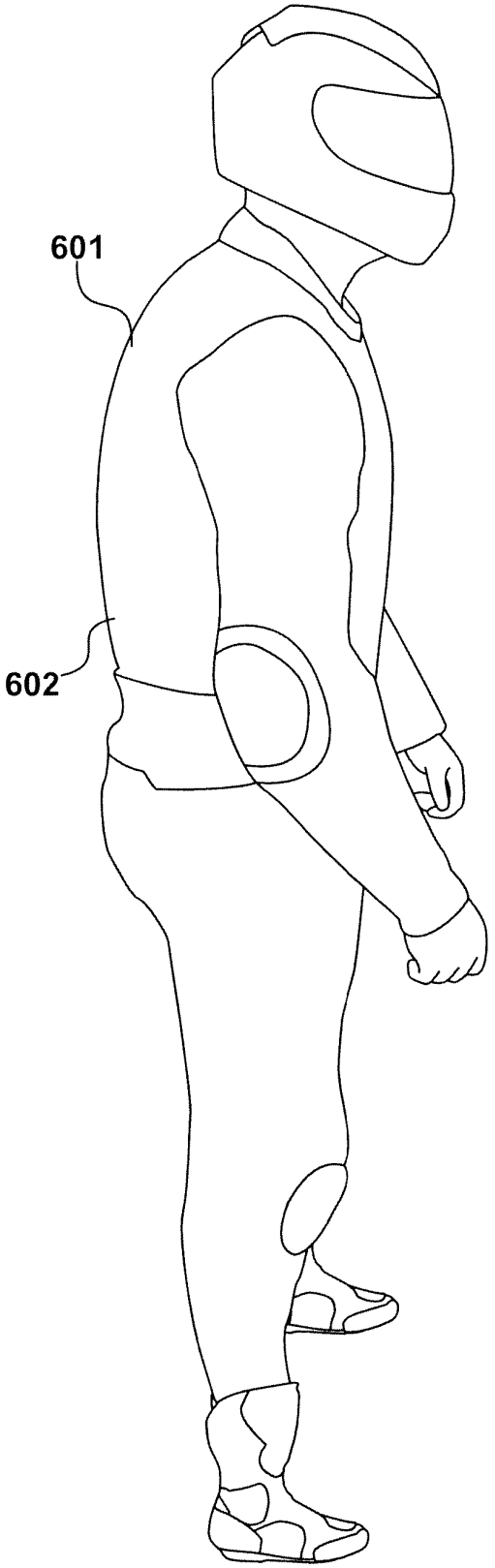

Fig. 6

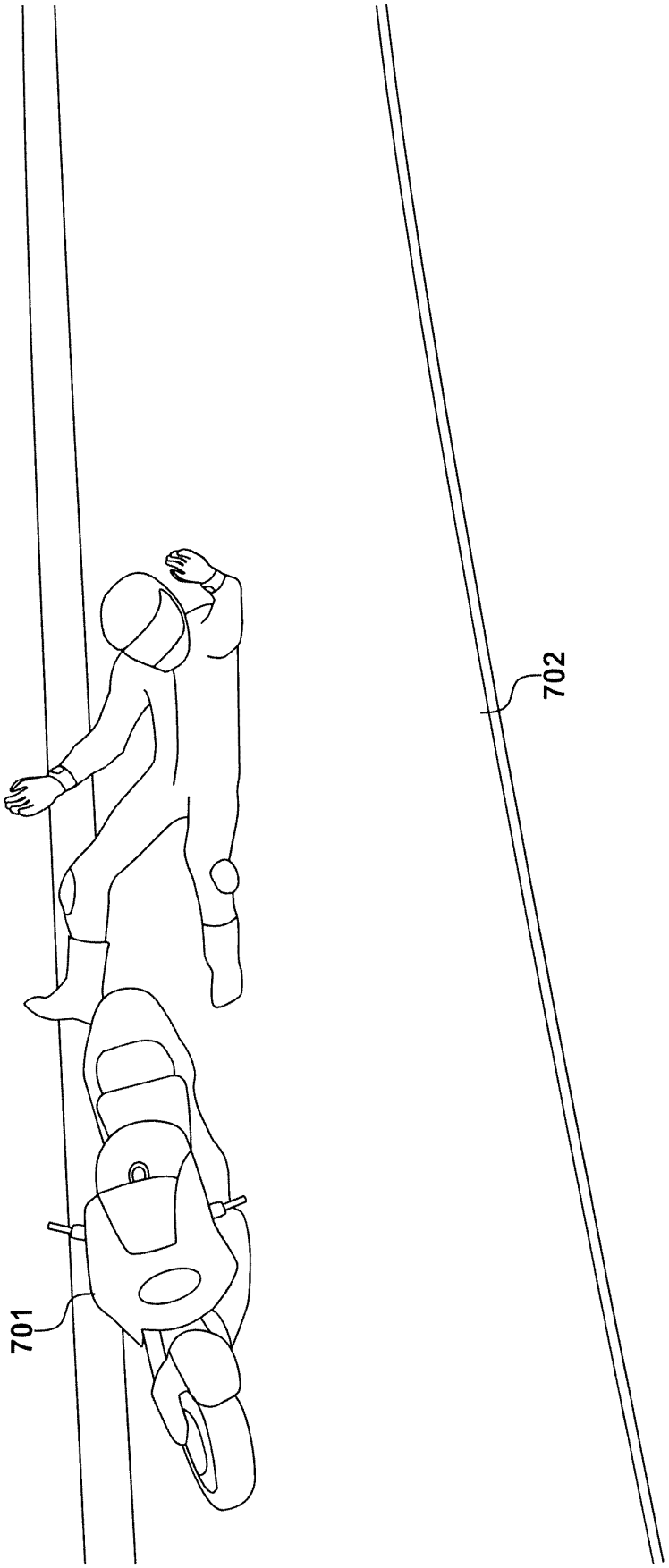

Fig. 7

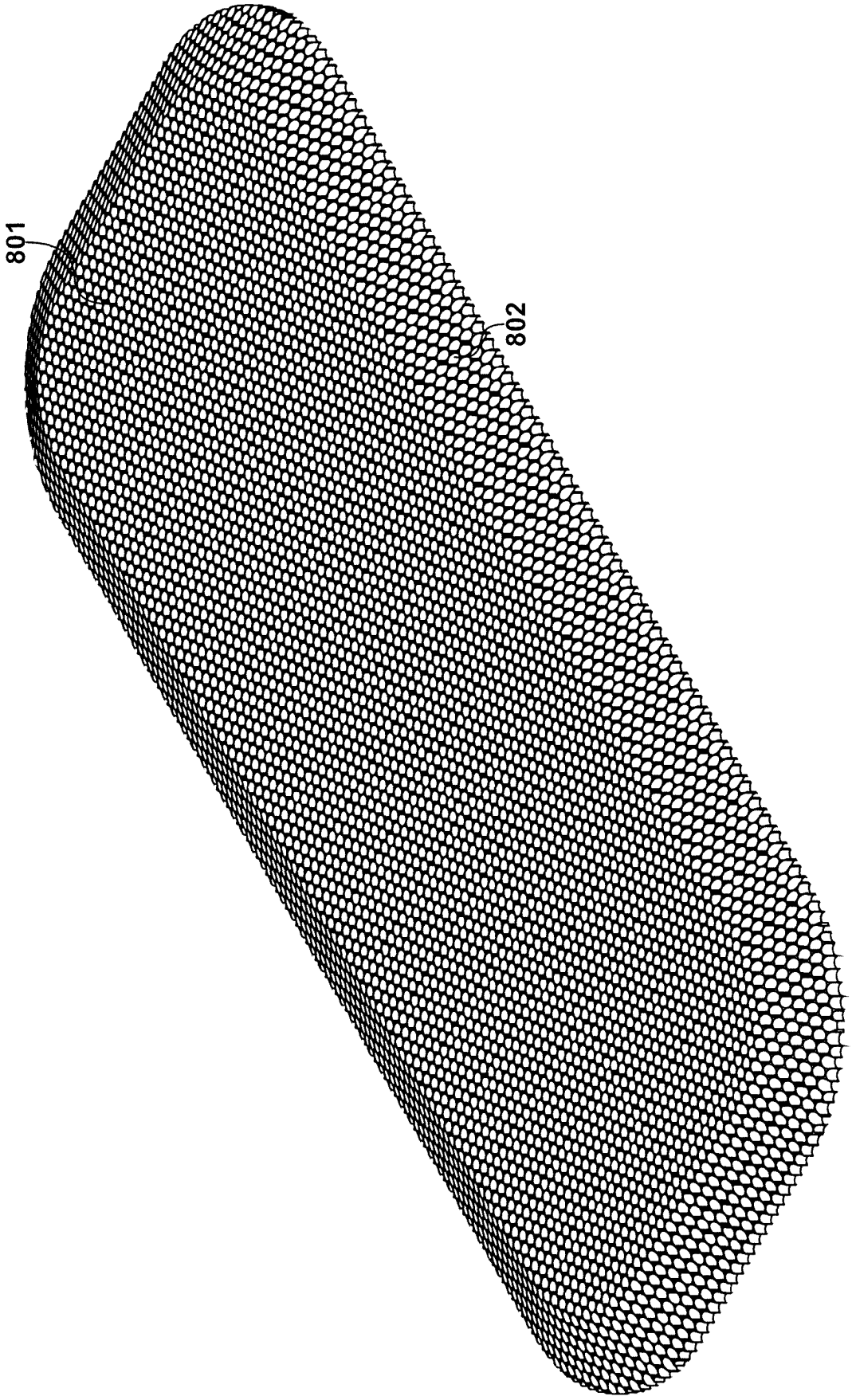

Fig. 8

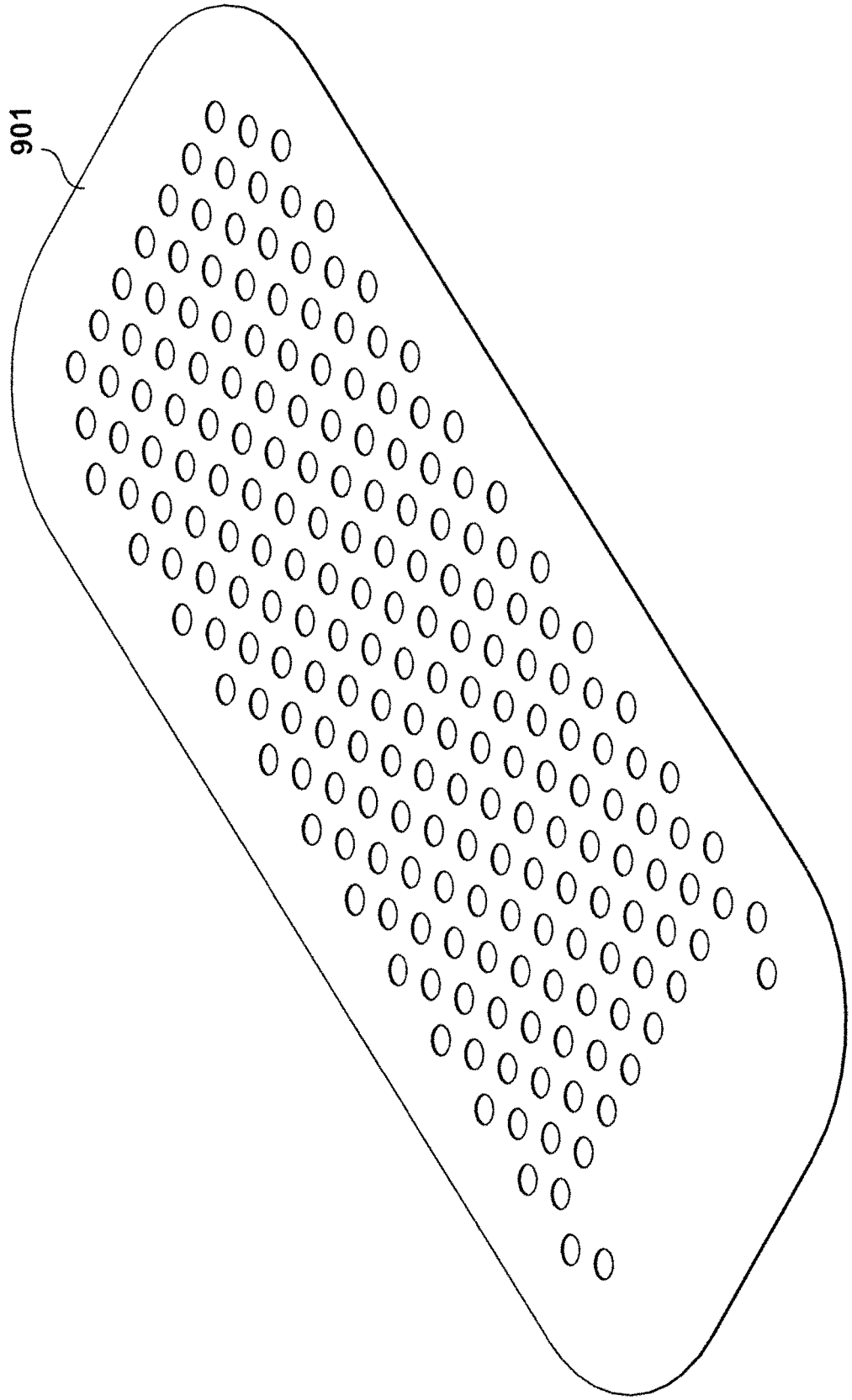

Fig. 9

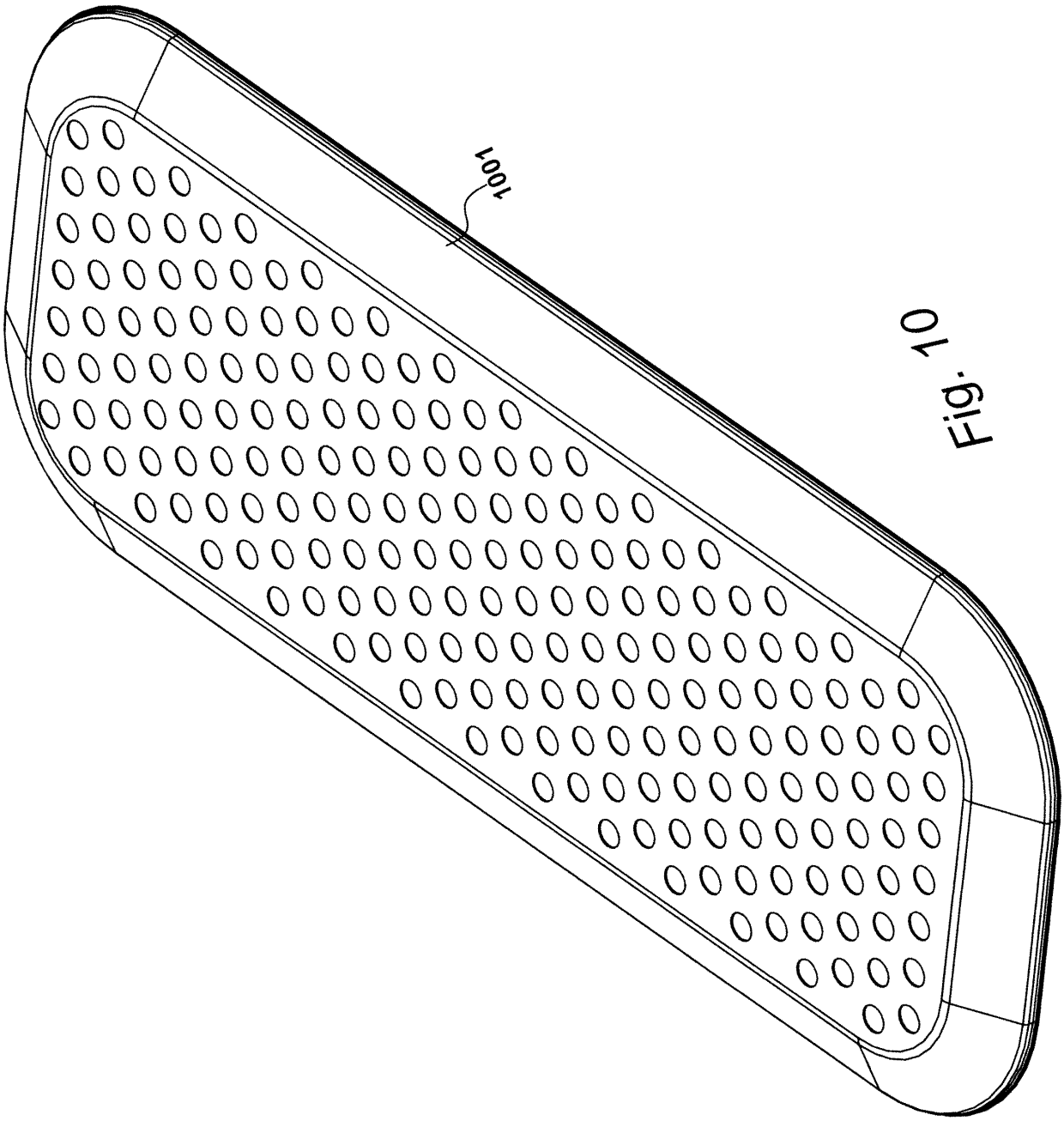

Fig. 10

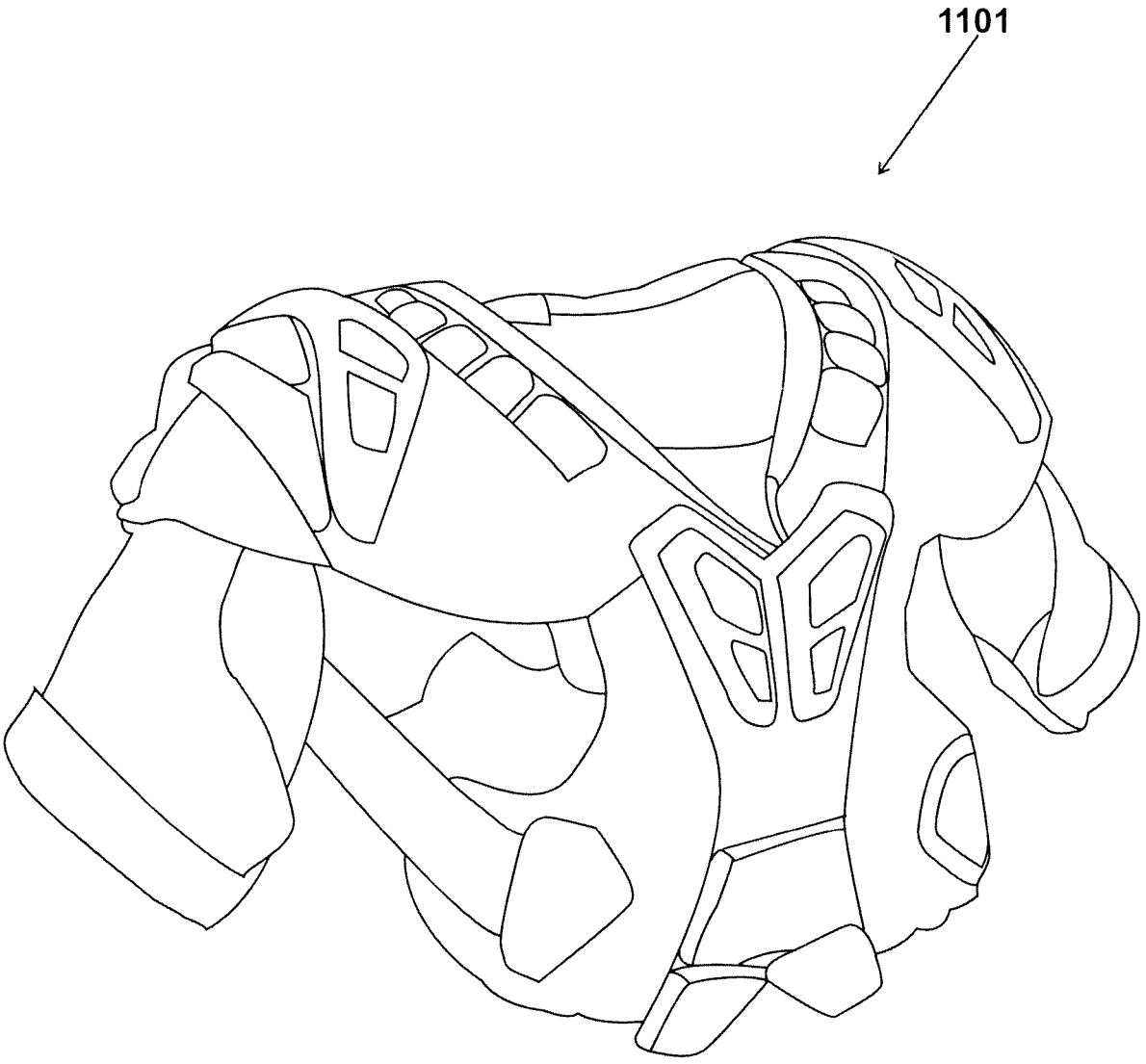

Fig. 11

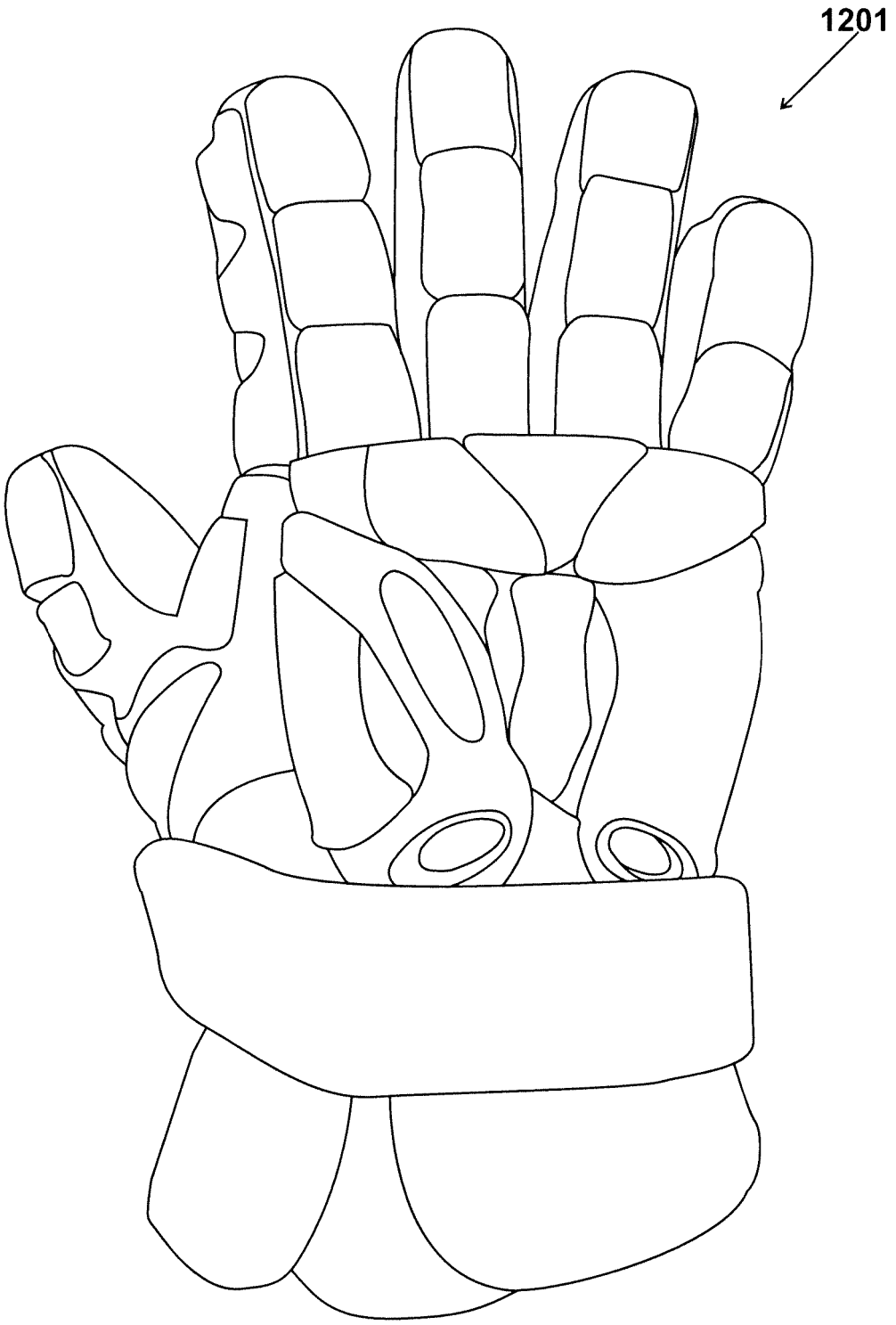

Fig. 12

REFERENCES CITED IN THE DESCRIPTION

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