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(54) **PROTECTION DEVICE**

(57) A protection device (1, 100) for the personal protection of a user is described. The protection device comprises an inflatable element (2, 102). The inflatable element (2, 102) defines an internal chamber (3, 104) apt to receive an inflation fluid and it is apt to assume an active inflated condition and a rest deflated condition in case of fall of a user, in case of danger or impact of a

user against an obstacle. A first portion (18, 103a) of the inflatable element (2, 102) has the ability to assume, in inflated condition, a certain surface extension, or an ability to occupy, in inflated condition, a determined area, or a different expansion capacity compared to a corresponding capacity of an opposite portion (19, 103b) of the inflatable element (2, 102).

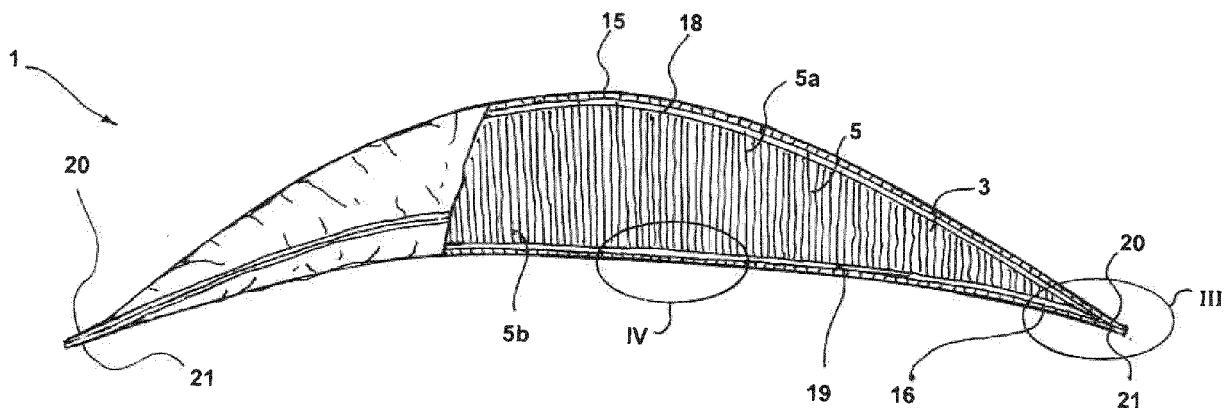


FIG. 2

Description

[0001] The present disclosure relates to a protection device for protecting a user. The protection device includes an inflatable element apt to protect from impacts and/or falls, or to prevent the consequences of an impact or fall, the body of a user, such as a passenger, a motor vehicle driver, a skier, a horseman or a similar user, during a sport and/or working activity.

[0002] A protection device, for example, is described in the International patent application WO 2010-067288 A1.

[0003] According to such International patent application, the inflatable element is a "bivalve" configuration device, that is two valves or opposite portions tied or connected along the perimeter to form a casing. More in particular, the casing is formed by two opposite walls or sheets, a textile structure including a first mesh and a second mesh and tie elements fixed to the meshes. The tie rods preferably connect opposite portions of the inflatable element. Each mesh is adherently associated to the respective wall. Each wall and respective mesh form a "valve" of the inflatable element.

[0004] The tie elements are threads and they have opposite ends fixed firmly to the mesh of the respective wall. The fixing at the opposite ends of the tie elements, for example, is obtained by interweaving tie elements between the mesh wefts. The length of the tie elements is adjusted so that the tie elements have a condition of maximum tension and/or maximum extension when the inflatable element is inflated. Practically, the shape and size of the inflatable element can be controlled and established in advance, as the maximum expansion of the inflatable element can be controlled by controlling the length and the maximum tension of the tie elements.

[0005] At the basis of the present disclosure there is the observation and recognition of the fact that the bag described in said International patent application, although advantageous from many points of view, has a structure which can be improved for certain applications, especially for applications on the human body.

[0006] In particular, it has been recognized that the base textile structure of the inflatable element is conceived as a prefabricated product. In particular, the first mesh and the second mesh belong to a structure with great sizes and prefabricated, that is a structure, usually sold in rolls, wherein the two meshes are opposed and overlapped. In order to implement the protection device, the prefabricated structure is tailored according to a design established in advance based upon the form or shape of the bag or airbag which one wants to obtain.

[0007] The bag or inflatable element most times has particular shapes with inlets or curves to be adapted to the various portions of a user body to be protected. However, it has been found that the cut of the prefabricated structure can be not sufficient for adapting and positioning the inflatable element around the human body and for following the anatomical shapes of the human body.

[0008] A technical problem underlying the present disclosure lies in making available a protection device for protecting a user capable of overcoming said drawback and/or obtaining additional advantages, and making available a garment including said device for the personal protection.

[0009] Such problem is solved by a protection device for protecting a user according to the respective independent claim. Secondary features of the subject of the present disclosure are defined in the corresponding depending claims.

[0010] The present disclosure is based upon the acknowledgment that, by differentiating a portion or face of the structure of the inflatable element with respect to an opposite portion or face, it is possible to obtain a different behaviour of the two portions during inflation, and then to pre-determine the assumption of a predetermined form and shape of the bag, in inflated condition. For example one can make that the bag has a specific bulge or a specific curvature. Under the term portion or face of the inflatable element a wall portion or a surface portion of the inflatable element is meant.

[0011] In particular, a portion of the inflatable element can extend or reach an inflated condition in a different way with respect to an opposite portion of the inflatable element. Practically, in inflated condition the first portion or first face can have a different "surface extension" with respect to the second portion or second face. The first portion then has an ability or possibility of assuming a different "surface extension" with respect to the second portion at time of inflation.

[0012] More in particular, under the expression "surface extension" it is meant that when the portion of the inflatable element is extended on a flat surface, it occupies a determined area or surface. The two opposite portions of the inflatable element, should they be ideally separated, in inflated condition, from the inflatable element thereto they belong, would occupy a different surface when extended on a flat surface. For example the first portion can be implemented in a mesh or wider and looser interweaving with respect to the second portion, so that once stretched and extended, it occupies a larger surface. The two portions then have different abilities to assume a certain surface extension, or an ability to occupy a determined surface, or a different expansion capacity with respect to an opposite portion of the inflatable element during a passage from the rest deflated condition to an active inflated condition.

[0013] In other words, the first portion or first face can be made of a material, or a different weft with respect to the second portion or second face, and then it can have a different extension capacity at time of inflation. For example, the first portion can have higher extension elastic capacity than the second portion or vice versa. In this case, the first portion and the second portion have an equal surface extension in rest condition, and a different behaviour at time of inflation.

[0014] In other words, according to the present disclo-

sure, the first portion and the second portion can be knitted in a different way so as to have a different ability to occupy a curved surface in inflated condition, or generally to occupy a curved area.

[0015] In an embodiment this is obtained by means of a different yield-ability or yielding of the material or fabric thereof the first portion is made with respect to the material or fabric thereof the second portion is made. The yield-ability is to be meant in the sense that, when the material or fabric, or the portion in general, is subjected to a deforming action, like the one which occurs upon inflation, such material or fabric or such portion yields, or it opposes less resistance, in a greater or different way with respect to the way the material, fabric, of the other portion, or the other portion in general, yields or opposes resistance. Such different yield-ability then appears in inflated condition. In other words, under different yield-ability or yielding a different lack in resistance to deformation, produced by the inflation action, is meant.

[0016] In fact it is to be considered that the areas and surfaces of the inflatable element in inflated condition are not wholly flat areas in inflated condition.

[0017] It follows that preferably the inflatable element is apt to assume a curved configuration in said inflated condition, and the portion having less expansion capacity, or less yield-ability than the opposite position is apt to form, in said inflated condition, an intrados side of the inflatable element and the portion having greater expansion capacity than the opposite position is apt to form, in said inflated condition, an extrados side of the inflatable element.

[0018] By referring to the curved shape assumed by the inflatable element, under intrados side and extrados side the side intended to be faced towards the user and the outer side facing towards the opposite side of the user are meant.

[0019] In an embodiment, a protection device is made available shaped like a casing and comprising two opposite walls or sheets, a textile structure including a first mesh and a second mesh and a plurality of tie elements fixed to the meshes. Each mesh is associated adherent to the respective wall, and the tie elements have opposite ends fixed firmly to the respective mesh. The first mesh and the first wall on one side, the second mesh and the second wall on the other side, form a valve of a substantially bivalve casing. Under valve each one of the portions thereof the airbag is formed is meant. The portions are joined along the perimeter.

[0020] According to an aspect of this embodiment, the first mesh and/or the first wall has/have said ability to assume a certain surface extension, or an ability to occupy a determined area, or a different expansion capacity with respect to the second mesh and/or second wall. For example, the first mesh and/or the first wall having said different yield-ability with respect to the second mesh and/or second wall.

[0021] For example, it is possible to differentiate the first mesh with respect to the second mesh, or the first

wall with respect to the second wall, or each valve formed by the first mesh and the first wall, or the second mesh and the second wall, so that when the inflatable element is inflated, the first mesh and/or the first wall has a different behaviour, with less or greater resistance to deformation, with respect to the second mesh or to the second wall. It follows that, since the configuration of the first mesh and the second mesh and/or of the first wall and of the second wall determines the structure of the inflatable element, such meshes and/or walls can be selected so that the first mesh and/or the first wall expand superficially less with respect to the opposite second mesh and/or second wall.

[0022] By acting in this way, at time of inflation, the wall with a smaller surface extension will tend to bend with a smaller radius of curvature than the portion with a greater surface extension, and thus to form the intrados side. Then, a bag curvature can be obtained.

[0023] It can be preferred that the two meshes or portions of the inflatable element have a substantially identical surface extension, and rather different expansion capacity for example, by different elasticity or as said different resistance to deformation. This solution would have the advantage that the meshes and/or the walls can be joined therebetween by gluing under a hot press, without the risk of creating folds, as they have identical or almost identical thermal extension in rest, not inflated condition. As to the outer walls, they can be sheets or walls or other layers intended to coat externally the first mesh or the second mesh. The walls can be made of a laminate, or a layer of TPU or another material capable of keeping air for a sufficient period of time in the inflatable element for a predetermined period of time.

[0024] It is observed that the inflatable element can be formed even in a configuration different from a bivalve configuration, that is, by definition, like two portions joined along the perimeter.

[0025] For example it could be an inflatable element having tubular, bag-like shape (with one access opening) or a wholly closed casing-like shape, and it could be obtained as one single body by knitting.

[0026] The knitting can be performed so that a first portion of the bag-like, casing-like or tubular body has a different surface extension or expansion capacity/extension with respect to a second opposite portion of the bag-like, casing-like or tubular body. Other advantages, features and use modes of the subject of the present disclosure will result evident from the following detailed description of some preferred embodiments thereof, provided by way of example and not for limitative purposes. However, it is evident that each embodiment can have one or more of the above-listed advantages; in each case, however, it is not requested that each embodiment has simultaneously all listed advantages.

[0027] The figures of the enclosed drawings will be referred to, wherein:

- figure 1 shows a top view of a protection device ac-

- cording to an embodiment of the present disclosure;
- figure 2 shows a partially section view according to line II-II of figure 1;
- figure 3 shows a detail III of figure 2;
- figure 4 shows a detail IV of figure 2;
- figures 5-7 and 9 show, schematically, respective phases for knitting a personal protection device according to the present disclosure;
- figure 8 shows a detail VIII of figure 7;
- figure 10 shows a partially section side view of a personal protection device like that of figure 1, but implemented according to an alternative embodiment of the present disclosure;
- figure 11 shows a detail XI of figure 10;
- figure 12 shows a detail XII of figure 10;
- figures 13-14 show, schematically, respective phases for knitting the personal protection device of figures 10-12.

[0028] By referring to the enclosed figures, a personal protection device according to the present disclosure in accordance to a first embodiment is designated with the reference numeral 1. In particular, the protection device comprises an inflatable element 2 shaped like a casing and wherein an internal chamber 3 is defined. The inflatable element 2 is apt to assume substantially a first rest condition or deflated condition, and a second active condition or inflated condition. The inflation modes of the inflatable element 2 will be described hereinafter in the description.

[0029] In the illustrated embodiment example, the inflatable element 2 is suitably cut to shape to be placed on the upper area of a user's chest. To this purpose, the inflatable element 2 has a shape with two side wings 7, 8 for covering the shoulders of a user, a substantially "C"-like shaped central portion 10 and a spinal portion 11, intended to protect the user's backbone. A gas generator 12, in the example a compressed gas canister, is included in the spinal portion 11 of the inflatable element.

[0030] The protection device 1 comprises a plurality of tie elements 5 distributed in the internal chamber 3 and firmly connected to respective portions of the inflatable element 2. Under the term tie element 5 an element or entity is meant, which, being tensile stressed, has the function of keeping joined or constrained or fixed two or more portions of the inflatable element 2, at least when the latter is in inflated condition.

[0031] In the example the tie elements 5 are of filiform type, and they are flexible and inextensible elements. Therefore, they are properly sized so that, when the inflatable element 2 is in rest condition, preferably they are not subjected to tensioning and they are collapsed in the internal chamber 3, whereas when the inflatable element 2 is in inflated condition they are subjected to tension.

[0032] The inflatable element comprises opposite walls 15, 16 perimetrically joined along the edges 20, 21. More in particular, the inflatable element 2 comprises a textile structure 40 comprising the above-mentioned tie

elements 5 and two opposite meshes 18, 19, each one thereof lines internally, that is on the side of the internal chamber 3, a respective wall 15, 16. Practically a textile structure 40 formed by two meshes 18, 19 is arranged inside the area between the two walls 15, 16 and each mesh, preferably, is fixed to the respective wall 15, 16.

[0033] Still more in particular, to give structural stability to the inflatable element, each mesh 18, 19 is firmly fixed to the surface of the respective wall 15, 16, preferably by means of a film of glue or layer of glue as described hereinafter. Considered from another point of view, the inflatable element 2 has a substantially bivalve-shaped structure, wherein each valve corresponds to a wall 15, 16 and to a respective mesh 18, 19.

[0034] According to an aspect of the present disclosure, and differently from the embodiments described in WO 2010-067288 A1, the first mesh 18 and the second mesh 19, in inflated condition, have a different surface extension therebetween, for example the second mesh 19 has a smaller surface extension or expansion capacity than the first mesh 18. In order to obtain such different surface extension the second mesh can be made of a less elastic, or less pliable (more resistant to tensile strength) material than the first mesh 18. Alternatively or in combination with the last embodiment, the first wall 15 and the second wall 16, in inflated condition, have a different surface extension therebetween, for example the second wall 16 has a smaller surface extension than the first wall 15, and it is made of a less elastic and less pliable material. For example, the first mesh 18 and/or the first wall 15 can be made of a different yarn with respect to the second mesh 19 and/or the second wall 16, respectively, for example a more elastic or more pliable yarn. The different yarns are not represented in the drawings.

[0035] Still alternatively the second mesh 19 and/or the second wall 16 can be made of a same material but with a thicker weft than the first mesh 18 and/or the respective first wall 15 during knitting, and then, it can have a lower extension capacity with respect to the first mesh 18. The different mesh affects the different yield-ability between the two portions.

[0036] The two meshes 18, 19 are joined along the respective perimeter by seaming, or by other connection system as described in WO 2010-067288 A1.

[0037] As it can be seen in figures, the walls 15, 16 can be wider with respect to the meshes 18, 19 and be further joined along the perimeter.

[0038] Each one of the two walls 15, 16 or sheets can be made of a laminate, like the one described in WO 2010-067288 A1, or in thermoplastic polyurethane or TPU. For example, in case of TPU, the walls 15, 16 are implemented by means of a layer of TPU 15a (which, for example, represents about 45% and 65% by weight, preferably between 48% and 55% by weight, and still more preferably about 50% by weight of the laminate) and a layer 15b with gluing or adhesive function (which represents about the remaining portion by weight of the lam-

inate), in the example a layer of (not thermoplastic) polyurethane glue, distributed on the layer of TPU 15a, by means of roller spreading or similar distribution technology. In the illustrated example there is then one sheet which before fixing to the mesh 18, 19 is formed by TPU + PU and as a whole it has a thickness, for example, of 200 micron.

[0039] As anticipated above, in the example the tie elements 5 are flexible ties and they have the shape of threads, and they are made for example of polyester or polyamide, with a thickness comprised between about 500 and about 1000 decitex (Unit of length of a continuous thread or of a yarn), and they have ends 5a, 5b fixed to the respective portions of wall 18, 19 which they connect. Still more in particular, each tie element or thread 5 includes a bundle of continuous torsion-free fibres coming out from one single point of a respective mesh 18, 19.

[0040] The tie elements 5 have opposite ends 5a, 5b fixed firmly to the mesh 18, 19 of the respective wall 18, 19. The fastening at the opposite ends 5a, 5b of the tie elements 5, for example, is obtained by simple insertion of the tie elements 5 between the wefts of the mesh 18, 19. Practically, in the example illustrated in the figures, the tie elements 5 are obtained by means of a determined number of threads which are fixed in alternate tracts to one mesh 18, and consequently to the other mesh 19. In other words, each thread 5 is threaded below a weft of the mesh 19 of the wall 16, it is bent upwards and extended again towards the opposite wall 15, wherein it is connected in the same way to the mesh 18. Alternatively the tie elements 5 are connected to the mesh 18, 19 by interweaving or binding or similar fastening.

[0041] The set of the two meshes 18 and 19 and of the tie elements 5 forms a so-called three-dimensional 3D or double-knit fabric.

[0042] Even the meshes 18 and 19 can be made of polyester or polyamide.

[0043] In the light of said description, it follows that the inflatable element 2 can have a structure similar to the one described with reference to the above-mentioned International patent, but it differs from this embodiment due to the fact that the two meshes 18, 19 and/or the two walls 15, 16 are not symmetric, on the contrary they have a different surface extension capacity. Practically an asymmetry between the two valves forming the inflatable element is provided. Such asymmetry allows to obtain a curvature of the inflatable element 2.

[0044] The just described protection device is implemented in the following way.

[0045] At first a portion 40, or textile structure, is provided, comprising meshes 18 and 19 thereto ends 5a, 5b of tie elements 5 are bound, or fixed in other way as mentioned above. In figure 5, the portion 40 is illustrated slightly inflated so as to imply the presence of the tie elements 5, and it is shown with substantially rectangular profile for simplicity's sake. However, it is clear that the portion 40 has shape and sizes substantially equivalent to a respective inflatable element 2 to be obtained; more-

over, the length of the tie elements 5 is selected so as to determine a maximum mutual distance between the meshes 18, 19 corresponding to a maximum local expansion of the respective inflatable element 2 in inflated condition.

[0046] An edge 43 of the mesh 18 is seamed to a respective edge 44 of the mesh 19 facing thereto (seam lines designated with 47 in figure 6). In figure 5, the seaming procedure is exemplified with a needle 49, however it is evident that the seams 47 can be made by machine or with other conventional equipment for a person skilled in the art, or they can be obtained by welding, or by means of the tie threads 5 themselves, for example by using tie threads with minimum length or "zero" length. The seam line 47 substantially follows the perimeter of the portion 40.

[0047] Before completing the perimetral seam, a canister 12 can be included between the meshes 18, 19. Alternatively a duct can be provided inside the meshes for the connection with a gas source placed outside the inflatable element 12.

[0048] It is to be noted that the above-mentioned perimetral seam crosses transversally the two meshes 18, 19, by tightening them in direct mutual contact, and without involving the walls 15, 16. The small seams too may not involve the walls 15, 16. The portion 40 is enclosed between the sheets 15, 16, wherein the sheets 15, 16 have a greater surface extension than said portion 40.

[0049] In the example, the sheets 15 and 16 are glued to the respective meshes 18, 19 by means of the layer 15b by using a hot press (which for example works at temperatures starting from 125°C) to favour adhesion and mutual gluing. In particular each layer 15b is included directly between a mesh 18, 19 of the portion 40 and the respective layer 15a of the wall 15, 16, as illustrated in figures 7-8.

[0050] From the above-mentioned description it comes out that the portion 40 is firstly cut to shape according to needs and the bag shape which is wanted to be obtained, and subsequently, after suitable seams, the two walls 15 and 16 or sheets are arranged on opposite sides of the meshes 18, 19 and fixed along the respective perimetral edges 20 and 21. It is noted that the so-obtained bag guarantees a sufficient gas tightness for the time required to protect a user wearing the inflatable element 2.

[0051] By referring to figures 10 to 14 a personal protection device 100 according to a second embodiment is described hereinafter.

[0052] Elements and portions of the present embodiments having the same function and the same structure of the elements and portions of the previously described embodiment keep the same reference numeral and they are not described again in details.

[0053] In the embodiment example of figures 10-14, the inflatable element 102 includes a knitted body 103, which has the same function of the two meshes 18, 19 of the previous embodiment. In the illustrated embodiment the knitted body 3 is a substantially bag-shaped

body which can have one single access opening 106 allowing to access the inner area 104.

[0054] The knitted body 103 then, when it is extended on a plane and squeezed in such extended position, includes two opposite portions or walls 103a, 103b and at least three side portions 103c, 103d, only two thereof can be seen in figures 10 and 11 extending continuously between the two opposite portions 103a, 103b.

[0055] Thanks to the tubular shape, and still better thanks to the bag-like or closed casing-like shape, the knitted body 103 has the advantage of being closed laterally on at least two sides (at the side portions 103c, 103d) and not requiring at least on said two sides a perimetral seam as described, for example, in the above-mentioned first embodiment.

[0056] Even the inflatable element 102, in the illustrated embodiment, has a shape with two side wings 7,8 for covering the shoulders of a user, a substantially "C"-like shaped central portion 10 and a spinal portion 11, intended to protect the user's backbone. In the illustrated embodiment, the spinal portion 11 can have said opening access 106 to allow to position, inside the inner area 104, a compressed gas generator 12. Practically, the compressed gas is introduced starting from the spinal portion 11.

[0057] The knitted body 103 has a shape using and following the shape of the inflatable element 102, and it is made as one single body according to said shape to define one single inner area 104.

[0058] The knitted body 103 further includes a plurality of union threads 5 or tie threads distributed in the internal chamber 104 and firmly connected to respective portions 103a, 103b of the knitted body 103, in particular to surface portions of the same. The knitted body 103 with the union threads 5 corresponds, by function, to the above-described portion 40. The union threads 5 have the same function of the above-mentioned tie elements.

[0059] According to an aspect of the present disclosure, the first portion 103a having function corresponding to the first mesh 18 of the preceding embodiment has a greater surface extension or extension capacity in inflated condition with respect to the second portion 103b.

[0060] The second portion 103b can be implemented with a thicker weft than the first portion 103a during knitting, and then it can have a lower extension capacity with respect to the first portion 103a. Alternatively, the first portion 103a can be made of a different yarn with respect to the second portion 103b, so as to obtain a different extension capacity.

[0061] The knitted body can be further coated and covered by a cover. The cover can include two walls 15, 16 or sheets made of a sheet of soft material made of TPU or other adequate material, such as the laminate described in WO 2010-067288 A1, which are opposed each other and fixed perimetally along respective perimetral edges 20, 21.

[0062] Practically, the walls 15, 16 can be like those described in the previous embodiment and they can be

made of a laminate, which is formed by a layer made of TPU and a layer with gluing and adhesive function, for example PU (which can be activated by heat).

[0063] The knitted body 103 is firmly fixed to the surface of the respective wall 15, 16, by means of the glue layer, that is in direct contact with the laminate glue layer.

[0064] As to the knitted body 103, it is further noted as follows.

[0065] The union thread 5, being tensile stressed, is an element or entity having the function of keeping joined or constrained or fixed two or more portions of the knitted body 3, at least when the latter is in inflated condition. It is noted that in the illustrated embodiment, a plurality of union threads 5 is obtained starting from or belonging to one single thread, or one single yarn constituted by at least two threads, wherein the single thread or single yarn is extended alternatively continuously between the first portion 103a and the second portion 103b of the knitted body 103.

[0066] Still more in particular, the single thread or the single yarn is arranged in zig zag way or with sinusoidal course between the first portion 103a and the second portion 3b of the knitted body 103 to cover and occupy an area of the inflatable element 2.

[0067] The union threads 5 are suitably sized so that when the inflatable element 102 is in rest condition, preferably they are not subjected to tension and they are collapsed in the internal chamber 104, whereas when the inflatable element 102 is in inflated condition they are subjected to tension. The threads can be arranged so as to connect opposite portions 103a, 103b of the knitted body 103 or they can be arranged diagonally so as to connect not perfectly opposed portions of the knitted body 103.

[0068] The threads distributed thickly for example with a density of at least one tie element per each cm² of surface of the internal chamber 104, still more preferably, still by way of example, with a density comprised between 1 and 15 threads per each cm² of surface of the inflatable element 102, preferably between 4 and 6 threads per each cm². The thread distribution can be varied depending upon the area of the protection device wherein the threads are situated. The union threads 5 for example can be made of polyester or polyamide, with thickness comprised between about 500 and about 1000 decitex (Unit of length of a continuous thread or a yarn). Each thread 5 can include a bundle of continuous torsion-free fibres coming out from one single point of a respective mesh of the knitted body 103.

[0069] In an embodiment of the present disclosure, the yarns used to implement the union threads 5 are different yarns with respect to those used to implement the casing-like body and the above-mentioned portions 103a, 103b, 103c, 103d. In particular the union threads are made of a material having greater tensile strength than the threads of the casing-like body. The threads of the casing-like body can be made of a softer material, so as to obtain an inflatable element which is as softest as pos-

sible and which has a light and flexible consistency that can be extremely comfortable for a user wearing it.

[0070] The threads of the knitted body 103 can be made of a material which is variable and differentiated even based upon the area of the protection device where they are situated and upon the area of a user body to be protected.

[0071] The knitted body 103 and the union threads 5 can be made by a knitting machine or flat knitting machine of known type which includes two beds, that is two rows of needles intended to knit the knitted body. A knitting machine of known type is a machine for gloves like the one with code SWG0991N by Shima Seiki.

[0072] The two beds have one needle field having an extension or length which corresponds to a shape size, such as for example shape width or length, of the inflatable element to be obtained, corresponding to one of the two portions 103a or 103b comprised between the portions 103c and 103d for example. The machine is equipped with a first thread-guiding device supporting a first thread intended to form the knitted body 103 and a second thread-guiding device carrying a second thread intended to form the union threads 5.

[0073] The machine can be programmed so as to implement the knitted body 103 by means of the first thread-guiding device which knits alternatively the thread on the first bed of needles and on the second bed of needles.

[0074] The machine can be programmed so as to join two opposite areas 103a, 103b of the mesh by means of the second thread carried by the second thread-guiding device, to form the union threads 5. For example the machine can be programmed to knit some mesh courses, so as to form some complete mesh rounds, and subsequently to join by means of the second thread-guiding device, and then the second thread, determined needles of the first bed with determined needles of the second bed. Subsequently, some mesh rounds are knitted again to repeat then the knitting with the second thread forming the union threads.

[0075] In order to define a specific length of the union thread, it is possible to join the meshes by means of diagonal union threads. In this case the second thread-guiding device will interweave the union thread with determined needles of the first bed and of the second bed so that the union threads are arranged diagonally between the needles of a first bed and the needles of a second bed.

[0076] Alternatively, the mesh can be knitted with a "drop-needle" technique wherein, for each bed, it is provided to use some needles as "operating" needles intended to knitting and then involved by the knitting of meshes of the knitted body, and other "not operating" free needles, not involved by the knitting. Such "not operating" needles, which are kept free, allow to receive temporarily the union thread. Practically, the union thread is "parked" temporarily on the "not operating" needle when it is knitted between the first bed and the second bed. In particular, the union thread is knitted on an "operating" needle of the first bed intended to knit the mesh-

es, it is then "parked" on a "not operating" needle of the same first bed and subsequently it is knitted on an "operating" needle of the second bed. In this way, by programming the distance between the first "operating" needle of the first bed, the not operating needle of the first bed and the "operating" needle of the second bed, it is possible to establish in advance the length of the union threads 5 when the knitted body is removed by the knitting machine.

[0077] It is to be meant that a person skilled in the art of using the flat knitting machines can be capable of programming the machine in the most optimal way to obtain the wished result.

[0078] In particular in order to obtain an asymmetry between the first portion 103a and the second portion 103b, the machine for knitting is programmed to obtain a different weft between the first portion 103a and the second portion 103b, or it can be provided to use a third thread-guiding device to implement the portion 103a with a different yarn with respect to the portion 103b.

[0079] Additional information on the knitting of a knitted body by means of union threads can be found in the Italian patent application TO-2013-A-472, which describes the implementation of knitted bodies equipped with union threads.

[0080] It is further noted that the flat knitting machine can even be programmed to vary the length of the union thread depending upon the area of the inflatable element to be implemented. For example, in an area of the knitted body 103 intended to be placed at the perimetral areas or areas 103c, 103d of the inflatable element 102, the union threads 5 can have a length which gradually reduces up to the minimum, in order to guarantee a tension of the union threads 5 even at the perimetral areas when the inflatable element 102 is inflated.

[0081] Moreover, the flat knitting machine can be even programmed to vary the mesh opening, for example by modifying the programming of the drop-needle, or when a thicker mesh is required by using a double thread to implement the mesh.

[0082] An important aspect deriving from the fact that the knitted body 103 is obtained in one single knitting phase lies in the fact that it is not necessary to provide perimetral seams in the meshes as it was instead provided in the preceding embodiment.

[0083] The just described protection device is implemented in the following way according to an embodiment, and in a way wholly similar to the implementation mode of the inflatable element 2 according to the preceding embodiment.

[0084] The knitted body 103 is arranged in extended condition, so that the two opposite portions 103a, 103b are collapsed one upon the other one. The knitted body 103 in such configuration is arranged between the two walls 15, 16 and fixed adherent to a respective portion, for example by means of glue.

[0085] Subsequently, respective opposite perimetral edges 20, 21 of the walls 15 and 16 are overlapped one

onto the other one along the perimeter.

[0086] From the above-mentioned description it comes out that the two walls 15 and 16 substantially are two elements or sheets of the inflatable element 2 opposed and fixed along the respective perimetral edges 20 and 21. In each case nothing prevents the two walls 15 and 16 from being opposite portions of one single sheet folded like a book and having then peripheral edges extended along a portion of the perimeter.

[0087] It is further noted that the protection device can be included in a garment, or it can be integrating portion of a garment. In fact, thanks to the programming potentiality of a flat knitting machine, nothing prevents from implementing in one single production phase a knitted body together with an item of clothing, that is the knitted body is integrated as single body with the item of clothing, or even coincides with the item of clothing. In fact, for example the knitted body can have a shape like a gilet or jacket and, for example, can be knitted with a mesh density so as to allow an adequate fluid tightness of the inflating gas.

[0088] In order to implement the inflation of the inflatable element 2, 102 of both embodiments, in case of unexpected fall and/or slipping and/or impact by a user or a vehicle whereon he/she proceeds, the protection device 1, 100 according to the present invention is apt to cooperate with suitable activation means connected operatively to inflation means, thereof in figures only by way of example a canister 12 of compressed cold gas is shown, included inside the inflatable element 2, 102 or connected by means of a duct or cannula to an interception valve which allows the insertion of an inflation fluid in the inflatable element.

[0089] Alternatively, such inflation means can comprise generators of gas of pyrotechnic type or of hybrid type or other types known to the state of art.

[0090] Said inflation means is controlled by a control unit based upon the detection of the vehicle/driver system status; for example said control unit can implement a system for predicting the fall allowing to identify in time the fall event and a reliable prediction thereof by means of accelerometric sensors integral to the vehicle (or to the driver) and a unit for processing the signals produced by the sensors themselves.

[0091] Alternatively, the device according to the present disclosure can be further applied by using an activation cable connected to a vehicle guided by a user, which cable controls the inflation of the inflatable element 2, 102 when the user moves away from the vehicle, for example after an unexpected fall or impact.

[0092] In each case the above-mentioned activation and inflation means can be integrated in the protection device 1 according to the present invention or they can be placed outside the same.

[0093] It is to be noted that the activation modes, even if they are a particularly important aspect for an effective operation of the device, will not further described with greater details as they are methods substantially already

known to a person skilled in the art for the protection of a person from unexpected impacts.

[0094] The protection device 1, 100 can further comprise a deflation valve (not represented in the drawings), communicating on one side with the internal chamber and on the other side with the outer environment, in order to allow the deflation of the inflatable element 2, 102 after activation, and when a protection action is no more requested. Alternatively, the protection device can be configured so that the inflatable element 2, 102 can deflate by itself after inflation in relatively reduced time, without the need for a deflation valve.

[0095] The subject of the present disclosure has been sofar described with reference to preferred embodiments. It is to be meant that other embodiments belonging to the same inventive core may exist, all within the protection scope of the hereinafter enclosed claims.

20 Claims

1. A protection device (1, 100) for the personal protection of a user, wherein said inflatable element (2, 102) defines an internal chamber (3, 104) apt to receive an inflation fluid and apt to assume an active inflated condition and a rest deflated condition in case of fall of a user, in case of danger or impact of a user against an obstacle, wherein a first portion or first face (18, 103a) of the inflatable element (2, 102) has an ability to assume, in inflated condition, a certain surface extension, or an ability to occupy, in inflated condition, a determined area, or a different expansion capacity compared to a corresponding capacity of an opposite second portion or second face (19, 103b) of the inflatable element (2, 102).
2. The protection device according to claim 1, wherein said inflatable element (2, 102) is apt to assume a curved configuration in said inflated condition, and the portion having lower expansion capacity than the opposite position is apt to form, in said inflated condition, an intrados side of the inflatable element and the portion having greater expansion capacity than the opposite position is apt to form, in said inflated condition, an extrados side of the inflatable element (2, 102).
3. The protection device (1, 100) according to claim 1 or 2, wherein said inflatable element (2, 102) is apt to assume a curved configuration in said inflated condition, and the portion having lower expansion capacity than the opposite position is a portion with lesser yield-ability, or greater resistance to deformation, than the opposite portion having greater expansion capacity and greater yield-ability, or less resistance to deformation.
4. The protection device (1, 100) according to any one

- of the preceding claims, including a plurality of tie elements (5) distributed in the internal chamber (3, 104), and wherein said inflatable element (2, 102) includes a first wall (15) and a second wall (16) opposing each other and connected along a perimeter to define said internal chamber (3, 104), a first mesh (18, 103a), which at least partly internally lines said first wall (15), and a second mesh (19, 103b) which at least partly internally lines said second wall (16), said tie elements (5) having opposite ends (5a, 5b) fixed to said first mesh (18, 103a) and to said second mesh (19, 103b), respectively, and wherein a portion of said first mesh (18, 103a) and/or the respective first wall (15) form the first portion and a portion of said second mesh (19, 103b) and/or the respective second wall (16) form the second portion of the inflatable element.
5. The protection device (1, 100) according to claim 4, wherein said first mesh (18, 103a) has said lower expansion capacity or yield-ability with respect to said second mesh (19, 103b) or vice versa.
 6. The protection device (1, 100) according to claim 4 or 5, wherein said first wall (15) has said lower expansion capacity or yield-ability than said second wall (16) or vice versa.
 7. The protection device (1, 100) according to any one of the preceding claims, wherein the first portion (18, 103a) of the inflatable element has a different elasticity or extensibility or yield-ability with respect to the opposite position (19, 103b) of the inflatable element.
 8. The protection device (1, 100) according to any one of the preceding claims, wherein the first portion (18, 103a) of the inflatable element has a different texture with respect to the opposite position (19, 103b) of the inflatable element.
 9. The protection device (1, 100) according to any one of the preceding claims, wherein the inflatable element includes a knitted body (103), said knitted body (103) having a closed structure on at least four sides or walls and/or being at least a partially tubular-shaped body, and defining said inner area or internal chamber (104) and/or wherein the knitted body (103) includes
 - a) at least a first side (103a) or first knitted wall forming part of said first portion or first face (103a),
 - b) at least a second side (103b) or second knitted wall forming part of said second portion or second face (103b) and opposite to first portion or first face (103a);
 - c) at least a third side or third portion (103c) or knitted wall and continuously connected with the first portion (103a) and the second portion (103b);
 - d) at least a fourth side or fourth portion (103d) or knitted wall and continuously connected with the first portion (103a) and the second portion (103b), wherein the fourth portion (103d) is opposed to the third portion (103c).
 10. The protection device (100) according to claim 9, wherein
 - e) the knitted body (103) includes a fifth side or fifth portion or knitted wall, wherein the fifth side is continuously connected with the first side or first portion (103a), the second side or second portion (103b), the third side or third portion (103c) and the fourth side or fourth portion (103d), and/or
 - f) the knitted body (103) is a closed body on at least a fifth side or fifth wall a to define a bag comprising at least one access opening (106) for accessing said internal chamber (104).
 11. The protection device (1) according to claim 9 or 10, wherein
 - e) the knitted body (103) includes a sixth side or sixth portion or knitted wall and continuously connected with the first side or first portion (103a), the second side or second portion (103b), the third side or third portion (103c) and the fourth side or fourth portion (103d), wherein the sixth side or sixth portion is opposed to the fifth side or fifth portion, and/or
 - f) the knitted body (103) is a closed body on all sides to define a closed casing.
 12. The protection device (1, 100) according to any one of the preceding claims from 9 to 11, wherein the inflatable element (2) comprises a plurality of union threads (5) distributed in the internal chamber (3, 104) and apt to connect at least the first portion (15, 18, 103a) and the second portion (16, 19, 103b) of the knitted body.
 13. The protection device (1, 100) according to any one of the preceding claims from 9 to 12, wherein said first wall (103a) has said lower expansion capacity or yield-ability or elasticity than said second wall (103b) or vice versa.
 14. The protection device (1, 100) according to any one of the preceding claims from 9 to 13, including a first wall (15) and/or a second wall (16) apt to cover said knitted body, wherein said first wall (15) has said lower expansion capacity or yield-ability or elasticity than said said second wall (16) or vice versa.

15. The protection device (1, 100) according to any one of the preceding claims in combination with claim 2, wherein said protection device (1, 100) is a wearable device and said curvature follows a curved anatomical profile of the human body of a user. 5

16. A garment including, or integrally incorporating, a protection device (1, 100) according to any one of the preceding claims, or garment coincident with a protection device (1, 100) according to any one of the preceding claims. 10

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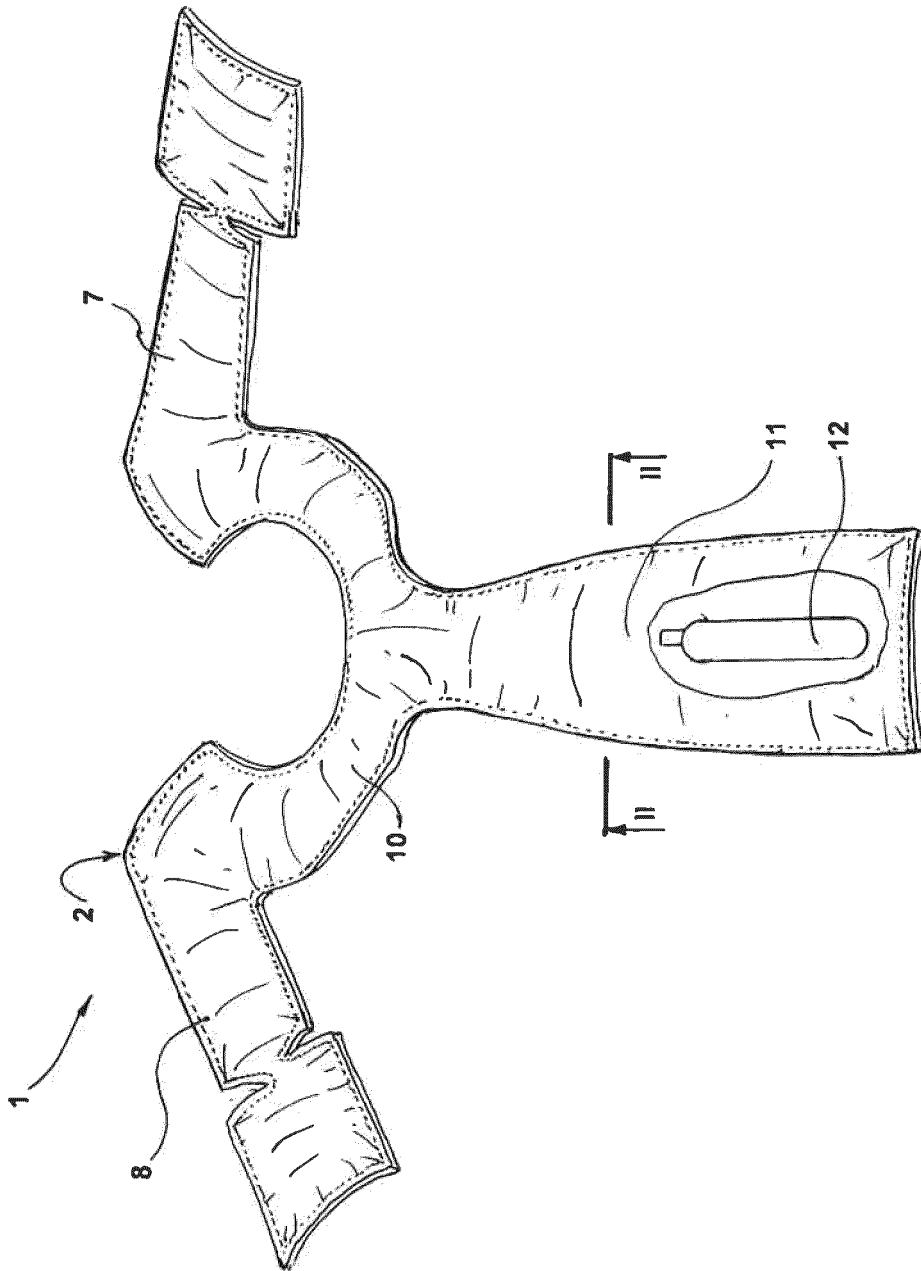


FIG.1

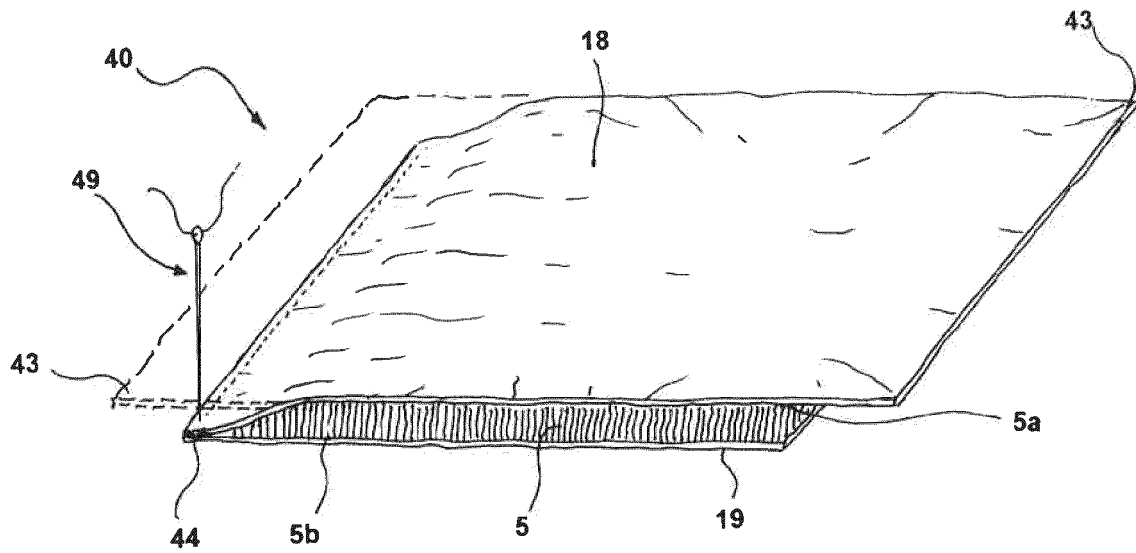


FIG. 5

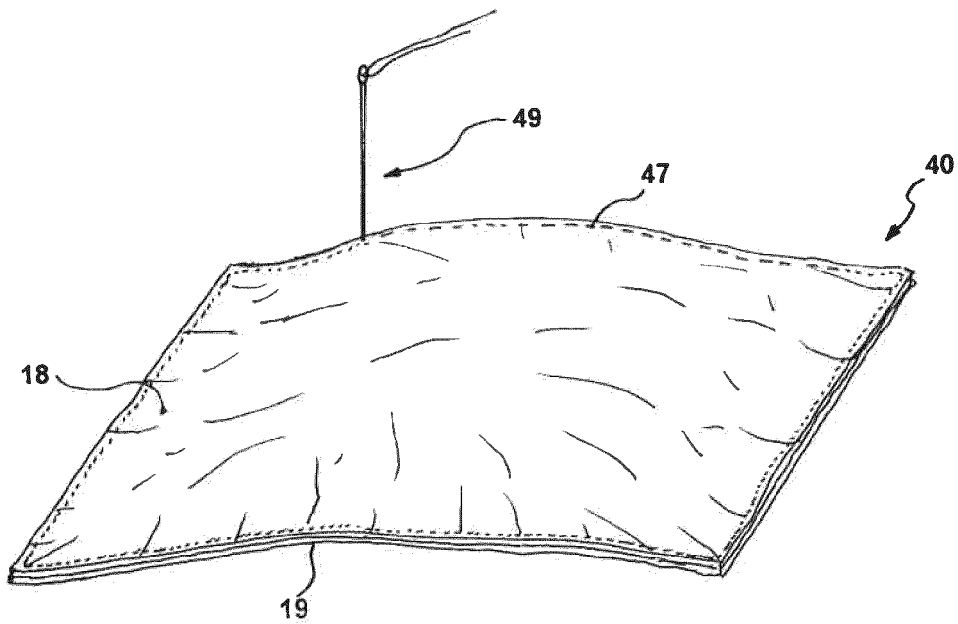


FIG. 6

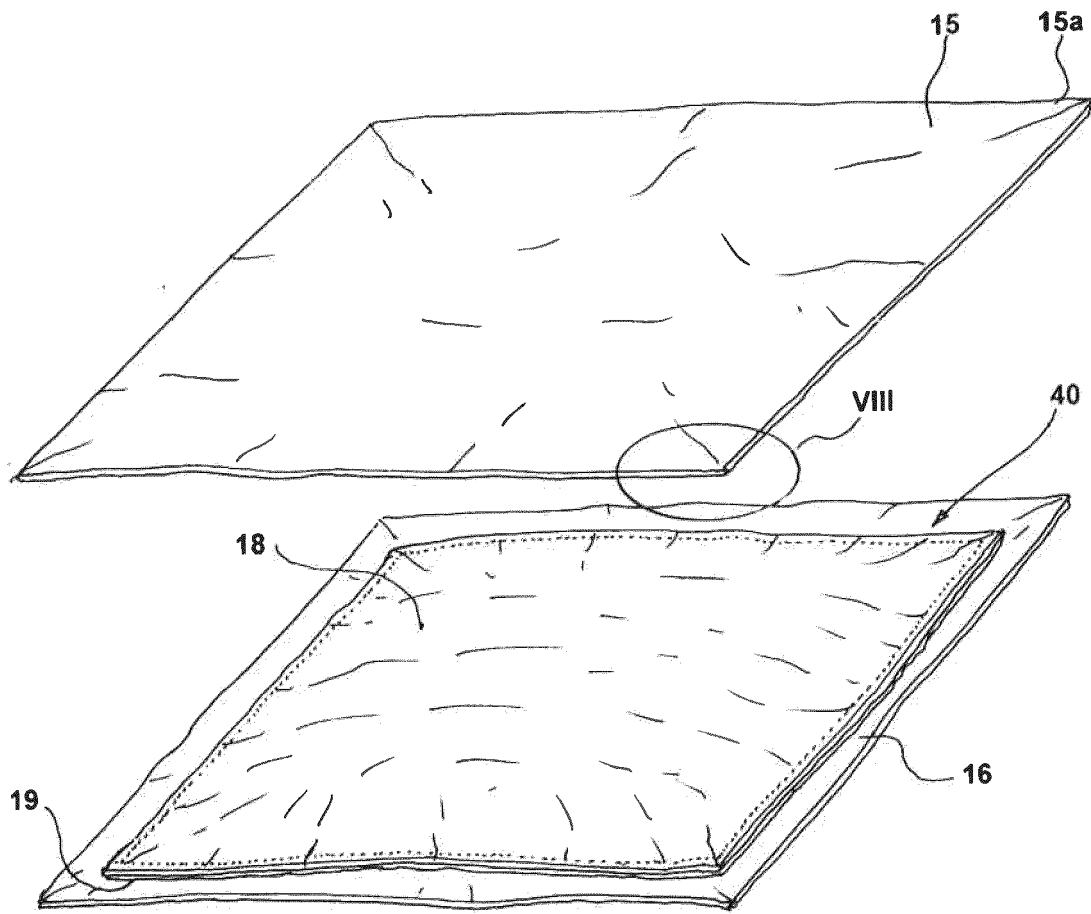


FIG. 7

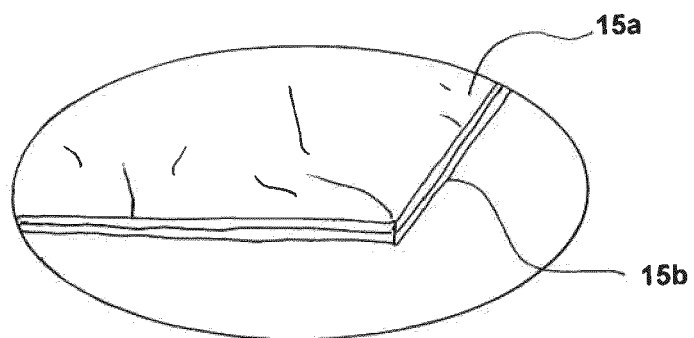


FIG. 8

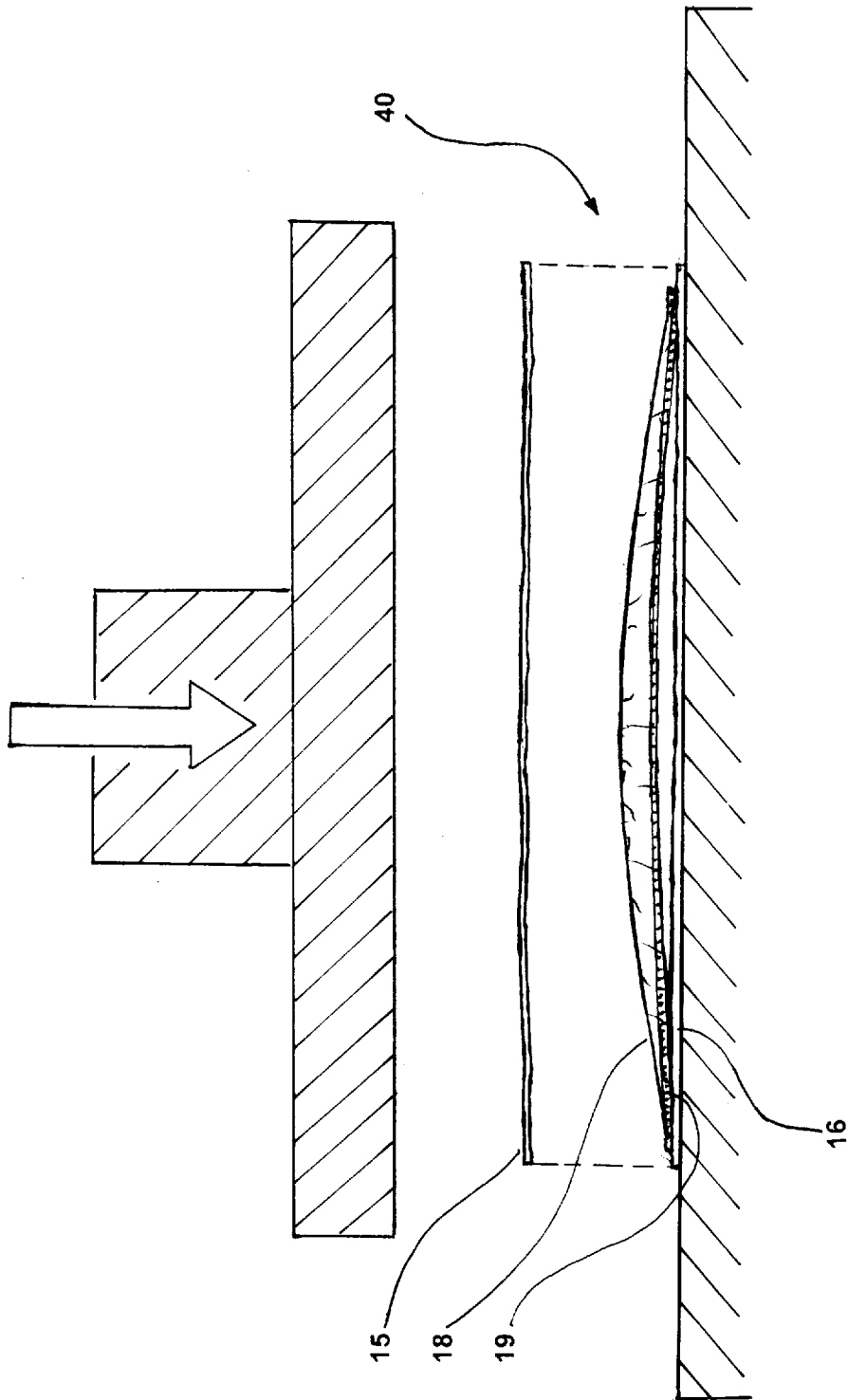


FIG.9

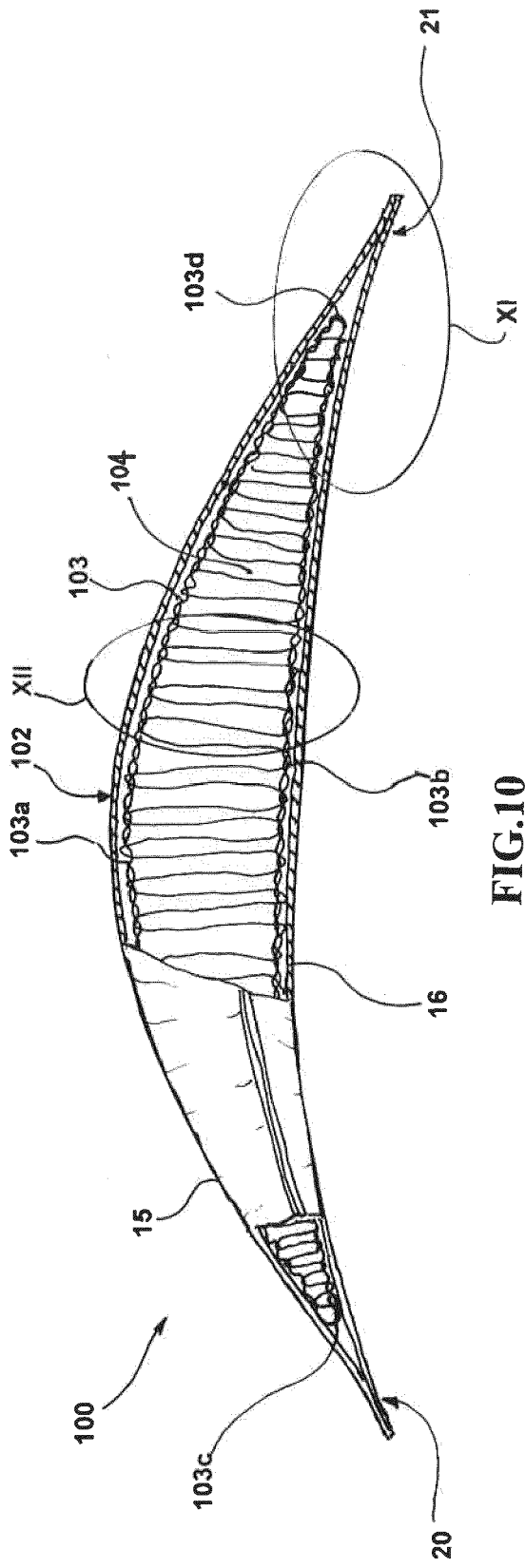


FIG. 10

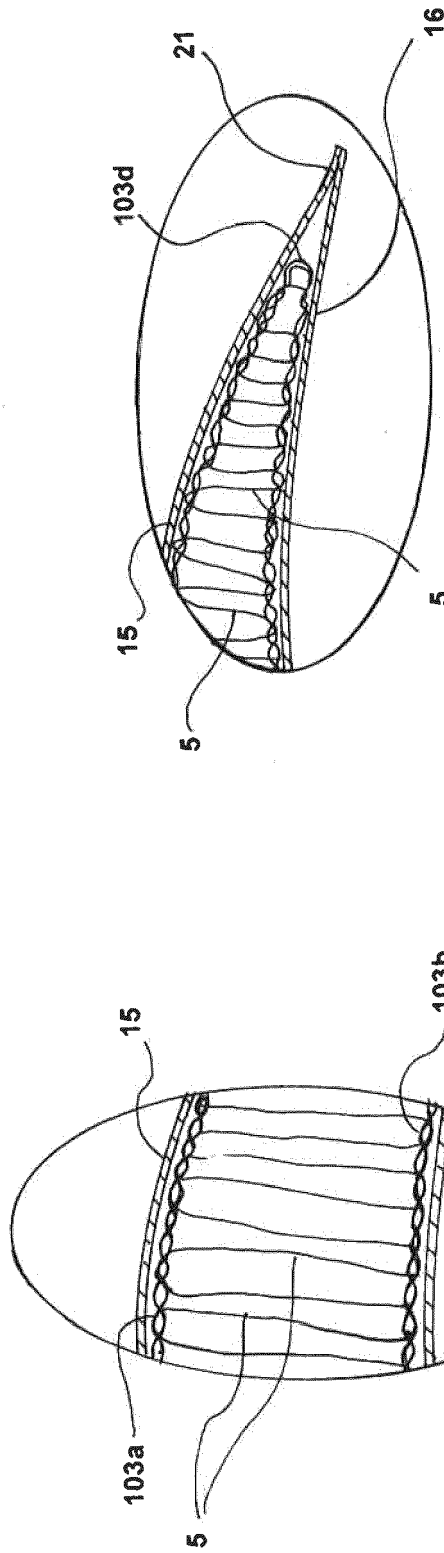


FIG. 11

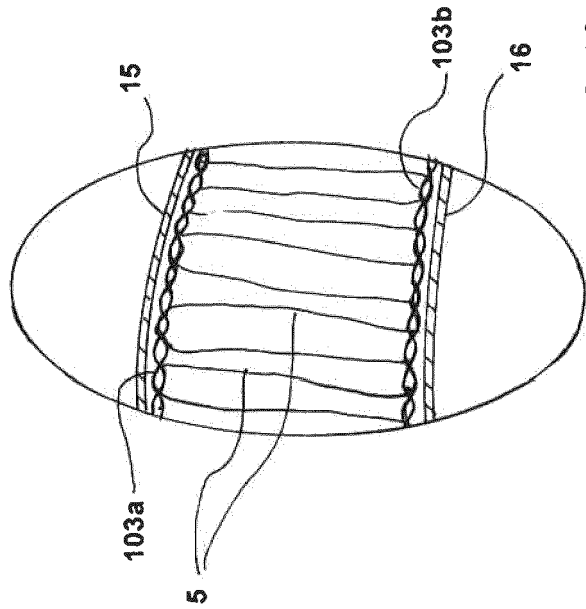


FIG. 12

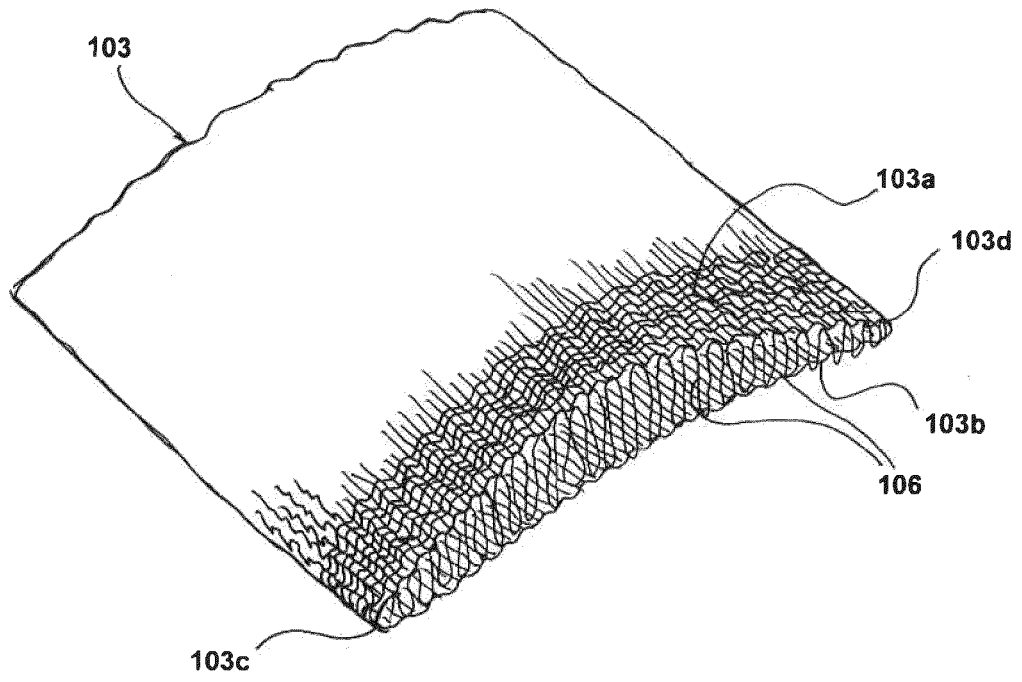


FIG. 13

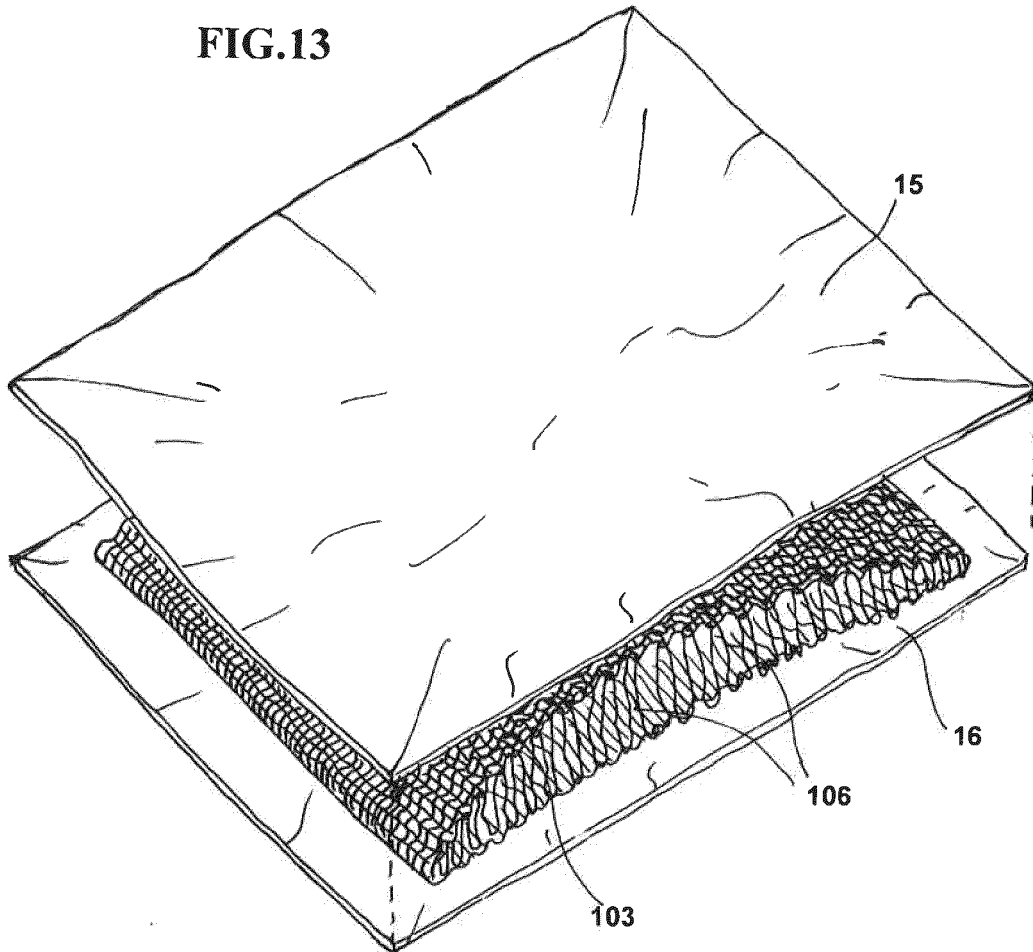


FIG. 14



EUROPEAN SEARCH REPORT

Application Number
EP 22 15 4301

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 15 August 2022	Examiner Debard, Michel
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