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(54) **WEARABLE PROTECTION DEVICE**

TRAGBARE SCHUTZVORRICHTUNG

DISPOSITIF DE PROTECTION POUVANT ÊTRE PORTÉ

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Description

[0001] The present disclosure relates to a protection device for protecting a user, preferably a wearable protection device. The present disclosure also relates to a garment including the protection device. The protection device includes an inflatable element adapted to protect the body of a user, such as a passenger, a motorcycle rider, a skier, a horse-rider, or a similar user, from impacts and/or falls, or to alleviate the consequences of an impact or fall, during a sporting and/or working activity.

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

[0003] In accordance with this international patent application, the inflatable element is a twin-leaf casing formed by two opposite walls or sheets, a structure including a first mesh and a second mesh and tie-members fixed to the meshes. The tie-members connect preferably opposite portions of the inflatable element. Each mesh is adheringly associated with the respective wall. The tie-members are threads and have opposite ends fixed stably to the mesh of the respective wall. Fixing at the opposite ends of the tie-members is, for example, performed by means of interweaving of tie-members with the woven threads of the mesh. The length of the tie-members is adjusted so that the tie-members have a fully tensioned condition and/or maximum extension when the inflatable element is inflated. Basically, the form and size of the inflatable element may be controlled and established beforehand, since the maximum expansion of the inflatable element can be controlled by means of control of the length and the maximum tension of the tie-members. In one embodiment the walls are made of a laminate, which is normally used as a lining for clothing. The laminate comprises a layer of fabric, in the example nylon (representing about 65% by weight of the laminate) and a layer of polyurethane (representing about 35% by weight of the laminate), which is heat-activatable and spread over the layer of fabric. Each mesh is stably fixed to the surface of the respective wall by means of a further film of glue. In particular, the film of glue is arranged in contact with the layer of glue of the laminate.

[0004] The authors of the present disclosure have noted that the bag described in said international patent application, while being advantageous from many points of view, has a structure which may not be optimal for certain applications.

[0005] In particular, in the aforementioned embodiment, owing to superimposition and fixing of the film of glue together with the polyurethane layer of the laminate and, in addition, impregnation of the polyurethane layer and the film of glue both in the fabric layer of the laminate and in the mesh connected to the threads, the inflatable bag may have a certain overall rigidity even in the deflated condition.

[0006] Moreover, this rigidity is particularly great in an edge zone of the inflatable element, where peripheral

edges of the fabric bag impregnated with glue define an edge which may be rigid and unsuitable for inserting the inflatable element inside an article of clothing.

[0007] Moreover, this rigidity may be disadvantageous for the comfort of a user, in particular when the garment in which the inflatable element is inserted is a light garment, such as the competition suit of a skier. Such a suit is made, as is known, of a light and thin material.

[0008] One technical problem forming the basis of the present disclosure is that of providing a protection device which has an improved softness compared to the protection device of the prior art and/or which has further advantages, while guaranteeing substantially the same - or at least a satisfactory - performance in terms of resistance to gas pressure, tensile strength, and/or conservation capacity in very hot and wet conditions. In other words, the aim is to provide a protection device which, while ensuring satisfactory performance features, offers new advantages, also in terms of softness and adaptation to the body of a user.

[0009] This problem is solved by a protection device for personal protection of a user according to claim 1. Secondary characteristic features of the subject of the present disclosure are defined in the corresponding dependent claims.

[0010] The present disclosure is based on the idea which has occurred to the inventors of the present disclosure to use a sheet including, or based on, TPU or thermoplastic polyurethane, called TPE-U, in order to form the wall of the inflatable element. The term "TPU", or thermoplastic polyurethane, is understood as meaning, for example, a polyurethane which belongs to the category of thermoplastic elastomers, namely the category of thermoplastic rubbers. The latter belong to the class of copolymers, crosslinking of which is able to achieve optimum elastic properties. Such a material has the characteristics of being soft and flexible and results in a "rubbery" feel. The softness characteristic makes the inflatable element particularly suitable for insertion inside an article of clothing.

[0011] The "rubbery" feel of the thermoplastic polyurethane, which is moreover typical of thermoplastic elastomers, also has the advantage that it ensures a high degree of softness and adaptability to the underlying textile structure of the meshes with the threads. Moreover, such a material may be used in sheets with very small thicknesses.

[0012] In other words, the present disclosure is based on the idea of using a sheet of TPU, namely a thermoplastic elastomer or TPE-U, or an elastomer belonging to the class of copolymers or a polymer mixture (usually a plastic and a rubber) with both thermoplastic and elastomeric properties. While most elastomers are thermosetting, TPEs are instead relatively easy to use during production, for example, by means of injection-moulding.

[0013] The expression "the sheet includes or is based on" is understood as meaning that the sheet includes at least one thermoplastic elastomer layer or that it is formed

mostly by a thermoplastic elastomer, such as to give the impression of being a rubber sheet which is soft to the touch. The sheet is an element which is initially separate from an underlying fabric or mesh and which can be handled separately from the mesh. The sheet is not spread onto an underlying mesh or fabric, but arranged on top and preferably hot-bonded thereto.

[0014] It should be noted, as mentioned above, that the thermoplastic polyurethane layer is used as one of the layers of the inflatable bag. The TPU layer may preferably act as a sealing wall of the inflatable bag and therefore be associated directly with the meshes with threads. In other words, the thermoplastic polyurethane sheet constitutes the layer with a gas-barrier function intended to contain the gas inside the inflatable chamber. Preferably, the TPU layer is the only layer of the airbag with a sealing function. The term "sealing" is understood as meaning in the context of the present disclosure, a function of the thermoplastic polyurethane sheet which is able to retain the bag inflation gas for most of the time necessary for the inflatable element to perform its protection function. In particular, in the sector of protective clothing, the time for which an inflatable element must remain in the inflated condition is 50 milliseconds. The term "sealing" must not be understood as meaning necessarily an absolute gas-retaining capacity, nor that the bag is totally gas-tight.

[0015] More particularly, a protection device in the form of a twin-leaf structure defining a casing is provided. The protection device comprises two opposite walls or sheets, a textile structure including a first mesh and a second mesh and a plurality of tie-members fixed to or associated with the meshes. Each mesh is adheringly associated with the respective wall, and the tie-members have opposite ends stably fixed to or associated with the respective mesh. According to one aspect of the present invention, each of the first wall and the second wall includes a layer of TPU or thermoplastic polyurethane..

[0016] In other words, according to the present disclosure, the wall of the inflatable element consists, at least partially, of thermoplastic polyurethane. The sheet of thermoplastic polyurethane may be an outer layer, and/or an externally visible layer, of the inflatable element. Even more particularly, with reference to the aforementioned international patent application, the layer of TPU, or thermoplastic polyurethane, replaces the fabric layer of the laminate.

[0017] It should be noted that the combination of the TPU layer and the meshes of the textile structure with threads results in a bag which is both resistant to the pressure impact at the time of inflation, maintaining pressure for a suitable period of time, and a soft and flexible configuration. In particular, it should be noted that, by using a sheet of TPU applied onto an outer side of the textile structure formed by a mesh with threads, it is possible to obtain a bag which responds positively to all the tests necessary for the application in the sector of sports clothing. For example, a bag is obtained such that it may

be inflated to high pressures and may withstand these pressures, for example even as high as 2.7 bar, and for a suitable period of time.

[0018] Moreover, the combination of the TPU layer and meshes of the textile structure with threads results in a bag which is resistant to high pressures and which may be adapted to the form of the human body. In fact the TPU sheet, owing to the typical properties of an elastomer, has a high elongation factor. Therefore, by combining a suitable height of the threads and the degree of elongation of the TPU sheet it is possible to predefine a priori the shape of the bag which is to be obtained, depending on the portion of the body to be protected, and obtain a bag which corresponds as far as possible to this form. In other words, it is possible to combine the choice of the textile structure with threads and the length of the threads with the degree of elongation of the TPU so as to obtain a bag which corresponds as far as possible to the predefined shape which is to be obtained. What is important in the context of the present disclosure is that it has been found that even an elastomeric material which is less rigid than that of the aforementioned patent application may be adapted to the use in the clothing sector where the pressure must be maintained for a long time. It has even been found that the use of a thermoplastic elastomer allows adaptation to the form and height of the textile structure with threads. In fact, the textile structure with threads may have zones with a different height and therefore specific shapes. By using a TPU sheet it is therefore possible to achieve better adaptation to the form and or shape of the textile structure with threads, even at a localized level where there may be specifically shaped zones of the bag.

[0019] Preferably, the thermoplastic polyurethane layer does not have pigments and has the characteristics of being transparent or semi-transparent, namely it is a sheet which does not provide full coverage and which leaves visible an inner zone of the bag, and therefore the meshes, the threads of the meshes, and any underlying stitches. This non-total visible coverage characteristic and property has proved to be particularly interesting for use in a protection device, where inflation devices or other functional structures for inflation are arranged inside the meshes. Owing to the transparency of the material it is possible to monitor and see from outside any defects of the inflatable element and understand any characteristics of the bag which can be deduced from the meshes. For example, the meshes may be of various kinds and types depending on the functional nature of the bag. It is therefore possible to understand from the outside what kind of bag is involved.

[0020] Preferably, the thermoplastic polyurethane sheet has properties of breathability, namely it is able to retain a gas and allow vapour to pass through.

[0021] Preferably a layer of thermoplastic polyurethane which is used normally in the textile sector for sealing stitches, heat-taping embroidery, or other zones of a fabric, a garment or other article may be used. It is

thus possible to seal "perforated" zones. Basically, unlike the art which taught using an already known fabric for lining articles of clothing, it is now proposed to use a layer which normally has a completely different function, such as a stitch sealing function.

[0022] The thermoplastic polyurethane is preferably used in sheets with a thickness of between 50 microns and 150 microns, still more preferably between 80 and 120 microns and even more preferably between 95 and 105 microns. For example the layer has a thickness of 100 microns.

[0023] TPU is a high-melting polyurethane, namely it melts or softens at high temperatures, ranging between 165°C and 185°C, of about 175°C, and differs from a non-thermoplastic polyurethane which melts from about 125°C.

[0024] In order to join together two sheets of thermoplastic polyurethane along their perimeter, or join a sheet of thermoplastic polyurethane to another layer of the inflatable bag, such as the mesh of the textile structure with threads, the wall of the inflatable bag is provided with an additional layer having the function of a glue or adhesive. In other words, the additional layer is a layer of glue or a layer of material with adhesive properties. The adhesive properties may be activated for example by means of heat or by means of thermoforming, for example under a press. In one embodiment, the additional layer consists of polyurethane, preferably thermosetting polyurethane, which once heated may be glued to another layer.

[0025] The advantage of using a sheet in which the TPU layer is combined with a PU layer lies in the fact that the two materials have different melting temperatures or softening points, and therefore the PU may be activated in a press at a temperature as low as 125°C, which does not affect the TPU. The TPU layer may therefore be fixed to the underlying mesh at relatively low temperatures.

[0026] The additional layer may be joined beforehand to the TPU layer to form a separate sheet. Preferably, the additional layer is spread on one side of the sheet to form a twin-layer or double-layer structure. In other words, the wall of the inflatable element is, before joining together with the meshes, at least a double-layer structure. The layer with glue function has a thickness ranging between 50 microns and 120 microns, still more preferably between 65 and 105 microns and even more preferably between 95 and 105 microns. For example the layer has a thickness of 100 microns. It is possible to attempt to reduce to a minimum the layer of glue in order to retain softness characteristics.

[0027] After spreading, a sheet with a layer of TPU and a layer of glue are obtained. It is possible to use sheets of TPU+PU with a thickness of between 100 mm and 270 microns, still more preferably between 150 and 240 microns and even more preferably between 170 and 230 microns, for example 200 microns.

[0028] An inflatable element provided with a wall having thicknesses such as those within the ranges, or the values, as indicated above, may be heavier than an in-

flatable element with identical dimensions realized in accordance with the aforementioned patent application. However, despite the heavier weight, the softness resulting from the use of TPU makes the inflatable element particularly more suitable than the more rigid inflatable elements of the above patent application for use with light articles of clothing, such as a competition ski suit or an undergarment.

[0029] Consequently the double-layer structure comprising the layer of thermoplastic polyurethane and the additional layer according to the present disclosure may be treated as a whole in a hot press at temperatures ranging between 125°C and 165°C so as to allow gluing or fixing along the perimeter.

[0030] The meshes of the aforementioned textile structure with threads may have a smaller surface area than the TPU layer or the sheet comprising the TPU layer and the adhesive layer. In this way, perimetral portions of the TPU project from the mesh of the textile structure with threads and may be joined perimetally along the perimeter so as to close an expansion chamber or inflatable chamber. Consequently, in the aforementioned embodiment, the additional layer associated with a first TPU layer is placed in direct contact along the perimeter of the inflatable element with the additional layer associated with the other TPU layer so as to be united to form the inner chamber. In this embodiment perimetral edges substantially consisting of four layers are obtained, i.e. two layers of TPU and two layers of PU or other adhesive which together form a single layer.

[0031] In other words, each of said first wall and said second wall is a sheet with the consistency of a rubber and having a surface area greater than said first mesh and said second mesh so as to define a zone for perimetral connection or perimetral joining together of said first wall and said second wall, said perimetral connection zone including at least two layers of TPU. The perimetral connection zone is therefore an edge with a rubbery consistency which is soft and entirely comfortable for a user, in particular when worn in an article of clothing. In fact the soft edge does not create friction nor does it conflict with the material of the garment, ensuring a high degree of comfort for the user.

[0032] Basically an inflatable bag is obtained where the peripheral edges of the first wall and the second wall, projecting respectively from each of said first mesh and second mesh, are joined together sealingly to form at least a double layer of TPU and without any fabric or mesh arranged between them so as to create an edge made of rubber. In other words, in the surface zone where the TPU sheet extends over a greater area than the underlying textile structure with threads, two TPU layers are connected together by means of direct contact so as to form an edge with the consistency of rubber and without any fabric or mesh arranged in between. One or two layers of glue or adhesive, such as PU, are arranged between the two layers of TPU.

[0033] It has been found that, owing to the use of a

TPU layer as sealing wall and the possibility of joining together the peripheral edges by means of direct contact, it is possible to obtain an inflatable chamber which may withstand the inflated condition for at least 4 second or preferably for a duration greater than or equal to 5 seconds after the maximum pressure has been reached. This result is particularly important for a wearable protection device since a sufficient time period during which the inflatable element remains in the inflated condition after inflation must be ensured. In fact, it must be considered that a user may fall hitting the ground several times or slide along the ground for a long time after falling. This result is all the more important and surprising when one considers that with the textile structure with threads it is possible to provide bags having a flat form and/or limited height able to contain limited volumes of fluid and therefore with deflation times which could be faster.

[0034] The pressures which may be reached inside the bag are high and may range between 1 bar and 3 bar, preferably between 1.5 and 2.7 bar, and even more preferably between 2 and 2.5 bar. The thermoplastic elastomer of the inflatable element, despite the typical properties of the elastomer, has proved to be adequate for withstanding these pressures, when combined with the textile structure with threads.

[0035] Moreover, owing to the use of the TPU sheet, it is possible to obtain improved results in terms of inflation in the perimetral zone compared to a sheet which has an inferior elastic capacity, such as that of the aforementioned international patent application.

[0036] In particular, the authors of the present patent application have found that, in the zones of the peripheral edge where the sheets are joined together and the meshes with threads are "squashed" and made to collapse by said peripheral edge, the tie-members in the inflated condition might not be suitably tensioned, creating dead zones. By using sheets consisting of a thermoplastic elastomer such as TPU it is possible to solve or improve these dead zones, owing to the fact that the TPU sheet in the inflated condition undergoes deformation and elongation which favours greater inflation of the textile structure with threads in the edge zones as well. The use of sheets which are more rigid and less expandable, such as those in the aforementioned patent application, did not allow maximum extension of the threads in the dead zone of the perimetral edge. A bag which corresponds more to the form defined a priori may be obtained in the inflated condition.

[0037] Furthermore, in one embodiment of the present disclosure, a first wall different from the second wall may be provided by using thermoplastic polyurethane with a different elongation capacity and properties. The use of two different materials may be useful for obtaining a bag shaped and curved to adapt to the form of the body. In fact the sheet with a greater expansion capacity may extend more than the other sheet and allow a curved inflatable element to be obtained.

[0038] Alternatively, in other embodiments, a layer of

glue separate from the TPU may be used and be arranged if necessary between the TPU and the respective mesh. The result in terms of softness and peripheral edge with rubbery consistency is comparable to that of the other embodiments.

[0039] In some embodiments, the inflatable bag includes at least one external sealing or retaining layer, for example consisting of fabric, mesh, netting or lattice and superimposed on the TPU sheet. In other words, the sealing or retaining layer may be positioned on an outer side of the TPU layer. The sealing layer is intended to provide the polyurethane sheet with a greater strength and capacity to withstand high gas pressures. The use of the additional sealing layer depends on the type of mesh (and associated elasticity) used for the textile structure with threads. The greater the elasticity of the mesh, the higher the probability that the additional layer will be required. On the other hand, if the mesh used has a very dense and rigid texture or weave, so that it practically forms a fabric, the sealing layer is not necessary.

[0040] It should be taken into account that the sealing layer is not necessary when the pressures applied to the inflatable element are not high.

[0041] In one embodiment, a textile structure with threads includes, instead of a prefabricated structure including two meshes such as those described above, a body knitted to size on the basis of the form of the inflatable element to be obtained. In other words, the protection device according to the present disclosure includes a textile structure realized by means of a knitting process. The soft structure with threads, which represents an alternative to the soft structure with threads described above and which may be combined in the same way and with the same results described above with the TPU layer or sheet, is described below.

[0042] Such a knitting technique is able to overcome the drawback of a high amount of waste material since portions of the airbag are knitted and form part of a single knitted body or three-dimensional knitted body (depending on the profile to be obtained) which is therefore not cut from a prefabricated roll.

[0043] In particular, the knitted body according to the present disclosure performs a similar or the same function as the first mesh and the second mesh described in the embodiments described above or in the international patent application mentioned above. The knitted body is knitted from a thread or band which is knitted in accordance with a predetermined design so that there is no waste of prefabricated material or this waste is reduced to a minimum. The term "thread" is understood as meaning a long and thin body with a flexible consistency made of a material suitable for a knitting process. It may also consist of a band or a strip which may be knitted by means of a knitting machine or hosiery knitting machine. As an alternative to the thread, a filament comprising a plurality of threads or fibres which are wound on themselves or a plurality of threads arranged next to each other may be used.

[0044] The expression "knitting process" is to be understood as meaning a process by means of which it is possible to obtain a series weave formed by threads, rings or loops of various material. The mesh may be understood as meaning a fabric or net having a given mesh size.

[0045] More particularly, according to the present disclosure, it consists of a knitted body having, differently from the international patent application mentioned above, a structure closed on at least four sides or walls, wherein basically said structure has an at least partially tubular form defining an internal zone or internal chamber. It may therefore consist of a knitted body defining an inner zone or inner chamber, wherein the knitted body includes at least one first knitted face, namely a first side or first portion or wall which is knitted, at least one second knitted face, namely a second side or second portion or wall which is knitted and situated opposite the first face; at least one third knitted face, namely a third side or third portion or wall which is knitted and connected continuously to the first face and the second face on one side of these two faces; at least one fourth knitted face, namely a fourth side or fourth portion or wall which is knitted and connected continuously to the first face and the second face on the other side of these two faces, wherein the fourth face is situated opposite the third face.

[0046] In other words, it consists of a body comprising at least one mesh having a tubular form. The tubular structure in the collapsed condition has two opposite and superimposed portions which are connected laterally in a single body without interruption by means of respective lateral connecting portions and which therefore do not require stitching or some other connection method. In other words, differently from the meshes of the aforementioned international patent application, the two opposite portions, namely the first face and the second face of the knitted body are knitted together continuously (without interruption) owing to the fact that the knitted body is a three-dimensional body, with at least a tubular form, processed as a whole.

[0047] Moreover, the inflatable element comprises a plurality of joining threads arranged in the inner area and designed to connect at least the first portion/face and the second portion/face of the knitted body. The joining threads form an integral part of the knitted body and act as tie-members and limit the maximum expansion of the knitted body. In other words, each of the joining threads has a respective first end portion connected to the first side or wall of the knitted body and a second end portion connected to the second side or wall of the knitted body. The joining thread is also to be understood as being a thread with any form as defined above. The joining threads are therefore also knitted from a thread or filament which is knitted together with the thread or filament which forms the faces of the knitted body.

[0048] In another words, in accordance with the present disclosure, the knitted body includes, in addition to the thread which forms the faces of the knitted body,

also the joining threads which have the function of tie-members and which perform the same function as the tie-members described in the aforementioned international patent application. In this case also, the joining threads are knitted together with the knitted body so as to form a single body therewith. The joining threads are located inside and cross the inner chamber. The joining threads may be processed together with the knitted body during a single production step in a respective knitting machine.

[0049] The knitted body is therefore a so-called three-dimensional body, namely it extends at least in three directions and is already provided at time of knitting of the joining threads.

[0050] In other words, the joining threads may be processed together with the knitted body in a knitting machine. For this purpose, at least one group of joining threads form part of, or are made from, a single thread or single filament composed of at least two threads, wherein the single thread or the single filament extends alternately continuously knitted between the first portion and the second portion of the knitted body.

[0051] Even more preferably, the single thread or the single filament is arranged in a zigzag or with a sinusoidal progression between the first portion and the second portion of the knitted body so as to cover or be associated with at least one region of the inflatable element. The zigzag arrangement may be understood in the broad sense, namely that the joining threads may be arranged so as to have a diagonal arrangement between the first portion of the knitted body and the second portion of the knitted body, or the joining threads are arranged substantially orthogonally between the first portion and the second portion.

[0052] According to an embodiment of the present disclosure, owing to the fact that the joining threads are joined and processed together with the knitted body by means of a same knitting machine, it is possible to adjust or program, already during the production stage, the length of the joining threads depending on the maximum width of the inflatable element which is to be obtained.

[0053] In particular, the inflatable element may comprise, in a first zone, first joining threads having a first length and, in a second zone, second joining threads having a second length, wherein the first length is different from the second length.

[0054] Similarly, according to an embodiment of the present disclosure, owing to the fact that the joining threads are joined and processed together with the knitted body by means of a same knitting machine, it is possible to adjust or program, already during the production stage, the density of the joining threads, understood as being the number of the threads per unit of surface area, depending on the zone of the inflatable element, for example in relation to the distance from a pressurized gas generator. The inflatable element may therefore comprise, in a first zone, for example in a zone close to the gas generator, joining threads distributed with a first

thread density and, in a second zone, for example further from the gas generator, joining threads distributed with a second thread density, wherein the first thread density is different from the second thread density, for example is a greater density.

[0055] It can be seen that the faces of the knitted body described above have mainly a supporting function for the joining threads. As a result, the faces of the knitted body may be made of a material different from the material of the joining threads and less resistant and less rigid than the joining threads so as not to affect, or affect minimally, the overall rigidity of the knitted body and favour the softness of the entire inflatable element in combination with the TPU sheet. The faces of the knitted body may be made for example of cotton or wool with a given yarn count, namely having yarns with a very soft consistency and suitable for insertion in an article of clothing with a minimum impact on the comfort. The joining threads may be made with a yarn having a high tensile strength. In one embodiment of the present disclosure the thread for forming the knitted body is 50 polyester thread, while the thread of the joining thread is 75 polyester thread.

[0056] Preferably, in an embodiment of the present disclosure, the knitted body is a body which has a bag-like structure, namely a structure closed on at least five sides and having only one open zone or access mouth or opening for accessing an internal zone of the knitted body.

[0057] In other words, according to this latter embodiment, the knitted body includes a fifth side or fifth portion/face or knitted wall, wherein the fifth side is continuously connected to the first side or first portion/face, the second side or second portion/face, the third side or third portion/face and the fourth side or fourth portion/face. This bag-like structure with a single access opening has the advantage of allowing access to the internal zone of the knitted body in order to position any technical instrumentation or devices inside the said inflatable device, such as a pressurized gas generator, sensors and/or electronics for management of the protection device. Should it not be necessary to provide anything inside the inflatable element, the knitted body may also be a casing closed on all sides, like a knitted bag collapsed onto itself so as to form two main layers situated opposite each other and joined together along the entire perimeter in the form of a single body. In other words, according to this latter embodiment, the knitted body includes a sixth side or sixth portion/face or knitted wall which is continuously knitted together with the first side or first portion, the second side or second portion/face, the third side or third portion/face and the fourth side or fourth portion, wherein the sixth side or sixth portion/face is situated substantially opposite the fifth side or fifth portion/face.

[0058] It should be understood that, since the knitted body is processed using a knitting machine, it is also possible to envisage the possibility of incorporating by means of weaving or knitting electrical cables for internal sensors, for example pressure sensors, or for connection

to the management electronics system, should it be inserted in the knitted body.

[0059] Preferably, when the textile structure is made with said knitted body, the protection device includes said additional sealing layer located on an outer side.

[0060] It should be understood that the aforementioned embodiments relating to the knitted body may be in combination with any one or all the embodiments described in connection with the TPU layer or the sheet containing the TPU layer.

[0061] Further characteristic features and modes of use of the subject of the present disclosure will become clear from the following detailed description of a number of preferred examples of embodiment thereof, provided by way of a non-limiting example. It is evident, however, that each embodiment may have one or more of the advantages listed above; in any case it is not required that each embodiment should have simultaneously all the advantages listed.

[0062] Reference will be made to the figures of the accompanying drawings in which:

- Figure 1 shows a top plan view of a protection device according to an embodiment of the present disclosure;
- Figure 2 shows a partially sectioned view along the 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, in schematic form, respective steps for processing a personal protection device according to the present disclosure;
- Figure 8 shows a detail VIII of Figure 7;
- Figure 10 shows a partially sectioned side view of a personal protection device such as that shown in Figure 1, but realized 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, in schematic form, respective steps for processing the personal protection device shown in Figures 10-12.

[0063] With reference to the accompanying figures, the reference number 1 indicates a personal protection device according to the present disclosure in accordance with a first embodiment. In particular, the protection device comprises an inflatable element 2 which is formed in the manner of a casing and inside which an inner chamber 3 is defined. The inflatable element 2 is adapted to assume substantially a first rest condition or deflated condition, and a second active condition or inflated condition. The modes of inflating the inflatable element 2 will be described in the description below.

[0064] In the example of embodiment shown, the inflatable element 2 is suitably shaped so as to be placed on the upper part of the chest of a user. For this purpose, the inflatable element 2 has a form comprising two side

wings 8, 9 for covering the shoulders of a user, a substantially C-shaped central portion 10 and a spine portion 11 intended to protect the spine of the user. A gas generator 12, in the example a pressurized-gas cylinder, is included in the spine portion 11 of the inflatable element.

[0065] The protection device 1 comprises a plurality of tie-members 5 distributed inside the inner chamber 3 and stably connected to respective portions of the inflatable element 2. The term "tie-member 5" is understood as meaning an element or part which has the function of keeping joined together or fastened or fixed, by means of tensile force, two or more parts of the inflatable element 2, at least when the latter is in the inflated condition.

[0066] In the example, the tie-members 5 have a thread-like form and are flexible and inextensible elements. Therefore, they have suitable dimensions such that, when the inflatable element 2 is in the rest condition, they are preferably not subject to tensioning and are collapsed inside the inner chamber 3, whereas when the inflatable element 2 is in the inflated condition they are tensioned.

[0067] The inflatable element comprises opposite walls 15, 16 which are perimetally joined together along the edges 20, 21. More particularly, the inflatable element 2 comprises meshes 18, 19, each of which lines internally, namely on the inner chamber 3 side, a respective wall 15, 16. Even more particularly, in order to provide the inflatable element with structural stability, each mesh 18, 19 is stably fixed to the surface of the respective wall 15, 16 preferably by means of a film of glue or layer of glue as described hereinbelow. Viewed from another point of view, the inflatable element 2 has a substantially twin-leaf structure, in which each leaf corresponds to a wall 15, 16. A textile structure 40 formed by two meshes 18, 19 is arranged inside the zone between the two walls 15, 16 and each mesh is preferably fixed to the respective wall 15, 16.

[0068] More precisely, each of the two walls 15, 16 or sheets is made at least partially of thermoplastic polyurethane. The walls 15, 16 are made of a laminate, namely a double-layer structure, comprising the layer of TPU 15a (which, for example, represents between about 45% and 65% by weight, preferably between 48% and 55% by weight, and even more preferably about 50% by weight of the laminate) and a layer 15b with a glue or adhesive function (which represents approximately the remaining part by weight of the laminate), in the example a layer of polyurethane (not thermoplastic) glue distributed over the TPU layer 15a by means of roller spreading or similar distribution technologies. In the example shown, it therefore consists of a sheet which, before fixing to the mesh 18, 19, is formed by TPU+PU and overall has a thickness, for example, of 200 microns.

[0069] It should be noted that preferably, differently from the embodiment described in the aforementioned international patent application, the mesh 18, 19 is arranged directly in contact with the aforementioned adhesive layer 15b, and no additional layer or film of glue for

gluing the wall 15, 16 to the respective mesh 18, 19 is required.

[0070] As mentioned above, in the example, the tie-members 5 are flexible tie-members and have the form of threads and are made for example of polyester or polyamide, with a thickness of between about 500 and about 1000 decitex (units of length of a continuous thread or a yarn) and have ends 5a, 5b which are fixed to the respective wall portions 18, 19 which they connect. Even more particularly, each tie-member or thread 5 includes a bundle of continuous untwisted fibres which emerge from a single point of a respective mesh 18, 19.

[0071] The tie-members 5 have opposite ends 5a, 5b which are stably fixed to the mesh 18, 19 of the respective wall 18, 19. The fixing at the opposite ends 5a, 5b of the tie-members 5 is, for example, achieved by means of simple insertion of tie-members 5 between the weaves of the mesh 18, 19. Basically, in the example shown in the figures, the tie-members 5 are obtained by a given number of threads which are fixed alternately to one mesh 18 and consecutively to the other mesh 19. In other words, with reference to Figures 3 and 4, each thread 5 is inserted underneath a weave of the mesh 19 of the wall 16, is curved upwards and extended again towards the opposite wall 15, where it is connected in the same manner to the mesh 18. Alternatively, the tie-members 5 are connected to the mesh 18, 19 by means of interweaving or by means of tying or similar fixing systems.

[0072] Alternatively, each tie-member 5 is a thread wholly interlaced with, or extends continuously from, both said first and second meshes 18, 19. Basically the thread/tie-member 5 extends from one of said first and second meshes 18, 19 and is wholly interlaced with the other one of said first and second meshes 18, 19.

[0073] The set of two meshes 18 and 19 and the tie-members 5 forms a so-called three-dimensional 3D or double needle-bed fabric.

[0074] The meshes 18 and 19 may also be made of polyester or polyamide.

[0075] In the light of the above description the inflatable element 2 may therefore have a structure which is similar to that described with reference to the aforementioned international application, but which differs from this embodiment owing to the presence of the TPU layer instead of the fabric layer and preferably in that it is no longer required to use a film of glue arranged between the laminate and the respective mesh.

[0076] It has been noted that an inflatable garment obtained with the aforementioned characteristics may be inflated to high pressures, even as high as about 2.7 bar, and moreover has a good resistance to heat and stress conditions which may occur when the inflatable element is housed inside a garment.

[0077] Moreover, the inflatable element 2, owing to the TPU, has a high tensile strength and abrasion resistance. The TPU sheet ensures better adaptation to inflation and allows the threads to extend fully in a peripheral zone.

[0078] The protection device described above is pro-

duced in the manner described below.

[0079] Firstly a portion 40, or textile structure, is provided, said portion comprising meshes 18 and 19 to which ends 5a, 5b of tie-members 5 are tied or fixed in another manner as described above. In Figure 5, the portion 40 is shown slightly inflated so that it is possible to appreciate the present of the tie-members 5 and is shown with a substantially rectangular structure for the sake of easier illustration. It is clear, however, that the portion 40 has a form and dimensions substantially equivalent to those of a respective inflatable element 2 to be obtained; moreover, the length of the tie-members 5 is chosen so as to determine a maximum relative distance between the meshes 18, 19 corresponding to a maximum local expansion of the respective inflatable element 2 in the inflated condition.

[0080] One edge 43 of the mesh 18 is stitched to a respective edge 44 of the mesh 19 facing it (stitching line indicated by 47 in Figure 6). In Figure 5, the stitching operation is represented by way of example by means of a needle 49, but it is evident that the stitches 47 may be performed by means of a machine or using other equipment conventional for a person skilled in the art, or may be obtained by means of welding, or by means of the tie-members 5 themselves, for example using tie-members having a minimum length or "zero" length. The stitching line 47 follows substantially the perimeter of the portion 40.

[0081] Before completing the perimetral stitch, a gas cylinder 12 may be included between the meshes 18, 19. Alternatively a duct may be provided inside the meshes for connecting a gas source located outside the inflatable element 12.

[0082] It should be noted that the aforementioned perimetral stitch passes transversely between the meshes 18, 19, causing them to come into direct contact with each other, and without touching the walls 15, 16.

[0083] The portion 40 is enclosed between the sheets 15, 16 of soft and gas-tight TPU material mentioned above, the sheets 15, 16 having a greater surface area than said portion 40.

[0084] In the example, the sheets 15 and 16 are glued to the respective meshes 18, 19 by means of the layer 15b using a hot press 60 (which for example operates at temperatures of 125°C and higher) so as to favour adhesion and gluing together.

[0085] In particular, each layer 15b is situated directly between a mesh 18, 19 of the portion 40 and the respective layer 15a of the wall 15, 16, as shown in Figures 7 and 8.

[0086] It has been found that the use of TPU provides satisfactory results. In particular, owing to the softness of the TPU, the layer of PU or other adhesive penetrates in a precise and uniform manner between the fibres of the meshes and no additional layer of glue is required. The laminate is also very light and at the same time imparts a greater strength to the inflatable element 2, 102.

[0087] Since the layer of TPU 15a is flexible and soft

it also adapts to any relative movements which occur with respect to the meshes. Even more particularly, by suitably adjusting the degree of elongation of the layer of TPU 15a and the length of the threads, adaptations may be made to the form of the bag in the inflated condition, while ensuring greater comfort.

[0088] From the above description it can be seen that the portion 40 is first cut according to the shape required and the form of the bag which is to be obtained and then, after suitable stitching, 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 however also possible for the two walls 15 and 16 to be opposite portions of a single sheet which is folded in book form and therefore has peripheral edges extending along a portion of the perimeter. In any case, it is pointed out that the bag thus obtained ensures a satisfactory gas-tightness for the time required to protect a user wearing the inflatable element 2. This time may be at least 4 seconds or preferably greater than or equal to 5 seconds.

[0089] With reference to Figures 10 to 14, a personal protection device 100 in accordance with a second embodiment is described below.

[0090] Elements and parts of the present embodiment having the same function and the same structure as the elements and parts of the embodiment previously described retain the same reference number and are not described again in detail.

[0091] In the example of embodiment shown in Figures 10 to 14, the inflatable element 102 includes a knitted body 103 which has the same function as the two meshes 18, 19 of the previous embodiment. In the embodiment shown the knitted body 103 is a substantially bag-like body which may have a single access opening 106 which allows access to an internal zone 104.

[0092] The knitted body 103 therefore includes, when extended on a surface and squashed in this extended portion, two opposite portions or walls 103a, 103b and at least three side portions 103c, 103d, only two of which can be seen in Figures 10 and 11 and which extend continuously between the two opposite portions 103a, 103b.

[0093] Owing to the tubular form, and even more so owing to the form of a bag or closed casing, the knitted body 103 has the advantage that it may be closed laterally on at least two sides (along the lateral portions 103c, 103d) and does not require at least a perimetral stitch at least on said two sides, as for example described in the aforementioned first embodiment.

[0094] The inflatable element 102 also has a form comprising two side wings 8, 9 for covering the shoulders of a user, a substantially C-shaped central portion 10 and a spine portion 11 intended to protect the spine of the user. In the embodiment shown, the spine portion 11 may have said access opening 106 for allowing the positioning, inside the internal zone 104, of a pressurized-gas generator 12. Basically the pressurized gas is introduced from the spine portion 11.

[0095] The knitted body 103 has a shape which repro-

duces and follows the shape of the inflatable element 102 and is formed as a single body according to said shape so as to define a single internal zone 104.

[0096] The knitted body 103 also includes a plurality of joining threads 5 or tie-threads which are distributed inside the inner chamber 104 and stably connected to respective portions 103a, 103b of the knitted body 103, in particular to surface portions thereof. The knitted body 103 with the joining threads 5 corresponds, in terms of function, to the portion 40 described above. The joining threads 5 have the same function as the tie-members indicated above.

[0097] The knitted body may also be lined with and covered by a covering. The covering may include two walls 15, 16 or sheets which are made of a soft TPU material and are arranged opposite each other and fixed perimetally along respective perimetral edges 20, 21.

[0098] The walls 15, 16 are like those described in the preceding embodiment and are made of a laminate material, which is formed by layer of TPU and a layer of glue or adhesive, for example PU (which can be hot-activated).

[0099] The knitted body 103 is stably fixed to the surface of the respective wall 15, 16 by means of the layer of glue, namely in direct contact with the layer of glue of the laminate.

[0100] It is pointed out that the knitted body 103, precisely because of the nature of the knitting process, may have a greater elasticity than the walls 15, 16 of the portion 40 of the first embodiment. In order to contain any thrusts of the gas and prevent the formation of any gas pockets between the knitted body 103 and the respective wall 15, 16, a further layer may be used on the outer side of the wall 15, 16.

[0101] The layer therefore consists of a layer with a containing and retaining function for withstanding the pressure of the gas. Consequently the use of the additional layer depends on the pressures used. For example, the layer may consist of a mesh, a fabric, a cloth, a lattice, a net or similar layer which may help the mesh body 103 to contain the gas pressure. The layer with the containing function may be glued to the wall 15, 16 or partially or completely embedded in the wall 15, 16.

[0102] In connection with the knitted body 103, the observations below may be made.

[0103] The joining thread 5 is an element or part which has the function of keeping joined together, fastened or fixed, by means of a tensile force, two or more parts of the knitted body 3, at least when the latter is in the inflated condition. It is pointed out that, in the embodiment shown, a plurality of joining threads 5 are obtained from, or form part of, a single thread or a single filament composed of at least two threads, wherein the single thread or the single filament extends alternately continuously between the first portion 103a and the second portion 103b of the knitted body 103.

[0104] Even more preferably, the single thread or the single filament is arranged in a zigzag or with a sinusoidal

progression between the first portion 103a and the second portion 3b of the knitted body 103 so as to cover or occupy a region of the inflatable element 2.

[0105] The joining threads 5 have suitable dimensions such that, when the inflatable element 2 is in the rest condition, they are preferably not subject to tensioning and are collapsed inside the inner chamber 104, whereas when the inflatable element 102 is in the inflated condition they are tensioned. The threads may be arranged so as to connect opposite portions 103a, 103b of the knitted body 103 or may be arranged diagonally so as to connect portions of the knitted body 103 which are not situated perfectly opposite each other.

[0106] The threads are distributed in a compact manner, for example with a density of at least one tie-member every cm² of surface area of the inner chamber 104, even more preferably, again by way of example, with a density of between 1 and 15 threads every cm² of surface area of the inflatable element 102, preferably, between 4 and 6 threads every cm². The distribution of the threads may be varied depending on the zone of the protection device in which the threads are located. The joining threads 5 may be made for example of polyester or polyamide, with a thickness of between about 500 and about 1000 decitex (unit of length of a continuous thread or a yarn). Each thread 5 may include a bundle of continuous untwisted fibres which emerge from a single point of a respective mesh of the knitted body 103.

[0107] In one embodiment of the present disclosure, the yarns used to form the joining threads 5 are yarns different from those used to form the case-like body and the aforementioned portions 103a, 103b, 103c, 103d. In particular, the joining threads are made of a material having a greater tensile strength than the threads of the case-like body. The threads of the case-like body may be made of a softer material so as to obtain an inflatable element which may be as soft as possible and have a light and flexible consistency and which may ensure maximum comfort for a user wearing it.

[0108] The threads of the knitted body 103 may be made of a variable material which differs also depending on the zone of the protection device in which they are located and the zone of the body of a user to be protected.

[0109] The knitted body 103 and the joining threads 5 may be made using a knitting machine, or a flat knitting machine of the known type which includes two needle beds, namely two rows of needles intended to process the knitted body. A knitting machine of the known type is a glove-making machine such as that identified by the code SWG0991N, made by Shima Seiki.

[0110] The two needle beds have a series of needles with an extension or length which corresponds to a shape dimension, 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 provided with a first thread guide supporting a first thread intended to form the knitted body 103 and a second

thread guide which has a second thread intended to form the joining threads 5.

[0111] The machine may be programmed so as to produce the knitted body 103 by means of the first thread guide which works alternately the thread on the first needle bed and on the second needle bed.

[0112] The machine may be programmed so as to join together two opposite zones 103a, 103b of the mesh by means of the second thread mounted on the second thread guide, in order to form the joining threads 5. For example, the machine may be programmed to work a number of mesh rows, so as to form a number of complete mesh rows, and then join together, by means of the second thread guide, and therefore the second thread, certain needles of the first needle bed with certain needles of the second needle bed. Then, a number of mesh turns may again be worked and the knitting with the second row which forms the joining threads repeated.

[0113] In order to define a specific length of the joining row it is possible to join together the meshes by means of diagonal joining threads. In this case, the second thread guide will interweave the joining thread with certain needles of the first needle bed and the second needle bed so that the joining threads are arranged diagonally between the needles of a first needle bed and the needles of a second needle bed.

[0114] Alternatively, it is possible to work the mesh using a "drop stitch" technique where, for each needle bed, some needles are used as "operative" needle intended to perform knitting and therefore involved in the knitting of the knitted body, and other free "non-operative" needles which are not involved in the knitting process. These "non-operative" needles which are kept free are able to receive temporarily the joining thread. Basically, the joining thread is "parked" momentarily on the "non-operative" needle when it is being worked between the first needle bed and second needle bed. In particular, the joining thread is used for knitting on an "operative" needle of the first needle bed intended to work the meshes, is then "parked" on a "non-operative" needle of the same first needle bed and then is worked on an "operative" needle of the second needle bed. In this way, by programming the distance between the first "operative" needle of the first needle bed, the non-operative needle of the first needle bed and the "operative" needle of the second needle bed, it is possible to establish a priori the length of the joining threads 5 when the knitted body is removed from the knitting machine.

[0115] It is understood that a person skilled in the art of using flat knitting machines may be able to program the machine in an optimum manner in order to obtain the desired result.

[0116] Further information regarding the processing of a knitted body by means of joining threads may be found in the Italian patent application TO-2013-A-472, which describes the manufacture of knitted bodies provided with joining threads.

[0117] It is pointed out moreover that the flat knitting

machine may also be programmed to vary the length of the joining thread depending on the zone of the inflatable element to be produced. For example, in a zone of the knitted body 103 intended to be arranged in the perimetral zones or zones 103a, 103d of the inflatable element 102, the joining threads 5 may have a length which gradually decreases to a minimum value, in order to ensure tensioning of the joining threads 5 also in the perimetral zones when the inflatable element 102 is inflated.

[0118] Moreover, the flat knitting machine may also be programmed to vary the mesh size, for example by modifying programming of the drop stitch, or when a more dense mesh is required, by using a double row to form the mesh.

[0119] An important aspect arising from the fact the knitted body 103 is obtained in a single processing operation is that it is not required to provide perimetral stitches in the meshes as instead was necessary in the preceding embodiment.

[0120] The protection device described above is made as follows in accordance with an embodiment and in a manner entirely similar to the method of manufacture of the inflatable element 2 according to the preceding embodiment.

[0121] The knitted body 103 is arranged in an extended condition with the two opposite portions 103a, 103b collapsed on top of each other. The knitted body 103 is in this configuration arranged between two walls 15, 16 and fixed so as to adhere to a respective portion, for example by means of glue.

[0122] Then respective, opposite, perimetral edges 20, 21 of the walls 15 and 16 are superimposed on each other along the perimeter.

[0123] From the above description it emerges that the two walls 15 and 16 are essentially two elements or sheets of the inflatable element 2 which are situated opposite each other and fixed along the respective perimetral edges 20 and 21. It is however possible for the two walls 15 and 16 to be opposite portions of a single sheet folded in book form and therefore having peripheral edges extending along a portion of the perimeter.

[0124] The peripheral edges of the two walls 15 and 16 therefore form an edge of the inflatable element which is made substantially of TPU, except for the layer of glue in between. The peripheral edges made of TPU, owing to the intrinsic elasticity of the material, allow maximum extension of the threads also in the perimetral zone of the textile structure.

[0125] It is also pointed out that the protection device may be included in a garment or may form an integral part of a garment. In fact it is quite possible, owing to the possibility of programming a flat knitting machine, to produce in a single production step a knitted body together with an article of clothing, namely it is possible for the knitted body to be incorporated integrally in the article of clothing or even for it to coincide with the article of clothing. In fact, for example, the knitted body may be in the form of a waistcoat or jacket and, for example, made with

a mesh density such as to ensure a suitable fluid-tightness in respect of the inflation gas.

[0126] In order to perform the inflation of the inflatable element 2, 102 of both the embodiments, in the event of a fall and/or sliding and/or sudden impact involving a user or a vehicle ridden by the user, the protection device 1, 100 according to the present invention is able to cooperate with suitable activation means operationally connected to inflation means; the figures show, merely by way of example of these inflation means, a compressed cold gas cylinder 12, included inside the inflatable element 2, 102 or connected by means of a duct or pipe to a shut-off valve which allows the introduction of an inflation fluid inside the inflatable element.

[0127] Alternatively, these inflation means may comprise gas generators of the pyrotechnic or other hybrid type or other types known according to the state of the art.

[0128] Said inflation means are controlled by a control unit depending on detection of the state of the vehicle/rider system; for example said control unit may implement a system for predicting the fall which allows early identification of the fall event and a reliable prediction of this event by accelerometer sensor means fixed to the vehicle (or rider) and a unit for processing the signals produced by the said sensors.

[0129] Alternatively, the device according to the present disclosure may also be applied using an activation cable connected to a vehicle ridden by a user, which cable activates inflation of the inflatable element 2, 102 following the movement of the user away from the vehicle, following a fall or a sudden impact.

[0130] In any case the aforementioned activation and inflation means may be integrated in the protection device 1 according to the present invention or located on the outside thereof.

[0131] It should also be noted that the activation modes, although being an aspect of particular importance for effective operation of the device, will not be further described in greater detail since they are methods which are essentially already known to a person skilled in the art of protection of an individual from sudden impacts.

[0132] The protection device 1, 100 may also comprise a deflation valve (not shown in the drawings) communicating on one side with the inner chamber and on the other side with the external environment, in order to allow the deflation of the inflatable element 2, 102 following activation and when a protective action is no longer required.

[0133] It is also pointed out that the protection device may be included in a garment or may form an integral part of a garment. In fact it is quite possible, owing to the possibility of programming a flat knitting machine, to produce in a single production step a knitted body together with an article of clothing, namely it is possible for the knitted body to be incorporated integrally in the article of clothing or even for it to coincide with the article of clothing. In fact, for example, the knitted body may have the

form of a waistcoat or jacket and, for example, be made with a mesh density such as to allow a suitable fluid-tightness of the inflation gas.

[0134] In order to make the knitted body impermeable or at least temporarily fluid-tight, a local covering may be provided for the knitted body or the knitted body may be provided with a denser mesh.

[0135] Two covering layers may be provided on opposite sides of the knitted body and these covering layers may be joined together by means of suitable openings provided around the knitted body.

[0136] The subject-matter of the present disclosure has been described hitherto with reference to preferred embodiments thereof. It is to be understood that other embodiments relating to the same inventive idea may exist, all of these falling within the scope of protection of the claims which are attached below.

Claims

1. Wearable protection device (1, 100) for the personal protection of a user, said protection device comprising an inflatable element (2, 102) in which an inner chamber (3, 104) is defined, and a plurality of tie-members (5) distributed in the inner chamber (3, 104), wherein said inflatable element (2, 102) is adapted to assume an inflated active condition and a deflated rest condition, and wherein said inflatable element (2, 102) includes a first wall (15) and a second wall (16) situated opposite each other and connected along a perimeter so as to define said inner 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-members (5) having opposite ends (5a, 5b) respectively fixed to or associated with said first mesh (18, 103a) and said second mesh (19, 103b), wherein each of said first wall (15) and second wall (16) is an independent double-layer structure including a first layer (15a) and a second layer (15b) and wherein said second layer is a layer (15b) with an adhesive or glue function, **characterized in that**, said first layer is made of TPU (15a) instead of a fabric layer.
2. Wearable protection device (1, 100) according to claim 1, wherein
 - each of said first wall and said second wall (15, 16) is a sheet having a surface area greater than said first mesh (18, 103a) and said second mesh (19, 103a) so as to define a zone for perimetral connection or perimetral fixing together of said first wall and said second wall and wherein said perimetral connection zone includes at least two layers of TPU, or
 - wherein each of said first wall (15) and said sec-

- ond wall (16) has a surface area greater than the respective first mesh (18, 103a) and second mesh (19, 103b) and wherein peripheral edges (20, 21) of said first wall (15) and said second wall (16), projecting respectively from each of said first mesh (18, 103a) and second mesh (19, 103a) are joined together sealingly to form at least one double layer of TPU.
3. Wearable protection device (1, 100) according to claim 1 or 2, wherein said TPU is a high-melting material and melts at temperatures ranging between at least 165°C and 185°C, preferably at a temperature of 175°C and/or wherein said layer of TPU has a thickness of between 50 mm and 150 microns, even more preferably between 80 and 120 microns and still more preferably between 95 and 105 microns, and/or has a thickness of 100 microns.
 4. Wearable protection device (1, 100) according to any of the previous claims, wherein said second layer is a layer (15b) of PU having a melting temperature, or softening point, lower than a melting temperature, or softening point, of the layer of TPU and wherein the layer (15b) of PU has a melting temperature, or softening point, as low as about 125°C and wherein the first layer (15a) of TPU has a melting temperature, or softening point, of about 175°C.
 5. Wearable protection device (1, 100) according to any one of the preceding claims, wherein said layer of TPU is a transparent or semi-transparent layer.
 6. Wearable protection device (1, 100) according to any one of the preceding claims, wherein said first layer and said second layer form a sheet having a thickness of between 100 mm and 270 microns, even more preferably between 150 and 240 microns, and still more preferably between 170 and 230 microns, for example 200 microns.
 7. Wearable protection device (1, 100) according to any one of the preceding claims, in combination with claim 2, wherein at least two layers with a glue function are arranged between the two layers of TPU (15, 16) in the perimetral connection zone or in the zone of the perimetral edges.
 8. Wearable protection device (1, 100) according to any one of the preceding claims, wherein said first mesh and said second mesh are opposite portions (103a, 103b) of a knitted body (103) having a closed structure on at least four sides or walls and/or having a shape which is at least partially tubular so as to define an inner area or inner chamber (104), wherein the knitted body (103) includes a plurality of joining threads (105) having the function of said tie-members, wherein said joining threads occupy at least partially the inner area and are able to connect together two sides or walls (103a, 1033b) of the knitted body (3).
 9. Wearable protection device (1, 100) according to claim 8, wherein the joining threads (105) cross the inner chamber and are knitted together with the sides of the knitted body and/or wherein at least one group of said joining threads (5) form part of a thread or of a filament composed of at least two threads, wherein the thread or the filament extends alternately continuously in the sides of the knitted body.
 10. Wearable protection device (1, 100) according to either one of claims 8 or 9, wherein the knitted body comprises at least one first knitted side or wall (103a); at least one second knitted side or wall (103b), opposite to the first side (103a); at least one third knitted side or wall (103c) continuously knitted together with the first side (103a) and with the second side (103b); at least one fourth knitted side or wall (103d) continuously knitted together with the first side (103a) and the second side (103b), wherein the fourth side (103d) is situated opposite the third side (103c) and wherein the joining threads (105) have a smaller length in a region of the inflatable element adjacent to the third side (103c) and/or to the fourth side (103d) than in a central area of the inflatable element distant from the third side (103c) and/or the fourth side (103d).
 11. Wearable protection device (1, 100) according to any one of the preceding claims, wherein the joining threads (105) are made of a material different from that of the walls or sides of the knitted body (103) and/or wherein the walls or sides of the knitted body (103) are made of a material which is softer and/or has a lower tensile strength than a material of the joining threads (105) and/or wherein the inflatable element comprises, in a first area, joining threads (105) distributed with a first thread density and, in a second area, joining threads (105) distributed with a second thread density, wherein the first thread density is different from the second thread density.
 12. Wearable protection device (1, 100) according to any one of the preceding claims, wherein the knitted body (103) is a body closed on at least five sides or walls so as to define a bag comprising at least one access opening for accessing said inner area (104).
 13. Wearable protection device (1) according to any one of the preceding claims, wherein the knitted body (103) is a body closed on all sides so as to define a closed casing.
 14. Wearable protection device (1, 100) according to any one of the preceding claims, comprising a further

layer placed on an outer side of the wall (18, 19, 103a, 103b) and having a retaining function so as to withstand an inflation pressure.

15. Wearable protection device (1, 100) according to claim 14, wherein said further layer is a mesh sheet, a fabric, a cloth, a lattice, a net or similar retaining layer.
16. Wearable protection device (1, 100) according to any one of the preceding claims, in combination with claim 2, wherein said inflatable element is adapted to maintain an inflated condition for at least 4 seconds, preferably at least 5 seconds.
17. Garment including a protection device (1, 100) according to any one of the preceding claims.

Patentansprüche

1. Tragbare Schutzvorrichtung (1, 100) für den persönlichen Schutz eines Benutzers, wobei die Schutzvorrichtung ein aufblasbares Element (2, 102) umfasst, in dem eine innere Kammer (3, 104) definiert ist, und eine Mehrzahl von Verbindungselementen (5) in der inneren Kammer (3, 104) verteilt ist, wobei das aufblasbare Element (2, 102) angepasst ist, um einen aufgeblasenen aktiven Zustand und einen entleerten Ruhezustand anzunehmen, und wobei das aufblasbare Element (2, 102) umfasst: Eine erste Wandung (15) und eine zweite Wandung (16), die einander gegenüberliegend angeordnet sind und entlang eines Umfangs verbunden sind, um die innere Kammer (3, 104) zu definieren, ein erstes Geflecht (18, 103a), das die erste Wandung (15) zumindest teilweise intern auskleidet und ein zweites Geflecht (19, 103b), das die zweite Wandung (16) zumindest teilweise intern auskleidet, wobei die Bindeglieder (5) gegenüberliegende Enden (5a, 5b) aufweisen, die jeweils an dem ersten Geflecht (18, 103a) und an dem zweiten Geflecht (19, 103b) befestigt sind oder damit verbunden sind, wobei sowohl die erste Wandung (15) als auch die zweite Wandung (16) eine unabhängige Doppelschichtstruktur mit einer ersten Schicht (15a) und einer zweiten Schicht (15b) ist und wobei die zweite Schicht eine Schicht (15b) mit einer Haft- oder Klebefunktion ist, **dadurch gekennzeichnet** die erste Schicht aus TPU (15a) statt einer Stoffschicht hergestellt ist.
2. Tragbare Schutzvorrichtung (1, 100) gemäß Anspruch 1, wobei sowohl die erste Wandung als auch die zweite Wandung (15, 16) eine Folie ist, die eine größere Oberfläche aufweist als das erste Geflecht (18, 103a) und das zweite Geflecht (19, 103a), so dass ein Bereich zur perimetrischen Verbindung oder perimetrischen Befestigung der ersten Wan-

dung und der zweiten Wandung miteinander definiert wird, und wobei der perimetrische Verbindungsbereich wenigstens zwei Schichten aus TPU umfasst, oder

wobei jede der ersten Wandung (15) und der zweiten Wandung (16) eine größere Oberfläche aufweist, als das jeweilige erste Geflecht (18, 103a) und zweite Geflecht (19, 103b) und wobei Umfangskanten (20, 21) der ersten Wandung (15) und der zweiten Wandung (16), die jeweils von dem ersten Geflecht (18, 103a) und dem zweiten Geflecht (19, 103a) vorstehen und dichtend miteinander verbunden sind, um mindestens eine Doppelschicht aus TPU zu bilden.

3. Tragbare Schutzvorrichtung (1, 100) gemäß Anspruch 1 oder 2, wobei das TPU ein hochschmelzendes Material ist und bei Temperaturen im Bereich zwischen mindestens 165 °C und 185 °C, vorzugsweise bei einer Temperatur von 175 °C schmilzt und / oder wobei die TPU-Schicht eine Dicke zwischen 50 mm und 150 Mikrometer, noch bevorzugter zwischen 80 und 120 Mikrometer und noch mehr bevorzugt zwischen 95 und 105 Mikrometer aufweist und / oder eine Dicke von 100 Mikrometer aufweist.

4. Tragbare Schutzvorrichtung (1, 100) gemäß einem der vorhergehenden Ansprüche, wobei die zweite Schicht eine Schicht (15b) aus PU mit einer Schmelztemperatur oder einem Erweichungspunkt ist, die niedriger ist als eine Schmelztemperatur oder ein Erweichungspunkt der Schicht aus TPU und wobei die Schicht (15b) aus PU eine Schmelztemperatur oder einen Erweichungspunkt von nur etwa 125 °C aufweist und wobei die erste Schicht (15a) aus TPU eine Schmelztemperatur oder einen Erweichungspunkt von etwa 175 °C aufweist.

5. Tragbare Schutzvorrichtung (1, 100) gemäß einem der vorhergehenden Ansprüche, wobei die TPU-Schicht eine transparente oder halbtransparente Schicht ist.

6. Tragbare Schutzvorrichtung (1, 100) gemäß einem der vorhergehenden Ansprüche, wobei die erste Schicht und die zweite Schicht eine Folie mit einer Dicke zwischen 100 mm und 270 Mikrometer bilden, noch bevorzugter zwischen 150 und 240 Mikrometer und noch weiter bevorzugt zwischen 170 und 230 Mikrometer, zum Beispiel 200 Mikrometer.

7. Tragbare Schutzvorrichtung (1, 100) gemäß einem der vorhergehenden Ansprüche in Verbindung mit Anspruch 2, wobei mindestens zwei Schichten mit einer Klebefunktion zwischen den zwei TPU-Schichten (15, 16) im perimetrischen Verbindungsbereich oder im Bereich der perimetrischen Kanten angeordnet sind.

8. Tragbare Schutzvorrichtung (1, 100) gemäß einem der vorhergehenden Ansprüche, wobei das erste Geflecht und das zweite Geflecht gegenüberliegenden Abschnitte (103a, 103b) eines gestrickten Körpers (103) sind mit einer geschlossenen Struktur an mindestens vier Seiten oder Wandungen und / oder mit einer Form, die zumindest teilweise rohrförmig ist, um einen inneren Bereich oder eine innere Kammer (104) zu definieren, wobei der gestrickte Körper (103) eine Mehrzahl von Verbindungsfäden (105) mit der Funktion der Verbindungs-Elemente umfasst, wobei die Verbindungsfäden wenigstens teilweise den inneren Bereich einnehmen und zwei Seiten oder Wandungen (103a, 1033b) des gestrickten Körpers (3) miteinander verbinden können.
9. Tragbare Schutzvorrichtung (1, 100) gemäß Anspruch 8, bei der die Verbindungsfäden (105) die innere Kammer kreuzen und mit den Seiten des gestrickten Körpers zusammengestrickt sind und / oder bei der mindestens eine Gruppe der Verbindungsfäden (5) einen Teil eines Filaments oder eines aus mindestens zwei Fäden zusammengesetzten Filaments bilden, wobei sich der Faden oder das Filament abwechselnd kontinuierlich in den Seiten des gestrickten Körpers erstreckt.
10. Tragbare Schutzvorrichtung (1, 100) gemäß einem der Ansprüche 8 oder 9, wobei der gestrickte Körper umfasst: Mindestens eine erste gestrickte Seite oder Wandung (103a); mindestens eine zweite gestrickte Seite oder Wandung (103b) gegenüber der ersten Seite (103a); mindestens eine dritte gestrickte Seite oder Wandung (103c), die kontinuierlich mit der ersten Seite (103a) und mit der zweiten Seite (103b) zusammengestrickt ist; mindestens eine vierte gestrickte Seite oder Wandung (103d), die kontinuierlich mit der ersten Seite (103a) und der zweiten Seite (103b) zusammengestrickt ist, wobei die vierte Seite (103d) der dritten Seite (103c) gegenüberliegt und die Verbindungsfäden (105) in einem Bereich des aufblasbaren Elements benachbart zu der dritten Seite (103c) und / oder zu der vierten Seite (103d) eine kleinere Länge aufweisen, als in einem zentralen Bereich des aufblasbaren Elements, der von der dritten Seite (103c) und / oder der vierten Seite (103d) beabstandet.
11. Tragbare Schutzvorrichtung (1, 100) gemäß einem der vorhergehenden Ansprüche, wobei die Verbindungsfäden (105) aus einem Material hergestellt sind, das sich von dem der Wandungen oder Seiten des gestrickten Körpers (103) unterscheidet und / oder wobei die Wandungen oder Seiten des gestrickten Körpers (103) aus einem Material hergestellt sind, das weicher ist und / oder eine geringere Zugfestigkeit aufweist als ein Material der Verbindungsfäden (105) und / oder wobei das aufblasbare Element in einem ersten Bereich Verbindungsfäden (105) aufweist, die mit einer ersten Fadendichte verteilt sind, und in einem zweiten Bereich Verbindungsfäden (105) aufweist, die mit einer zweiten Fadendichte verteilt sind, wobei sich die erste Fadendichte von der zweiten Fadendichte unterscheidet.
12. Tragbare Schutzvorrichtung (1, 100) gemäß einem der vorhergehenden Ansprüche, wobei der gestrickte Körper (103) ein Körper ist, der an mindestens fünf Seiten oder Wandungen geschlossen ist, um einen Beutel zu definieren, der mindestens eine Zugangsöffnung für den Zugang zum inneren Bereich (104) aufweist.
13. Tragbare Schutzvorrichtung (1) gemäß einem der vorhergehenden Ansprüche, wobei der gestrickte Körper (103) ein Körper ist, der an allen Seiten geschlossen ist, um ein geschlossenes Gehäuse zu definieren.
14. Tragbare Schutzvorrichtung (1, 100) gemäß einem der vorhergehenden Ansprüche, umfassend eine weitere Schicht, die an einer Außenseite der Wandung (18, 19, 103a, 103b) angeordnet ist und eine Haltefunktion aufweist, um einem Aufblasdruck zu widerstehen.
15. Tragbare Schutzvorrichtung (1, 100) gemäß Anspruch 14, wobei die weitere Schicht eine Gitterschicht, ein Stoff, ein Gewebe, ein Gitter, ein Netz oder eine ähnliche Rückhalteschicht ist.
16. Tragbare Schutzvorrichtung (1, 100) gemäß einem der vorhergehenden Ansprüche in Kombination mit Anspruch 2, wobei das aufblasbare Element angepasst ist, um einen aufgeblasenen Zustand für mindestens 4 Sekunden, vorzugsweise mindestens 5 Sekunden beizubehalten.
17. Kleidungsstück mit einer Schutzvorrichtung (1, 100) nach einem der vorhergehenden Ansprüche.

Revendications

1. Dispositif de protection portable (1, 100) pour la protection individuelle d'un utilisateur, ledit dispositif de protection comprenant un élément gonflable (2, 102) dans lequel une chambre interne (3, 104) est définie, et une pluralité d'éléments de fixation (5) répartis dans la chambre interne (3, 104), dans lequel ledit élément gonflable (2, 102) est adapté pour assumer une condition active gonflée et une condition au repos dégonflée, et dans lequel ledit élément gonflable (2, 102) comprend une première paroi (15) et une seconde paroi (16) situées de manière opposée l'une à l'autre et reliées le long d'un périmètre de

- façon à définir ladite chambre interne (3, 104), une première maille (18, 103a) qui recouvre au moins en partie de manière interne ladite première paroi (15) et une seconde maille (19, 103b) qui recouvre au moins en partie de manière interne la seconde paroi (16), lesdits éléments de fixation (5) ayant des extrémités opposées (5a, 5b) respectivement fixées ou associées à ladite première maille (18, 103a) et à ladite seconde maille (19, 103b), dans lequel chacune desdites première paroi (15) et seconde paroi (16) est une structure double couche indépendante comprenant une première couche (15a) et une seconde couche (15b) et dans lequel ladite seconde couche est une couche (15b) avec une fonction adhésive ou collante, **caractérisé en ce que** ladite première couche est fabriquée à partir d'un TPU (15a) au lieu d'une couche de tissu.
2. Dispositif de protection portable (1, 100) selon la revendication 1, dans lequel
- chacune desdites première paroi et seconde paroi (15, 16) est une feuille ayant une aire de surface plus grande que ladite première maille (18, 103a) et ladite seconde maille (19, 103b) de façon à définir une zone pour une connexion périmétrique ou une fixation périmétrique de ladite première paroi et de ladite seconde paroi et dans lequel ladite zone de connexion périmétrique comprend au moins deux couches de TPU, ou dans lequel chacune desdites première paroi (15) et ladite seconde paroi (16) a une aire de surface plus grande que la première maille (18, 103a) et la seconde maille (19, 103b) respective et dans lequel des bords périphériques (20, 21) de ladite première paroi (15) et de ladite seconde paroi (16) faisant respectivement saillie à partir de chacune desdites première maille (18, 103a) et seconde maille (19, 103b) sont joints ensemble de manière étanche de façon à former au moins une double couche de TPU.
3. Dispositif de protection portable (1, 100) selon la revendication 1 ou 2, dans lequel ledit TPU est un matériau à point de fusion élevé et fond à des températures comprises entre au moins 165° C et 185° C, de préférence à une température de 175° C et/ou dans lequel ladite couche de TPU a une épaisseur entre 50 mm et 150 microns, de préférence entre 80 et 120 microns, et d'une manière encore plus préférée entre 95 et 105 microns, et/ou a une épaisseur de 100 microns.
4. Dispositif de protection portable (1, 100) selon l'une quelconque des revendications précédentes, dans lequel ladite seconde couche est une couche (15b) de PU ayant une température de fusion, ou point de ramollissement, inférieur à une température de fusion, ou point de ramollissement, de la couche de TPU et dans lequel la couche (15b) de PU a une température de fusion, ou point de ramollissement, aussi bas que 125° C environ et dans lequel la première couche (15a) de TPU a une température de fusion, ou point de ramollissement, d'environ 175° C.
5. Dispositif de protection portable (1, 100) selon l'une quelconque des revendications précédentes, dans lequel ladite couche de TPU est une couche transparente ou semi-transparente.
6. Dispositif de protection portable (1, 100) selon l'une quelconque des revendications précédentes, dans lequel ladite première couche et ladite seconde couche forment une feuille ayant une épaisseur comprise entre 100 et 270 microns, voire de préférence entre 150 et 240 microns et d'une manière préférée entre toutes entre 170 et 230 microns, de 200 microns par exemple.
7. Dispositif de protection portable (1, 100) selon l'une quelconque des revendications précédentes, en association avec la revendication 2, dans lequel au moins deux couches avec une fonction collante sont agencées entre les deux couches de TPU (15, 16) dans la zone de connexion périmétrique ou dans la zone des bords périmétriques.
8. Dispositif de protection portable (1, 100) selon l'une quelconque des revendications précédentes, dans lequel ladite première maille et ladite seconde maille sont des parties opposées (103a, 103b) d'un corps tricoté (103) ayant une structure fermée sur au moins quatre côtés ou parois et/ou ayant une forme qui est au moins en partie tubulaire de façon à définir une aire interne ou chambre interne (104), dans lequel le corps tricoté (103) comprend une pluralité de fils de liaison (105) ayant la fonction desdits éléments de fixation, dans lequel lesdits fils de liaison occupent au moins en partie l'aire interne et peuvent relier deux côtés ou parois (103a, 103b) du corps tricoté (3) ensemble.
9. Dispositif de protection portable (1, 100) selon la revendication 8, dans lequel les fils de liaison (105) traversent la chambre interne et sont tricotés ensemble avec les côtés du corps tricoté et/ou dans lequel au moins un groupe desdits fils de liaison (5) fait partie d'un fil ou d'un filament composé d'au moins deux fils, dans lequel le fil ou le filament s'étend de manière continue en alternance dans les côtés du corps tricoté.
10. Dispositif de protection portable (1, 100) selon l'une quelconque des revendications 8 ou 9, dans lequel le corps tricoté comprend au moins un premier côté ou paroi tricoté (103a) ; au moins un deuxième côté

ou paroi tricoté (103b), opposé au premier côté (103a) ; au moins un troisième côté ou paroi tricoté (103c) tricoté en continu conjointement avec le premier côté (103a) et le deuxième côté (103b) ; au moins un quatrième côté ou paroi tricoté (103d) tricoté en continu conjointement avec le premier côté (103a) et le deuxième côté (103b), dans lequel le quatrième côté (103d) est situé à l'opposé du troisième côté (103c) et dans lequel les fils de liaison (105) ont une longueur plus petite dans une région de l'élément gonflable adjacente au troisième côté (103c) et/ou au quatrième côté (103d) que dans une aire centrale de l'élément gonflable distante du troisième côté (103c) et/ou du quatrième côté (103d).

11. Dispositif de protection portable (1, 100) selon l'une quelconque des revendications précédentes, dans lequel les fils de liaison (105) sont réalisés à partir d'un matériau différent de celui des parois ou côtés du corps tricoté (103) et/ou dans lequel les parois ou côtés du corps tricoté (103) sont réalisées à partir d'un matériau qui est plus doux et/ou qui a une résistance à la traction inférieure qu'un matériau des fils de liaison (105) et/ou dans lequel l'élément gonflable comprend, dans une première aire, des fils de liaison (105) répartis avec une première densité de fil et, dans une seconde aire, des fils de liaison (105) répartis avec une seconde densité de fil, dans lequel la première densité de fil est différente de la seconde densité de fil.
12. Dispositif de protection portable (1, 100) selon l'une quelconque des revendications précédentes, dans lequel le corps tricoté (103) est un corps fermé sur au moins cinq côtés ou parois de façon à définir un sac comprenant au moins une ouverture d'accès pour accéder à ladite aire interne (104).
13. Dispositif de protection portable (1) selon l'une quelconque des revendications précédentes, dans lequel le corps tricoté (103) est un corps fermé sur tous les côtés de façon à définir une enveloppe fermée.
14. Dispositif de protection portable (1, 100) selon l'une quelconque des revendications précédentes, comprenant une couche supplémentaire placée sur un côté externe de la paroi (18, 19, 103a, 103b) et ayant une fonction de retenue de façon à résister à une pression de gonflement.
15. Dispositif de protection portable (1, 100) selon la revendication 14, dans lequel ladite couche supplémentaire est une feuille de maille, un tissu, une toile, un treillis, un filet ou similaire.
16. Dispositif de protection portable (1, 100) selon l'une quelconque des revendications précédentes, en as-

sociation avec la revendication 2, dans lequel ledit élément gonflable est adapté pour maintenir une condition gonflée au moins pendant 4 secondes, de préférence au moins pendant 5 secondes.

17. Vêtement comprenant un dispositif de protection (1, 100) selon l'une quelconque des revendications précédentes.

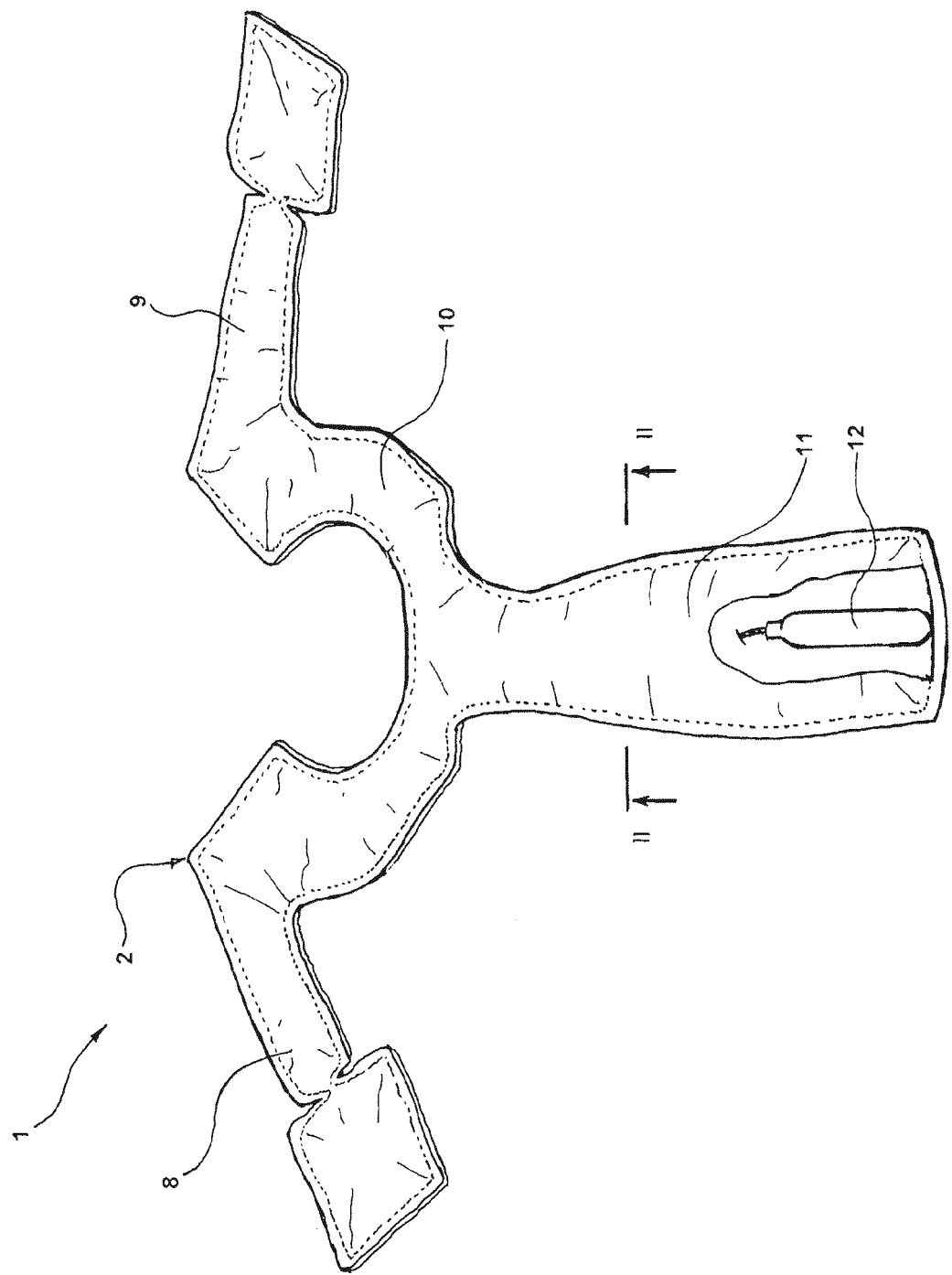


FIG.1

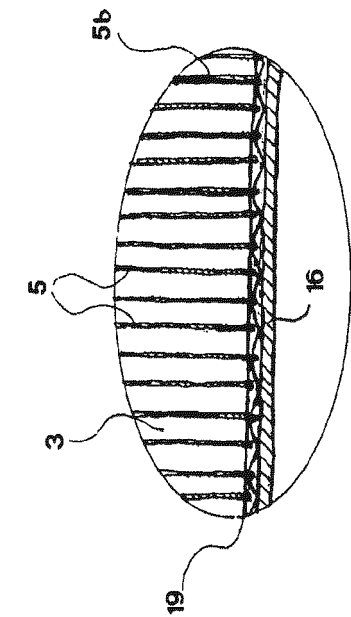
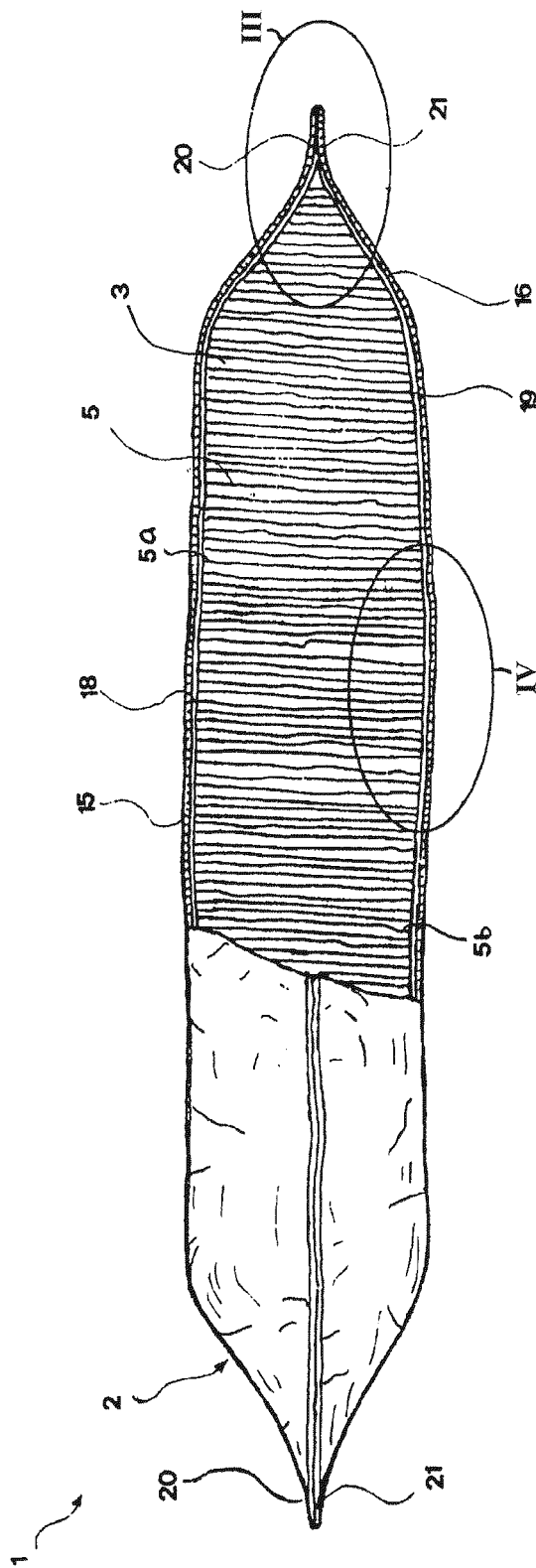


FIG. 2

FIG. 4

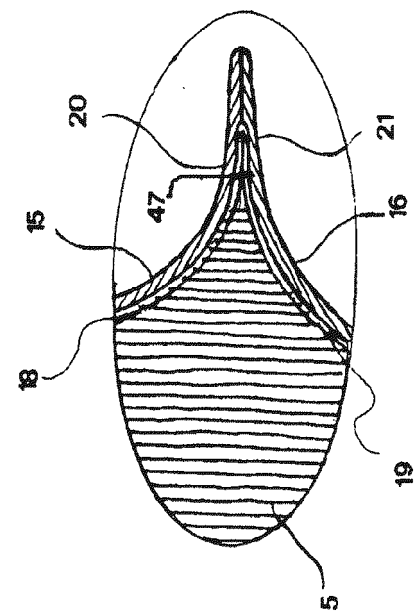


FIG. 3

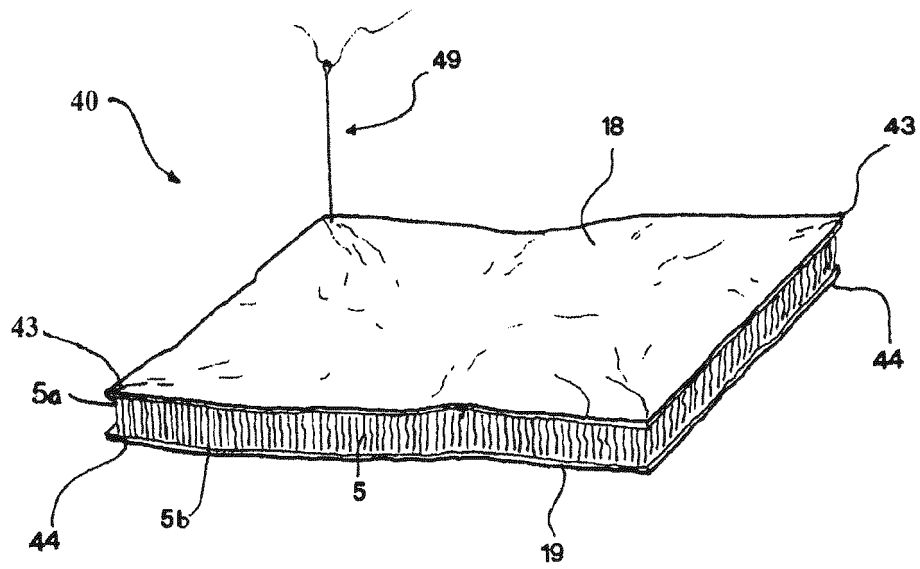


FIG. 5

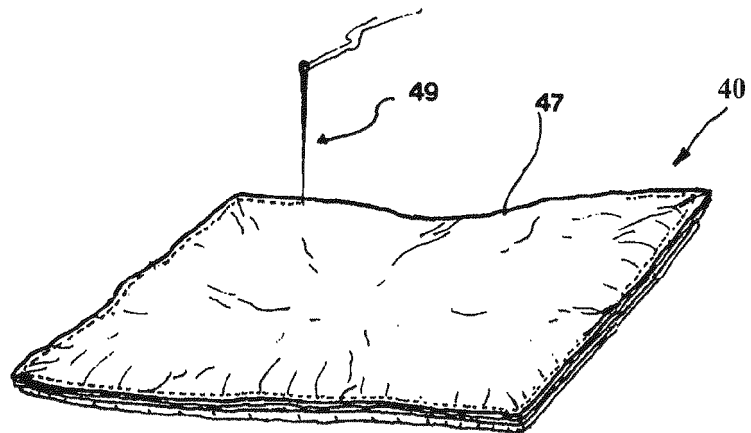


FIG. 6

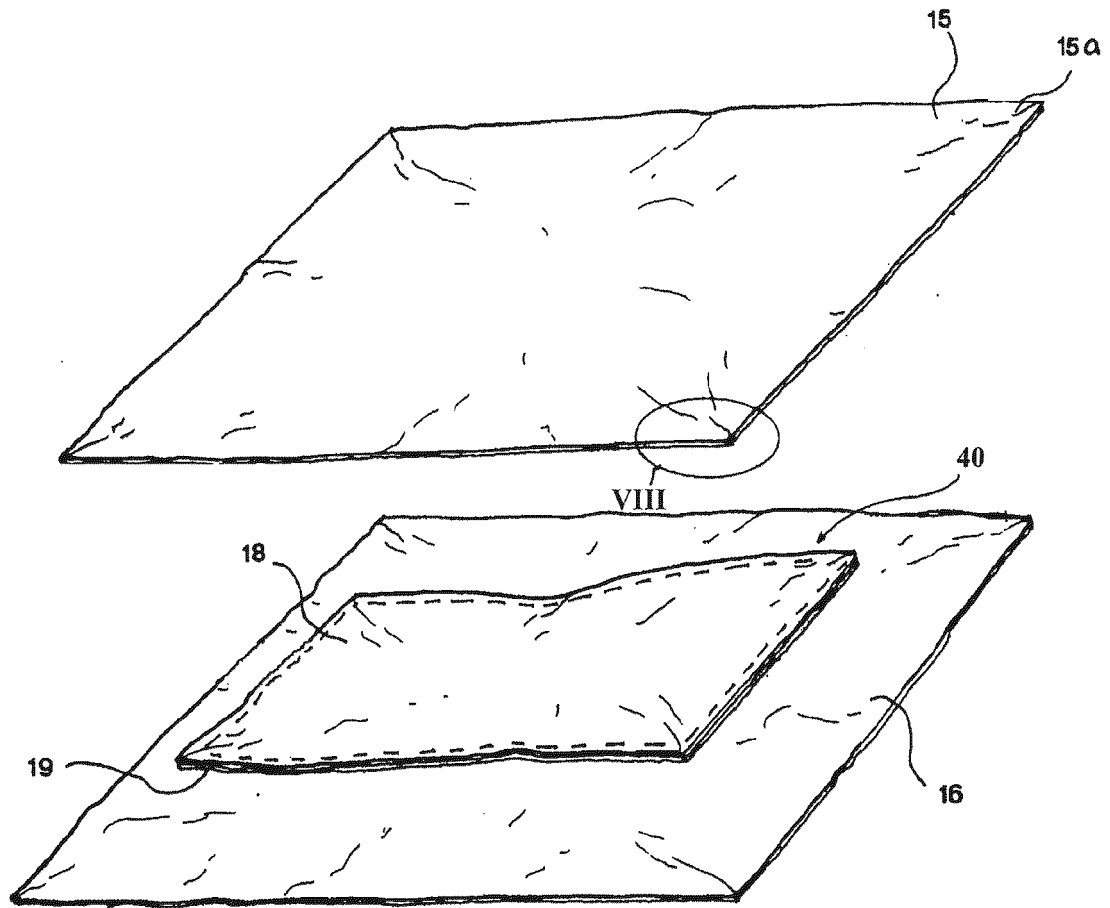


FIG. 7

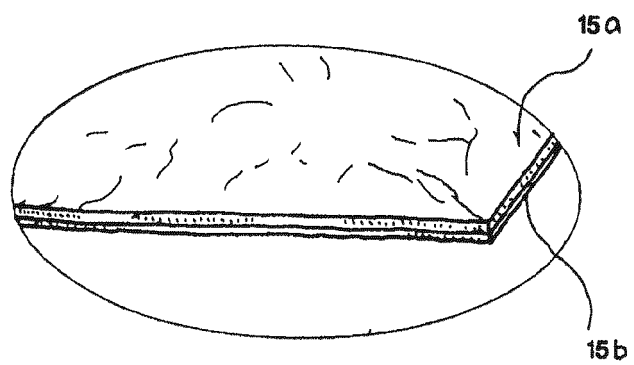


FIG. 8

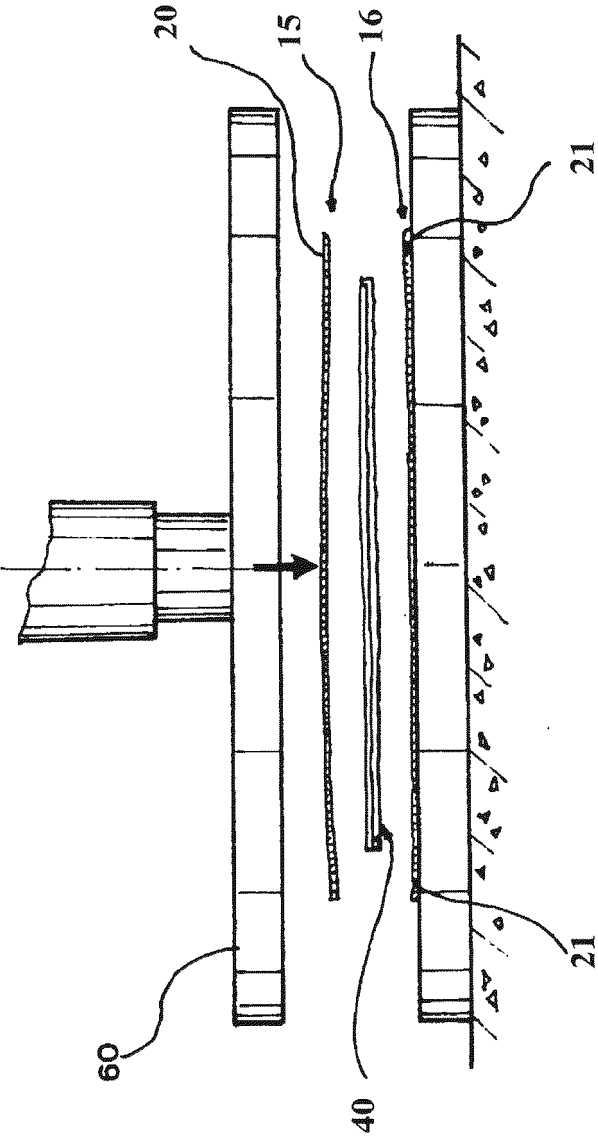


FIG. 9

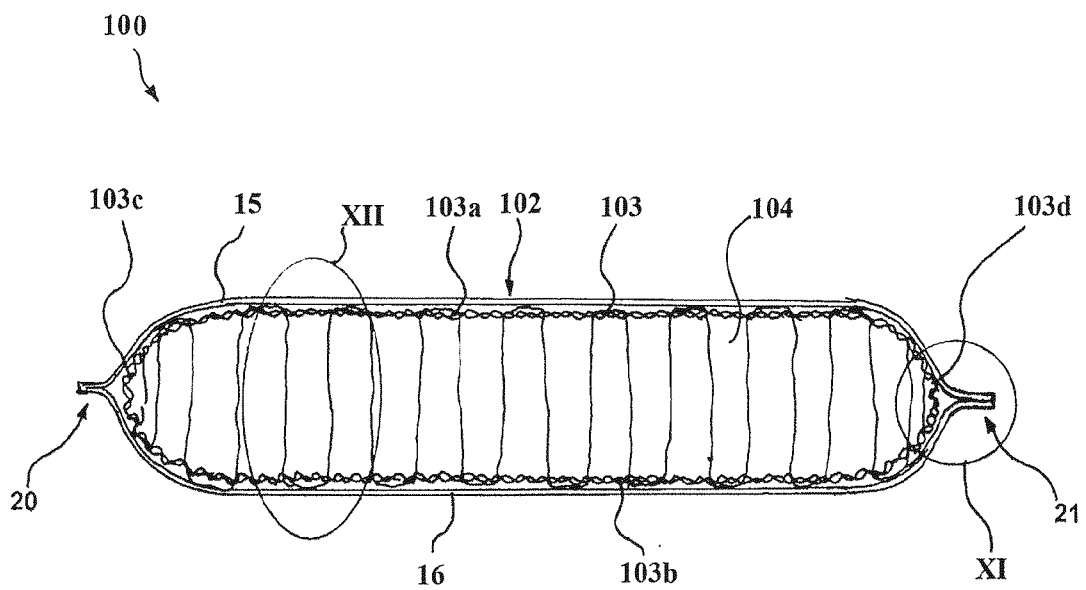


FIG. 10

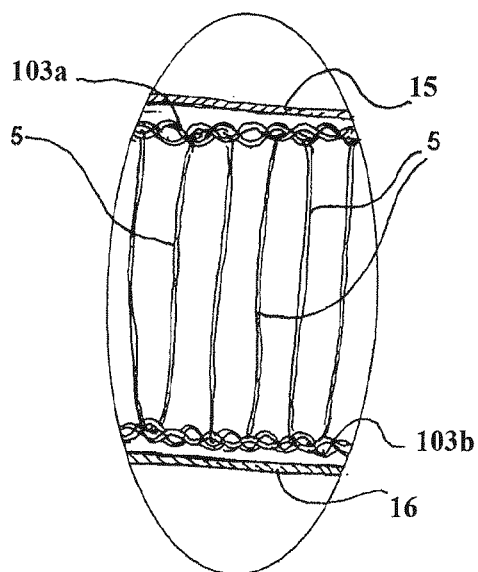


FIG. 12

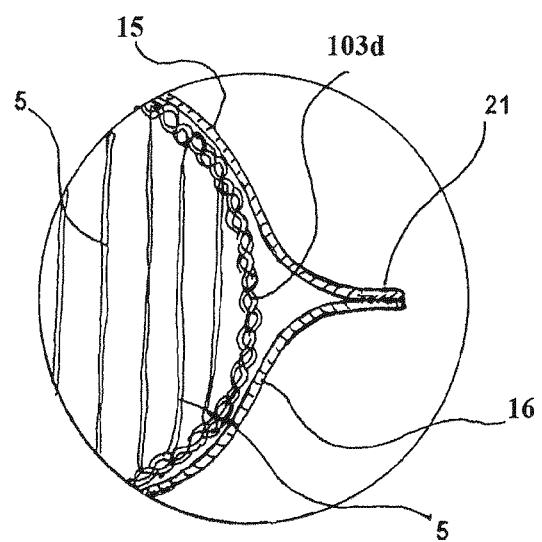


FIG. 11

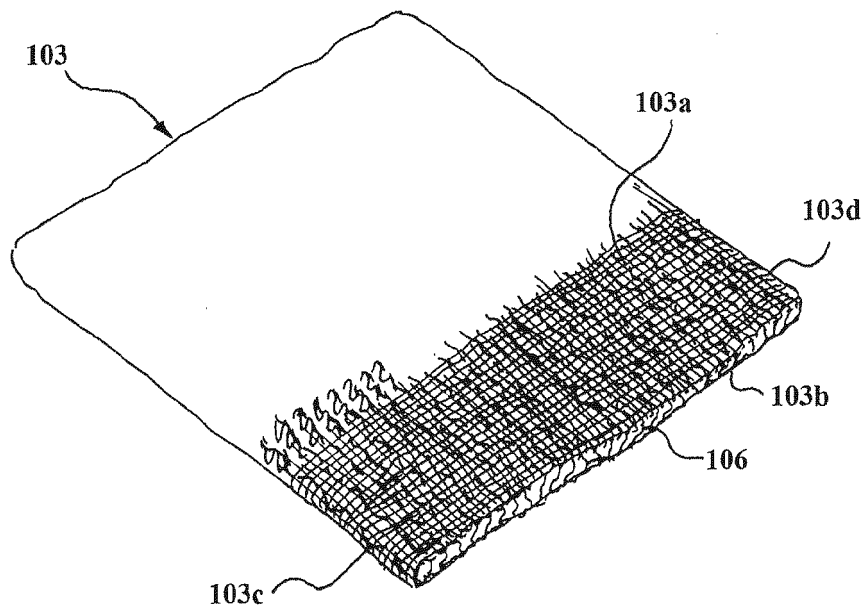


FIG. 13

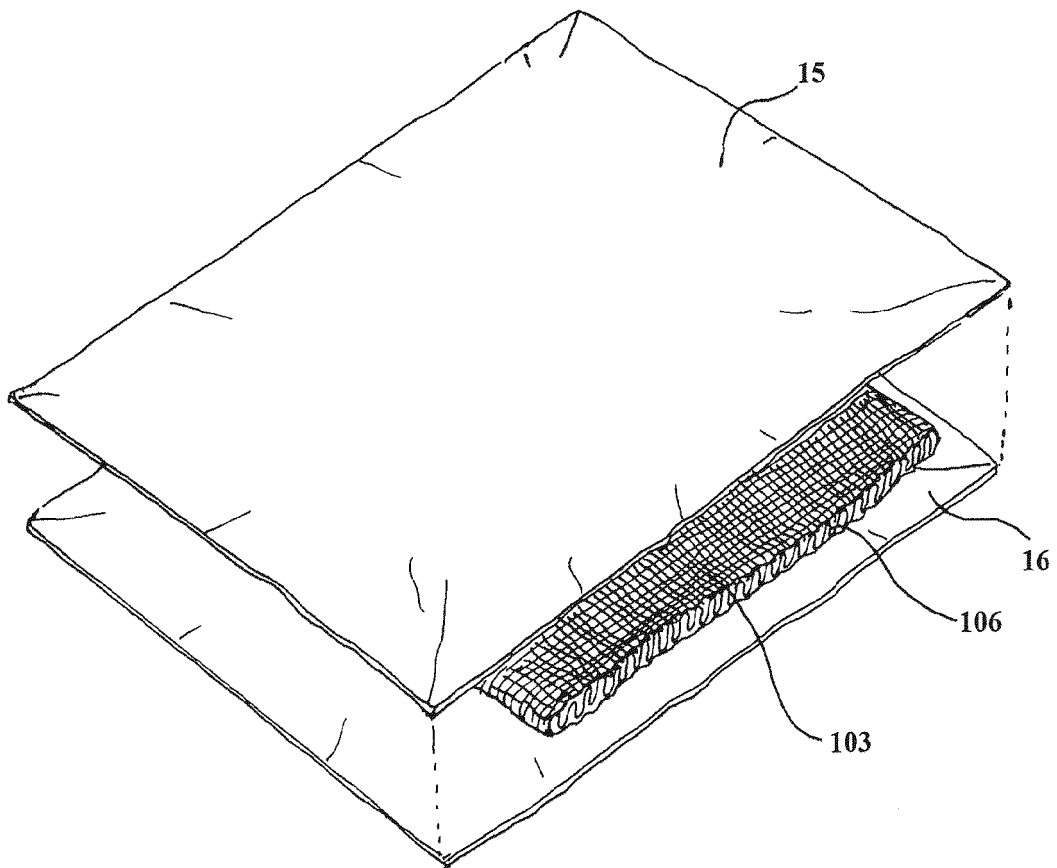


FIG. 14

REFERENCES CITED IN THE DESCRIPTION

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- IT TO20130472 A [0116]