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(71) Applicant: **Dainese S.p.A.**
36064 Colceresa (Vicenza) (IT)

(72) Inventor: **AZZOLIN, Mr. Andrea**
36064 Colceresa (Vicenza) (IT)

(74) Representative: **Manfrin, Marta et al**
Società Italiana Brevetti S.p.A.
Stradone San Fermo 21 sc. B
37121 Verona (VR) (IT)

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(54) **PROTECTION DEVICE AND PROCESS FOR MANUFACTURING SUCH PROTECTION DEVICE**

(57) A protective device for protection (1) of a user, a process for manufacture thereof and use of a knitting machine for manufacturing such a protective device. In particular the protective device includes an inflatable element (2) able to assume an active inflated condition and a deflated rest condition. The inflatable element (2) includes a knitted body with closed structure on at least

four sides or walls and having an at least partially tubular form and defining an inner zone or inner chamber (4). The knitted body also includes a second filament (50) which forms a plurality of joining threads (5) which cross the inner chamber and are knotted to two faces (3a, 3b) of the knitted body (3).

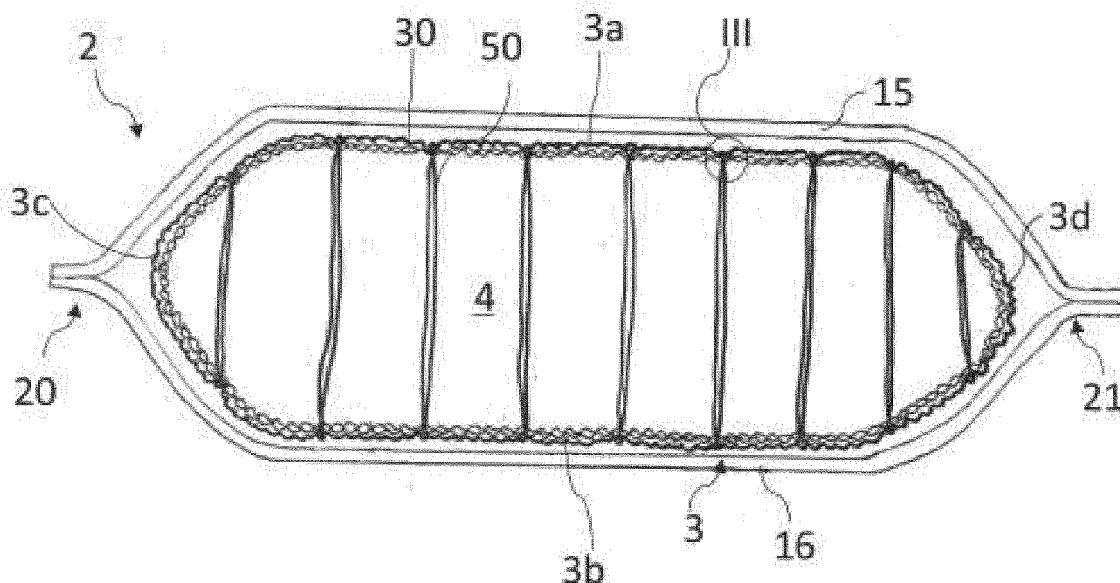


Fig. 2

Description

[0001] The present disclosure relates to a protective device for protection of a user. The protective device includes an inflatable element which, in the inflated condition, is designed to protect from impacts and/or falls a motorcycle rider or passenger or similar user during a sporting and/or working and/or any other activity.

[0002] A known protective device is, for example, the device disclosed in European Patent EP3291697B1. Such a device includes an inflatable element designed to assume an active inflated condition and a deflated rest condition. The inflatable element includes a knitted body, namely a body made by means of knitting process. Said knitted body is a closed structure or at least tubular structure defining an inner region or area or chamber. This inner chamber is occupied at least partially by a plurality of joining threads which connect together opposite portions of the knitted body. The fact of providing a single knitted body has the advantage of limiting the manufacturing waste and minimizing the production time; in fact, the joining threads and meshes may be processed using a single knitting machine. The joining threads form part of a single thread connected to the opposite portions of the knitted body. In particular, the thread passes along alternate sections or continuously between a first portion and a second portion of the knitted body.

[0003] Preferably, the inflatable element includes sealing walls which allow the inflation fluid to be contained for a given period of time. The walls consist, for example, of a first sheet, or first wall, and of a second sheet, or second wall, which are fixed together along respective perimetral edges which cover and line the knitted body respectively on an outer side or outer surface.

[0004] The present disclosure is based on the realization that in a protective device, when the inflatable element is in the inflated condition, a knitted body with joining threads has an "elastic" behavior, namely has a certain yielding capacity, which avoids having to predict beforehand a behavior of the knitted body when inflated. For this purpose it is necessary to use covering walls which are more rigid or have a predefined consistency in order to counteract the behavior of the knitted body.

[0005] Moreover, in connection with the known protective device, it has been found that, on occasions, in the active inflated condition, cuts or tears may occur on the knitted body itself, or in the first sheet or wall, and/or in the second sheet or wall. In order to overcome this drawback one possible solution is to increase the thickness or the cutting resistance of the first sheet or wall and of the second sheet or wall. However this involves, disadvantageously, a greater weight, volume and rigidity of the inflatable element also in the deflated condition which may not be compatible with wearability and fit of the device, as well as certain activities, for example dynamic sports activities such as skiing or horse-riding.

[0006] One technical problem forming the basis of the present disclosure is that of providing a protective device

for protection of a user able to overcome said drawback(s) or reduce the risk of tearing of the walls, without increasing the weight or rigidity of the inflatable element, and/or of achieving further advantages, and of providing a garment including said personal protection device.

[0007] This problem is solved by a protective device for protection of a user, by a production process for manufacturing a protective device and by a use according to the respective independent claims.

[0008] Secondary characteristics forming the subject of the present disclosure are defined in the respective dependent claims.

[0009] A protective device according to the present disclosure for protection of a user comprises an inflatable element, able to assume an active inflated condition and a deflated rest condition. The inflatable element includes a knitted body, made with at least a first thread or first filament so as to form a plurality of knit units, wherein the knitted structure is closed on at least four faces, namely has an at least partially tubular form, so as to define an inner zone or inner chamber. The knitted body comprises a second thread or second filament which extends several times into the inner area or inner chamber between at least a first face and a second face of the knitted body so as to form a plurality of second thread or second filament portions. The second thread or second filament portions are also called joining threads.

[0010] According to a characteristic aspect of the present disclosure, the second thread or second filament is interwoven to form a knot with at least one knit unit of the first face and is interwoven to form a knot with at least one knit unit of the second face in a corresponding area for connecting or point for joining together the second thread or second filament and the knit unit.

[0011] In other words, each second thread or second filament portion is not only interwoven or tied, but also knotted to the knit unit to which it is connected, or vice versa each knit unit connected to the second thread or second filament portion forms a knot with said second thread or second filament portion. It therefore consists not only of a knitted weave, but also of a weave made so as to create, in particular upon inflation, a knot which tightens the one or more knit units and second thread portions.

[0012] In fact, the knot is such that in the active inflated condition of the inflatable element the knot is tightened and prevents the relative movement of the second thread or second filament and the one or more knit units in the connecting area or joining point, or the second thread or second filament causes tightening with one or more knit units, or vice versa, in the connecting area or joining point.

[0013] Preferably, the knot is such that in the deflated rest condition of the inflatable element, the knot is loose and is able to allow a relative movement of the second thread or second filament and the knit unit.

[0014] Consequently, as a result of the knot, the second thread or filament is no longer free to slide with respect to the knit units in the inflated condition. It is possible

to have during inflation a greater control of the behavior, and therefore of the shape of the knitted body in the inflated condition.

[0015] In other words, sliding of the second thread or filament along the face of the knitted body is avoided. The second thread or filament may not slide along the outer surface of the knitted body. A movement of this type of thread or filament could cause in fact rubbing together of the first thread and second thread of the said knitted body, or friction or rubbing of the second thread or the first thread on the outer wall, if present, namely on the outer covering which covers the knitted body.

[0016] In particular, preferably in the case where the knitted body is covered by two walls or by two sheets, when the inflatable element is in the active inflated condition, the meshes of the knitted body and respective sheet or wall adhere tightly together. In this condition, since the second thread or filament does not slide or tend to slide along the outer surface of the knitted body, rubbing or friction on the sheet or wall which as a result may be weakened - for example being torn or directly cut - is avoided.

[0017] Similarly, according to a process to make the device according to the present disclosure the following manufacturing steps are performed:

knitting at least one first thread or first filament to obtain a knitted body having a closed structure on at least four faces or walls and having an at least partially tubular form, so as to define an inner area or inner chamber;
and wherein said step of knitting said first thread or first filament comprises:

forming with said first thread or first filament a plurality of knit units on at least a first face and a second face of the knitted body, and

knitting at least a second thread or second filament so that the second thread or second filament extends several times into the inner area or inner chamber between the first face and the second face of the knitted body so as to define a plurality of second thread or second filament portions or a plurality of joining threads which cross the inner chamber. The step of knitting the second thread or second filament comprises:

weaving said second thread or second filament together with at least one knit unit of the face first and at least one knit unit of the second face and

forming a knot with said knit units in a respective contact area or joining point. The knot tightens the second thread and the respective knit unit at least when the second thread is tensioned.

[0018] With different words, it is envisaged to weave the second thread or second filament with one or more knit units of the first face and with one or more knit units of the second face and to form a knot with a portion of said second thread and said one or more knit unit of the first face in a respective contact area or joining point, and a knot between another portion of said second thread and one or more knit units of the second face in a respective contact area or joining point.

[0019] According to a preferred aspect of the aforementioned device and/or process, the second thread or second filament extends alternately and/or is arranged in a zig-zag and/or with a sinusoidal progression between at least one knit unit of a first face and one knit unit of said second face of the knitted body so as to form a second thread or joining thread portion between the knit unit of the first face and the knit unit of said second face of the knitted body. The knot is formed on both the knit units, namely the joining thread portion may be fixed to the knitted body at both the ends where it is knitted and interwoven with the faces of the knitted body. As a result, in the inflated condition of the inflatable element, each joining thread portion, is fixed locally and it acts as a tie member, and may have overall a very rigid and fixed structure in the inflated condition.

[0020] The knot is preferably such that tightening occurs gradually as the inflatable element is inflated. Therefore, an intermediate inflated condition, between an inflated condition and a maximum inflated condition, corresponds to or is associated with an intermediate tightened condition of the knot.

[0021] Even more preferably, the knot is a slipknot, this being understood as meaning a knot which gradually tightens as the second thread is tensioned. Even more particularly, in order to form the knot, it must be considered that each knit unit is an eyelet or loop of the first face or opposite second face of the knitted body, and the second thread or second filament is inserted in each of said eyelets. When the bag is in the inflated condition, the second thread, passing through each eyelet, tightens the eyelets together, or vice versa. Each eyelet is tightened around the portion of the second thread in the joining zone.

[0022] According to an even more preferred aspect of the aforementioned device and/or process, the second thread or second filament forms said knot with three knit units in the respective connecting area or joining point. In other words, in order to ensure a greater tightening stability, the second thread fixes together three knit units.

[0023] Even more particularly and preferably, considering that each face of the knitted body comprises a plurality of knitted rows and said knit units are formed in an orderly manner along said knitted rows, of the aforementioned three knit units, a first knit unit and a third knit unit are arranged side-by-side or adjacent to each other and are part of a first knitted row and a second knit unit is part of a second knitted row, preferably adjacent to the first row, so as to form three areas for connecting or points

for joining the second thread or second filament to the respective knit units.

[0024] Even more preferably, in order to ensure more uniform tightening on the knitted body, the second knit unit is arranged in an intermediate zone or position along the respective second knitted row with respect to the first knit unit and the third knit unit.

[0025] Even more preferably, the second thread or second filament is inserted inside said first knit unit and said second knit unit so as to form an eyelet or loop which engages said first knit unit and second knit unit, and wherein the second thread or second filament is inserted twice into the third knit unit. This knot structure may be more easily made using a knitting machine.

[0026] More particularly, preferably, the process according to the present disclosure involves knitting said first thread or first filament so as to form a plurality of knitted rows and providing a first eyelet or loop so as to form a first knit unit and providing a third eyelet or loop so as to form a third knit unit, these being arranged side-by-side along a first knitted row, and providing a second eyelet or loop so as to form a second knit unit along a second knitted row in an intermediate zone or position with respect to said first knit unit and said third knit unit. The second knitted row is preferably adjacent to the first knitted row.

[0027] Similarly to the knitted body of EP3291697B1 mentioned above, the knitted body may also be a body which is closed on five sides and comprises at least a third face, continuously knitted together with the first face and with the second face, at least one fourth face continuously knitted together with the first face and the second face, the fourth face being situated opposite the third face, a fifth face connected continuously with the remaining faces, and optionally also a sixth face which encloses the knitted body. Moreover, as in the preceding patent EP3291697B1, the joining thread portions have a smaller length in a region of the knitted body adjacent to the third face and/or to the fourth face than in a central zone of the knitted body remote from the third face and/or the fourth face, so as to control further the shape of the inflatable element in the inflated condition.

[0028] Basically, according to a preferred aspect of the present disclosure, the process involves processing the second thread so as to adjust the length of the joining threads depending on the region of the inflatable element. Even more preferably, the knitted body is covered by a first wall and a second wall, or by a single cover. The cover or the walls may be those described in the embodiments of the international patent applications WO 2010-067288 A1, WO20171323196A1 or in the European patent application EP3167730A1.

[0029] According to a further aspect of the present disclosure, the first thread or first filament and the second thread or second filament are knitted by means of a same knitting machine, and therefore also the knot is made during the knitting operation.

[0030] Even more preferably, the knitting machine is a

rectilinear knitting machine.

[0031] The knitting operation and knitted body referred to in the present disclosure are to be understood as being those described in the aforementioned European patent EP3291697B1 with the exception of the knot here disclosed.

[0032] It should be pointed out that the knitted body may also be made from several threads, namely the aforementioned first thread and a third thread and the knit units may be made from these one or more threads. The knots may therefore be made using any of the threads which form the knitted body and the threads (aforementioned second thread) which form the joining threads.

[0033] Other advantages, characteristic features and modes of use of the subject of the present disclosure will emerge more clearly from the following detailed description of a number of preferred embodiments thereof, provided by way of a non-limiting example. It is nevertheless evident that each embodiment may have one or more of the advantages listed above; in any case it is nevertheless not necessary that each embodiment should have simultaneously all the advantages listed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] Reference will now be made to the figures in the attached drawings in which:

Figure 1 shows a top plan view of a protective device resting on a surface and made according to the present disclosure;

Figure 2 shows a cross-sectional view along the line II-II of Figure 1;

Figure 3 shows a detail III of Figure 2 in the loose condition;

Figure 4 shows the detail III of Figure 3 in the tensioned condition;

Figure 5 shows a top plan view of a knitted body according to the present disclosure;

Figure 6 shows a view of a step for manufacture of a protective device according to the present disclosure, in which a knitted body is associated with a cover.

Figure 7 shows a garment including a protective device according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0035] With reference to the attached figures, the reference number 1 indicates a protective device according

to the present disclosure in accordance with a specific example of embodiment.

[0036] In particular, the protective device 1 comprises an inflatable element 2 which is able 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. In particular, the protective device comprises optionally inflation means, a control unit and one or more impact sensors.

[0037] The protective device 1 comprises a knitted body 3 having, in the example, a closed structure, namely a body which is formed substantially in the manner of a casing, namely a three-dimensional structure at least with a tubular form and preferably mainly closed on five sides or on all the sides and defining an inner zone or chamber 4.

[0038] In the embodiment shown the knitted body 3 is a substantially bag-like body which has a single opening 6 allowing access to an inner zone 4.

[0039] The knitted body 3 therefore includes, when extended on a surface and flattened in this extended position, two opposite portions/faces or walls 3a, 3b and at least three side portions/faces 3c, 3d, only two of which can be seen in Figure 2 and which extend continuously between the two opposite portions 3a, 3b.

[0040] In the example shown in the drawings, the inflatable element 2 has a form with two side wings 8, 9 for covering the shoulders of a user, a central portion 10 shaped substantially in the form of a "C" and a spinal portion 11 intended to protect the backbone of the user. The knitted body 3 has a shape which reproduces and follows the shape of the inflatable element 2 and is formed as a single body according to said shape so as to define a single inner zone 4.

[0041] Figure 5 and Figure 6 show the knitted body 3 schematically as having a substantially rectangular form in order to illustrate how it is lined and covered by means of a cover. It is to be understood, as mentioned, that the knitted body 3 may have or offer a shape corresponding to that of the inflatable element 2 to be obtained. The knitted body 3 is included between two covering walls 15, 16. Alternatively, the knitted body 3 may be without a cover, if it is able to keep the fluid in the inflated condition, or if the threads are impregnated with a sealing material.

[0042] In the embodiment shown, the spinal portion 11 may have said access opening 6 for allowing a pressurized-gas generator 12 to be positioned inside the inner zone 4. In practice, the pressurized gas is introduced via the spinal portion 11.

[0043] In fact the knitted body 3 and the covering walls 15, 16 may be made based on the information and the processing technology described in the European patent EP3291697B1 in the name of the same Applicant and which may be referred to for the technical information in common with that of the present disclosure.

[0044] The knitted body 3 includes a closed mesh

structure on at least four sides or faces and has an at least partially tubular form so as to define an inner zone or inner chamber 4. As mentioned in the specific embodiment, the knitted body 3 has five or six faces. The mesh structure is formed by means of at least a first thread or first filament 30 and defines a plurality of knit units 32.

[0045] The knitted body 3 comprises a second thread or second filament 50 which extends several times into the inner area or inner chamber 4 between said first face 3a and said second face 3b of the knitted body 3 so as to form a plurality of second thread portions 50 or so-called joining threads. Even more particularly, the second thread or the second filament 50 extends alternately and/or is arranged in zig-zag fashion and/or with a sinusoidal progression between at least one knit unit 32 of the first face 3a and at least one knit unit 32 of the second face 3b of the knitted body 3, so as to form said second thread or joining thread portions.

[0046] The second thread portions 50 or so-called joining threads have the function of tie members and are subject to tension when the inflatable element is inflated.

[0047] According to one aspect of the present disclosure, the second thread or second filament 50 is interwoven with at least one knit unit 32 of the first face 3a and at least one knit unit 32 of the second face 3b in order to form respective knots 35 in a corresponding connecting area or joining point.

[0048] In other words, the second thread or second filament 50 tightens by means of the knot 35 one or more knit units 32 of the knitted body, or vice versa. The knot 35 is formed with the mesh 32 and the thread 50 on each face, namely at the ends of the single joining threads or tie members.

[0049] In the active inflated condition of the inflatable element 2 the knot 35 is tightened and prevents the relative movement of said second thread or second filament 50 and said one or more knit units 32 in the connecting area or joining point, or said second thread or second filament 50 causes tightening with one or more knit units 32 in the connecting area or joining point. Even more particularly, in the deflated rest condition of the inflatable element 2, the knot 35 is loose and is able to allow a relative movement of the second yarn or second filament 50 and the knit unit 32.

[0050] The knot 35 may be a slipknot, namely it is a knot which has the characteristic feature of tightening in response to tensioning of the joining thread. The knot tightens increasingly the second thread together with one or more knit units as the inflatable element is inflated. Preferably, the knot is formed by the same knit unit and by the same second thread. In fact, the knit unit is a loop which gradually tightens as the second thread is tensioned and fixes the latter.

[0051] Preferably, in order to provide stability, the second thread or second filament 50 forms said knot 35 with three knit units 32 in the respective connecting area or joining point, namely each knit unit 32 of the three knit units is an eyelet or a loop in the first face 3a or the second

face 3b of the knitted body 3, and said second thread or second filament 50 is inserted inside each said eyelet.

[0052] Even more particularly, as can be seen in Figures 3 and 4, the first face 3a for example of the knitted body 3 comprises a plurality of knitted rows, of which a first knitted row 31a and a second knitted row 31b, adjacent to each other. Said knit units 32 are formed along said knitted rows 31a, 31b. Even more particularly, of the said three knit units 32, a first knit unit 321 and a third knit unit 323 are arranged side-by-side and are part of the first knitted row 31a and a second knit unit 322 is part of the second knitted row 31b, so as to form three areas for connecting or points for joining the second thread or second filament 50 to the respective knit unit 321, 322, 323.

[0053] In order to ensure tightening, the second knit unit 322 is arranged in an intermediate zone or position along the respective second knitted row 31b with respect to the first knit unit 321 and the third knit unit 323. In this way, the second thread or second filament 50 is inserted inside the first knit unit 321 and inside the third knit unit 323 so as to form an eyelet or loop 52 which engages said first knit unit 321 and said third knit unit 323, as well as with the end portions of said eyelet or loop 52 in the second knit unit 322. The second thread or second filament 50 is then inserted twice, or with two portions, inside said second knit unit 322. The two portions indicated above consist or are the aforementioned joining threads or tie members.

[0054] As a result, in said active inflated condition of the inflatable element 2, the first knit unit 321, the second knit unit 322 and the third knit unit 323 are all closed, namely the respective eyelets become smaller and stably tighten the second thread or second filament 50 and in fact create the knot 35.

[0055] According to a further aspect of the present disclosure, a knitting machine is used to work the second thread or second filament 50 together with said first thread or first filament 30 and so that the knot is also formed at the moment of knitting.

[0056] In this case, the knitting machine is suitably programmed to guide the second thread 50 so as to create the aforementioned knot with the knit units 32.

[0057] A process for manufacturing a protective device 1 for protection of a user according to the present disclosure comprises the steps of:

knitting at least one first thread or first filament 30 to obtain a knitted body 3 having a closed structure on at least four faces or walls and having an at least partially tubular form, so as to form a plurality of knit units 32;

knitting together with the first thread 50 also a second thread or second filament 50 so that the second thread or second filament 50 extends several times into the inner zone or inner chamber 4 between two faces of the knitted body 3 so as to define a plurality

of joining threads 5 which cross the inner chamber 4; and wherein said step of knitting said second thread or second filament 50 involves interweaving said second thread or second filament 50 with at least one knit unit 32 of one face and at least one knit unit 32 of another face so as to form a respective knot 35 with said knit units 32 in a respective contact area or joining point.

[0058] It is to be understood that the second thread or second filament 50 is gradually knitted together with the first filament as the knitted body is made. Therefore the knots 35 are gradually formed as the knitted body is being made and is not yet complete.

[0059] The knitting operation is performed in such a way that preferably the knot 35 is loose when machining is performed, namely during the construction of the knitted body with the second thread.

[0060] The knot is made so as to tighten the joining threads in the inflated condition. The knot is in fact formed by the specific interweaving of the first thread or first filament 30 and the second thread or second filament 50 and is such that, when the inflatable element 2 is made to assume the inflated condition, the meshes are tightened with the second thread 50 and the latter is tensioned so as to cause simultaneous tightening. The eyelets of the meshes are tightened and the thread 50 is tensioned.

[0061] In order to perform this operation it is possible to use a rectilinear knitting machine as described in European Patent EP3291697B1.

[0062] A knitting machine of the known type is a glove-making machine such as that identified by the code SWG0991N of Shima Seiki, or the rectilinear knitting machine SIR 122 SV F14.

[0063] The machine may be programmed to create knot joining points with the first thread 30 and the second thread 50. It is to be understood that a person skilled in the art of using rectilinear knitting machines may be able to program the machine in an optimum manner for obtaining the desired result.

[0064] In particular, the rectilinear knitting machine may also be programmed to vary the mesh opening so as to control the mesh tightening step as the second thread portions 50 are gradually tightened.

[0065] As in the above patent EP3291697B1, the knitted body may also be lined with and covered by a cover.

[0066] The cover may include two walls 15, 16 or sheets made from a sheet of soft gas-tight material, for example polyamide or polyurethane, which are arranged opposite each other and fixed perimetally along respective perimetral edges 20, 21.

[0067] The walls 15, 16 may be like those described in the aforementioned international patent application and may be made of a laminate which is normally used as a lining for clothing and comprising a layer of fabric, in the example 100% nylon which constitutes about 65% by weight of the laminate, and a layer of glue, in the example a film of glue which constitutes about 35% by

weight of the laminate, for example polyurethane glue, distributed over the fabric layer, by means of roller coating.

[0068] The knitted body 3 is stably fixed to the surface of the respective wall 15, 16 by means of a film of glue, not visible in the figures. In the case where the aforementioned laminate material is used, the film of glue is arranged in contact with the layer of glue of the laminate material.

[0069] The protective device described above is made in the manner described below in accordance with an embodiment.

[0070] The knitted body 3 is arranged in an extended condition so that the two opposite portions 3a, 3b are arranged collapsed on top of each other. The knitted body 3 is in this configuration arranged between two walls 15, 16 and fixed so as to adhere to a respective wall 15, 16, for example by means of glue.

[0071] Then respective, opposite, perimetral edges 20, 21 of the walls 15 and 16 are superimposed on each other along the perimeter.

[0072] From the above description, it can be understood that the two walls 15 and 16 are essentially two elements or sheets of the inflatable element 2 arranged opposite each other and fixed along the respective perimetral edges 20 and 21. It is possible in any case for the two walls 15 and 16 to be opposite portions of a single sheet with a book-like fold and therefore having peripheral edges extending along a portion of the perimeter and closed by means of sealing tape.

[0073] Owing to the presence of the knots, it has been noted that both the knitted body and the walls 15 and 16 are not subject to tearing or cutting.

[0074] In order to perform inflation of the inflatable element 2, in the event of a sudden fall and/or sliding and/or impact affecting a user or a vehicle ridden by said user, the protective device 1 according to the present invention is able to cooperate with special activation means operationally connected to inflation means. In this respect the figures show, only by way example, a canister 12 of compressed cold gas. The canister 12 is connected by means of a pipe or tube to a shut-off valve which is fixed to the inflatable element 2 and which allows the introduction of an inflation fluid into the inflatable element 2.

[0075] The canister 12 may also be incorporated, as indicated above, inside the inflatable element 2.

[0076] Alternatively, these inflation means may comprise pyrotechnic or hybrid or other types of gas generators which are known in the present state of the art.

[0077] Said inflation means are operated by a control unit depending on detection of the state of the vehicle/rider system; for example said control unit may implement a fall prediction system which allows advance identification of the fall event and reliable prediction thereof by means of accelerometric sensors which are fixed to the vehicle or rider and a unit for processing the signals which produced by the said sensors.

[0078] Alternatively, the device according to the

present disclosure is also used with an activation cable which is connected to a vehicle ridden by a user where the cable activates inflation of the inflatable element 2 following movement of the user away from the vehicle, for example following a fall or sudden impact.

[0079] In any case the aforementioned activation means and inflation means, as well as the impact sensors, may be incorporated in the protective device 1 according to the present invention or located on the outside thereof.

[0080] It should also be noted that the activation methods, while being a particularly important for efficient operation of the device, will not be further described in greater detail, said methods being essentially already known to the person skilled in the sector relating to the protection of persons from sudden impacts.

[0081] The knitted body 3 may also include electric wires, which may be knitted together with the knitted body, for the connection of internal/external sensors and/or management electronics or valves or other electrical devices.

[0082] It is also pointed out that the protective device may be included in a garment 100 (Figure 7) or may form an integral part of a garment. In fact, it is quite possible, owing to the programming potential of a rectilinear knitting machine, to produce in a single production step a knitted body together with an article of clothing, i.e. such that the knitted body is incorporated integrally with the article of clothing or even constitutes the article of clothing itself. 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 ensure a suitable fluid-tightness in relation to the inflation gas.

[0083] In order to make the knitted body impermeable or at least temporarily fluid-tight, it may be envisaged providing a localized cover for the knitted body or providing a denser mesh on the knitted body.

[0084] Two covering layers may be provided on opposite sides of the knitted body, and these covering layers may be joined together by means of special openings provided around the knitted body.

[0085] It is also possible to envisage, in the case of particular applications, the possibility of keeping the protective device always in an inflated state, without the need for actual activation.

[0086] 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. Protective device (1) for the protection of a user, said protective device comprising an inflatable element (2), able to assume at least an active inflated condi-

tion, and wherein said inflatable element (2) includes a knitted body (3) made with at least a first thread or first filament (30) so as to form a plurality of knit units (32), the knitted body (3) defining an inner area or inner chamber (4), and wherein the knitted body (3) comprises a second thread or second filament (50) extending several times in the inner area or inner chamber (4) between a first face (3a) and a second face (3b) of the knitted body (3) to form a plurality of union threads (5), or portions of second thread or second filament (50), wherein said second thread or second filament (50) is knitted to form a knot (35) with one or more knit units (32) of the first face (3a) in a corresponding connecting area or joining point and a knot (35) with one or more knit units (32) of the second face (3b), and wherein

in said active inflated condition of the inflatable element (2), each knot (35) is tightened, and prevents the relative movement of said second thread or second filament (50) and said one or more knit units (32) in the respective connecting area or joining point, or by means of said knot (35), said second thread or second filament (50) causes a tightening with one or more knit units (32) in the connecting area or joining point.

2. Protective device (1) according to claim 1, wherein the inflatable element is also able to assume a deflated resting condition, wherein in said deflated resting condition of the inflatable element (2), each knot (35) is loose and is able to allow a relative movement of said second thread or second filament (50) and said knit unit (32);
3. Protective device (1) according to claim 1 or 2, wherein said knot (35) is a slipknot formed by one or more knit units and the second thread (50) in the connecting area, said slipknot being able to tighten in response to a tension of said second yarn (50).
4. Protective device (1) according to any one of the previous claims, wherein each knit unit (32) is an eyelet or loop of the first face (3a) or of the second face (3b) of knitted body (3), and said second thread or second filament (50) is inserted in each of said eyelet, and said eyelet is smaller or narrower in said tightening condition corresponding to the inflated condition of the inflatable element (2).
5. Protective device (1) according to claim 4, wherein the second thread or filament (50) forms said knot (35) with three knit units (32) in the respective connecting area or joining point.
6. Protective device (1) according to any one of the previous claims, wherein each of said first face (3a)

and second face (3b) of the knitted body (3), comprise a plurality of knitted rows (31a, 31b), and wherein said knit units (32) are made along said knitted rows (31a, 31b).

7. Protective device (1) according to claims 5 and 6, wherein a first knit unit (321) and a third knit unit (323) of said three knit units (32) are arranged side by side to each other and are part of a first knitted row (31a), and a second knit unit (322) is part of a second knitted row (31b) adjacent to the first knitted row, to form three connecting areas or joining points of the second thread or second filament (50) with the respective knit units (321, 322, 323).
8. Protective device (1) according to claim 7, wherein said second knit unit (322) is arranged in an intermediate zone or position along the respective second knitted row (31b) with respect to the first knit unit (321) and to the third knit unit (323).
9. Protective device (1) according to claim 7 or 8, wherein the second thread or filament (50) is inserted in said first knit unit (321) and said second knit unit (322) to form an eyelet or loop (52) engaging said first knit unit (321) and third knit unit (323), and wherein the second thread or filament (50) is inserted twice inside said second knit unit (322).
10. Protective device (1) according to any one of the previous claims, wherein said first face (3a) and said second face (3b) of the knitted body (3) are situated opposite each other, and wherein the knitted body (3) comprises at least a third face (3c), continuously knitted together with the first face (3a) and with the second face (3b), and at least a fourth face (3d), continuously knitted together with the first face (3a) and the second face (3b), wherein the fourth face (3d) is situated opposite the third face (3c).
11. Protective device (1) according to any one of the previous claims, comprising at least one first wall (15) and a second wall (16) acting as covering and wherein the knitted body (3) is covered with the first wall (15) and the second wall (16), or wherein the knitted body (3) includes a single cover.
12. Garment including, or integrally incorporating, a protective device (1) according to any one of the previous claims, or garment constituting a protective device (1) according to any one of the previous claims.
13. Process for manufacturing a protective device (1) for the protection of a user, comprising the steps of:

knitting at least one first thread or first filament (30) to obtain a knitted body (3) having an inner area or inner chamber (4); and wherein said step

of knitting said first thread or first filament involves forming with said first thread or first filament (30) a plurality of knit units (32) on at least a first face (3a) and a second face (3b) of the knitted body (3),

during the knitting of the first thread (30), knitting at least one second thread or second filament (50) so that the second thread or second filament (50) extends several times into the inner area or inner chamber (4) between said first face (3a) and said second face (3b) of the knitted body (3) being processed to define a plurality of union threads (5) crossing the inner chamber (4) and acting as tie members in inflated condition; and wherein said step of knitting said second thread or second filament (50) involves:

weaving said second thread or second filament (50) with one or more knit unit (32) of the first face (3a) and one or more knit unit (32) of the second face (3b) and forming a knot of a portion of said second thread (50) with said one or more knit units (32) of the first face (3a) in a respective contact area or joining point and a knot with another portion of the second thread (50) and one or more knit unit (32) of the second face (3b) in a respective contact area or joining point.

14. Process according to claim 13, wherein the knot is obtained by tightening one or more of said knit units (32) and the second thread (50) or vice versa in a respective contact area or joining point.
15. Process according to claim 13 or 14, wherein the process involves knitting said first thread or first filament (30) so as to form a plurality of knitted rows (31a, 31b) and providing a first eyelet or loop so as to form a first knit unit (321) and providing a second eyelet or loop so as to form a third knit unit (323) arranged side by side along a first knitted row (31a) and providing a second eyelet or loop so as to form a second knit unit (322) along a second knitted row (31b) in an intermediate zone or position with respect to said first knit unit (321) and said third knit unit (323), wherein the first knitted row (31a) is adjacent to the second knitted row (31b).
16. Process for manufacturing a protective device (1) according to claim 15, wherein the process involves knitting said second thread or second filament (50) according to the following sequence: inserting said second thread or second filament (50) within said second knit unit (322), said first knit unit (321) and said third knit unit (323) and again into said second knit unit (322).
17. Process according to any one of claims 13 to 16, wherein the first thread or first filament (30) and the second thread or second filament (50) are knitted by

means of a same knitting machine, preferably a rectilinear knitting machine, and the knot is formed by means of knitting.

18. Use of a rectilinear knitting machine for the manufacture of a protective device (1), or airbag device, having an inner chamber (4), wherein said rectilinear knitting machine is configured to process a first thread or first filament (30) for making a knitted body (3) comprising a plurality of knit units (32) defining an inner chamber (4) and a second thread or second filament (50) for making union threads (5) arranged in the inner chamber, wherein by means of the knitting machine a knot or tie is created with one or more knit units and the second thread in a zone of mutual connection or joining zone..
19. Use of a rectilinear knitting machine according to claim 18, wherein the protective device (1) is the protective device according to any one of the previous claims from 1 to 11, or a device obtained by means of the process according to any one of claims from 13 to 17.

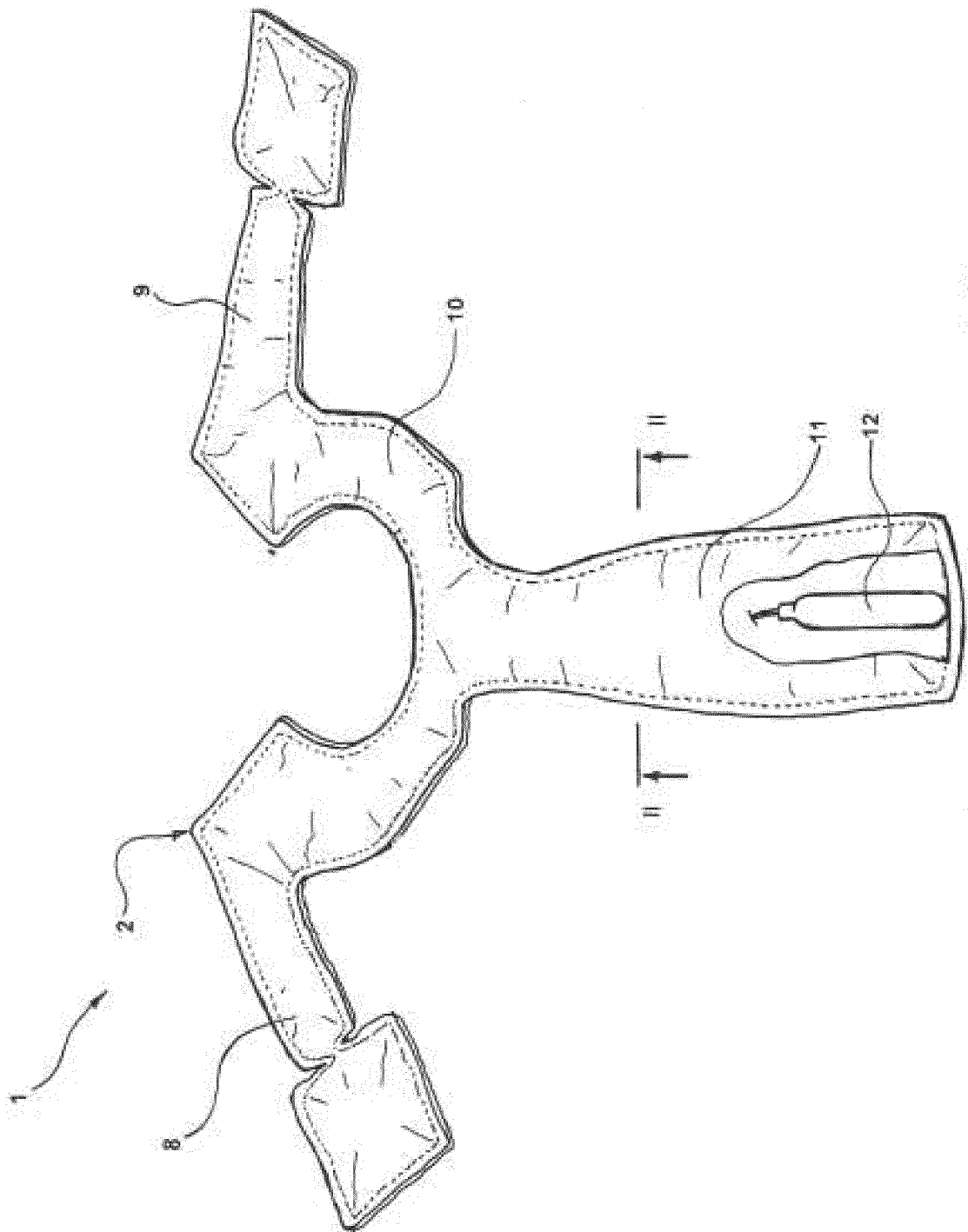


FIG. 1

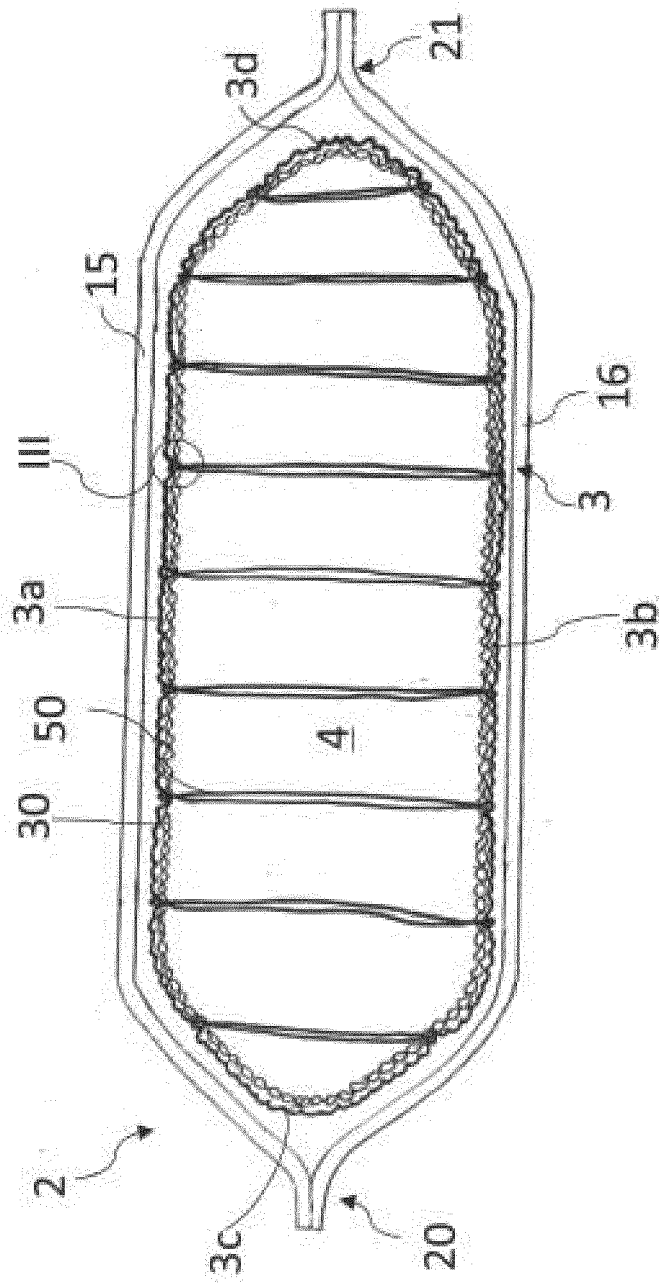


Fig. 2

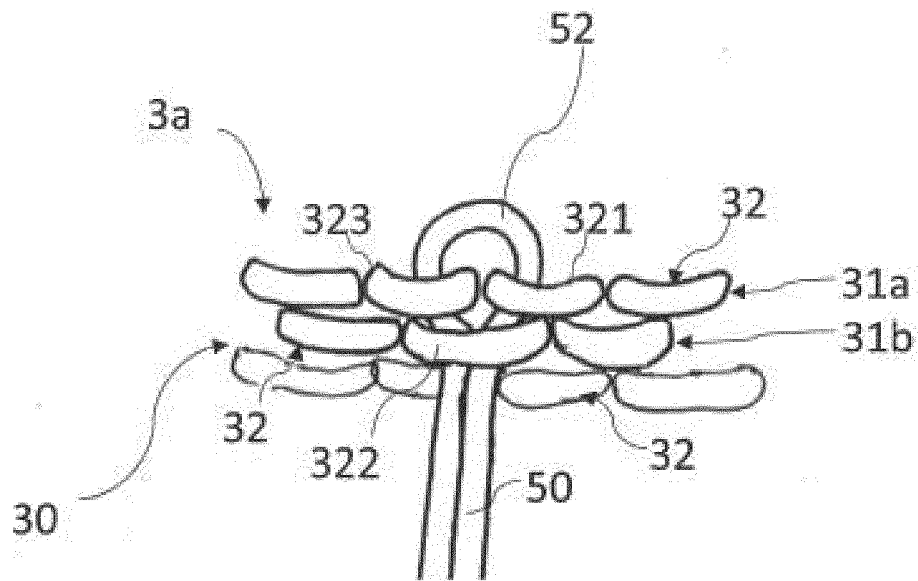


Fig. 3

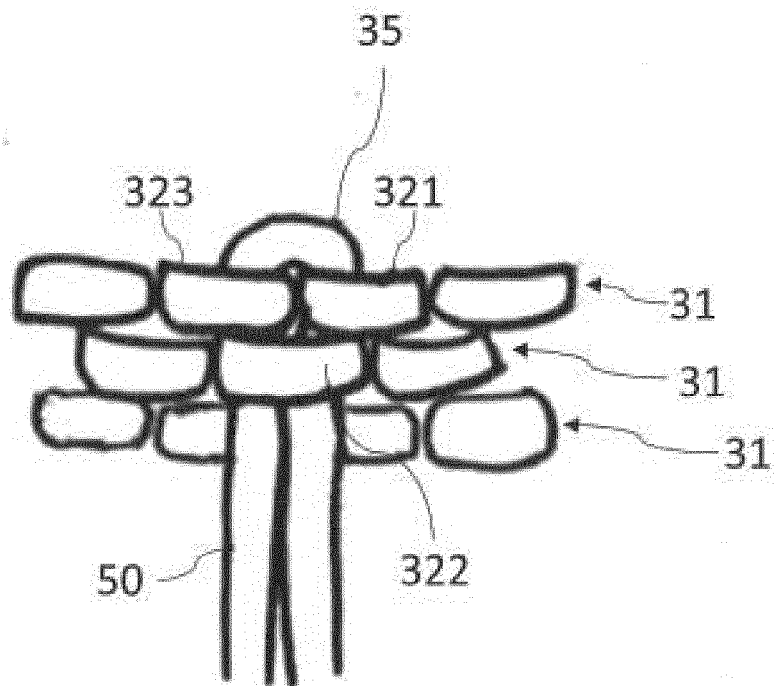


Fig. 4

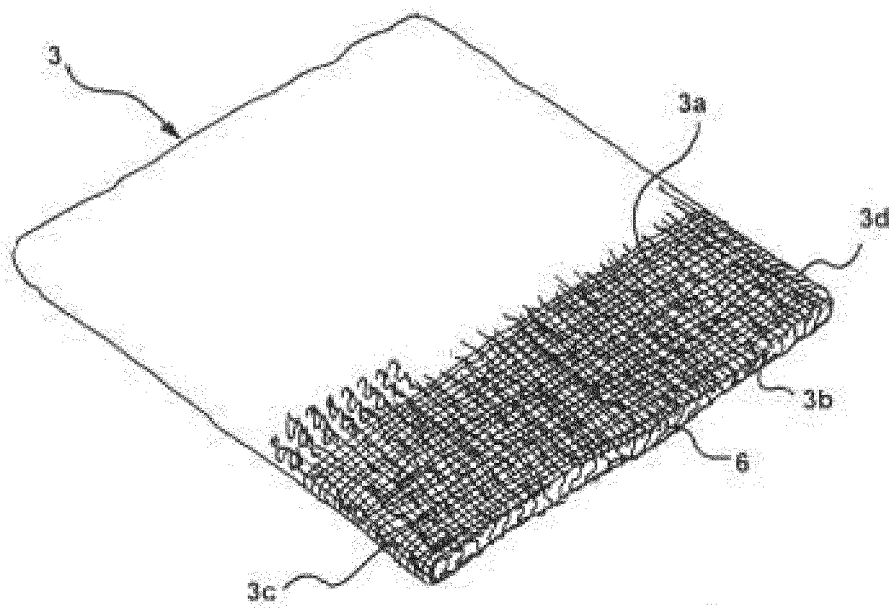


FIG. 5

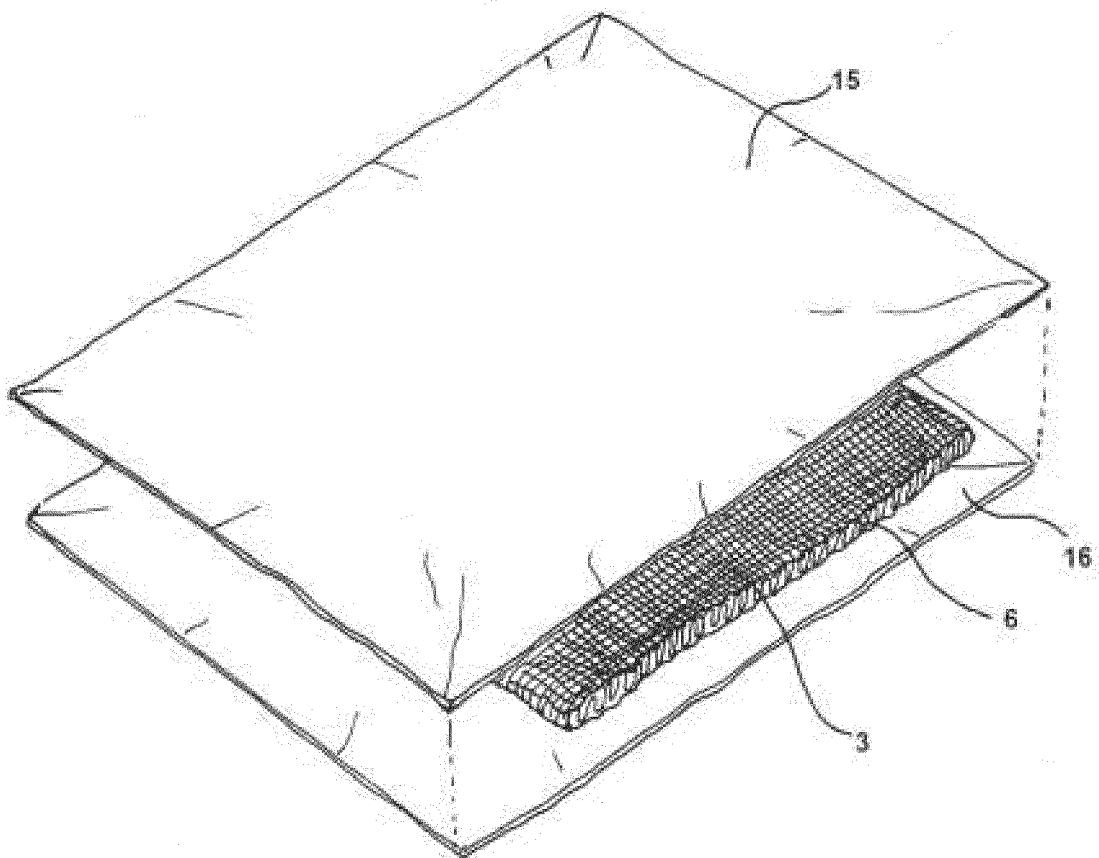


FIG. 6

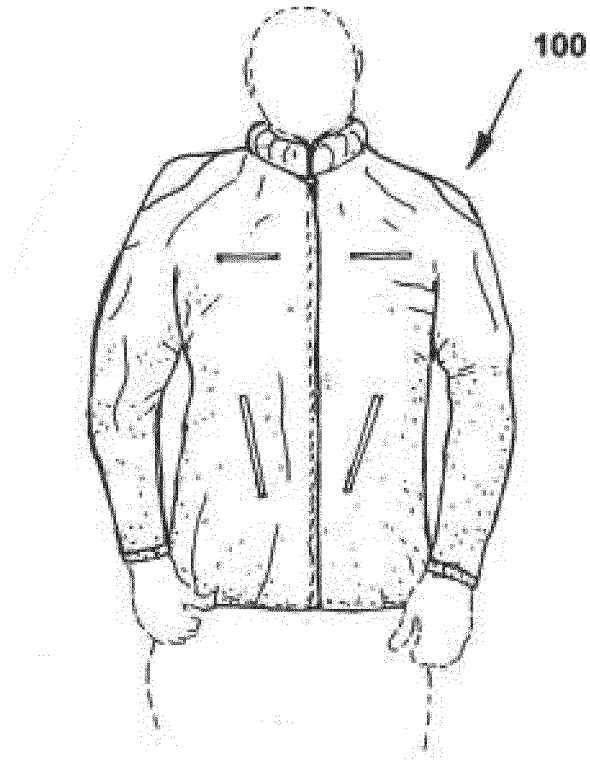


FIG. 7



EUROPEAN SEARCH REPORT

Application Number
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A	IT RM20 080 657 A1 (DAINESE SPA) 10 June 2010 (2010-06-10) * figure 9 *	1-19	
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			A41D
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 20 November 2020	Examiner van Voorst, Frank
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