



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**12.03.2014 Bulletin 2014/11**

(51) Int Cl.:  
**F41H 1/02 (2006.01) F41H 5/04 (2006.01)**

(21) Application number: **13183808.8**

(22) Date of filing: **10.09.2013**

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

(72) Inventors:  
 • **Hoebeke, Jean-Claude**  
**9700 Oudenaarde (BE)**  
 • **Smisaert, Lieven**  
**9920 Lovendegem (BE)**

(30) Priority: **10.09.2012 BE 201200596**

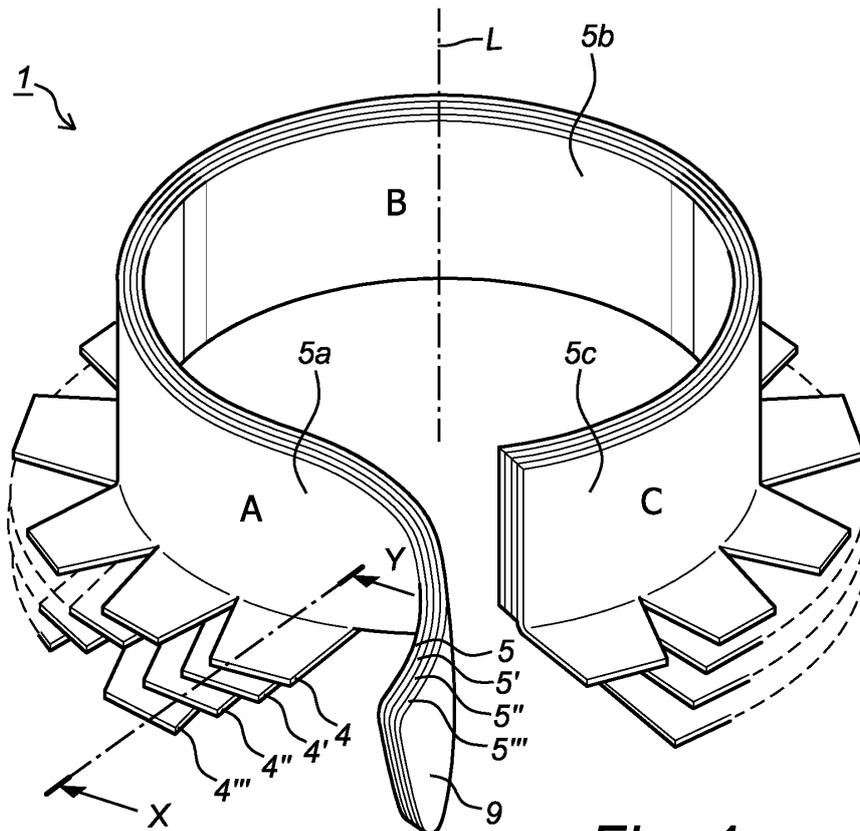
(74) Representative: **Brantsandpatents bvba**  
**Guldensporenpark 75**  
**9820 Merelbeke (BE)**

(71) Applicant: **Seyntex NV**  
**8700 Tielt (BE)**

(54) **Continuous ballistic collar for ballistic protection vest**

(57) The invention relates to a collared ballistic protection vest, comprising a torso part and a cylindrically collar part connected by coupling means so as to provide a continuity in ballistic resistance between the cylindri-

cally shaped collar part and the torso part. The invention also relates to a cylindrical collar part for the protection vest and provides a method for manufacturing the collared vest.



**Fig. 4**

## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a protection vest, especially to a bulletproof and/or shrapnel-proof vest. The invention further relates to a method for the manufacture of such a vest and for a continuous protective ballistic collar in particular.

**[0002]** The invention is particularly useful in the textile industry, in the field of ballistic protective clothing.

### BACKGROUND

**[0003]** Ballistic vests, in particular bulletproof and/or shrapnel-proof vests include a torso part and a neck part, wherein the torso of the wearer is protected by one part and the neck of the wearer is protected by a collar. The protective structure to protect the torso is either of the flexible or rigid type and includes bulletproof and/or shrapnel-proof material.

**[0004]** With the flexible type of protective clothing, each of these parts comprises bulletproof and/or shrapnel-proof materials such as polyaramide fibers, including Kevlar®, and high-density polyethylene, such as Dyneema®. With the rigid type of protective clothing, ceramic plates or plates of high-density polyethylene are being used.

**[0005]** Around the protective structure comes a classic fabric, often polyamide, potentially with a color print, possibly with a camouflage pattern. Furthermore, the protection vests are usually provided with attachment means for equipment like ammunition.

**[0006]** Ballistic protective clothing is used by the military, by security personnel and in professions with a high risk of ballistic impact, such as cash transporters. A highest possible and complete protection is required from this garment.

**[0007]** Protective clothing that protects the human body against various impacts, like that of a bullet, bullet-shrapnel, knife and the like, should not only offer sufficient protection but should preferably also be sufficiently light and comfortable. Protective clothing is confectioned with different parts being assembled to one another. The clothing manufacturer cuts pattern pieces from the fabric, which are then put together into a garment, in combination with haberdashery products like zips, attachment strips, reinforcement etc. This has the result that in different places of the garment transition zones are present with respect to protection.

**[0008]** These transitions zones create weak elements in the structure of the garment; more specifically it is an impact-permeable zone. This zone can be quite large; there are configurations known where this weak zone is up to 6 cm wide.

**[0009]** Especially problematic is the transition zone of the impact-resistant collar towards the torso. Making the transitions of impact-resistant clothing fully impact-resist-

ant between e.g. neck and torso is currently not sufficiently achieved.

**[0010]** The protection zones at the level of the shoulders, the top side of the torso and the back should follow the course of the upper side of the torso, the protection of the neck should show a cylindrical shape and display a distinct angle of inclination relative to the protection zones of shoulder, upper torso and back, and this in a circle of 360°. The construction of such a continuous protection system, without ballistic unprotecting transition is not evident.

**[0011]** Different ways have been investigated to make such critical places and transitions impact-resistant.

**[0012]** US20110145965 discloses the use of an additional ring around the collar to create an impact-resistant transition. As such, use is made of additional overlapping elements by which the intermediate zone between collar and torso is protected. However, in this case an additional plate of the protection material is necessary. It is questionable whether continuity in ballistic resistance is realized.

**[0013]** In US20110010830 the garment that should protect the neck is confectioned separate from the garment that should protect the torso. In this case, the comfort of the wearer diminishes by the use of the various materials.

**[0014]** The disadvantage of all the solutions that are presently known is that one is forced to work with multiple elements that should provide sufficient impact resistance. This leads to a loss in comfort and to the use of additional material.

**[0015]** The aim of the invention is to provide a vest with improved protection in transition zones, specifically in the transition zone between neck and torso. The invention aims to provide a construction in which perforation of the transition zone is avoided.

### SUMMARY

**[0016]** This aim is achieved according to the invention, by providing a vest with an improved collar extension, more particularly as described in claim 1.

**[0017]** In the present invention, a continuous transition between the neck and torso with improved impact-resistance is provided by way of folding techniques and confectioning. This will be obtained by the use of layered structures provided with coupling means, to make the transition of an impact-resistant garment impervious to ballistic and/or stabbing impact.

**[0018]** In a first aspect, the present invention provides a collared ballistic protection vest comprising a torso part and a cylindrically shaped collar part connected by coupling means to the torso part, wherein collar part and torso part comprise one or more multi-layered material stacks, wherein a material stack comprises an aramide fiber or a high-density polyolefin fiber, wherein individual material stacks of the cylindrically collar part are provided with coupling means extending outwardly of the cylindri-

cally shaped collar part in the direction of the torso part, wherein said coupling means are inserted between individual material stacks of the torso part in a tilted position in relation to one another so as to provide a continuity in ballistic resistance between the cylindrically shaped collar part and the torso part.

**[0019]** The collar extension is such that the ballistic resistance obtained by the provision of enough ballistic material in the form of layer thickness and material choices such as aramide and HDPE is preserved in the area where the collar part transitions to the torso part. Because of the tilted position of the coupling means, a bullet that would hit this area still encounters ballistic material in an amount required to stop it. Continuity in ballistic resistance is preserved. A continuous ballistic collar is achieved.

**[0020]** In prior art embodiments, abrupt transitions between collar part and body part are present. These discontinuities present safety risks.

In the present invention, continuity in ballistic properties is maintained by the avoidance of abrupt transitions in the fabric.

**[0021]** Furthermore, the invention provides in a collar for a protection vest, in accordance with claim 13.

**[0022]** In a second aspect, the invention provides a collar for a collared ballistic protection vest according to any of the preceding paragraphs, comprising a collar part provided with coupling means for coupling with the torso part, to form in coupled condition the collared protection vest, wherein the collar part is constructed of one or multiple stacks of multi-layered material stacks, wherein a material stack comprises an aramide fiber or a high-density polyolefin fiber, wherein individual material stacks of the collar part are provided with coupling means outwardly extending in the direction of the torso part, to be positioned between individual material stacks of the torso part, such that collar part is connectable to the torso part and a continuity in ballistic resistance is provided between torso part and collar part.

**[0023]** Finally, the invention provides in a method for the manufacture of a collar and a protection vest, provided with the collar part according to an embodiment of the invention, in accordance with claim 14.

**[0024]** In a third aspect the invention provides a method for manufacturing a collared ballistic protection vest comprising a torso part and a collar part according to any of the previous paragraphs, comprising the steps of:

- a) providing a multi-layered material stack for the formation of the torso part of a protection vest,
- b) providing a multi-layered material stack for the formation of the collar part of the protection vest, provided with coupling means extending from the collar part outwardly in the direction of the torso part for coupling with the torso part,
- c) inserting the coupling means of the individual material stack of the collar part between two individual material stacks of the torso part,

d) repeating steps a) to c),

e) positioning the coupling means of different material stacks in a tilted position in relation to one another,

thereby providing a continuity in ballistic resistance between torso part and collar part.

**[0025]** Preferred embodiments are detailed in the dependent claims.

## DETAILED DESCRIPTION OF THE FIGURES

### **[0026]**

Figure 1 shows a simplified view of a part of an impact-resistant garment from the prior art.

Figure 2 shows a simplified view of the various components for an impact-resistant collar according to an embodiment of the invention. In this embodiment the collar part will be constructed with three collar part sections A, B and C. They will be put together with a torso part 2. Each part will be repeated four times (4x) as four multi-layered material stacks will be used in the illustrated example.

Figure 3 shows a simplified view of a composition of the individual components, in order to form one layer of an impact-resistant collar according to an embodiment of the invention. Figure 3a is a view of the collar along the bottom. Figure 3b is a view of the collar as seen from above.

Figure 4 provides a three dimensional view on a collar according to an embodiment of the invention. This example is made from four material stacks. It displays a collar part in cylindrical shape comprising three parts A B C provided with coupling means in a tilted position in relation to one another when compared for the different material stacks, as can be seen from their position versus the line X-Y.

Figure 5 schematically shows a cross-sectional view according to a plane parallel to the longitudinal axis L along the line X-Y. It illustrates the position of the individual material stacks, in particular the interlaced position of the coupling means of the collar part with the torso part layers. The amount of overlap is shown as A-A'.

Figure 6 schematically shows an impact-resistant collared part of a protection vest according to an embodiment of the invention. It is made up of four layers (6, 6', 6'', 6'''), wherein each time sufficient overlap is foreseen to insure impact-resistance in the transition zones, i.e. between collar part and body part according to cross sectional view X-Y (Fig 5) and between collar parts according to cross sectional

view Q-S (Fig 7).

Figure 7 shows a detailed view of the construction of the collar part that is depicted in Figure 6. It is a cross-sectional view of the collar zone along a plane that is perpendicular to the longitudinal axis L and around the line Q-S in Figure 6. It shows the interlaced position of the material stacks (5 of B, 5 of A, 5' of B, 5' of A, 5" of B, 5" of A, 5''' of B, 5''' of A) where two collar part sections (A, B) meet.

Figure 8 schematically shows the three dimensional assembly of the material stacks of the collar part and torso part. Material stacks overlap as a transition between collar part sections (A B, B C) and between collar part sections and torso part (Q D, B D, C D). The dotted lines represent the tilted position of the coupling means of individual materials stacks in relation to one another. The striped line 7 represents stitchings that connect together material stacks. The otherwise upright collar part is put flat for the purpose of representation.

Figure 9 is a schematic representation focusing on the material overlaps in the collar part. It is a top view on a cross section through a plane parallel to the flat laid torso part with upright collar part.

**[0027]** A more detailed view of the overlap of the individual materials stacks of collar part sections B and C is provided in Fig. 10. The tilted position of the coupling means of four individual material stacks (4, 4', 4", 4''') is displayed by respectively a full line (—), a pointed line (—.), a striped line (— —) and a dotted line (.....).

**[0028]** Figure 11 shows a simplified view of a part of an impact-resistant garment 10, especially a torso part 2 with impact-resistant collar 1, packaged and confectioned in a woven outfit, according to an embodiment of the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

**[0029]** A vest according to one embodiment of the invention is **characterized in that** in the transition zones between the various parts of the garment; in particular between collar part and torso part, use is made of layers with coupling means.

**[0030]** In a first aspect, the invention provides a protection vest, in particular a projectile-delaying vest, preferably a bulletproof vest. The vest comprises a torso part and a collar part connected to the torso part by coupling means.

**[0031]** In its simplest execution, the collar part is made of a single piece of fabric providing an essentially cylindrical form when folded. In a preferred embodiment, the collar part comprises several collar part sections, at least two. Most preferably the collar part consists of three collar part sections. This is advantageous for providing flexibility.

There is some variability in the diameter of the cylindrically shaped collar part. This provides improved comfort to the wearer of the collared vest.

**[0032]** In a preferred embodiment the material stacks of the at least two collar part sections are interlaced. This has the effect that the layers can move freely, which is beneficial to flexibility. The overlaps in material maintain the ballistic resistance of the collar. To the front collar part section A it provides pivot functionality. It aids a person in putting on the vest.

**[0033]** Collar part and torso part are constructed of one or several layers of material stacks, wherein individual material stacks of the collar part are provided with coupling means extending in the direction of the torso part, and said coupling means between individual material stacks of the torso part are positioned such that torso part and collar part are connected, and thereby a continuous transition between the torso part and collar part is provided. To this end the layers must provide a sufficiently large transition zone, preferably at least 4 cm of transition zone. The different parts of the garment, such as the torso and the neck, consisting of several combined, sufficiently overlapping layers ensure that there is impact-resistance in these zones. The protection vest has the advantage that the safety in transition zones is increased. The general level of protection is increased.

**[0034]** The result is an impact-resistant garment without impact-permeable, weak zones in the transition between torso and neck. This garment is particularly suitable for use with risk of bullet-impact, shrapnel-impact and stabbing. The layers ensure that there is a sufficient impact-resistance for the wearers of this protective garment. The continuous transition the normally weaker zones to be also sufficiently impact-resistant, without having to use additional elements and without the loss of comfort.

**[0035]** In a preferred embodiment of the protection vest, the coupling means provide in a transition zone of at least 4 cm, preferably at least 5 cm. This procures sufficient width to reach a safety level. Also in dynamic state the impact-resistance in the transition zone is improved.

**[0036]** In a preferred embodiment of the protection vest, the coupling means are tooth-shaped with a 4 cm wide base and a 5 cm height. The layers of the neck protection have a tooth-structure on the side of the torso, in order to provide the attachment. These teeth are preferably trapezoidal, with a base of preferably 5 cm, a short side of preferably 4 cm and a height of at least 3 cm, preferably of at least 4 cm.

**[0037]** In a preferred embodiment of the protection vest, coupling means of different material stacks are crosswise positioned with respect to one another, and according to the longitudinal axis L of the vest. This position could also be described as tilted (in Dutch: "geschrankt").

**[0038]** For the provision of impact-resistance, use is made of strong fibers. Suitable "strong fibers" are fibers

of aramide, silicon carbide, and/or a polymer, such as for example high-density polyethylene, or other proven ballistic fibers.

**[0039]** "Strong fibers" in this invention are preferably polyaramide, sometimes referred to as aramide, or high-density polyethylene fibers. Aramide, for example, is available under brand names such as Twaron® and Kevlar®. Polyethylene, suitable to be used in garments according to an embodiment of the invention, is for example available under the brand name of Dyneema®. Aramide and polyethylene are both materials that are lightweight, yet boasting a high tenacity and abrasion-resistance. Both materials also exhibit excellent high shock absorption.

**[0040]** In a preferred embodiment, the strong fibers are characterized by a tenacity of at least 6 dN/tex, a modulus of at least 130 dN/tex, and a breaking energy of at least 8 J/kg. Preferably, strong fibers are fibers with a tenacity of at least 10 dN/tex, a modulus of at least 200 dN/tex, and a breaking energy of at least 20 J/g. More preferably fibers have a tenacity of at least 16 dN/tex, a modulus of at least 400 dN/tex, and a breaking energy of at least 27 J/g. Most preferably fibers have a tenacity of at least 28 dN/tex, a modulus of at least 1200 dN/tex, and a breaking energy of at least 40 J/g.

**[0041]** Parts made from lightweight high-density polyethylene, HD-PE known under the trade name of Dyneema®, can offer a ballistic protection which is equivalent to a steel plate for 45% of the weight. In contrast to ceramic tiles HD-PE can be molded, including complex designs that match with the human body. This increases the level of protection and comfort.

**[0042]** The layers in the material stacks themselves preferably comprise fabric or unidirectional (UD) fibers. The layers preferably consist of aramide and/or of polyethylene fabrics or unidirectional fibers. Most preferably the layers exist of unidirectional polyethylene fibers.

**[0043]** With layers consisting of unidirectional fibers is meant layers that consist of several sub-layers, in the sub-layers the fibers lie in one direction, wherein between the various sub-layers the fibers lie perpendicular to each other.

**[0044]** Various unidirectional (UD) layers may be grouped into one or multiple packs or stacks. Preferably, the stack of UD-layers consists of multiple UD-layers, each of which has two or four UD-layers. The packs are preferably on both sides provided with a smooth film, by which friction between the packs decreases, and the stack gains flexibility.

**[0045]** Preferably, the vest according to the invention has a stack of UD-layers, in which the UD-layers mainly consist of aramide or ultra-high molecular polyethylene. As a result, a vest with a continuous transition of preferably at least 4 cm is also impact-resistant in the transition from neck to torso.

**[0046]** In another preferred embodiment a material stack comprises a textile fabric. The advantage of woven aramide compared to HDPE is the suppleness and lim-

ited susceptibility to permanent creasing. In combinations where stab-protection is required, it is also easier to combine the specific stab-protection with the bullet-resistance/shrapnel resistance.

5 **[0047]** In a preferred embodiment of the protection vest, a material stack is a stack of flexible unidirectional layers with fibers having a tenacity of at least 6 dN/tex, a modulus of at least 130 dN/tex, and a breaking energy of at least 8 J/kg. This choice of material provides a layer that is strong, and well resistant to deformation and strain.

10 **[0048]** The layers preferably have a weight of 100 - 300 g/m<sup>2</sup>. More preferably, the layers have a weight of at least 190 g/m<sup>2</sup>. This weight of the layers ensures a sufficient impact-resistance of the clothing. Preferably the number of layers is between 20 and 40, more preferably a number of layers between 25 and 35 is being used.

15 **[0049]** Besides the use of impact-resistant layers, there is also the possibility to add between these layers one or more anti-trauma layers. These layers can be flexible, woven layers consisting of aramide or polyethylene fibers. Said layers have preferably a grammage between 100 and 600 g/m<sup>2</sup>. Preferably at least 2 layers are being used.

20 **[0050]** A material suitable for use as an anti-trauma layer is commercially available under the name LFT AT-flex. LFT stands for "laminated fabric technology", in which a fabric is used, that is woven from Twaron® fiber, with a high number of densely packed, very fine denier fibers. These increase the protection level in comparison with thicker, coarse fabrics made from the same composite material. These microfibers are woven so that the intersection between warp and weft is minimized, and the fabric is then formed into a sandwich with extremely thin thermoplastic film. This produces a lightweight armor that provides a fast energy-dissipation at impact. This makes it suitable for application in soft body armor applications such as a protection vest.

25 **[0051]** Moreover, application of anti-trauma layers in a vest according to an embodiment of the invention reduces the ultimate impact-depth of a projectile on the wearer.

30 **[0052]** In a preferred embodiment, the ballistic material is wrapped in a waterproof cover. This also provides UV-protection, ensuring that the ballistic performance is not affected during use.

35 **[0053]** In a preferred embodiment, the torso part is connected to the neck part, wrapped and confectioned in a woven outfit comprising a polyethylene, a polyester, a cotton, or a polyamide fiber, or a mixture of the previous fiber materials. These are colorable, printable materials, directly or indirectly, or by means of additives. Preferably, this is a polyamide fabric.

40 **[0054]** In a preferred embodiment of the protection vest, the collar part is in closed position substantially parallel to the longitudinal axis L, following the longitudinal axis of the neck. This ensures that the collar becomes located substantially perpendicular to the torso. It is important that the collar part follows the vertical line of the

neck in order to avoid impediment to the mobility of the neck. Although the ballistic protection is constructed of a number of layers, this gives no suppleness at the level of a one-layered system. The intended mobility for example is essential to allow a person to do his job, to react alertly for his own safety.

**[0055]** A vest according to one embodiment of the invention reaches the security levels in terms of ballistic resistance and impact-resistance that usually apply to security personnel.

**[0056]** The ballistic resistance of a vest can be classified according to various standards. One of those standards is the standard of the National Institute of Justice, the NIJ Standard, in which different levels of protection are defined. For example, a vest according to the US NIJ 01.01.04, Class III A standard should be able to stop a .44 Magnum at 427 m/s.

**[0057]** An advantage of a collared vest according to the invention is that the requirement set by the NIJ Standard is also achieved in the transition zone between collar part and torso part.

**[0058]** In a preferred embodiment of the protection vest, the transition between collar and torso has such a ballistic resistance, that a bullet with a speed up to 436 m/s is stopped in accordance to NIJ Standard 01.01.04, Class III A.

**[0059]** In addition to not being perforated by a projectile, a second requirement of the NIJ 01.01.04, Class III A Standard is the extent to which the body side deforms behind an impact. This deformation measures the trauma that is experienced by the wearer of a vest after the impact of a projectile.

**[0060]** In a preferred embodiment of the protection vest, the transition between collar and torso has such a ballistic impact resistance, that a bullet with a speed up to 436 m/s is stopped, with a trauma of less than 44 mm in accordance to NIJ Standard 01.01.04, Class III A.

**[0061]** In a second aspect, the invention provides for a collar for a protection vest. More specifically, the invention provides for a collar for a protection vest in accordance with an embodiment of the invention, comprising a collar part that is provided with coupling means for a torso part, in order to form in coupled state a protection vest, wherein whereby collar part and torso part are constructed of one or more multi-layered material stacks, wherein a material stack comprises an aramide fiber or a high-density polyolefin fiber, individual material stacks of the collar part are provided with coupling means extending in the direction of the torso part, to be positioned between individual material stacks of the torso part in such a way, that the torso part and the collar part are connectable, and that thereby a continuous transition of at least 4 cm is provided between the torso part and collar part.

**[0062]** In a preferred embodiment of the protection vest, the collar has a surface weight of less than 5.5 kg/m<sup>2</sup>. This has the advantage that the collar is light. This is comfortable for the user. The weight presents no obstruction to additionally provide the vest with a collar.

**[0063]** In a third aspect, the invention provides in a method for the manufacture of a collar and protection vest in accordance with a preferred embodiment of the invention.

**[0064]** More specifically, the invention provides in a method for the manufacture of a collared protection vest in accordance with an embodiment of the invention, comprising a torso part and a collar part, comprising the steps of:

- providing a multi-layered material stack for the formation of a torso part of a protection vest,
- providing a multi-layered material stack for the formation of a collar part of the protection vest, wherein the material stacks of the collar part are provided with coupling means, to form a protection vest in condition,
- confectioning the material stacks by successively coupling a layer of the torso part to a layer of the collar part by means of the coupling means, thereby providing the collared protection vest with a continuous transition of preferably at least 4 cm between torso part and collar part.

**[0065]** Through this way of construction, zones with an overlap of preferably at least 4 cm were provided, with the consequence that there is sufficient material present in the transition zones to work impact-resistant.

**[0066]** The total surface-weight of the vest is preferably 5.4 kg/m<sup>2</sup>. This is but a slight difference to the total surface-weight of the collar. The average weight differs from that of the collar because of the overlaps in the collar zone. More material is present there. Because the overlap zone is limited, the increase in weight for the entire shoulder/neck is logically limited.

**[0067]** Besides the use of impact-resistant layers, there is also the possibility to add one or more anti-trauma layers between these layers. These layers reduce the ultimate impact-depth of the projectile on the wearer. These layers are flexible woven layers consisting of aramide or polyethylene fibers. These layers have preferably a grammage between 100 and 600 g/m<sup>2</sup>. Preferably at least 2 layers are used.

**[0068]** Preferred embodiments of the invention are as follows:

**[0069]** A collared protection vest (10), comprising a torso part (2) and a collar part (1) connected by coupling means to the torso part, wherein collar part (1) and torso part (2) are constructed of one or more multi-layered material stacks, wherein a material stack (5) comprises an aramide fiber or a high-density polyolefin fiber, wherein individual material stacks of the collar part (5) are provided with coupling means (4) extending in the direction of the torso part, wherein said coupling means are positioned between individual material stacks of the torso part (6) such that torso part (2) and collar part (1) are connected and a continuous transition (A-A') of at least 4 cm is provided between torso part (2) and collar part (1).

**[0070]** Protection vest (10) as described above, wherein the coupling means (4) is a tooth-shaped coupling means with 4 cm wide base and 5 cm height.

**[0071]** Protection vest (10) as described above, wherein coupling means (4) of various material stacks (5) are positioned crosswise in relation to one another and according to the longitudinal axis of the vest (L).

**[0072]** Protection vest (10) as described above, wherein the collar part (1) in closed position is positioned substantially parallel to the longitudinal axis (L) of the collar part (2).

**[0073]** Protection vest (10) as described above, wherein said transition (A-A') has a ballistic resistance such that a bullet with a speed of up to 436 m/s is stopped according to NIJ Standard 01.01.04, class III A.

**[0074]** Preferably said transition (A-A') of the previously described protection vest, has an impact-resistance such that a bullet with a speed of up to 436 m/s is stopped with a trauma of less than 44 mm, according to NIJ Standard 01.01.04, class III A.

**[0075]** Protection vest (10) as described above, wherein the collar (A, B, C, x4) has a surface-weight of less than 5.5 kg/m<sup>2</sup>.

**[0076]** Protection vest (10) as described above, wherein a material stack (5 x4) is a stack of flexible unidirectional layers (5) with fibers having a tenacity of at least 6 dN/tex, a modulus of at least 130 dN/tex, and a breaking energy of at least 8 J/kg. Preferably this high tenacity fiber is an aramide or a polyolefin fiber; the polyolefin fiber is preferably high-density polyethylene.

**[0077]** Protection vest (10) as described above, wherein a material stack (5 x4) comprises a textile fabric from woven aramide fibers or high-density polyethylene fibers.

**[0078]** Protection vest (10) as described above, packaged and confectioned in a woven outfit comprising a polyethylene, a polyester, a cotton or a polyamide fiber.

**[0079]** Protection vest (10) as described above, wherein the individual layer (5) in the material stack has a weight of 100 - 300 g/m<sup>2</sup> and the number of layers is 20 - 40.

**[0080]** Protection vest (10) as described above, wherein the individual layer (5) in the material stack has a weight of at least 190 g/m<sup>2</sup>; or wherein the number of layers is 25 to 35; or with at least two anti-trauma layers.

**[0081]** Collar for a protection vest (10) described in any of the preceding paragraphs, comprising a collar part (1) provided with coupling means (4) for a torso part, to form in coupled condition a protection vest, wherein collar part (1) and torso part (2) are constructed of one or multiple stacks of multi-layered material stacks (4, 5, 6, x4), wherein a material stack comprises an aramide fiber or a high-density polyolefin fiber, wherein individual material stacks of the collar part (5) are provided with coupling means (4) extending in the direction of the torso part, to be positioned between individual material stacks of the torso part (6), such that the torso part (2) and the collar part (1) are connectable and a continuous transition of at least 4 cm is thereby provided between torso part and collar part.

**[0082]** Method for the manufacture of a collared protection vest according to any of the preceding paragraphs, comprising a torso part (2) and a collar part (1), comprising the steps of:

- providing in a multi-layered material stack (6) for the formation of a torso part of a protection vest,
- providing in a multi-layered material stack (5) for the formation of a collar part of the protection vest, wherein the material stacks of the collar part are provided with coupling means (4), to form in coupled condition a protection vest,
- confectioning of the material stacks, thereby successively coupling a layer of the torso part (6) to a layer of the collar part (5) by means of the coupling means (4), thereby providing the collared protection vest with a continuous transition of at least 4 cm between torso part and collar part.

**[0083]** The invention will now be further explained with reference to the following examples, without being limited hereto.

#### EXAMPLES

Example 1: prior art (Fig. 1)

**[0084]** In Figure 1, a neck protection 1 is shown from the prior art. The neck part 1 and the torso part 2 from which the vest was constructed 10 were made separately, after which both parts were confectioned into a vest. The result is a tapered and creased collar. It is not standing upright. The seam 3 between torso part and collar part is a weak spot. A bullet that hits this area will not meet with resistance of ballistic material. The compromise made to put together the parts aimed to protect the neck and torso presents a safety risk. The neck protection 1 is displayed in a laid out and essentially flat position. To protect a wearer, it will be draped around the neck of a person. It is closed in the front by making part of the panels of the neck part and body part overlap. They are fixated by Velcro strips 8.

Example 2: protection vest and method for obtaining a protection vest according to an embodiment of the invention (Fig. 2-11)

**[0085]** As an example a neck protection 1 was made that merges into a torso protection, according to the aspects of the invention. The various steps of the construction are shown in Fig. 2-10. The end result is presented in Fig. 11.

The individual components that will be part of the internal structure of the vest are shown in Fig. 2. These elements were first cut from sheets of multi-layered material stacks. They were cut into shapes to either provided sections (A, B, C, D) for the collar part 1 or torso part 2.

**[0086]** In the depicted collar part three components 5a,

5b, 5c can be distinguished, each component defines a part A, B, C of a perimeter and is provided with tooth-shaped structures 4.

**[0087]** The example displayed depicts a collar part section made up of three parts. In other embodiments the number of pieces can be one, two, or more than three. The advantage of a collar part comprising at least three collar part sections is the provision of flexibility to movements. When a person wearing the vest moves, he will not be hindered by a rigid collar.

**[0088]** As the layers of different collar part sections are interlaced there is some variability in the diameter of the cylindrically shaped collar part. This provides improved comfort to the wearer of the collared vest. It provides a pivotal functionality to collar part A. It aids in putting on the vest and bringing together parts A and C.

**[0089]** The parts A, B and C are provided with tooth shaped coupling means 4a, 4b, 4c. They form one part with the respective collar part sections. Part A is provided with an extra strip of material 9 for connecting parts A and C.

**[0090]** The torso part 2 consists of a plate-like structure with circular recess and opening.

**[0091]** In order to obtain a multilayered structure, this pack of components was provided in plural. In this example, the collared vest (Fig. 11) was constructed of four layers (Fig. 4-10), shown in the figure 2 as 4x.

**[0092]** A combination of components is shown in Fig. 3a and 3b, which respectively display a bottom view and a top view of a single layer. The parts A, B, C and D are put together once, indicated as 1x in the Figure.

**[0093]** The components A, B, C were put together so that an overlap between the different pieces was obtained. The tooth-shaped structures 4 were folded beneath the torso part 6, so that an upright collar was obtained and sufficient overlap was provided between the transitions of the collar part 5a, 5b, 5c towards the torso part D. The components were fastened with stitching 7. The stitchings run along the outer edges of the torso part 6 and through the coupling means 4a, 4b, 4c and torso part at the foot of the collar part 2.

**[0094]** The following step was the provision and attachment of another material stack for the torso part to the construction displayed in Fig. 3. The result is the insertion of one layer of coupling means 4 between two layers of the torso part 6, 6'. Next, an additional material stack for the collar part is provided. It is positioned substantially parallel to the cylindrically shaped form provided by the first collar part layer 5. However, the coupling means 4'a, 4'b, 4'c were applied in a tilted position towards each other such that only a partial overlap was provided with the previous ones 4a, 4b, 4c.

**[0095]** This tilted position can be obtained with collar part sections which are identical to the ones previously used. Or they can be constructed with collar part sections which are identical with respect to the areas indicated as A, B and C in the figure, but with coupling means 4'a, 4'b, 4'c which have a slightly different position versus the

previous ones 4a, 4b, 4c.

**[0096]** This process was repeated several times until the desired amount of material stacks was obtained. It will be clear that the amount of materials stacks used and the material from which they are made determines their ballistic properties.

**[0097]** In order to provide a sufficiently impact-resistant transition, multiple layers of the collar parts for the neck protection 5a, 5b, 5c were confectioned beyond the transition zone 3 to multiple layers for the torso protection 6, on the basis of a tooth-structure 4. To this end, the layers were taken together and divided into preferably at least 4 packs of layers (x4). The various packs of layers were crosswise confectioned as shown in Figure 4 and 5. Because of this the layers do not shift from one another and they continue to provide sufficient impact-resistance.

**[0098]** The tooth-structure 4 provides the attachment between the different packs of layers. Alternately, a pack of layers of the torso was interspersed with a pack of layers of the neck protection, as shown in Fig. 5.

**[0099]** In Fig. 4 the multi-layered stacks of the collar part 1 are displayed from which the vest has been constructed.

**[0100]** The layers of the neck protection have a tooth-structure 4 on the side of the torso 6, in order to provide for the attachment. These teeth are trapezoidal, with a basis of preferably 5 cm, a short side of preferably 4 cm and a height of at least 3 cm, preferably of at least 4 cm. The height is measured from the basis, starting at the collar part denominated as A, to the opposed short side denominated as A' (Fig. 5).

**[0101]** It can be seen that the coupling means of individual collar part layers 4, 4', 4'', 4''' are in a tilted position versus each other as they only partly overlap (X-Y, Fig. 4). In the construction of the collared vest as displayed in Fig. 6, this has for effect that a gap between the teeth of one collar part layer is covered up by the material of teeth in the following layers. No passage way is provided for a projectile to pass through.

**[0102]** Fig. 6 is a three dimensional representation of a collard protection vest according to a preferred embodiment of the invention. The collar part is made of three parts A, B, C. The torso part is made of a single part D. All parts comprise four multi-layered material stacks, e.g. 6, 6', 6'', 6'''. The individual layers are fixated by means of stitchings 7. The way the collar part transitions into the torso part is detailed in Fig. 5. A cross-sectional view provides the internal structure. It can be seen that a material stack of the collar part is interlaced with a material stack of the torso part. The amount of overlap corresponds to the height of the coupling means A-A'. Stitchings 7 across several layers keep the material stacks together.

The construction method of the present invention allows for the collar part to be positioned essentially perpendicular to the torso part, as is displayed by the 90 ° angle between collar part layer 5 and torso part layer 6. The effect is a better fit with the neck of a person wearing the

collard vest.

**[0103]** The provision of coupling means all around the cylindrically shaped collar part and over different layers of collar parts in combination with the interlacing with the torso part layers provides for a continuous ballistic collar.

**[0104]** Fig. 7 is schematic view of the overlap between the collar parts A with B and B with C respectively. The cross-section along the line Q-S depicts an interlacing of collar part layers of part A with part B. The overlap of layers provides continuity in impact resistance. No passage way is provided that would allow a projectile unhindered entrance into the cylindrically shaped collar region.

**[0105]** Preferably no fixation, such as stitches, is applied to keep the collar part layers together in these areas of overlap. This has the advantage that the individual layers can move freely. It provides a pivotal effect to part A.

**[0106]** An alternative way of representation is provided by Fig. 8. The collared torso part is essentially laid flat. The individual layers of material stacks are visible 6, 6', 6", 6''' . The overlap between parts A, B and C is displayed. The effect of the tilted positioning of the coupling means is depicted by dotted lines. It can be seen that a ring shaped structure at the base of the collar is provided thereby providing continuity in ballistic resistance between collar part and torso part. The safety risk presented by seams in prior art embodiments are overcome.

**[0107]** In the view presented in Fig. 9 a top view on the collared torso part is presented along a plane parallel to the torso part 2. The plane cross-sections the collar part 1. The individual material stacks are displayed as thick parallel black lines. The overlapping area is a rectangular black square. Details are provided in Fig. 10. A layer of a collar part section B is followed by a layer of a collar part section C, followed by again a layer of collar part section B, then C, then B, etc. This interlacing of layers preserves ballistic resistance.

**[0108]** Visible here is the tooth-structure 4 that was confectioned, and which thus connects the layers of the neck protection 5 with the torso protection 6.

**[0109]** Stitchings 7 run along the outer edges of the torso part and through the coupling means 4 and torso part at the foot of the collar part 2.

**[0110]** The tilted position of the coupling means of the four individual material stacks (4, 4', 4", 4''') is displayed by respectively a full line (—), a pointed line (—\_—), a striped line (— \_ \_) and a dotted line (.....). It can be seen that they are in a tilted position towards each other as they only partly overlap.

**[0111]** After a pre-determined number of repetitions the coupling means of a first layer may overlap with the coupling means of a fifth layer, for instance.

**[0112]** The end-result of the construction and confectioning is displayed in Fig. 11.

**[0113]** The whole of the layers was packaged in a waterproof cover, and was confectioned into a woven outfit, from a polyamide fabric. When the whole was at rest, the

collar stood vertically upright on the torso, as shown in Fig. 11.

**[0114]** A person in need of ballistic protection can put the collared vest around his neck. The front end of the vest is closable with Velcro means. Collar parts A and C and the front parts of the collar part are thereby brought together. Protection is provided all around the neck and covered torso parts of the person.

**[0115]** The vest provides uninterrupted ballistic protection in the region of the seam, as the collar part continues into the torso part, between sections of the collar, and in the front.

### Example 3

**[0116]** A second vest was constructed according to the principles set out in Example 2. In this additional example, a neck protection NB-01 was created, which merges into a torso protection according to the aspects of the invention, and which is outlined in Example 2 in accordance with the approach.

**[0117]** The torso part 6 consisted of 25 layers of unidirectional high-density polyethylene fibers, with a layer-weight of 190 g/m<sup>2</sup>. Moreover there were also 2 anti-trauma layers present, types LFT ATflex. These 27 layers were proportionally divided over 4 different packs of layers, so that multilayered stacks were obtained.

**[0118]** The neck part 5 consisted of 25 layers of unidirectional polyethylene fibers, with a layer-weight of 190 g/m<sup>2</sup>. Moreover there are also 2 anti-trauma layers present, types LFT ATflex. These 27 layers are proportionally distributed over 4 different packs of layers. These 4 packs were applied as 3 separate bands, in order to obtain a complete neck protection.

**[0119]** The packs for neck and torso were confectioned together by way of a tooth-structure 4. These teeth had a basis of 5 cm and a height of 4 cm.

### Example 4: impact-resistance test

**[0120]** In order to test the impact-resistance of the transition zone (seam), shooting tests were performed on the vest from Example 3, according to an adjusted U.S. NIJ 01.01.04, Class III A standard. The adjustment of the test consisted of the fact that a shooting pattern was used specifically for Italy. Here, six projectiles were fired, first perpendicular at a sample, together for 9 mm and .44. Then followed with a second test at an angle of inclination, again 9 mm coupled with .44. In the standard NIK six projectiles are being fired, all of the same bullet type, partly perpendicular and partly under an angle of inclination.

**[0121]** Two different projectiles were fired at the transition line between torso and neck of the vest NB-01 from Example 3. The perforation of the various layers was examined on the basis of different standardized bullet impacts. Here the main consideration was that, if the different layers had not been perforated, the vest part would

be considered sufficiently impact-resistant. In addition, the impact of the bullet in a plasticine matrix was examined. This impact should be smaller than 44 mm, according to the standard.

**[0122]** The transition zone of the vest was tested with a 9 mm Fiocchi, wherein 0,385 grams of powder N330 were used to shoot the bullet with 436 m/s. Respectively 6 and 7 layers were perforated. Thus the bullets did not perforate all the layers, which implies a sufficient impact-resistance. The impact-depth was each time smaller than 44 mm.

**[0123]** Additionally there was testing with a .44 Magnum, wherein 1.265 grams of powder N110 were used to shoot the bullet with 436 m/s. Respectively 5 and 6 layers were perforated. Thus the bullets did not perforate all the layers, which imply a sufficient impact-resistance. The impact-depth was each time smaller than 44 mm.

### Claims

1. Collared ballistic protection vest (10) comprising a torso part (2) and a cylindrically shaped collar part (1) connected by coupling means (4, 4', 4", 4''') to the torso part (2), wherein collar part (1) and torso part (D) comprise one or more multi-layered material stacks (5, 5', 5", 5''', 6, 6', 6", 6'''), wherein a material stack (5, 6) comprises an aramide fiber or a high-density polyolefin fiber, wherein individual material stacks of the cylindrically collar part (5, 5', 5", 5''') are provided with coupling means (4, 4', 4", 4''') extending outwardly of the cylindrically shaped collar part (1) in the direction of the torso part (2), wherein said coupling means (4, 4', 4", 4''') are inserted between individual material stacks of the torso part (6, 6', 6", 6''') in a tilted position in relation (X-Y) to one another so as to provide a continuity in ballistic resistance between the cylindrically shaped collar part (1) and the torso part (2).
2. Protection vest (10) according to claim 1, wherein the coupling means overlap with torso part material stacks by at least 4 cm (A-A').
3. Protection vest (10) according to claim 1 or 2, wherein coupling means (4) are tooth-shaped.
4. Protection vest (10) according to any of claims 1-3, wherein the cylindrically shaped collar part (1) comprises at least two collar part sections (A, B, C) and material stacks of the at least two sections (A, B, C) are interlaced.
5. Protection vest (10) according to any of the preceding claims, wherein the continuity in ballistic resistance is such that a bullet with a speed of up to 436 m/s is stopped according to NIJ Standard 01.01.04, class III A.
6. Protection vest (10) according to claim 5, wherein the continuity in ballistic resistance has an impact-resistance such that a bullet with a speed of up to 436 m/s is stopped with a trauma of less than 44 mm, according to NIJ Standard 01.01.04, class III A.
7. Protection vest (10) according to any of the preceding claims, wherein the cylindrically shaped collar part (1) has a surface-weight of less than 5.5 kg/m<sup>2</sup>.
8. Protection vest (10) according to any of the preceding claims, wherein a material stack (5, 5', 5", 5''') comprises fibers having a tenacity of at least 6 dN/tex, a modulus of at least 130 dN/tex, and a breaking energy of at least 8 J/kg.
9. Protection vest (10) according to any of the preceding claims, wherein a material stack (5, 5', 5", 5''') comprises a textile fabric woven from aramide fibers or high-density polyethylene fibers.
10. Protection vest (10) according to any of the preceding claims, wherein the vest is packaged and conditioned in a woven outfit comprising a polyethylene, a polyester, a cotton or a polyamide fiber.
11. Protection vest (10) according to any of the preceding claims, wherein the individual layer (5) in the material stack has a weight of 100 - 300 g/m<sup>2</sup> and the number of layers is 20 - 40.
12. Protection vest (10) according to any of the preceding claims, wherein the individual layer (5) in the material stack has a weight of at least 190 g/m<sup>2</sup>; or wherein the number of layers is 25 to 35; or with at least two anti-trauma layers.
13. Collar for a collared ballistic protection vest (10) according to any of the preceding claims, comprising a collar part (1) provided with coupling means (4) for coupling with the torso part, to form in coupled condition the collared protection vest, wherein the collar part (1) is constructed of one or multiple stacks of multi-layered material stacks (4, 4', 4", 4''', 5, 5', 5", 5''', 6, 6', 6", 6''', ), wherein a material stack comprises an aramide fiber or a high-density polyolefin fiber, wherein individual material stacks of the collar part (5) are provided with coupling means (4) outwardly extending in the direction of the torso part (2), to be positioned between individual material stacks of the torso part (6), such that collar part (1) is connectable to the torso part (2) and a continuity in ballistic resistance is provided between torso part and collar part.
14. Method for manufacturing a collared ballistic protection vest (10) comprising a torso part (2) and a collar part (1) according to any of claims 1-12, comprising

the steps of:

- a) providing a multi-layered material stack (6) for the formation of the torso part (2) of a protection vest (10), 5
  - b) providing a multi-layered material stack (5) for the formation of the collar part (1) of the protection vest (10), provided with coupling means (4) extending from the collar part (1) outwardly in the direction of the torso part (2) for coupling with the torso part (2), 10
  - c) inserting the coupling means of the individual material stack of the collar part (4) between two individual material stacks of the torso part (6, 6'), 15
  - d) repeating steps a) to c),
  - e) positioning the coupling means of different material stacks (4, 4', 4'', 4''') in a tilted position in relation to one another, 20
- thereby providing a continuity in ballistic resistance between torso part (2) and collar part (1).

15. Method according to claim 14, wherein the coupling means (4) are sewn to the torso part (2).

25

30

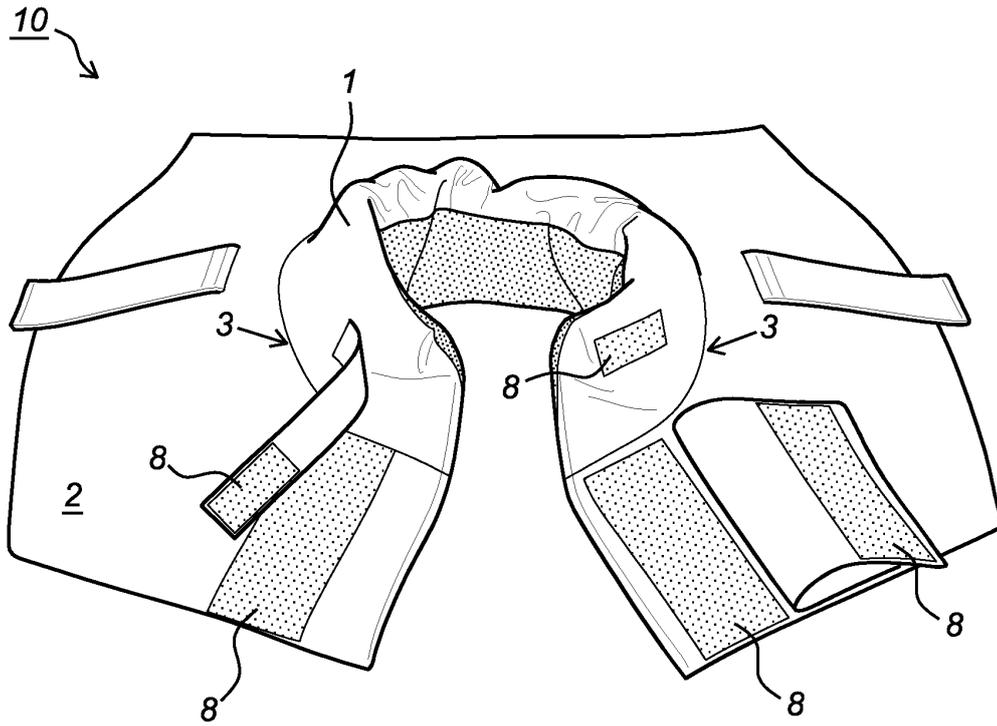
35

40

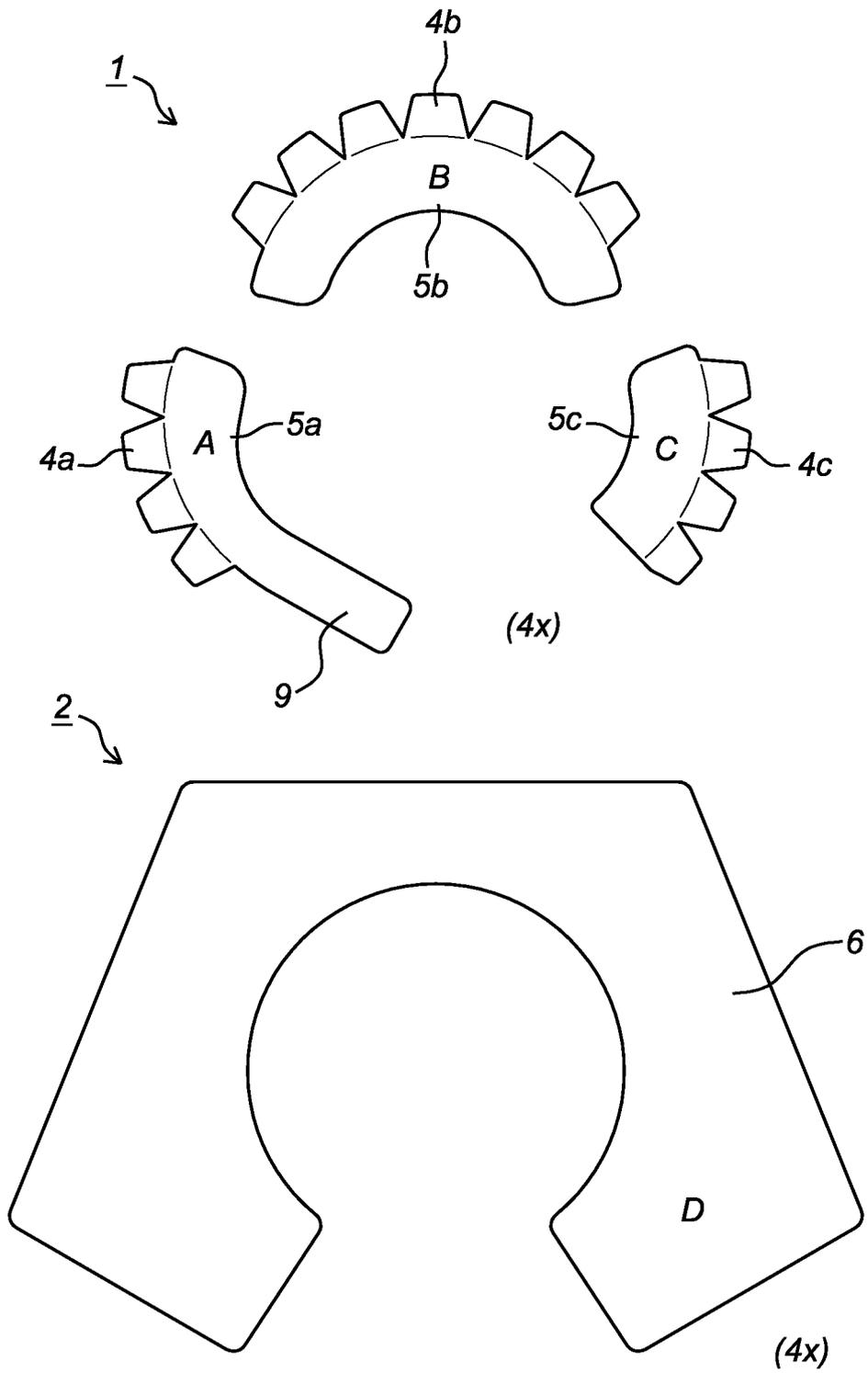
45

50

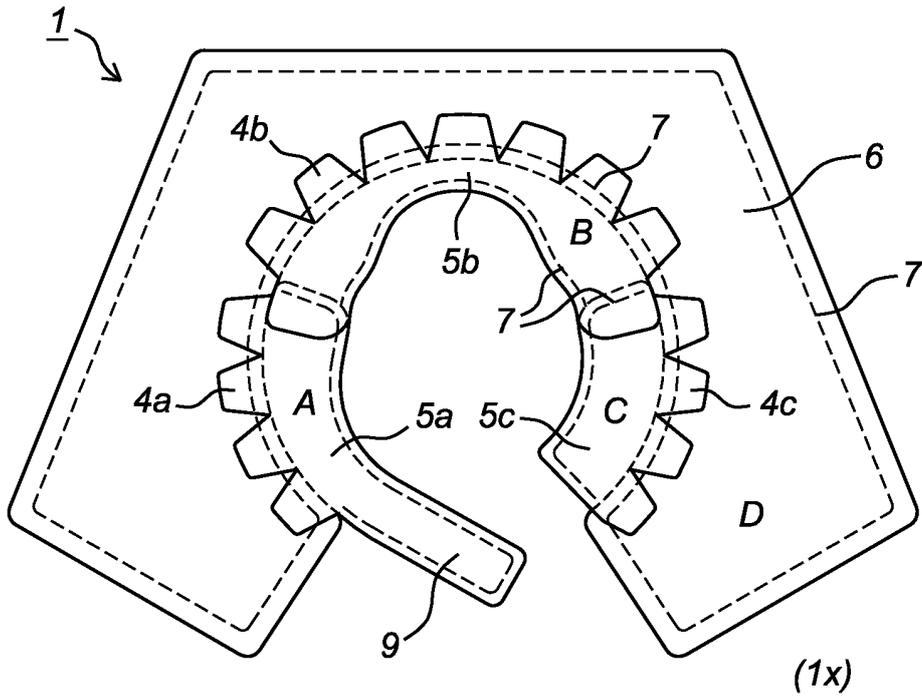
55



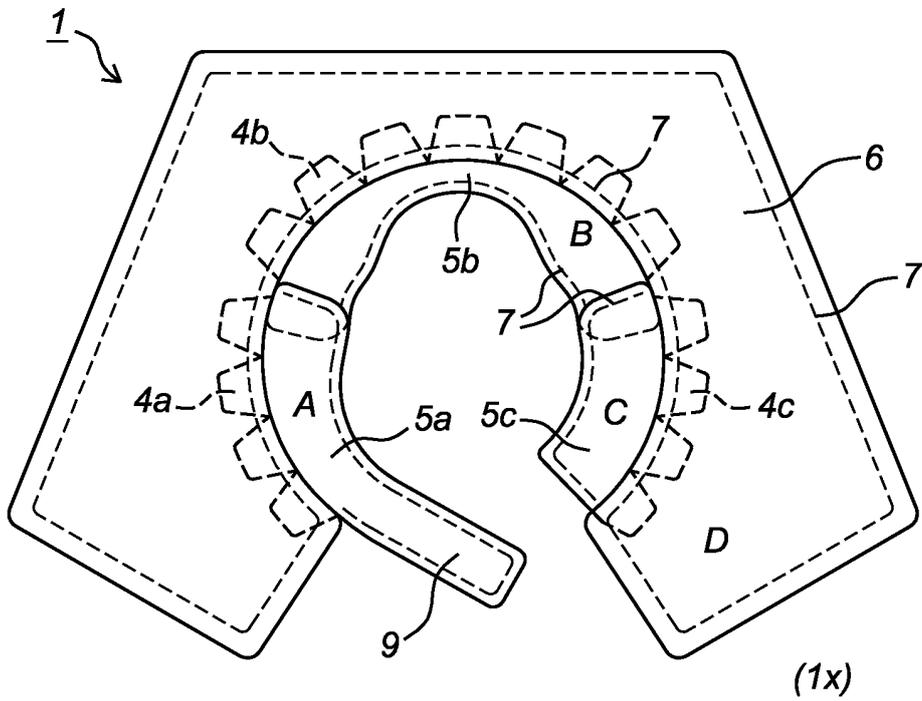
*Prior Art*  
**Fig. 1**



**Fig. 2**



**Fig. 3a**



**Fig. 3b**

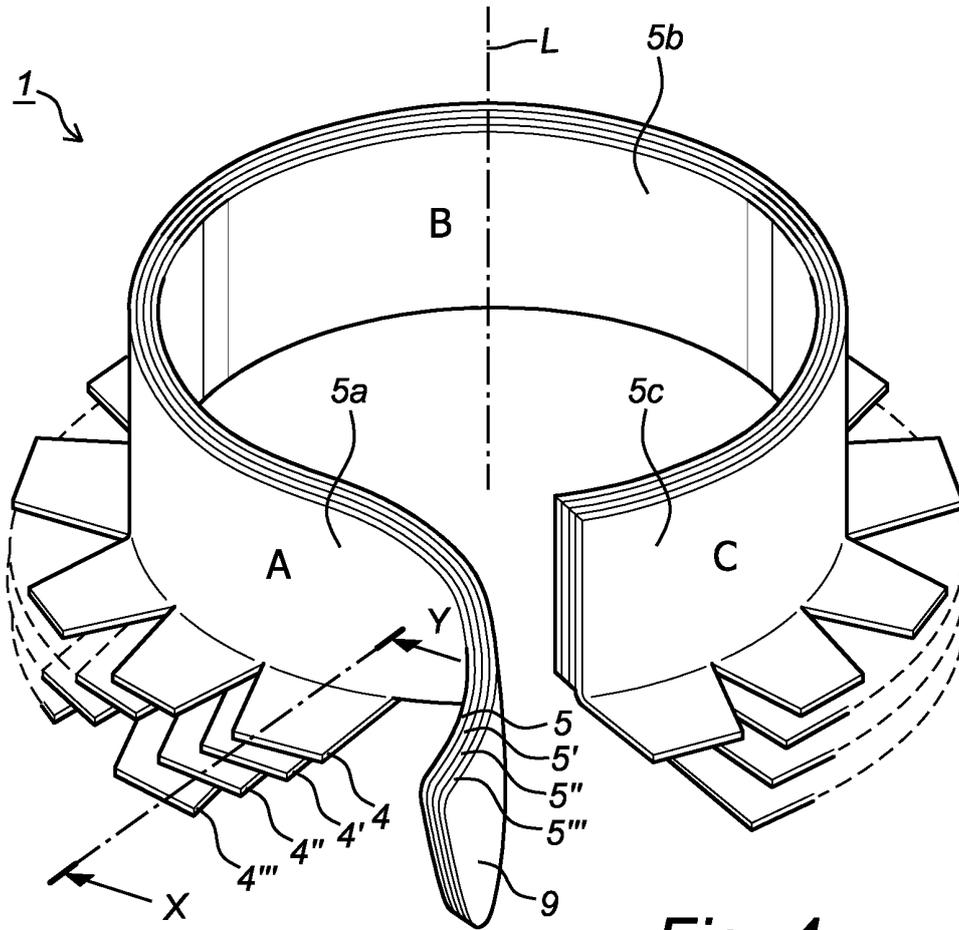


Fig. 4

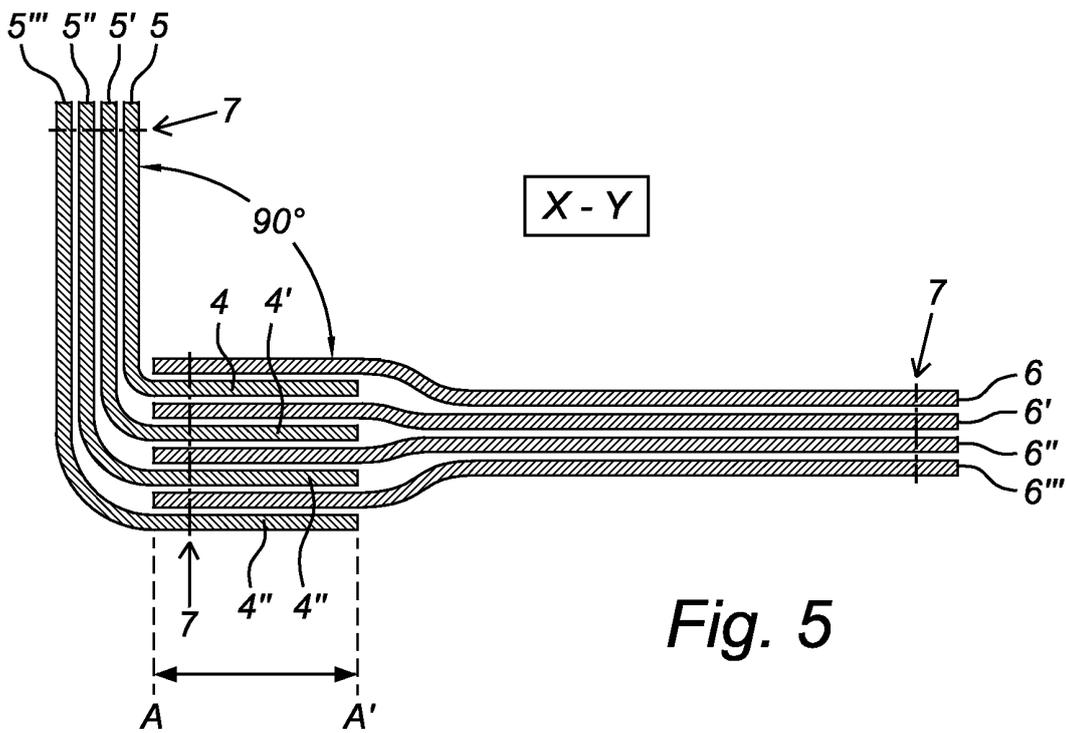
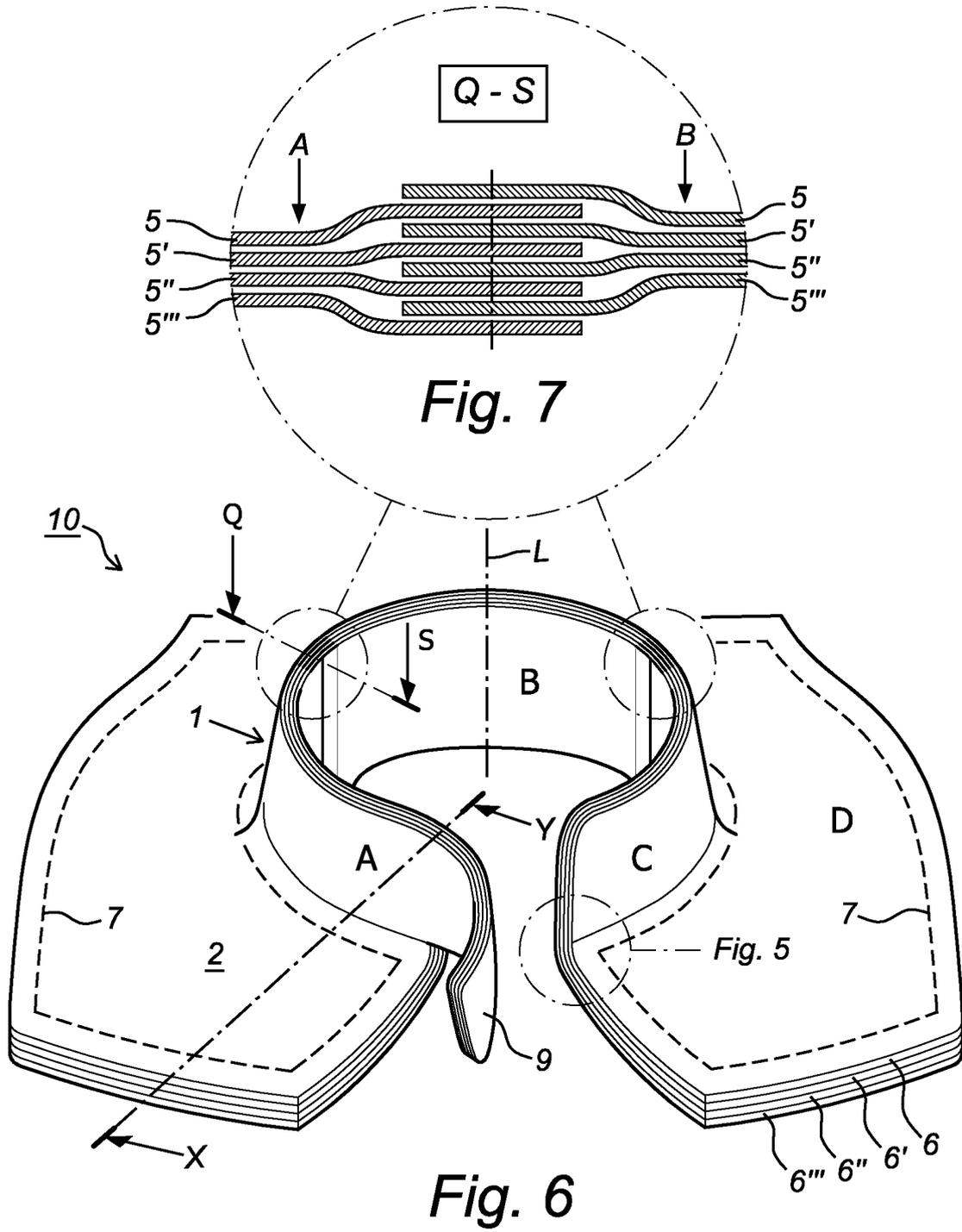


Fig. 5



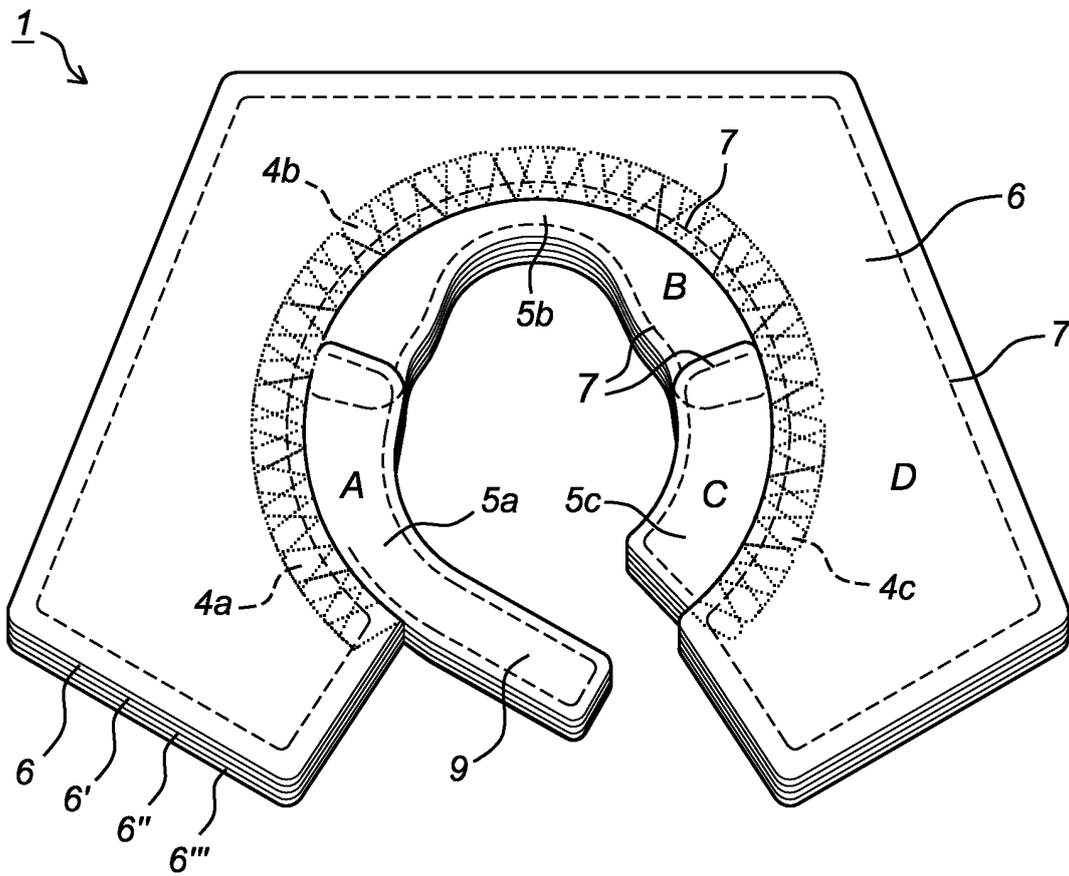
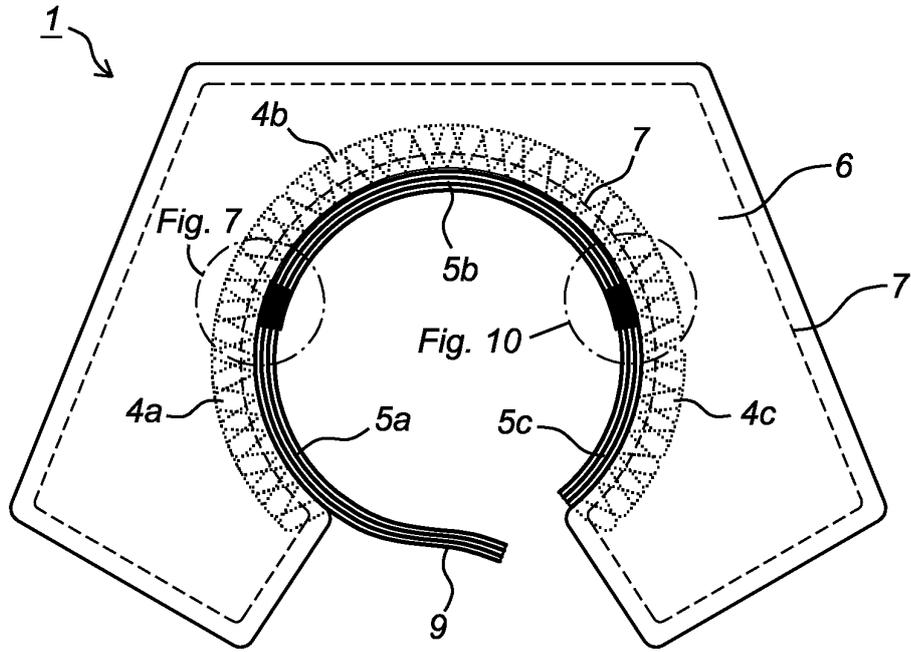
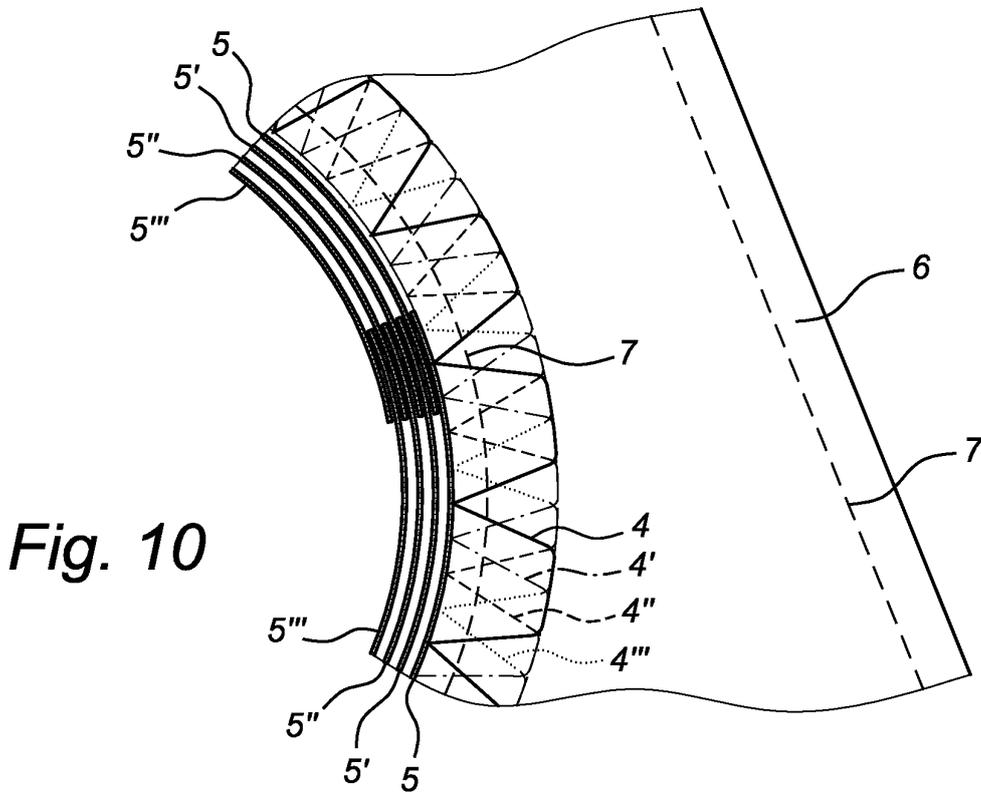


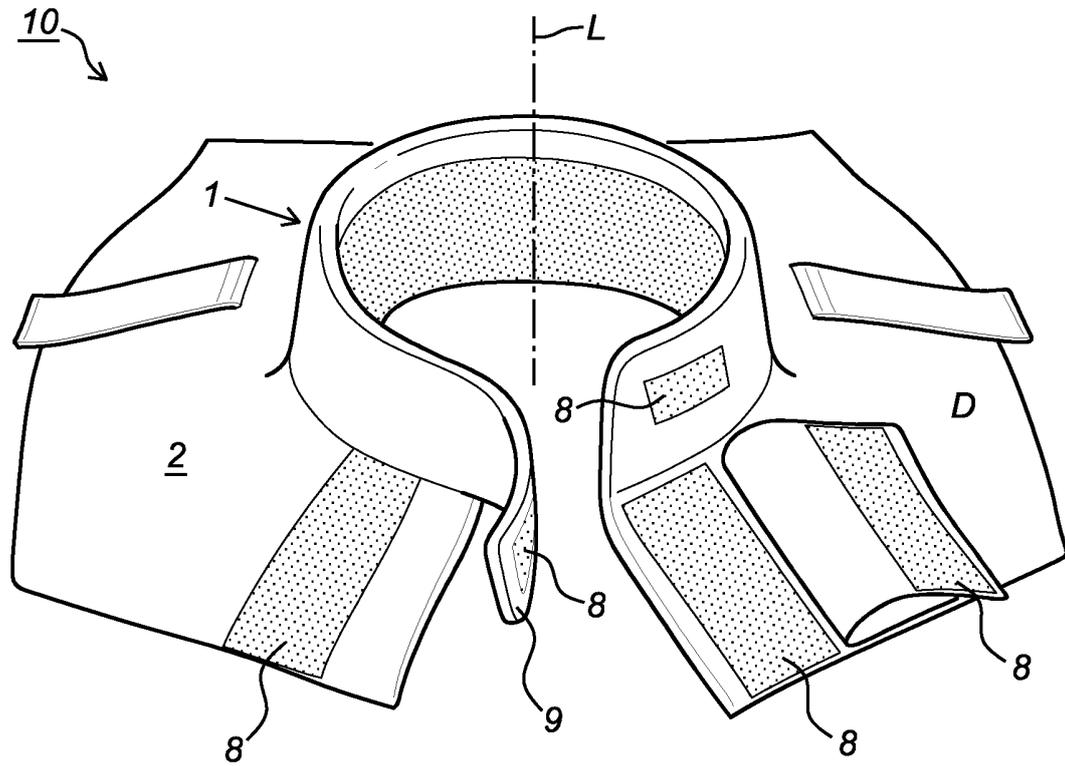
Fig. 8



**Fig. 9**



**Fig. 10**



**Fig. 11**



EUROPEAN SEARCH REPORT

Application Number  
EP 13 18 3808

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	DE 80 24 488 U1 (VAL. MEHLER AG [DE]) 12 March 1981 (1981-03-12) * page 2, line 36 - page 3, line 17 * * page 3a, lines 7-19 * * page 4, line 6 - page 5, line 5 * * page 5, lines 19-22 * * page 6, lines 11-18, 33-36 * * page 7, lines 10-15 * * page 8, lines 6-10 * * figures 1-4 *	1-15	INV. F41H1/02 F41H5/04
Y	US 4 183 097 A (MELLIAN SIRVART A [US]) 15 January 1980 (1980-01-15) * column 1, lines 14-48 * * column 2, line 64 - column 3, line 49 * * figures 1-5 *	1-15	
A	US 2011/061141 A1 (LAZAROWICH LINDA M [CA]) 17 March 2011 (2011-03-17) * paragraphs [0003], [0006], [0008], [0011], [0019], [0021], [0022], [0024] - [0028] * * figures 1, 4 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F41H
Y	KR 101 080 179 B1 (C & AMP S ARMOR TECH LTD [KR]) 7 November 2011 (2011-11-07) * paragraphs [0001], [0002], [0030], [0032], [0033], [0036], [0049], [0051], [0052], [0079] * * figures 1, 3, 14 *	4	
A	WO 2011/093868 A1 (SAFARILAND LLC [US]; WEBER BOB [US]; MILLER DAVID [US]) 4 August 2011 (2011-08-04) * paragraphs [0017] - [0019], [0023] - [0024], [0033] - [0035], [0048] * * figures 1-8 *	1,14	
A	WO 2011/093868 A1 (SAFARILAND LLC [US]; WEBER BOB [US]; MILLER DAVID [US]) 4 August 2011 (2011-08-04) * paragraphs [0017] - [0019], [0023] - [0024], [0033] - [0035], [0048] * * figures 1-8 *	1-15	
		-/--	
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 9 December 2013	Examiner Van Leeuwen, Erik
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document	

EPO FORM 1503 03.82 (P04C01)



EUROPEAN SEARCH REPORT

Application Number  
EP 13 18 3808

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2003/188631 A1 (PARK ANDREW D [US]) 9 October 2003 (2003-10-09) * paragraphs [0016], [0039], [0040] * * figures 1, 4 * -----	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 9 December 2013	Examiner Van Leeuwen, Erik
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document	

3  
EPC FORM 1503 03/82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.

EP 13 18 3808

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

09-12-2013

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 8024488	U1	12-03-1981	NONE	
US 4183097	A	15-01-1980	CA 1115902 A1 US 4183097 A	12-01-1982 15-01-1980
US 2011061141	A1	17-03-2011	CA 2678937 A1 CA 2714870 A1 US 2011061141 A1	16-03-2011 16-03-2011 17-03-2011
KR 101080179	B1	07-11-2011	NONE	
WO 2011093868	A1	04-08-2011	AU 2010344199 A1 CA 2791558 A1 EP 2529175 A1 WO 2011093868 A1	20-09-2012 04-08-2011 05-12-2012 04-08-2011
US 2003188631	A1	09-10-2003	NONE	

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- US 20110145965 A [0012]
- US 20110010830 A [0013]