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(54) **PROTECTIVE ELEMENT**

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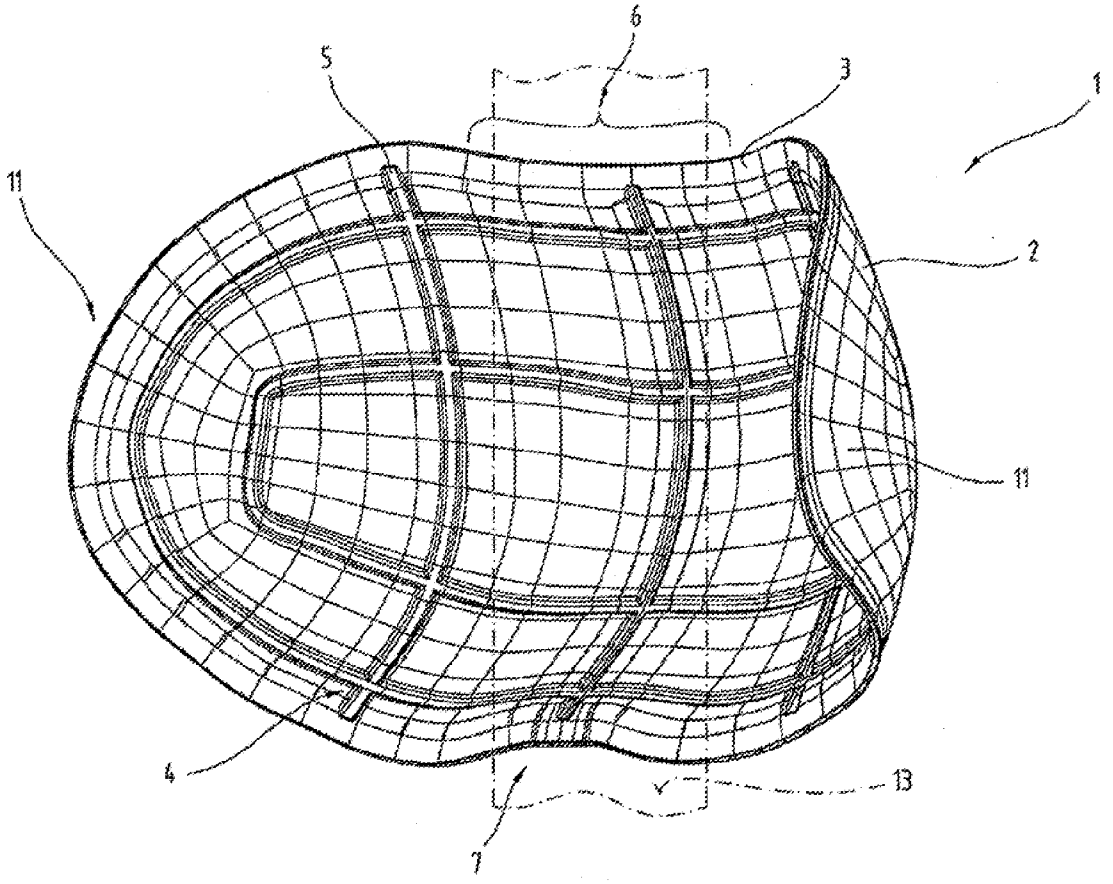
(57) **ABSTRACT**

The invention relates to a protective element for a portion of the human body, comprising a tub-shaped molded piece that has an internal side (IS) facing the body and a compensation layer. The shape of the molded piece is adapted to the human anatomy, in particular the hip or pelvis region. At least some sections of the compensation layer are arranged on the internal side (IS). The molded piece is monolithically formed from a cured composite material, while the compensation layer is made of an elastically deformable foam material and includes a duct system of groove-like depressions on the side facing the body.



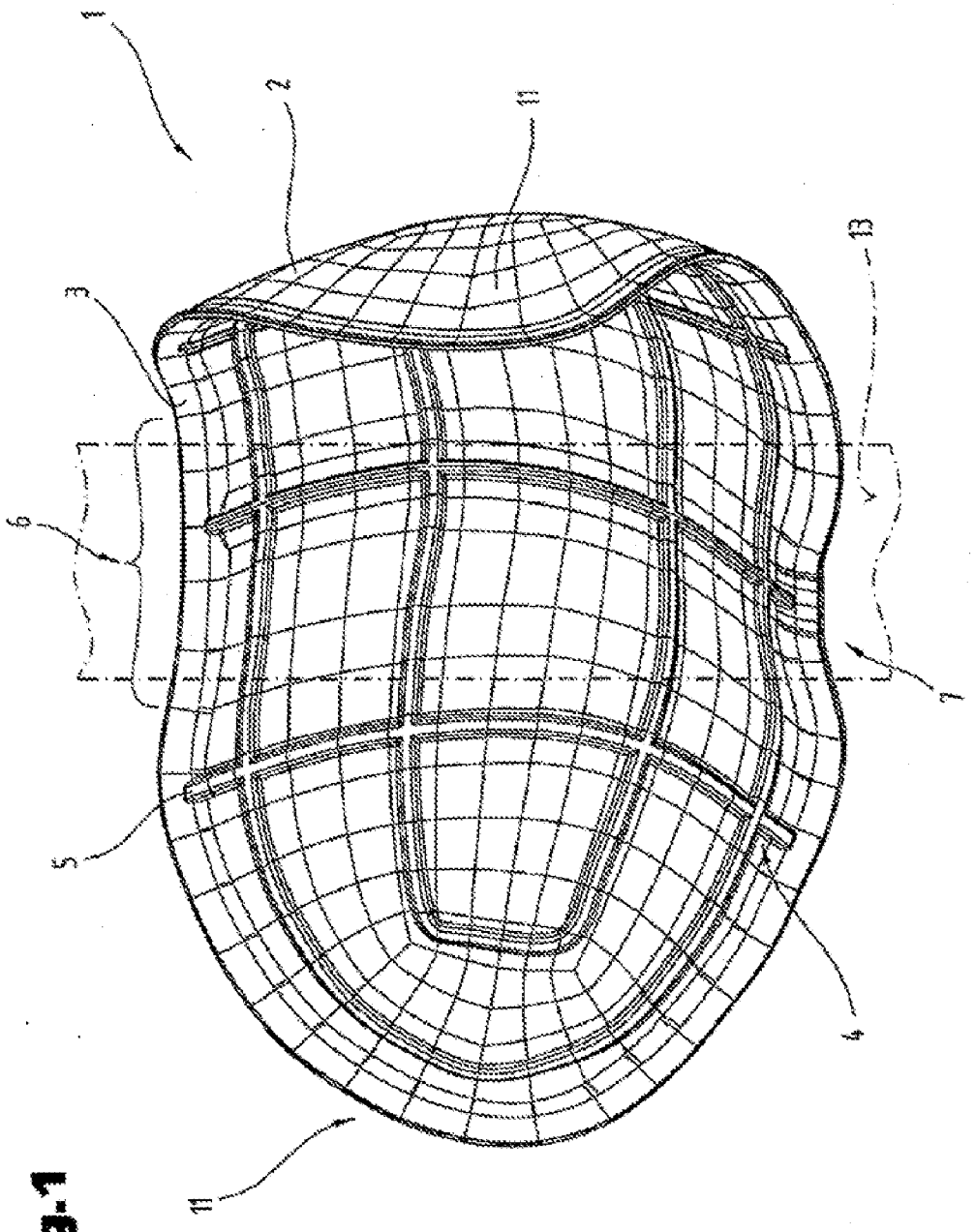



Fig.1

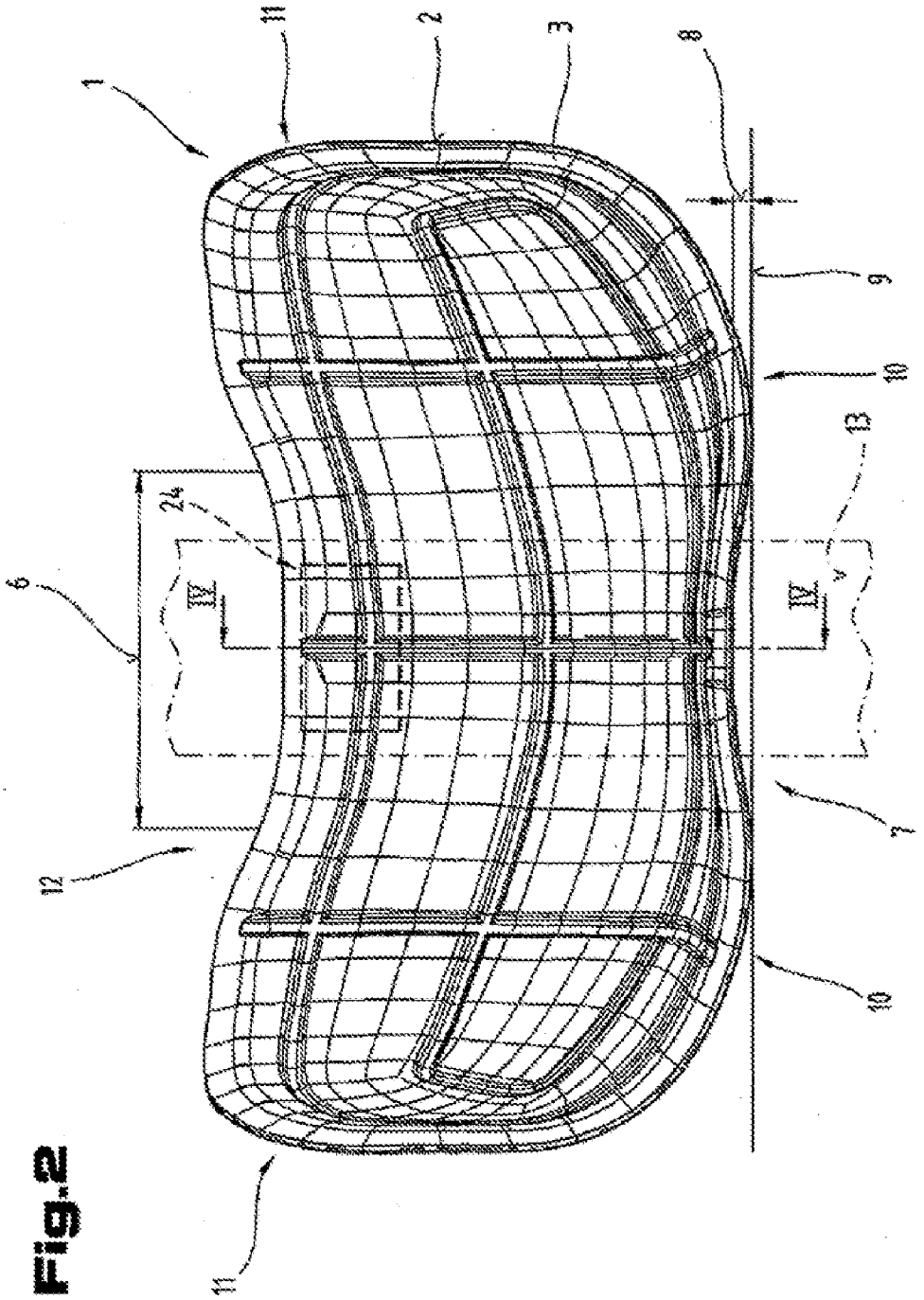



Fig.2

Fig.3

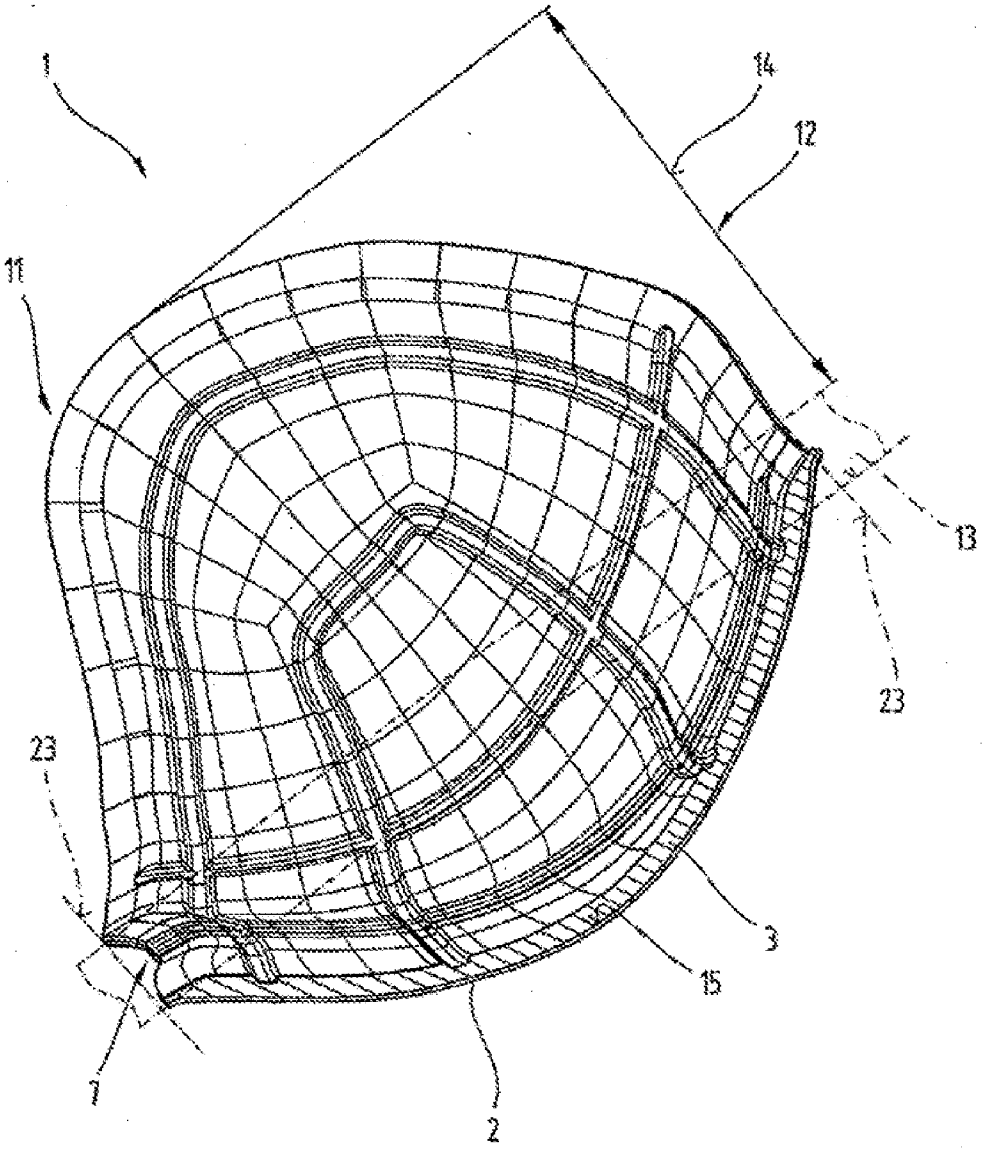


Fig.4

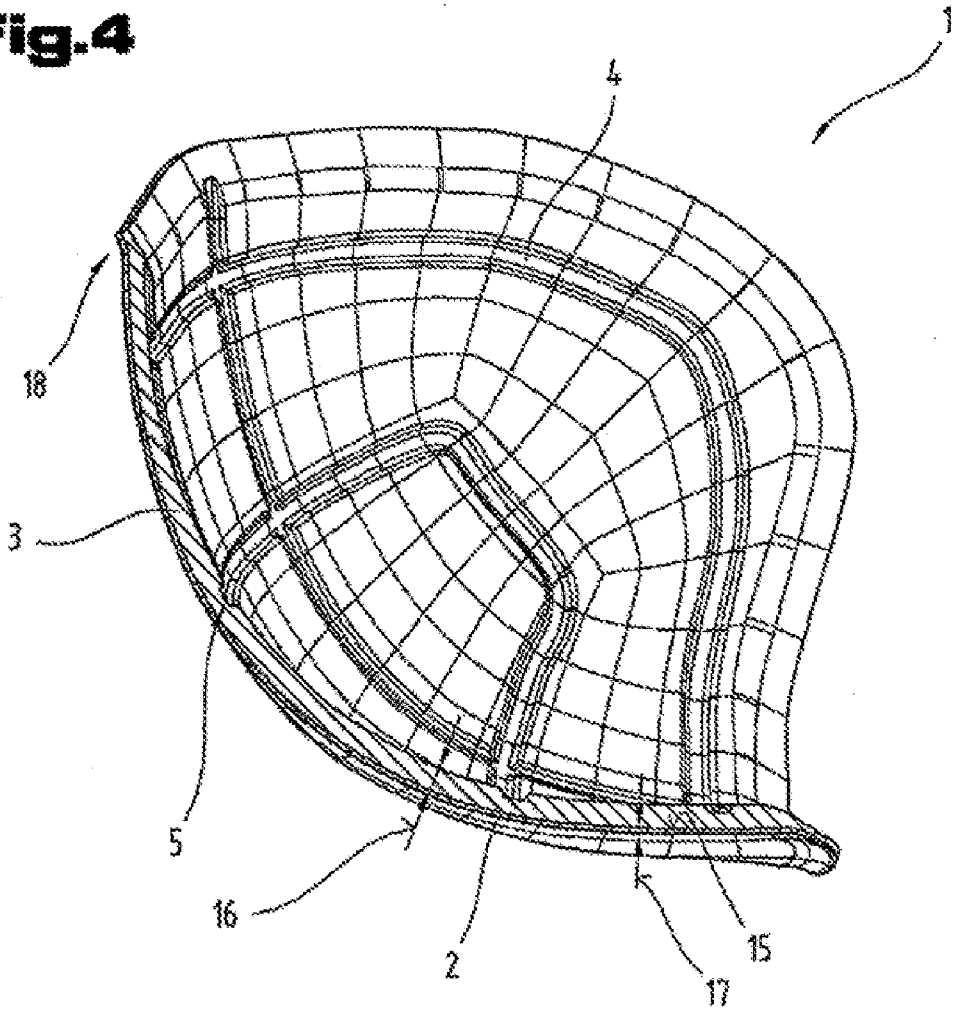
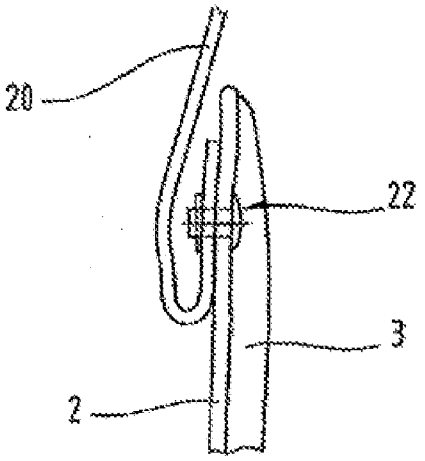



Fig.5b



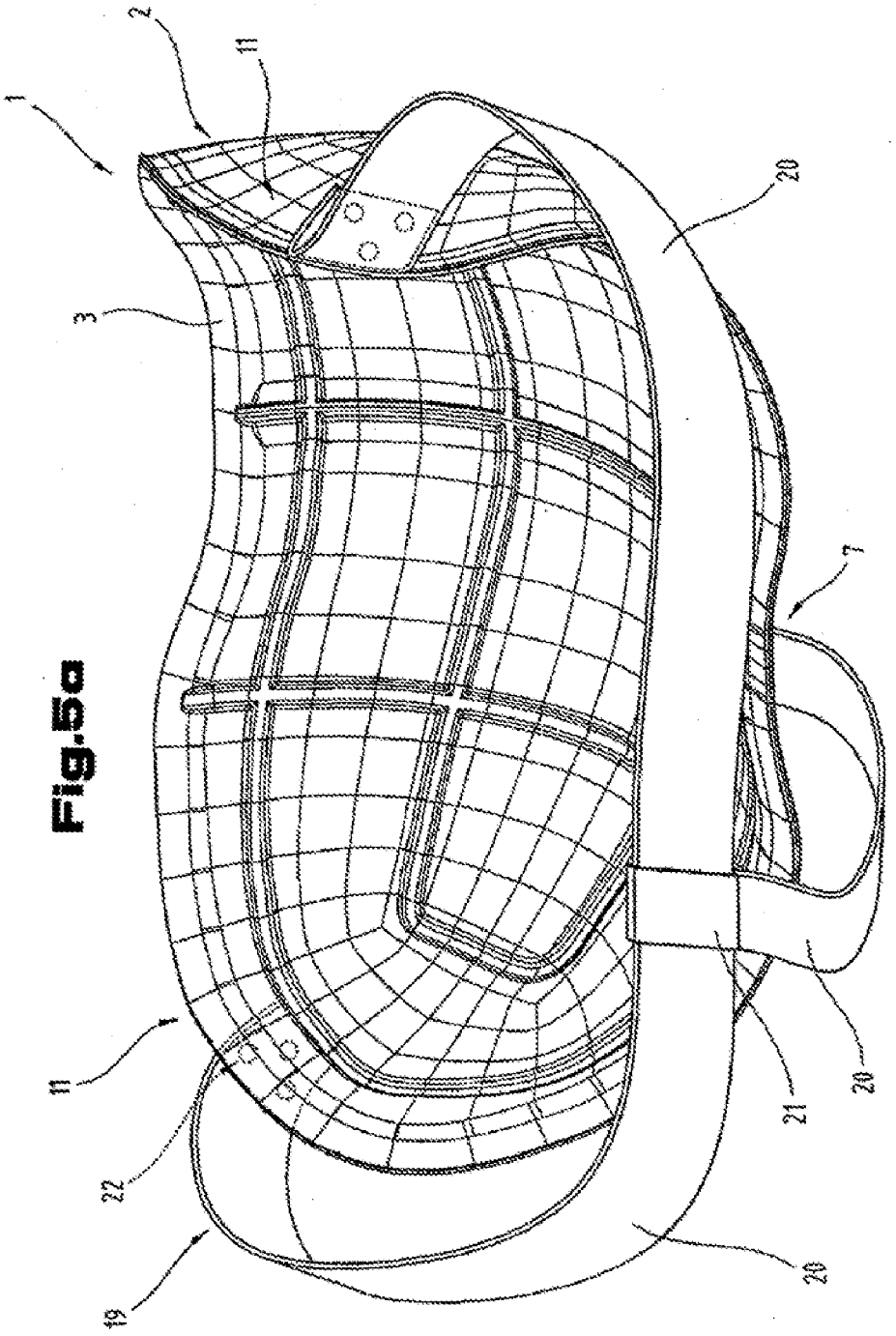



Fig.5a

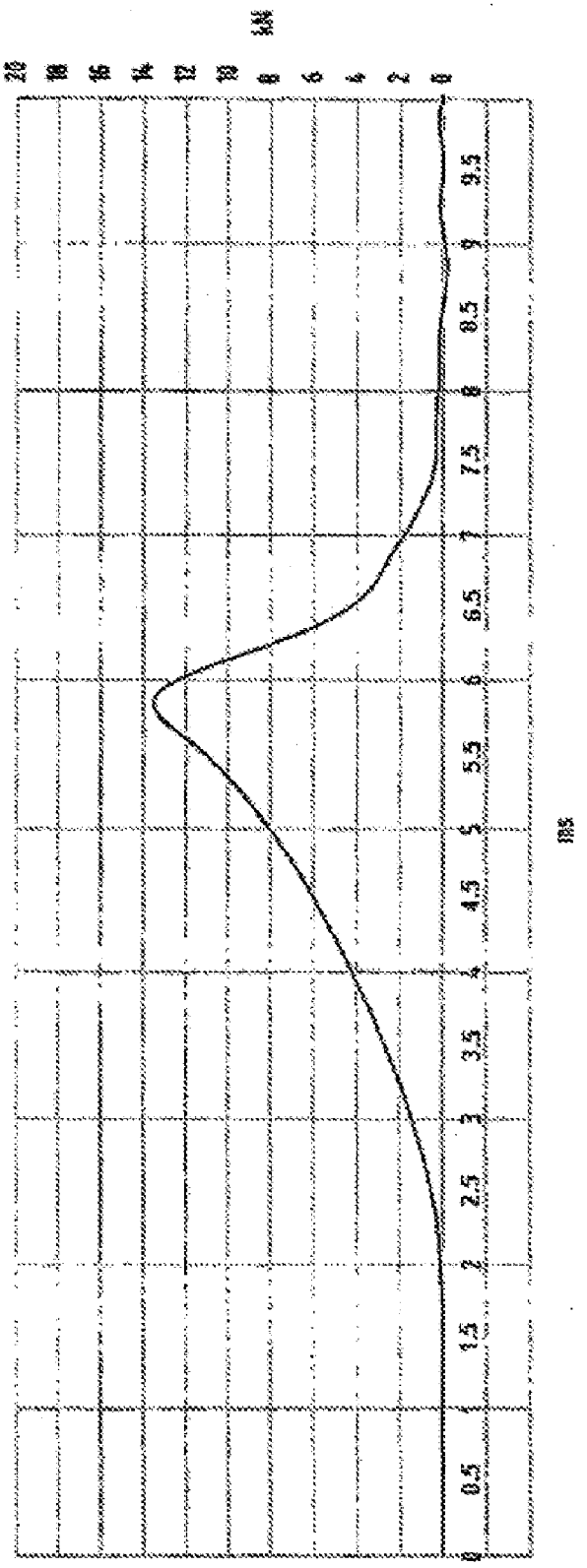

kN
20
18
16
14
12
10
8
6
4
2
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
mm

Fig.6

# PROTECTIVE ELEMENT

**[0001]** The invention relates to a protective element for a portion of the human body.

**[0002]** In a wide variety of physical activities or types of sport there is the possibility in exceptional cases of exposed parts of the body being endangered. In particular, it is then possible for an excessive force to act on the body, and so there is a high risk of injury and the danger of permanent harm. In particular in the area of motorcycle sport, an accident or fall very quickly results in excessively high loading of the pelvis or hip region and consequent serious physical harm. Known items of motorsport clothing therefore have in the region of the hip joints and wings of the ilium, and elsewhere, damping elements which are intended to offer protection in an accident. However, such elements are usually quite small in their overall size and therefore often offer only little protection in the event of exposure to loading in the form of impact. In particular, in the case of such uses there is always the risk of slipping, so that under some circumstances the protective element is not arranged in the intended place in an accident, and consequently the protective effect is to the greatest extent lost. Disadvantages of known protective elements are therefore particularly that they only offer protection in certain portions, the individual protective elements are movable in relation to one another and consequently they do not provide full protection for the pelvis or hip region.

**[0003]** The object of the invention is therefore to provide a protective element for a body part that offers extensive protection to the body part along with great wearing comfort. It is also the object of the invention to design the protective element in such a way that it can be combined with clothing or further protective clothing.

**[0004]** The object of the invention is achieved by the protective element comprising a molded part and a compensating layer, the molded part being formed in one piece from a cured composite material and the compensating layer being formed from an elastically deformable foam material and having, facing the body, a system of channels comprising groove-like depressions. With regard to the mechanical loadings to be expected, a one-piece molded part has the particular advantage that there is no join, and consequently the risk of rupture at such a weak point in the material is prevented. Since the molded part is formed from a cured composite material, it can be adapted particularly well and individually to the anatomical characteristics of different bodies in a non-cured state and consequently retains the specific shape in the cured state. Slight different anatomical details can be compensated in an advantageous way by the elastically deformable foam material, whereby a particularly good fit, and consequently great wearing comfort, is achieved. Since a one-piece cup-shaped molded part encloses the portion of the body that is to be protected, in this portion the moisture exchange between the surface of the body and the surroundings is restricted, which can lead to local accumulations of moisture, and consequently significantly reduced wearing comfort, in particular when such a molded part is worn for some considerable time. According to the invention, the compensating layer thus has a system of channels comprising groove-shaped depressions facing the body, whereby the unavoidably occurring moisture can be led away along these channels to the surroundings, whereby particularly great wearing comfort is achieved in particular.

**[0005]** An embodiment in which the composite material comprises a fibrous material and a curable filler has the advantage in particular that the fibrous material can be adapted very well to the anatomical shape to be formed, and then the filler is subsequently applied or introduced and said filler is cured by means of specific production processes. For example, the composite material may comprise glass-fiber and/or carbon-fiber layers which are impregnated or coated with a resin, in particular an epoxy resin, and subsequently cured by exposure to air, light, temperature and/or pressure. With respect to the process or production steps for composite materials comprising a fibrous material and a curable filler, reference is made to the general knowledge of a person skilled in the art of plastics and composite material technology.

**[0006]** To form a stable molded part which offers a high degree of protection of the body part from loadings occurring, according to a development the composite material has a modulus of elasticity of at least 40 $kN/m^2$. A molded part formed in such a way is consequently capable of absorbing the energy occurring in the event of a crash or an accident, so that substantially puntiform excessive loading of the human body is prevented. Such a stable molded part also has the advantage that the risk of grazing in the event of a fall is significantly reduced.

**[0007]** It is also of advantage if the compensating layer is formed from an elastomer foam, in particular a polyurethane foam, since such foams can be shaped very well and there is consequently good adaptation to the shape of the molded part, and consequently to the anatomy of the body. Since the compensating layer is arranged between the body and the comparatively stiff molded part, and is consequently ultimately relevant for wearing comfort, this development is also of advantage since elastomer foams adapt themselves in an elastically deformable manner to the actual anatomical characteristics, and consequently great wearing comfort is achieved even when the item is worn for some considerable time.

**[0008]** For reliable protection of the pelvis, an advantageous development is one in which the molded part has two side pieces, which extend beyond a plane that is defined by tangents to the peripheral lines of a central portion of the molded part. The side pieces are particularly formed in such a way that they laterally cover at least the hip joints and in certain portions also the wings of the ilium, so that, when exposed to force from the side that would act directly on the region of the hip joints or wings of the ilium without the protective element, the force acting is absorbed by the molded part, whereby this force is distributed over a larger surface area, which in turn reduces the risk of puntiform overloading, and consequently of injury.

**[0009]** For pleasant wearing comfort, it is also of significance if the protective element is formed as thinly as possible, since this protective element is preferably worn under a further item of protective clothing. According to a development, the molded part therefore has a thickness of between 0.7 and 1.7 mm, which has the advantage in particular that the composite material already offers sufficiently high strength, that is to say can absorb well and correspondingly dissipate the loading forces occurring, but at the same time is still flexible enough that it can still elastically deform in response to movements of the body part to the extent that once again great wearing comfort is achieved.

**[0010]** With regard to greatest possible wearing comfort in combination with a good protective effect, an advantageous development is one in which the compensating layer has an

average thickness of 8.5 mm, since this thickness provides a good degree of damping of the foam material, but the entire protective element is still sufficiently thin to be able to be worn under an item of protective clothing. Alternatively, however, a thickness of the foam in the range from 8.5 mm to 12 mm is possible.

**[0011]** According to a development, the depth of the depressions lies in the range between 20% and 45% of the thickness of the compensating layer, which has the advantage that the damping and compensating properties of the compensating layer are only insignificantly restricted, but the moisture occurring is reliably transported away. This development also has the advantage that impairment of the wearing comfort is prevented, since these depressions consequently cannot press as a reverse impression into the surface of the body. The transition from the body-facing side of the compensating layer to the groove-like depression is preferably continuously formed, so that there are no unpleasant edges occurring in this region, which once again is of advantage for wearing comfort. The width of the depression is preferably about 70% of the thickness of the compensating layer, since this prevents the skin from being pressed into the depression and, as a consequence, reduced wearing comfort. This development advantageously ensures that it is possible for moisture to be adequately transported away, without thereby reducing the wearing comfort, in particular without any occurrences of the skin being pressed into the groove-like depressions.

**[0012]** According to a further possible embodiment, the system of channels is arranged facing the inner side of the molded part, which has the advantage that the surface of the compensating layer that is facing the body is substantially smooth, that is to say has no depressions. For transporting the moisture to the system of channels, the compensating layer may be transparent to moisture, that is to say the material of the compensating layer is permeable to moisture. Furthermore, it is possible to provide between the body-facing side of the compensating layer and the system of channels a plurality of connecting portions via which moisture can be led away from the body. Furthermore, a moisture-permeable layer may be arranged on the body-facing side of the compensating layer, and thereby prevent a buildup of moisture between the body and the compensating layer.

**[0013]** To achieve high-grade protection, the protective element will usually lie quite closely against the body, it being possible during use as intended for there to be a slight, and possibly-locally limited, relative movement between the body and the protective element. Therefore, an advantageous development is one in which the compensating layer is connected in certain portions to the inner side of the molded part, since the compensating layer can consequently take over these relative movements and remains substantially at rest in relation to the body, so that the risk of chafing points, and accompanying wound formation, is prevented. In the event of an accident, this development also has the advantage that the damping, function of the compensating layer is retained, even if there are slight deformations or displacements of the molded part.

**[0014]** Since the protective element is preferably intended to be arranged such that it lies as closely as possible against the body, in order in the event of an accident to be held reliably at the respective position, an advantageous development is one in which a flexible holding device is arranged on the molded part. This holding device may, for example, be formed by flexible securing straps, which are connected to the molded part in a contact portion of the molded part, preferably in the region of the side pieces. A preferred embodiment of the holding device is one in which it is formed as a so-called three-point belt, in which flexible securing straps, for example of a high-strength sailcloth, respectively extending from a side piece and from the central part of the molded part, are connected to one another by means of a closure in such a way that they can be opened. Particularly reliable fixing of the protective element in relation to the body is achieved by this three-point belt.

**[0015]** With regard to the arrangement of the protective element according to the invention in an item of protective clothing, for example protective motorcycle clothing, an advantageous development is one in which a contact portion is arranged in the central portion of the molded part, since this allows the molded part to be connected to a back protector. Items of protective clothing usually have such a protector, this development being of advantage to the extent that a continuous protective element for the spinal column and the pelvis is created, offering corresponding flexibility and yet ensuring at the same time that this protective element forms a coherent unit and, in particular, always remains arranged at the respectively intended place.

**[0016]** With regard to the wearing comfort, an advantageous development is one in which the peripheral portion of the molded part has a curvature opposed to the curvature of the inner side. Since the molded part, is formed from a composite material, the strength of which is at least significantly greater than that of the human body, it may happen during body movements, for example when walking, that the edge of the molded part presses unpleasantly into adjacent parts of the body. If the curvature of this peripheral portion is thus formed such that it is opposed to the curvature of the inner side, the peripheral portion will be bent outwardly, that is to say away from the body, whereby significantly increased freedom of movement, and consequently improved wearing comfort, is achieved.

**[0017]** On account of the anatomical characteristics, the inward curvature of the upper leg in the region of the groin that occurs when sitting produces an inward curvature of the outer contour of the body. It is therefore once again of advantage for wearing comfort if the molded part has in the central portion an inwardly curved portion facing the body. In particular, this improves sitting comfort, since the molded part makes allowance for the natural, anatomical characteristics, and there is consequently no increased bearing pressure in the region of the upper leg.

**[0018]** Another development may also be that a moisture-permeable layer is arranged on the body-facing side of the compensating layer, since this prevents the compensating layer from being in contact with the skin directly, or separated only by a thin layer of material, which is of advantage in particular for transporting moisture away. By means of this moisture-permeable layer, the unavoidably occurring moisture can be led away well to the system of channels, which once again improves wearing comfort.

**[0019]** For better understanding of the invention, it is explained in more detail on the basis of the following figures.

**[0020]** In a highly schematically simplified representation in each case:

**[0021]** FIG. **1** shows a perspective representation of the protective element according to the invention;

**[0022]** FIG. **2** shows a front view of the protective element according to the invention;

**[0023]** FIG. **3** shows a sectional representation of the protective element according to the invention to illustrate the lateral protective pieces;

**[0024]** FIG. **4** shows a sectional representation of the protective element according to the invention to illustrate the layer structure;

**[0025]** FIG. **5** *a*) shows a holding device for fixing the protective element according to the invention to the body;

**[0026]** *b*) shows a representation of a detail of a possible connection of the holding device to the protective element;

**[0027]** FIG. **6** shows a test record for a drop test in accordance with DIN 1621-1.

**[0028]** It should be stated at the outset that, in the embodiments variously, described, the same parts are provided with the same reference signs or the same component designations, it being possible for the disclosures contained in the description as a whole to be transferred analogously to the same parts with the same reference signs or the same component designations. The position indications chosen in the description, such as for example upper, lower, to the side etc., also refer to the figure being described and depicted at the particular time and, if the position is changed, can be transferred analogously to the new position. Furthermore, individual features or combinations of features from the various exemplary embodiments shown and described may also represent in themselves solutions that are independent, inventive or according to the invention.

**[0029]** All indications of ranges of values in the present description should be understood as also including any and every subrange, for example the indication 1 to 10 should be understood as meaning that all subranges between the lower limit 1 and the upper limit 10 are also included, i.e. all subranges beginning with a lower limit of 1 or more and ending with an upper limit of 10 or less, for example 1 to 1.7, or 3.2 to 5.1 or 5.5 to 10.

**[0030]** FIG. **1** shows the protective element **1** according to the invention, comprising a molded part **2** and a compensating layer **3**, the compensating layer **3** being arranged on the inner side **15** of the molded part **2** that is facing the body. Furthermore, the compensating layer has a system of channels **4**, which is formed by a plurality of groove-like depressions **5** connected to one another. These depressions **5** are facing the body and make it possible for the moisture given off by the body to be transported away out of the cup-shaped protective element **1**. Since the molded part is formed from a composite material, which is usually not moisture-permeable, this system of channels **4** ensures that the moisture is transported away, which is of advantage in particular when the protective element is worn for some considerable time. In a central portion **6**, the molded part **2** has on the lower side an inward curvature **7**, which once again improves the wearing comfort, since as a result the areas of attachment of the upper leg are supported anatomically correctly. In the document, the lower side refers to any portion of the protective element **1** that is oriented in the direction of a bearing surface when the protective element is arranged on the body. Accordingly, the upper side is oriented in the direction of the spinal column or the shoulder region.

**[0031]** FIG. **2** shows a front view of the protective element **1** according to the invention, the anatomically shaped inward curvature **7** being clear to see here. In particular, this inward curvature **7** has a distance **8** from the base plane **9** of the portions **10** of the upper leg protection.

**[0032]** As can be seen in FIGS. **1** and **2**, the molded part **2** is of a cup-shaped form and has in particular a predominantly concave curvature, facing the body. This cup shape in combination with the concave curvature offers particularly great torsional resistance and dimensional stability, which is of most particular significance especially for impact protection. The inward curvature **7** in the region of the coccyx consequently improves the wearing or fitting comfort and serves furthermore as a structural stiffening element for increasing the mechanical strength of the molded part **2**.

**[0033]** The protective element **1** according to the invention also has two laterally arranged side pieces **11**, which are formed in such a way that protection of the hip joints from laterally acting forces is achieved.

**[0034]** The upwardly aligned central region **6** has a clearance **12** in comparison with the highest extent in the region of the side pieces **11**, which is of advantage in particular to the extent that reliable protection of the lower lumbar vertebrae or the sacrum is provided, but the clearance **12** means that freedom of movement is not restricted in the region of the lumbar vertebrae. Furthermore, known back protectors are usually formed in such a way that they cover at least the region up to the lumbar vertebrae, and consequently a protective element **1** without a clearance **12** could possibly give rise to a hindrance in this region. In a development, a contact portion **24**, by way of which the protective element **1** according to the invention can for example be connected to a back protector, may be arranged on the outer surface of the molded part **2** in the upper region of the central portion **6**, whereby a continuous protective unit for the spinal column and the pelvis is formed.

**[0035]** FIG. **3** then shows a representation of a detail of the side pieces **11**; in particular, the figure shows that the side pieces extend well beyond a plane **13** by a distance **14**, the plane **13** being defined by tangents **23** to the peripheral lines in the central portion **6** of the molded part. This has the particular advantage that there is reliable protection of the hip region, without the molded part, and consequently the protective element, having to be made unnecessarily large as a result, which would be disadvantageous particularly for wearing comfort.

**[0036]** FIG. **3** also shows that, on account of the clearance **12** or inward curvature **7**, a particularly compact, cup-shaped molded part is formed, whereby particularly great wearing comfort is achieved, in particular even when the wearer of the protective element **1** according to the invention is standing or walking. The large-area side pieces, extending far beyond the cup-shaped portion of the molded part, have the effect of achieving reliable protection of the hip region, and in particular the cup-shaped form has the effect of achieving particularly great stiffness, and consequently very reliable protection of the wearer.

**[0037]** FIG. **4** shows a sectional representation through the protective element **1** according to the invention. The compensating layer **3** is connected to the molded part **2**, it being possible for this connection to be provided in certain portions. However, it is also possible for the compensating layer **3** to be connected to the inner side **15** of the molded part over its full surface area, for example by adhesive bonding. However, it is also possible for the compensating layer **3** to be introduced into a mold in which the molded part **2** has been placed and to cure in this shape, including the reverse impression to form

the system of channels **4**. The compensating layer **3** preferably has an average thickness **16** of 8.5 mm, although an average thickness in the range from 6 mm to 12 mm is also possible. For example, a thinner compensating layer may be chosen for a smaller likely weight loading, and similarly a thicker compensating layer may be arranged for a greater weight loading or a desired greater damping.

**[0038]** According to a preferred embodiment, with an average thickness **16** of the compensating layer of 8.5 mm, a groove-shaped depression **5** of the system of channels **4** has a depth of 2 mm and a width of 6 mm. For adaptation to different body geometries on account of different body dimensions, a number of basic sizes of the molded part or the compensating layer are formed, the dimensions of the depressions **5** of the system of channels **4** substantially changing linearly. In particular, a size variation by up to 25% is provided.

**[0039]** The mechanical strength and required load-bearing capacity are provided by the molded part **2**, this part having a thickness **17** in the range between 0.7 mm and 1.7 mm, a thickness of 1.2 mm being preferred. With this preferred thickness, the molded part is sufficiently stable to be able to absorb the likely loadings and protect the body part correspondingly, though at the same time the molded part is still flexible enough to make an adaptation to the anatomical characteristics possible, in particular during movements as can occur when walking. With regard to the least possible restricted freedom of movement, it is also envisaged to curve the peripheral portion **18** of the molded part outwardly, that is to say away from the body, in order to prevent the stiff periphery of the molded part from pressing against the body during movement, which is disadvantageous for wearing comfort. In this peripheral portion it is also provided that the compensating layer **3** has a tapering thickness, in order as a result to achieve a periphery of the protective element **1** that is as narrow as possible.

**[0040]** Glass fiber or carbon fiber may be used for example as the fibrous material of the composite material, the mixing ratio of fiber and resin allowing different strength values to be set. According to the mixing rule specified below, the modulus of elasticity (E**11**) for the composite of a single layer in the longitudinal direction of the fiber is determined as follows:

$$E_{11}=\phi f*Ef+(1-\phi f)*Ef$$

where the following designations apply:

ϕf proportion by volume of the fiber

Ef modulus of elasticity of the fiber

EM modulus of elasticity of the resin (filler)

**[0041]** Moduli of elasticity for fibrous materials (in the longitudinal direction of the fiber) are given by way of example in the following list:

| | |
|---|---|
| carbon fiber (T300 fiber) | 230 000 N/mm$^2$ |
| carbon/Kevlar woven fabric | 130 000 N/mm$^2$ |
| glass fiber woven fabric | 70 000 N/mm$^2$ |
| epoxy | 3500 N/mm$^2$ |

**[0042]** A mixing ratio of 25% to 45% of a T300 carbon fiber in an epoxy resin is preferably chosen, thereby achieving a modulus of elasticity of the composite material of about 45 000 N/mm$^2$. At this mixing ratio, a single layer of the composite material has a thickness of about 0.4 mm, so that a molded part of the desired thickness and strength is formed by arranging multiple single layers.

**[0043]** This mixing ratio of the composite material creates a molded part which has an extremely high impact strength and at the same time can absorb well the forces acting, so that even a force acting in a puntiform or linear manner is uniformly transmitted to the molded part. For protective elements there is a corresponding drop test in accordance with DIN 1621-1 and DIN 1621-2, an article with a weight of 5 kg hitting the protective element from a height of one meter without being retarded, which produces a force effect that would act on an unprotected body of 150 kN. To determine the protective effect, the force profile and the maximum force that acts on the part to be protected are measured. On account of the cup-shaped form and with the preferred combination of materials, it has been possible to achieve very good damping and a very uniform force profile. The maximum force acting of 13.48 kN is achieved in this case 5.83 ms after the test part hits the protective element, which means that there is outstanding damping and, together with the very uniform profile of the increase in force, means that there is a very good protective effect. In particular, the values for the force transmission to the body are well below the limit values stipulated by the standard. DIN 1621-1 concerns protection of the pelvis and hips and stipulates for this a maximum force that may act on the body of 25 kN. DIN 1621-2 concerns protection of the back and stipulates for this a maximum force of 17 kN. FIG. **6** shows in this respect a record of the measurement carried out.

**[0044]** In particular, the composite material is understood here as meaning any material or any material combination in which a fibrous material and a curable filler are joined together, the filler permanently enclosing and fixing the fibrous material after the curing of the filler. This achieves an increase in the strength of the material as a whole that would not be achievable with the individual components without a much greater requirement for material, and consequently a much greater wall thickness, having to be accepted.

**[0045]** The fibrous material may thus take the form, for example, of a woven fabric, which is placed in the filler and in turn covered with filler. The steps may then be repeated a number of times until a molded part that has the sufficient or desired strength is formed. Preferably used for this purpose is a negative mold of the molded part in which this layer structure is formed, the molded part being removed after curing of the filler. Furthermore, the fibrous material may be impregnated with the filler or wetted by it and thus applied together.

**[0046]** A further possible embodiment is one in which the fibrous material is dispersed in the filler and is consequently applied together with the application of the filler, for example once again to a negative mold. This embodiment also has the advantage that molding, in particular injection molding, is also possible. In this case, the filler is pressed together with the fibrous material into a cavity, the cavity corresponding exactly to the volume of the molded part to be formed. One possible example of this is polypropylene with, a dispersed proportion of glass fibers of about 25%, it being possible for the proportion of fibers to vary in order to achieve a corresponding strength. Polypropylene has the advantage that it already has a high basic strength, and in particular a high impact resistance, without anything being added, which is of particular advantage for use as a protector. Apart from, or in addition to, admixing glass fibers, carbon fibers may also be dispersed, thereby allowing the strength of the formed

molded part to be increased further. Plastics, in particular thermoplastics, also have the advantage that an individual adaptation to specific anatomical characteristics of the wearer is possible. For this purpose, the molded part is specifically heated, whereby the plastic becomes deformable again, and can consequently be adapted, the dispersed fibers thereby likewise being newly aligned. After cooling down, the individually adapted shape is obtained.

**[0047]** FIG. **5** then shows a development in which a flexible holding device **19** is arranged on the protective element **1** according to the invention, this holding device preferably being formed as a so-called three-point belt. In the case of such an embodiment, two belt straps **20** are connected to the molded part **2** at the side pieces **11**, and a further belt strap **20** is connected to the molded part in the region of the inward curvature **7**. The three belt straps **20** are connected to one another by means of a closure element **21**, and consequently ensure that the protective element **1** is reliably fixed on the body, and in particular is reliably held in its intended position for protecting the pelvis or the hip joints. The belt straps **20** may be formed for example from sailcloth, which makes a particularly high strength possible with at the same time great flexibility and a thin form. The closure element may be formed by a mechanically engaging and releasable catch element, a form of the Velcro type of fastener being preferred. The connection of the belt straps **20** to the molded part **2** may take place for example by means of an adhesive connection, but a connection by means of a mechanical clamping connection is also possible.

**[0048]** FIG. **5***b* shows for this purpose a representation of a detail of a possible connection. In this case, the belt strap **20** is connected to the molded part **2** by means of a mechanical clamping connection **22**, for example a rivet. The portion of the connecting means **22** that is facing the body is preferably covered by the compensating layer, so that as a result no impairment of the wearing comfort can occur. The example represented shows one possibility of connecting a belt strap to a molded part, a person skilled in the art being familiar with further possibilities for establishing such a connection. The protective element according to the invention thus advantageously offers great wearing comfort both when sitting and when moving, for example when walking, without the protective effect being impaired as a result. Furthermore, the compact form of this protective element makes it possible for it to be worn under further protective clothing, once again the compact structure having the effect that the freedom of movement of the wearer is not restricted, or only insignificantly. A development with a holding device has the effect of achieving a particularly simple arrangement of the protective element on the body and also ensuring that the protective element is held reliably in its intended position.

**[0049]** The exemplary embodiments show possible configurational variants of the protective element, it being noted at this point that the invention is not restricted to the configurational variants of the same that are specifically shown, but that, rather, various combinations of the individual configurational variants with one another are also possible and this possibility for variation on the basis of the teaching for technical action that is provided by the present invention is within the ability of a person skilled in the art engaged in this technical area. Therefore, all conceivable configurational variants that are possible by combinations of individual details of the configurational variant that is shown and described are also covered by the scope of protection.

**[0050]** As a matter of form, it should finally be pointed out that, for better understanding of the construction of the protective element, it or the component parts thereof have in some cases not been shown to scale and/or have been shown enlarged and/or reduced in size.

**[0051]** The object underlying the independent inventive solutions can be taken from the description.

**[0052]** In particular, the individual configurations shown in FIGS. **1** to **6** can form the subject matter of independent solutions according to the invention. The relevant objects according to the invention and solutions achieving them according to the invention can be taken from the detailed descriptions of these figures.

LIST OF DESIGNATIONS

**[0053]** **1** Protective element.
**[0054]** **2** Molded part
**[0055]** **3** Compensating layer
**[0056]** **4** System of channels
**[0057]** **5** Groove-like depression
**[0058]** **6** Central portion
**[0059]** **7** Inward curvature
**[0060]** **8** Distance
**[0061]** **9** Base plane
**[0062]** **10** Portion of the upper leg protection
**[0063]** **11** Side pieces
**[0064]** **12** Clearance
**[0065]** **13** Plane
**[0066]** **14** Distance
**[0067]** **15** Inner side
**[0068]** **16** Average thickness of the compensating layer
**[0069]** **17** Average thickness of the molded part
**[0070]** **18** Peripheral portion
**[0071]** **19** Holding device
**[0072]** **20** Belt strap
**[0073]** **21** Closure element
**[0074]** **22** Connecting means
**[0075]** **23** Tangent
**[0076]** **24** Contact portion

**1**. A protective element for protecting the hip or pelvis region, having a cup-shaped molded part with a body-facing inner side and a compensating layer,

the compensating layer being arranged at least in certain portions on the inner side,

the molded part being formed in one piece from a cured composite material and

the compensating layer being formed from an elastically deformable foam material,

the molded part having a concave shape that is adapted to the human anatomy of the hip or pelvis region and has a central portion, the central portion having an inwardly curved portion which is facing the body, is arranged in the region of the coccyx when the protective element is being worn and, as a structural stiffening element, increases the mechanical strength of the molded part.

**2**. The protective element as claimed in claim **1**, which has an upper leg protection with two portions lying on a base plane, the inwardly curved portion that is arranged between the portions having in the central portion a distance from the base plane of the portions of the upper leg protection.

**3**. The protective element as claimed in claim **1** in which the molded part has two side pieces for protecting the hip joints from laterally acting forces.

**4**. The protective element as claimed in claim **3**, in which the side pieces extend beyond a plane that is defined by tangents to peripheral lines of the central portion of the molded part.

**5**. The protective element as claimed claim **1**, in which the central portion of the molded part has on the side opposite from the inwardly curved portion a clearance in comparison with the highest extent of the molded part in the region of the side pieces.

**6**. The protective element as claimed in claim **1**, in which the composite material comprises a fibrous material and a curable filler.

**7**. The protective element as claimed in claim **1**, in which the composite material has a modulus of elasticity of at least 40 $kN/mm^2$.

**8**. The protective element as claimed in claim **1**, in which the compensating layer is formed from an elastomer foam, in particular a polyurethane foam.

**9**. The protective element as claimed in claim **1**, in which the molded part has a thickness of between 0.7 mm and 1.7 mm.

**10**. The protective element as claimed in claim **1**, in which the compensating layer has an average thickness of 8.5 mm.

**11**. The protective element as claimed in claim **1**, a system of channels being arranged facing the inner side of the molded part.

**12**. The protective element as claimed in claim **11**, the system of channels having groove-like depressions and the depth of the depressions lying in the range between 20% and 45% of the thickness of the compensating layer.

**13**. The protective element as claimed in claim **1**, in which the compensating layer is connected in certain portions to the inner side.

**14**. The protective element as claimed in claim **1**, in which a flexible holding device is arranged on the molded part.

**15**. The protective element as claimed in claim **1**, in which a contact portion is arranged in the central portion of the molded part.

**16**. The protective element as claimed in claim **1**, in which a peripheral portion of the molded part has a curvature opposed to the curvature of the inner side of the molded part.

**17**. The protective element as claimed in claim **1**, in which a moisture-permeable layer is arranged on the body-facing side of the compensating layer.

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