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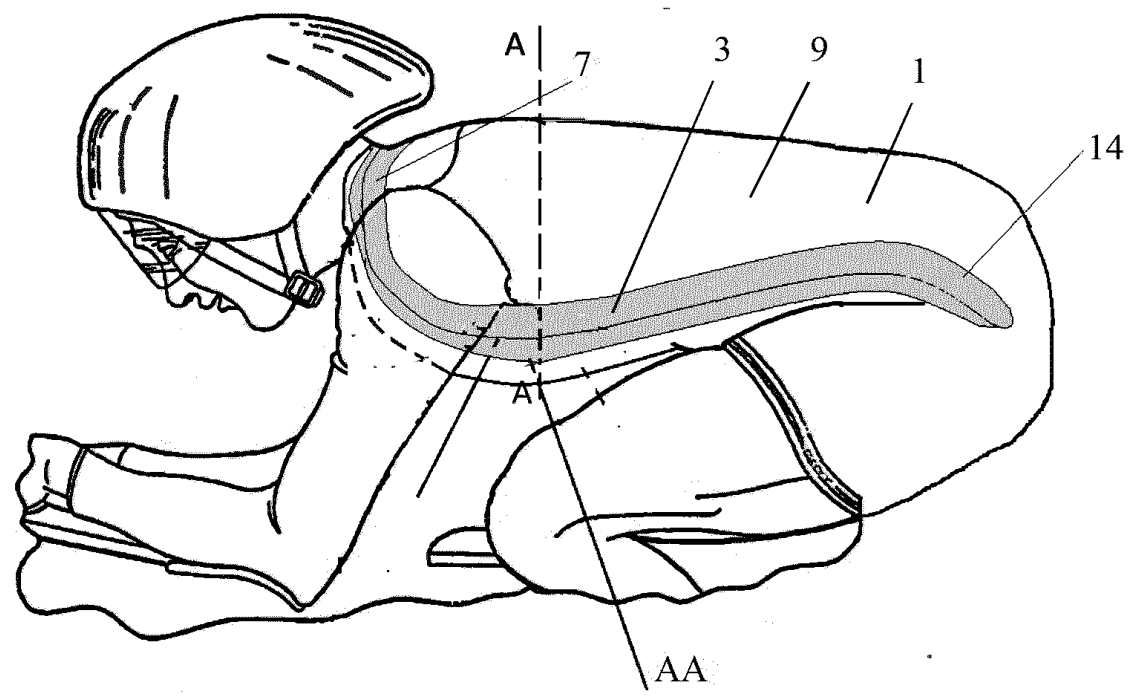
(54) **SPORTS CLOTHING FOR CYCLING AND ACCOMPANYING COOLING METHODS**

(57) The invention relates to the field of sports clothing and, more specifically, cycling clothing with a view to improving safety combined with improving performance through improved cooling and/or improved aerodynamic resistance.

Fig. 3a



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Description

FIELD OF THE INVENTION

[0001] The invention relates to the field of sports clothing and, more specifically, cycling clothing with a view to improving safety combined with improving performance through improved cooling and/or improved aerodynamic resistance.

[0002] More specifically, the invention described relates to inserting airbag and/or cooling products in a stretch shirt or stretch sports clothing such as a cycling suit, in which the airbag and/or cooling products are preferably located in a zone on the chest and abdomen, the pelvis and (top of the) thigh or the lower back. However, the airbag is comfortable enough, fits closely and takes cyclists' different positions into account, for example, and allows leg movement in the different cycling positions. The invention concerns a new product and the working method to create this product, which ensures, for example, that although using the product does increase the weight for racing cyclists or cyclists, it results in a reduction in air resistance (aerodynamic losses) and provides additional cooling. In addition, the invention provides better protection by also protecting the pelvis and femur. The triggers for the airbag may also use sensors in click pedals, which can trigger the airbag very early as from certain speeds. This ultimately results in the fact that the racing cyclist or cyclist is better protected, but also needs less power to move the bike forward or to be able to perform better by reducing aerodynamic resistance and improving body cooling.

BACKGROUND OF INVENTION AND STATE OF THE ART

[0003] In US5371903 (13/12/1994), reference is already made to aerodynamic modules for cycling, skating and other sports where speed is relevant. The design of the suit is adapted in such a way that it clearly differs significantly on a macro scale from a tailored suit that tightly fits the rider. The difference between this invention and US5371903 is that the modifications to the suit are made specifically with a view to accommodating airbag technology and cooling technology. In other words, this invention concerns combining aerodynamic modules with airbag modules or cooling modules and integrating them into one single new concept.

[0004] The current bicycle airbags on the market do not show any aerodynamic improvements and the components are not positioned in places that can lead to lower air resistance coefficients (drag coefficients). The current cooling methods too, including phase-changing materials or fabrics leading to faster cooling by evaporation, are not specifically designed according to the aerodynamics of the racing cyclist or cyclist. In addition, the current bicycle airbags do not take into account lower bicycle positions (e.g. time trial positions) and do not use stretch fabrics that precisely follow the contours of the body and provide a close fit with the body. As a result, the current bicycle airbags cannot be used in cycle racing or in other sports where sufficient freedom of movement is required. In particular, the combination of stretchability (the ability to breathe easily and comfortably) and a tight fit around the body has not yet been created to date in existing airbags for the body.

[0005] EP2576295 lists the system components used for an airbag. The system components include the electronic control unit (ECU), the CO_2 cartridge, the connector to the bag of the airbag with the seal and attachment to the bag, and, finally, the bag of the airbag. The electronic control unit (ECU), which consists of a number of motion sensors that determine whether or not the airbag may open. This ECU is electrically connected to the head of the CO_2 cartridge containing a small bursting charge that explodes when triggered and allows the CO_2 to escape and fill the bag of the airbag. As soon as it opens, the CO_2 will fill the bag of the airbag very quickly (<80msec). This patent does not indicate an exact position on the body for these system components, the consequence of which is that it obviously results in an increase in the rider's weight and, therefore, performance loss if positioned incorrectly. After all, for vehicles powered by engines, it is not a problem that the additional weight leads to additional energy consumption. The insulating nature and the poor air and moisture permeability of the bag of the airbag as described in EP2576295 also cause worse thermoregulation on the racing cyclist or cyclist. The airbag and its system components specified in EP2576295 are therefore not optimally positioned. In addition, this patent refers to a non-stretchable airbag jacket, which does not fit closely and is not comfortable for racing cyclists and cyclists but which applies to motorcyclists. The airbag mentioned in EP2576295 does not apply to modern bicycle racing, where it is required to use close-fitting and stretch fabrics that lead to a comfortable fit, which enables a racing cyclist or cyclist to adopt both the different cycling positions and make the repetitive movements. There is currently no bicycle airbag whatsoever that is able to protect the pelvis and it currently only goes as far as the abdomen. In the field of application of a cycling suit that consists of a shirt and pants with a zip at the back, this is possible, however. Neither are there currently any airbag shirts or airbag suits that take aerodynamics into account and that could thus possibly compensate for the energy loss due to the weight of the airbag. For cyclists and racing cyclists, at 50 km/h approximately 90% of the energy goes to aerodynamic loss. As a result, correct airbag positioning can compensate for energy losses due to increased weight. Therefore, in professional bicycle racing and other sports where weight and thermoregulation play an important role in the athlete's performance, there is a need for bicycle airbags that provide a solution for this.

[0006] Although US2012307060 does mention inflatable sections that provide aerodynamic efficiency gains, there is clearly a difference in that the inflatable sections here are static and always inflated, as opposed to airbag shirts or airbag suits that are only inflated when triggered. GB2467977 also lists an inflatable chamber or balloon that can be deflated in case of emergency. This is in contrast to the operation of a bicycle airbag that will only inflate if there is an accident or emergency. In this patent, only the airbag components are placed in an aerodynamically beneficial position, but no inflated airbag is used to achieve aerodynamic gains. In brief, patents such as US2012307060 and GB2467977 focus exclusively on aerodynamics in bicycle racing and use airbags that are full of air during cycling to achieve the desired gain; in this patent, the airbag is only filled prior to a fall and the positioning of the unfilled (folded) bag of the airbag and the airbag components result in improved aerodynamics, which can compensate for weight gain during rides on the flat by adding an airbag system. It goes without saying that the bag of the airbag is not filled and is only filled when activated (prior to a fall).

[0007] An airbag system to protect people is also described in EP2956026 and WO2011148353. A big difference from these patents is that the airbag bag is fully unfolded and applied parallel to the body as opposed to rolled up and folded up in this patent. Because the bag of the airbag does not allow any moisture to pass through it, this strongly hinders getting rid of perspiration. Neither are the airbag components in the most aerodynamic positions of the body and there is no protection of the pelvis or hip. This therefore makes the EP2956026 suitable as an airbag jacket to protect persons who move less (such as on a motorcycle) but not for cycling, bicycle racing or sports where many movements are necessary. In this patent, comfort is greatly enhanced by improved perspiration drainage because of the greater compactness of the bag of the airbag, the improved aerodynamics and better protection of the pelvis. This makes the airbag suit or airbag shirt in this patent more suitable for cycling and bicycle racing. More specifically, a suit can consist of shorts extending up the body and becoming a shirt, for which the term "bib shorts" is often used. The bag of the airbag is fitted in a very compact manner and folded, reducing the barrier for perspiration discharge by at least 50% compared to the airbag concepts mentioned in EP2956026 and WO2011148353. The wraparound elastic fabric (e.g. lycra) provides sufficient flexibility for the bag of the airbag to be able to fully deploy at adequate high pressure (30-60 bar) from the CO_2 cartridge. In brief, the EP956026 and WO2011148353 are focused on airbag concepts for people who practise activities in which exercise and the resulting heat and perspiration discharge is less important. However, when cycling (e.g. for recreational or commuting purposes) and bicycle racing, the perspiration discharge and the air permeable nature of the shirt or suit are extremely important, as is the improvement of the aerodynamics with which the weight gain due to the addition of airbag components and bag can be compensated especially for riding on the flat.

[0008] Moreover, no patent whatsoever is found where the airbag is activated optionally from a contact sensor in the click pedals. Image analyses of bicycle accidents showed that unlocking the click pedal (at relatively high speed > 5 m/sec) is the first action and indication there will be a fall; no other patent whatsoever mentions the activation of an airbag system from click pedals.

AIM OF THE INVENTION

[0009] The purpose of the invention is to provide sports clothing, for example a stretch airbag shirt or full airbag suit (shirt and trousers), which is aerodynamic and in which the airbag has been integrated, taking into account the aerodynamic resistance losses already mentioned.

SUMMARY OF THE INVENTION

[0010] To this end, the invention provides sportswear for racing cyclists that is made of stretch textile to have a close and tight fit around the body, with the characteristic that the sportswear comprises a bag for an airbag, where the bag is folded up and/or rolled up in at least a U-shape and/or S-shape, in such a way that perspiration discharge especially is hindered less.

[0011] In an embodiment, the U-shaped bag of the airbag and the airbag components are positioned on the sports clothing in such a way that the user's drag coefficient improves during use; in particular at the thorax, lower back or combinations of both.

[0012] In some embodiments, the U-shaped bag of the airbag is positioned in front over the thorax and extends to the bottom and back of the sports clothing.

[0013] In another embodiment, the U-shaped bag of the airbag also extends to the neck to strengthen and keep the neck in position.In a further embodiment, the sports clothing is a cycling shirt or a cycling suit, wherein the U-shaped bag of the airbag runs from the cycling shirt or the shirt of the cycling suit to trousers to the top of the femur and possibly even over the thigh joint.

[0014] In yet another embodiment, the U-shaped bag of the airbag comprises an electronics module and a CO_2 cartridge and/or a cartridge containing gas or air at high pressure to fill the airbag, wherein the electronics module and the CO_2 cartridge are positioned in an aerodynamic shape; preferably at the thorax.

[0015] In a next embodiment, the U-shaped bag of the airbag comprises an external shape in non-inflated state to increase the circumference of the thorax by approximately 1 to 30 cm, wherein the circumference is measured just below the edge of the chest.

[0016] In another embodiment, the bag of the airbag is optionally reduced at the neck, such that the sports clothing is compatible with the helmet used.

[0017] In a following embodiment, the bag of the airbag folded into a U-shape is fitted with additional cooling fabric, in particular fabric having high water absorption and high evaporation rates to facilitate the perspiration discharge.

[0018] In a further embodiment, the electronics module of the sports clothing is optionally configured to use sensors in the click pedals to trigger the bag of an airbag.

[0019] In yet a further embodiment, the electronics module provides a Bluetooth connection, wherein the Bluetooth connection is configured to communicate with the controller of an electric bicycle or the smart lock, wherein the controller or smart lock (lock containing a controller) is configured to check up on the user to ensure that the user is indeed wearing his airbag shirt; the controller is optionally configured to provide an audible or visual signal of the Bluetooth connection to the sports clothing.

[0020] In a next embodiment, the bag of the airbag is extended over the pelvis and femur to provide protection from the femur to the knee.

[0021] In some embodiments, the sports clothing further comprises an internal explosive, in particular NaN_3 to activate the bag of the airbag, wherein the CO_2- cartridge is placed externally next to the bag of the airbag and the internal explosive is activated internally in the bag of the airbag.

[0022] In a further embodiment, the user is an athlete, a cyclist or a racing cyclist, and wherein the sports clothing is clearly intended to be used in sports, wherein freedom of movement is necessary and more extreme positions are adopted and wherein repetitive movements or very rapid movements are necessary and/or for recreational cyclists or cyclists on the daily commute.

[0023] In a following embodiment, the bag of the airbag protrudes from under the shirt and extends to the pelvis and thigh joint and, as such, can be attached to matching trousers.

DETAILED DESCRIPTION OF THE INVENTION

[0024] In the invention, the know-how of airbag positioning and thermoregulation is combined with the know-how of airbag technology which, despite the weight gain of about 1000g, even leads to improved performance measured on the flat. The performance gain was measured in the wind tunnel of Flanders' Bike Valley and is measured in the range between 10W and 40W (average of 25W) in a laminar airflow of 50 km/h (and yaw angle = 0°). After cycling positioning and aerodynamic cycling shirts, the aerodynamic airbag described here can be a 3rd major factor to improve performance in bicycle racing. The combination of increased safety, increased comfort *and* increased performance because of improved aerodynamics will lead to full acceptance in cycle racing and, after that, also by the public at large.

[0025] In addition, everything is incorporated in a stretch and comfortable racing cyclist's suit and sensors can also be used in the click pedals, and in the case of a full racing cyclist's suit (top and trousers), the airbag can be used to protect the pelvis and thigh. In the case of previous airbag patents, often only the thorax, neck and back are protected, whereas in the case of cycling suits, the pelvis and the top of the thigh can also be protected. A factor that must also specifically be taken into account for cycling is helmets with a longer tail that may reach to between the shoulder blades. It is said that due to the extremely large clasping of the neck, existing airbag jackets shift a number of cycling helmets from their position because there is an overlap of the airbag volume in the neck with the position into which the helmet is put. As explained in further detail below, in the present invention this is covered by ensuring that the expansion volume of the bag of the airbag in this zone is reduced before they are used with such helmets.

[0026] The airbag bag itself, together with the electronic components and the CO_2 cartridge or a cartridge of high-pressure air or gas, is incorporated into a stretch cycling shirt in such a way that the shirt fits any user such as an athlete, cyclist and racing cyclist, well and comfortably. The comfortable fit allows a cyclist or racing cyclist to adopt an aerodynamic position in which the airbag shirt or suit fits well and movements can still be made comfortably in the shirt or suit. This means that when in a time trial position or when using the brackets, the racing cyclist's leg movements do not come into contact with the electronic components in the airbag shirt or the airbag suit. An excellent and close fit are necessary to avoid additional aerodynamic losses and can be achieved by using a stretch textile (e.g. lycra) in addition to the non-stretchable bags of the airbags. In addition, the solution ensures that it is easy to print on the textile used so that sponsors' names can be printed on them.

[0027] The encasing and textile around the airbag components (bag of the airbag, cartridge with gas and electronic control unit) must also be specifically adjusted for this to improve the drag coefficient. The possible positions for these adjustments are, for example, the thorax where the typical adjustments around the airbag components result in a design resembling the shape of a drop of water, which improves the drag coefficient, the lower back where the air flow around the rider has already released the textile, or a combination of these adjustments. For adjustments on the rider's back,

the airbag components, in particular the bag of the airbag, and the fabric around the airbag components are placed in a position where there is lower pressure and wake. Positioning one or more of the airbag components in the wake hereby results in aerodynamic gains by holding the airflow on the rider's body for a longer time span. Apart from the positioning, the various components are preferably fitted in an aerodynamic shape, such as the shape of a drop of water at the thorax, which results in a reduction of the drag coefficient; in this aerodynamic shape, one can place the other components of the airbag or cooling system in addition to the bag of the airbag. For example, the bag of the airbag can be folded into a U-shape within this aerodynamic shape, thus improving air permeability and perspiration discharge and, consequently, overall comfort will improve. When the airbag bag runs parallel to the skin surface, the air and moisture discharge is limited because the bag of the airbag, as such, does not allow air or moisture to pass through and is also highly insulated. Consequently, the U-shape improves cooling and acts as a type of cooling fin for the racing cyclist. The contact surface of the bag of the airbag with the body is greatly reduced by the fact that the bag is folded (e.g. in U-shape or in a spiral shape), which reduces the barrier for perspiration discharge by more than 50% in this concept; because the bag of the airbag can be folded up, it becomes very compact and the perspiration discharge is less obstructed, making the airbag shirt or airbag suit more comfortable and more suitable for applications where movement is necessary and much heat and perspiration are produced. The bag of the airbag is then placed in a stretchable pocket (e.g. lycra) that is kept in its place when the bag of the airbag is inflated.

[0028] The air permeability and perspiration discharge is greatly improved because the bag of the airbag is folded up and a cooling space is created (e.g. by using the U-shape of the folded bag of the airbag with the opening of the U away from the rider's body) next to the folded bag of the airbag and between the rider's body and the folded bag. The dominant mechanism for body cooling at ambient temperatures below 32°C consists of heat and convection. The heat radiation is proportional to the free surface (A) according to the formula below (Stefan-Boltzman).

$$\text{Radiation} = A \cdot \varepsilon \cdot \sigma \cdot (Tm\,4 - Tomg4)$$

[0029] At temperatures higher than 32°C, the dominant mechanism is cooling by evaporation, whereby the evaporation rate (g_s) is calculated by:

$$g_s = \theta \cdot A \cdot (x_s - x) / 3600$$

with θ = 25 + 19 v (kg/m2 h) with v, the speed in m/s, A= surface - water surface area (m2), x_s = maximum humidity ratio at saturation (kg/kg), i.e. maximum quantity of H_20 that can absorb dry air and finally x = humidity level (kg/kg).

[0030] Since the free surface plays a role in both heat radiation and cooling by evaporation, the aim is to maximise this surface in an aerodynamic form. For this purpose, it is preferable to use a 3D structure with increased capillary action (wicking effect) for the supporting structure of the aerodynamic form to be able to absorb perspiration quickly and, on the other hand, to create a very large free surface area. On the other hand, the non-breathable or non-moisture-permeable surfaces (such as the bag of the airbag) must be minimised for adequate thermoregulation. The surface area of the bag of the airbag (which is parallel to the body) is therefore limited by folding it (in a U-shape or an S-shape). With the U-shape, only one part of the U is adjacent or parallel to the body. A typical property of the bag of an airbag is that it is neither air permeable nor moisture permeable; by making it compact and folding it, the barrier for the perspiration discharge is less great (reduction of approximately 50% for the U-shape and more than 66% for the S-shape) and the comfort level for the cyclist or racing cyclist is increased.

[0031] Folding the bag of the airbag in a U-shape requires more space and creates a bulge in relation to the surface of the shirt or suit, but, as indicated above, this additional volume will preferably be created within an aerodynamic shape, more specifically because of the combination with the supporting structure that provides such aerodynamic shape. Folding it in a U-shape also creates sufficient overall elasticity so that the zip (in the case of an airbag shirt) can also be closed easily. In its preferred form, the bag of the airbag will also be positioned low enough in the shirt or suit so that the pelvis, hip joint and top of the thigh (femur) can also be protected. In another design, the bag of the airbag can transform from a U-shape to a flat shape in certain areas, e.g. in the neck between the shoulder blades, where the expansion volume of the bag of the airbag is reduced to allow for the use of long-tail and lightweight helmets.

[0032] In its preferred form, the bag of the airbag passes from the cycling shirt to the trousers to the top of the femur and possibly even over the thigh joint, but does not hinder the rapid leg movements. In the shirt design, the bag of the airbag might protrude from the shirt and rider will attach it manually in the cycling shorts and may decide to fasten it, e. g. with Velcro, so that the pelvis and thigh at the top are also protected. In the design of the bib shorts, the bag of the airbag also runs from the lower back over the pelvis and thus through the existing shoulder straps of the bib shorts up to the neck.

[0033] In another design according to the invention, the bag of the airbag also extends up to the neck and provides

the neck with reinforcement and fixation; a typical factor of the cycling airbag according to the invention is that low positions of the helmet are taken into account; for example, for a helmet with a low tail (long tail), the tail of the helmet can extend to the neck and one must avoid having a filled bag of the airbag that pushes the helmet out of its position. After all, the bag of the airbag will fill up faster than the rider hits the ground with his head. So, in a specific design, the expandable volume of the bag of the airbag will be reduced when passing on to the neck, and at the neck, so that when the bag of the airbag is filled, it will not push the helmet out of its position. Existing airbag bags for neck protection do not take into account the typical design and light weight of a bicycle helmet, which makes it easy to move out of position when the airbag inflates.

[0034] The invention also includes the method of positioning and repositioning the airbag or cooling components according to the position of the racing cyclist or cyclist in the wind tunnel or on a cycling track equipped for aerodynamic measurements, in such a manner that the airbag position creates the greatest aerodynamic gains. The main areas where the aerodynamic shape is created are the thorax and the lower back. The airbag components must also be positioned within this aerodynamic shape.

[0035] The airbag is triggered based on known sensors such as average speed measurement (GPS-based), IMU motion sensors and accelerometers. What is typical for an airbag in a cycling shirt is that sensors in the click pedals can be used in addition to this, which means that unlocking the click pedal at higher speeds (>5 m/sec) can possibly be used as a trigger. In addition, a validated algorithm that uses speed measurement, motion sensors and accelerometers ensures that the airbag is triggered at just the right time.

[0036] The invention is described by means of several examples, with references to corresponding figures.

Fig. 1 shows a user, for example, a racing cyclist (2) in an aerodynamic position wearing sports clothing (1) for cycling, for example an aerodynamic airbag suit. In this suit (1) an airbag module or cooling module was applied to the position of the thorax (chest) and the design around the airbag module and cooling module was adjusted to reduce the overall drag coefficient.

Fig. 2 shows the rider (2) in an aerodynamic position where the shoulders (12) are placed in a "shrugging" position and the suit (1) and the aerodynamic airbag align with the elbows, which are brought together. In this position, the aerodynamic airbag shirt and the system components (5, not shown) fill the wake behind the arms and behind the elbow, reducing the overall drag coefficient. The rider's head (13) goes down and the head's wake is also filled by the aerodynamic airbag.

Fig. 3a shows sports clothing (1), in particular the aerodynamic bicycle racing suit, in which the bag of the airbag (3) starts from the neck (7) and goes all the way over the pelvis (14), also protecting it in the case of a lateral fall. A cross-section A-A is taken at the thorax (AA) which is shown in Figure 3b

Fig. 3b shows the aerodynamic airbag at the thorax (AA). Here the bag of the airbag (3) is folded in a U-shape, increasing the total volume and chest circumference and forming an aerodynamic shape. To support the U-shape, use is made of chamois fabric (e.g. NILIT Breeze or 3D-printed structure) which causes perspiration to be absorbed quicker (wicking effect) and, on the other hand, the fabric (15) has a large free surface area which causes the evaporation rate to increase. At the side (16) and back, this fabric changes to a stretch and flexible fabric (e.g. lycra). The U-Shape used (4) provides sufficient flexibility and elasticity, making it easy to close the zip (17). The U-shape (4) of the bag of the airbag (3) not only improves moisture permeability and aerodynamics, but also results in increased stretchability, which is needed to breathe easily and still allows the airbag shirt as a whole to fit closely to the body.

Figure 4 shows as an example an airbag shirt (8) in which the airbag bag (3) is attached internally and which continues around the neck (7), as well as at the lower back (6). The electronics module (10), for example an electronic control unit, is attached at the top and the CO_2 cartridge or a cartridge containing gas or air at high pressure (11) is attached externally at the abdominal cavity; the electronics module (10) and the CO_2 cartridge or the cartridge containing gas or air at high pressure (11) form the airbag system components (5).

Figure 5 shows, as an example, an airbag suit in which the bag of the airbag (3) is internally attached and continues from around the neck all the way to the pelvis (14); because this is one suit,

the airbag can continue all the way and also protect the side of the pelvis (14). By using the U-shape of the bag of the airbag in the other direction, flexibility and freedom of movement are also accommodated in the groin. The electronic control unit (10) is located at the thorax, and the CO_2 cartridge (11) at the abdominal cavity.

Figure 6 shows the aerodynamic cycling suit in which the bag of the airbag (3) starts from the neck (7) and runs all the way over the pelvis (14), causing this to also be protected in the case of a lateral fall. A cross-section A-A is taken at the thorax (AA) which is shown in Figure 6b In this design, the bag of the airbag was folded up and placed in a stretch pocket (e.g. lycra). Figure 6c shows the bag of the airbag when inflated in this pocket

Figure 6b shows the cross-section when the uninflated bag of the airbag (3) is folded up in the stretch pocket (18). The stretch pocket (18) is incorporated in the stretch shirt (19) which continues and fits close to the body.

Figure 6c shows the same bag of the airbag (3) in inflated state; it is then held bordered to the right position by the stretchable pocket (18).

Figure 7 shows the airbag concept when it is incorporated in bib shorts in which Figure 7a represents the frontal view of the bib shorts and Figure 7b represents the view of the back of the bib shorts. The bib shorts run in one piece from the upper part (20) to the shorts (21). The bag of the airbag (3) is incorporated in the stretchable braces (22) of the upper part (20). Figure 7c shows how the bag of the airbag is folded into a U-shape inside the stretchable outer part (20). This stretchable outer part (2) and the folded bag of the airbag (3) extend in one piece to the pelvis (14) and finally to the final part (23). The bag of the airbag starts at the CO_2 cartridge (11) with valve (24) and the electronics module (10). In this example, the CO_2 cartridge (11) and the electronics module (10) are positioned on the lower back, resulting in improved aerodynamics. As was already indicated in Figure 1, installing components in the lower back results in improved aerodynamics. The components themselves are enveloped by a drop-shaped speed hump (25) which is incorporated into the bib shorts and integrated into the back of the bib shorts (21).

Figure 7c and Figure 7d show a cross-section of the thorax in which, in Figure 7c, the bag of the airbag (3) is folded up in the U-shape inside the stretchable enveloping fabric (26) and the barrier for perspiration discharge is reduced by approximately 50%. The U-shape is directed outwards or away from the body so that the perspiration discharge is also easier. The element (21) is a back of the bib shorts. Figure 7d shows the bag of the airbag (3) folded up in an S shape, reducing the barrier for perspiration discharge by more than 60%. Both for regular cyclists (e.g. for commuting purposes) and for racing cyclists, this greatly increases the comfort level compared to airbag systems where the bag of the airbag, unfolded or parallel to the body, almost sticks to the body. The elastic properties of the enveloping outer part (26) (e.g. made of lycra) allow the airbag to inflate to a large enough volume. The element (21) is a back of the bib shorts.

[0037] The invention can be summarized according to numbered embodiments:

1. In this invention, an airbag is integrated into a cycling shirt where the cycling shirt is tight and has a tight fit with the body due to the use of a stretch fabric (e.g. lycra) and U-shape bag of the airbag. As a result, the airbag shirt is comfortable and adapted to the different positions adopted by a racing cyclist or cyclist and more specifically applicable to a racing cyclist's time trial position. This also makes it possible to print the sponsors on the airbag shirt. The bag of the airbag bag does not run over the back, but in front, over the thorax through to the bottom, and to the back of the shirt and it can be attached in the cycling shorts.

2. In this invention, an airbag is integrated in a cycling suit, consisting of a shirt and trousers in one piece, in which the cycling suit has a tight and close fit with the body, due to the use of stretch fabric (e.g. lycra) and U-shape of the bag of the airbag. This makes the airbag shirt comfortable and adapted to the different positions adopted by a racing cyclist or cyclist. The bag of the airbag bag is folded into a U-shape or other compact shape and the enveloping stretch fabric (e.g. lycra) provides a pocket in which the bag of the airbag is kept in position or as a limit for the final shape of the bag of the airbag when it is inflated. As a result, sponsors' names can also be printed on the cycling

suit and the internal airbag runs into the trousers in one piece and can be attached at the pelvis in the trousers.

3. The positioning of the electronics module and the CO_2 cartridge or a cartridge containing gas or air at high pressure for filling the airbag ensures that the legs cannot touch the electronics components in the different cycling positions (e.g. in the time-trial position) and the racing cyclist or cyclists can continue to cycle comfortably without encountering any hindrance from the airbag shirt.

4. The external shape of the airbag shirt or airbag suit ensures that, in a non-inflated state, there is an increase in the circumference of the thorax by approximately 1 to 30 cm, measured just below the edge of the chest, resulting in an aerodynamic gain, between 1W and 40W, measured in a wind tunnel at 50 km/h on a rider in time-trial position (and wind direction = 0° = frontal wind).

5. The bag of the airbag fitted in the aerodynamic airbag shirt or airbag suit does not only protect the neck, thorax and abdominal cavity, but is extended over the pelvis and at the top of the thigh so that this is also protected. This means that the racing cyclist is also protected in the event of a lateral fall on the pelvis or thigh joint.

6. The bag of the airbag at the neck takes into account bicycle helmets that may extend very low and rest on the neck. Therefore, the bag of the airbag is optionally reduced in size at the neck, making it compatible with the helmet used. This prevents the helmet from being thrown off by an inflated airbag even before the racing cyclist or cyclist hits the ground. The airbag shirt or suit is therefore compatible with all bicycle helmets.

7. The airbag shirt or airbag suit has the bag of an airbag that can be optionally folded into a U-shape and is equipped with extra cooling fabric (fabric having high water absorption and a high evaporation rate) in such a way that the bag of the airbag facilitates perspiration drainage. The U-shape provides improved cooling properties because the evaporation surface increases and the heat radiation surface increases. The U-shape also provides sufficient elasticity, a tight fit and a high feeling of comfort; the racing cyclist can breathe easily because the U-shape of the bag of the airbag moves backwards and forwards along with the body while still maintaining its close fit. The flexible U-shape can also be applied to the back.

8. In addition to the standard motion sensors and accelerometers, optional sensors in the click pedals are used to trigger the airbag because (after extensive image analyses) it appears the click pedal is often unlocked just before a fall at high speed.

9. The electronics module also has a Bluetooth connection that can communicate with the controller of an electric bike or a smart lock, allowing the controller or a smart lock (lock containing a controller) to check whether the user is indeed wearing his airbag shirt; the controller can be set to give an audible or visual signal when such connection with an airbag shirt is detected. This integrates an additional safety mechanism similar to the signal when a person does not wear a seatbelt in a car.

10. In an airbag suit (shirt + trousers), the airbag bag can be extended over the pelvis and over the femur to protect the femur up to the knee. The athlete's body is therefore fully protected from the head to both feet.

11. The airbag shirt or airbag suit is either activated via a CO_2 cartridge or a cartridge containing high pressure gas or air placed externally next to the airbag bag or via an internal explosive (e.g. NaN_3), which is activated internally in the airbag. If a CO_2 cartridge is used, the bag of the airbag can be reused; in the case of an internal explosive, the bag of the airbag can only be used once. The advantage of working with an internal explosive and not with the CO_2 cartridge is the lower weight (CO_2 cartridge weighs approx. 250g) and faster filling time of the airbag (<100 msec).

12. The stretchable airbag shirt or suit can be applied to various sports where freedom of movement is necessary and more extreme positions are adopted and where repetitive movements (>1Hz) or very fast movements are necessary.

13. The airbag shirt where the bag of the airbag protrudes from under the shirt to the pelvis and thigh joint and can be attached as such (e.g. by using Velcro) to the matching trousers. This creates the possibility for an airbag shirt to protect the pelvis and thigh joint as well.

Claims

1. Sports clothing (1) for race cycling and cycling made of stretch fabric to have a close and tight fit with a user's body (2), **characterized in that** the sports clothing (1) comprises a bag (3) for an airbag, wherein the bag of the airbag (3) is folded up and/or rolled up in at least a U-shape (4) and/or S-shape, such that there is mainly less hindrance to perspiration discharge.

2. Sports clothing (1) according to claim 1, wherein the U-shaped bag of the airbag (3) and the airbag components (5) are positioned on the sports clothing (1) such that the user's drag coefficient (2) improves during use; in particular at the thorax (AA), lower back (6) or combinations of both.

3. Sports clothing (1) according to one of the claims above, wherein the U-shaped bag of the airbag (3) is positioned in front over the thorax (AA) and extends to the bottom and back of the sports clothing (1).

4. Sports clothing (1) according to one of the claims above, wherein the U-shaped bag of the airbag (3) also extends to the neck (7) to strengthen and keep the neck in position (7).

5. Sports clothing (1) according to one of the claims above, wherein the sports clothing (1) is a cycling shirt (8) or a cycling suit (9), wherein the U-shaped bag of the airbag (3) runs from the cycling shirt (8) or the shirt of the cycling suit (9) to trousers to the top of the femur and possibly even over the thigh joint.

6. Sports clothing (1) according to one of the claims above, wherein the U-shaped bag of the airbag (3) comprises an electronics module (10) and a CO_2 cartridge and/or a cartridge containing gas or air at high pressure (11) to fill the airbag, wherein the electronics module (10) and the CO_2 cartridge (11) are positioned in an aerodynamic shape; preferably at the thorax (AA).

7. Sports clothing (1) according to one of the claims above, wherein the U-shaped bag of the airbag (3) comprises an external shape in non-inflated state to increase the circumference of the thorax (AA) by approximately 1 to 30 cm, wherein the circumference is measured just below the edge of the chest.

8. Sports clothing (1) according to claim 4, wherein the bag of the airbag (3) is optionally reduced at the neck (7), such that the sports clothing (1) is compatible with the helmet used.

9. Sports clothing (1) according to one of the claims above, wherein the bag of the airbag folded into a U-shape (3) is fitted with additional cooling fabric, in particular fabric having high water absorption and high evaporation rates to facilitate the perspiration discharge.

10. Sports clothing (1) according to claim 7, wherein the electronics module (10) of the sports clothing (1) is optionally configured to use sensors in the click pedals to trigger the bag of an airbag.

11. Sports clothing (1) according to claim 7, wherein the electronics module (10) provides a Bluetooth connection, wherein the Bluetooth connection is configured to communicate with the controller of an electric bicycle or the smart lock, wherein the controller or smart lock (lock containing a controller) is configured to check up on the user (2) to ensure that the user is indeed wearing his airbag shirt; the controller is optionally configured to provide an audible or visual signal of the Bluetooth connection to the sports clothing (1).

12. Sports clothing (1) according to one of the claims above, whereby the bag of the airbag (3) is extended over the pelvis and femur to provide protection from the femur to the knee.

13. Sports clothing (1) according to one of the claims above, whereby the sports clothing (1) further comprises an internal explosive, in particular NaN_3 to activate the bag of the airbag (3), wherein the CO_2- cartridge (11) is placed externally next to the bag of the airbag (3) and the internal explosive is activated internally in the bag of the airbag (3).

14. Sports clothing (1) according to one of the claims above, wherein the user (2) is an athlete, a cyclist or a racing cyclist, and wherein the sports clothing (1) is clearly intended to be used in sports, wherein freedom of movement is necessary and more extreme positions are adopted and wherein repetitive movements or very rapid movements are necessary and/or for recreational cyclists or cyclists on the daily commute.

15. The cycling shirt (8) according to claim 5, whereby the bag of the airbag (3) protrudes from under the shirt and extends to the pelvis and thigh joint and, as such, can be attached to matching trousers.

Fig. 1

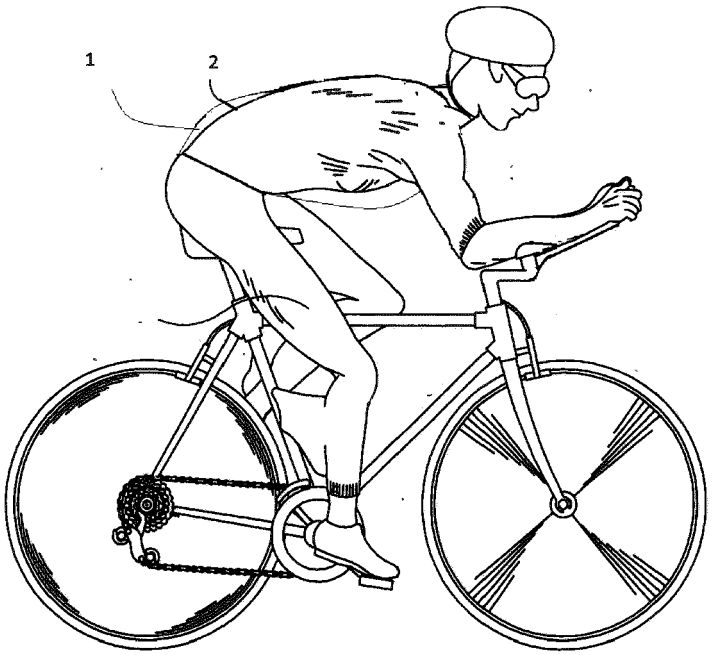


Fig. 2

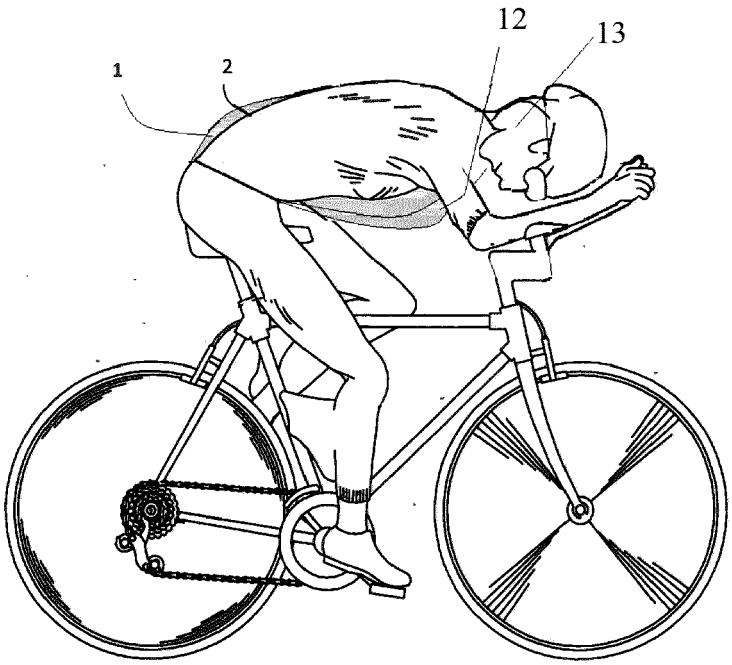


Fig. 3a

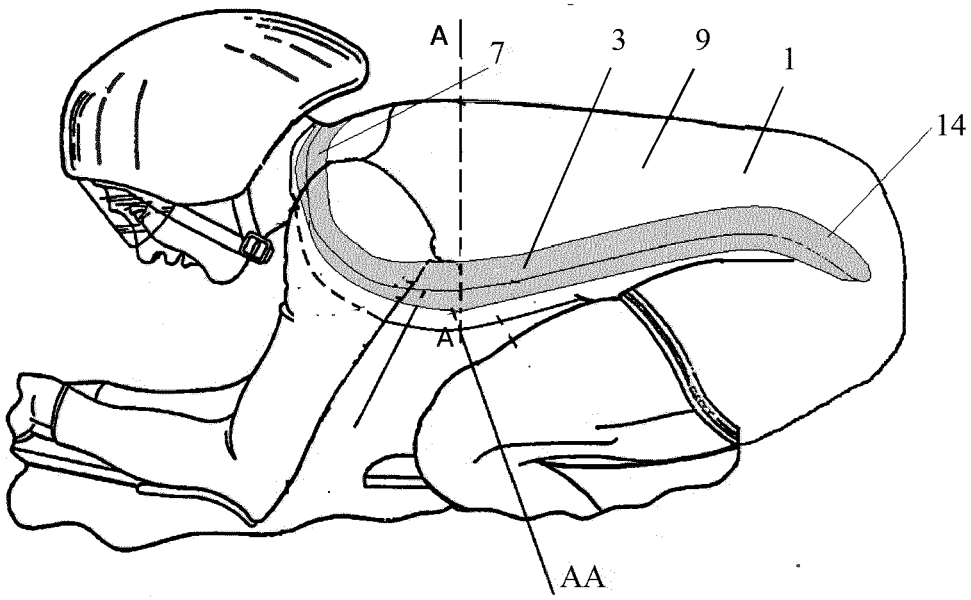


Fig. 3b

A-A cross-section of the thorax

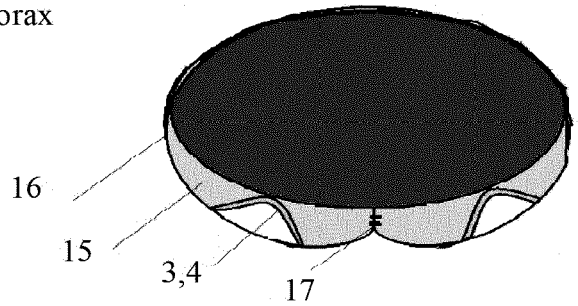


Fig. 4

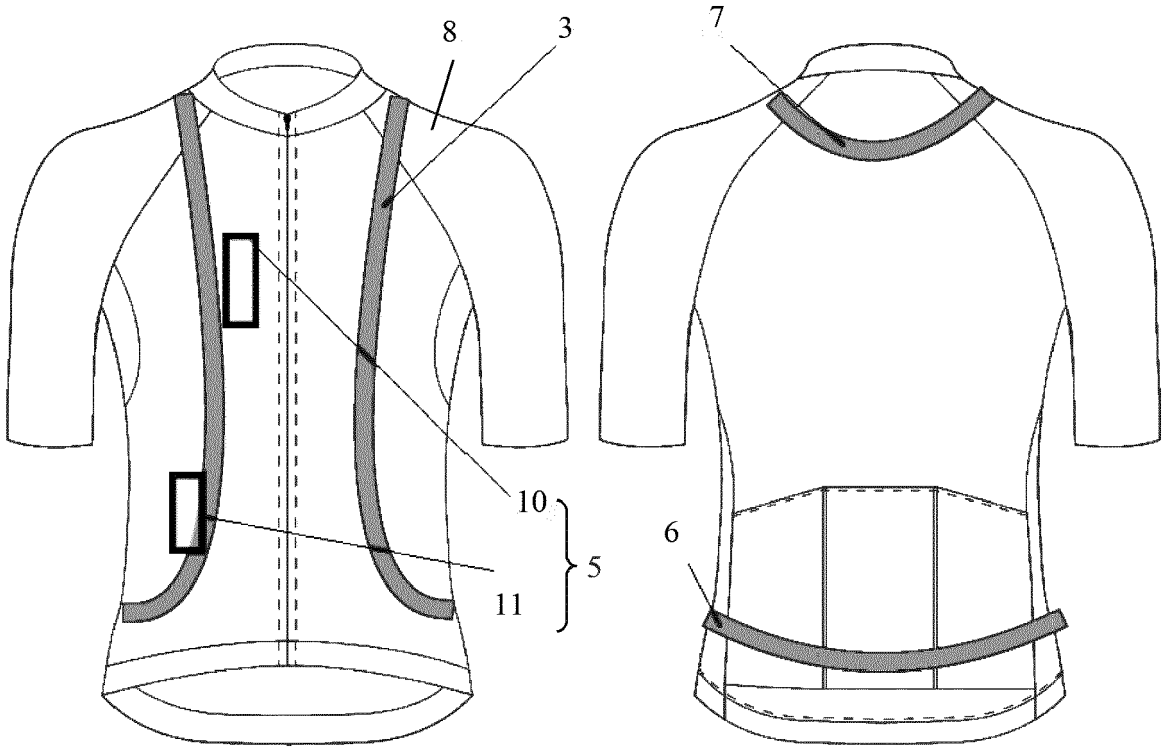


Fig. 5

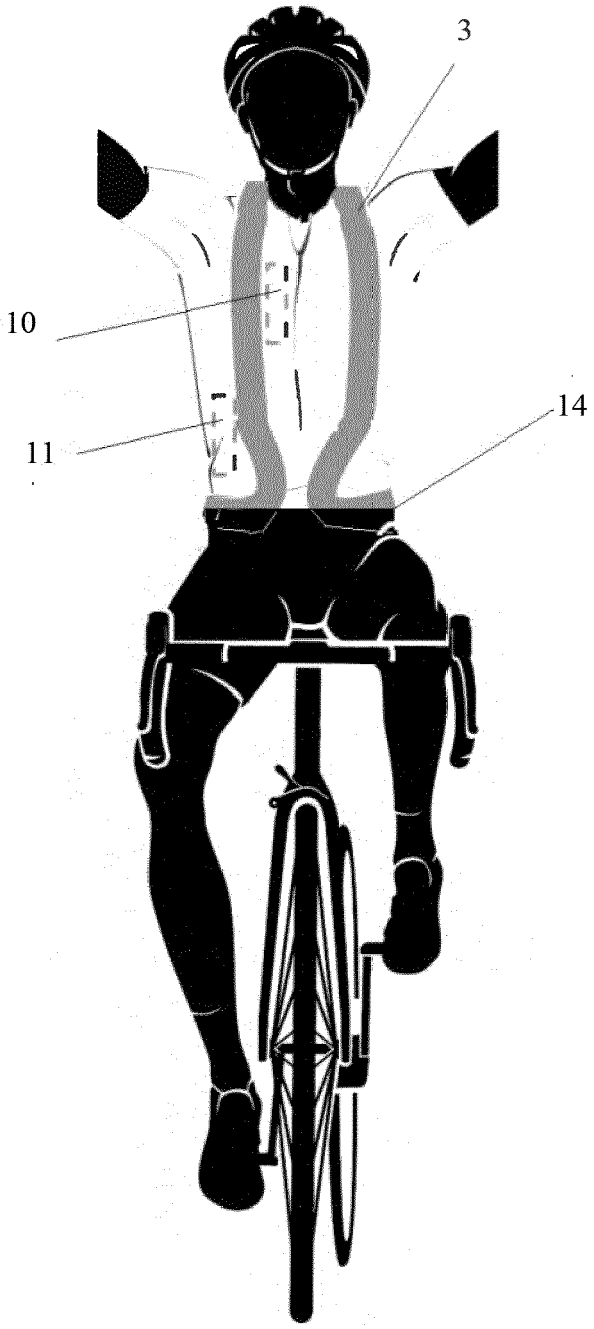


Fig. 6a

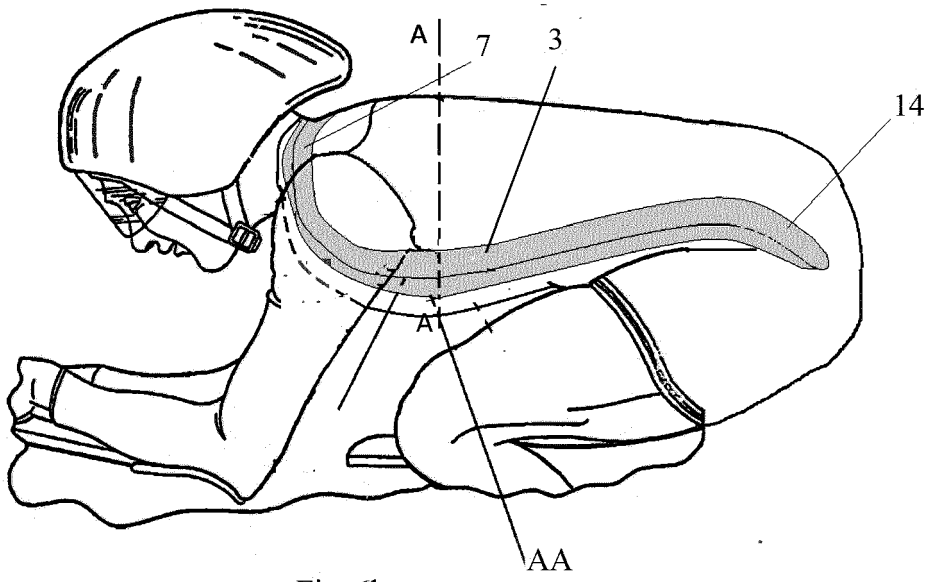


Fig. 6b

A-A cross-section of the thorax

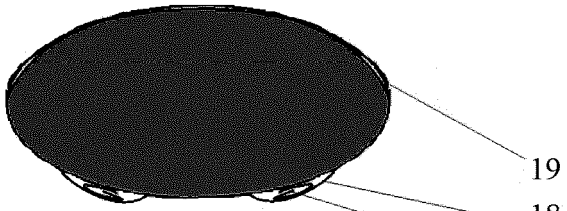


Fig. 6c

A-A cross-section of the thorax

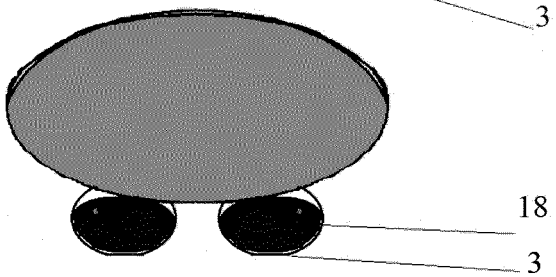


Fig. 7a

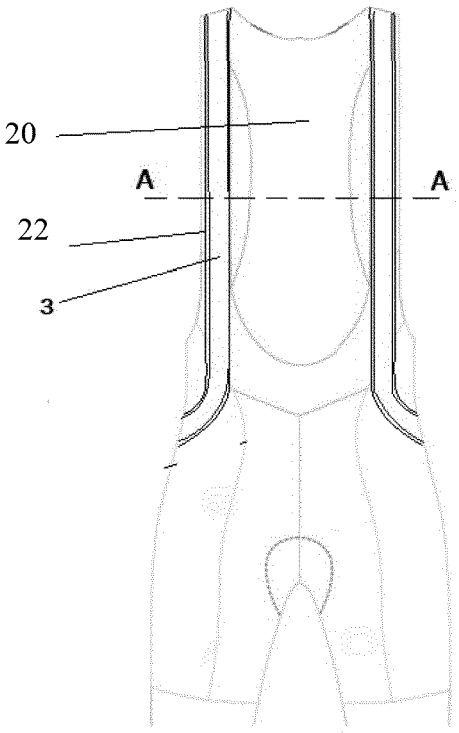


Fig. 7b

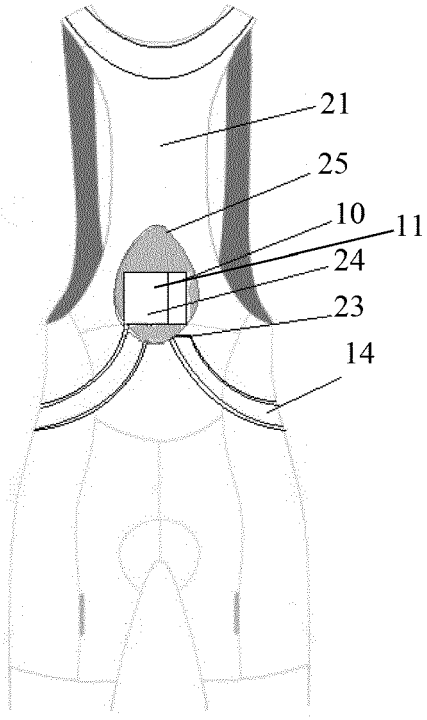


Fig. 7c cross-section of the thorax

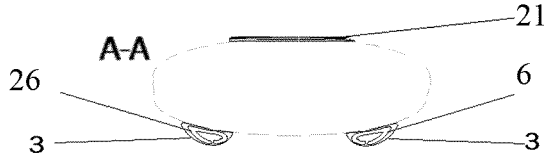
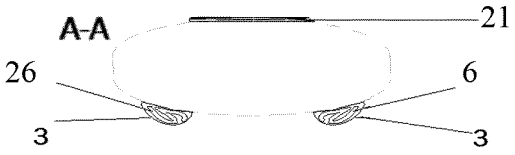


Fig. 7d cross-section of the thorax



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EUROPEAN SEARCH REPORT

Application Number
EP 21 19 4866

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A41D
B62J
B60R

2 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 January 2022	Krüger, Sophia

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