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DRIVER SEAT AIRBAG DEVICE

Abstract

[Problem]
To provide a driver seat airbag device with a simple configuration and that enables suppressing injury value of the driver.
Resolution Means
An airbag cushion **108** of the airbag device **100** for a vehicle includes a rear panel **122** positioned on the steering wheel **106** side, a front panel **120** positioned on the driver **104** side for restraining the driver **166**, and a side panel **124** that connects an edge of the rear panel **122** and an edge of the front panel **120** and constitutes a side part of the airbag cushion **108**. The front panel **120** is a combination of sub-panels **120***a* to **120***d* that gradually narrow from the outer edge of the front panel **120** toward the center thereof. The airbag cushion **108** further includes an internal tether **144** inside the airbag cushion **108** that pulls the center region of the front panel **120** toward the rear panel **122.**

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Background/Summary

TECHNICAL FIELD

[0001] The present invention relates to a driver seat airbag device installed in a vehicle steering wheel.

BACKGROUND ART

[0002] Currently, nearly all vehicle steering wheels are equipped with a driver seat airbag device. The airbag cushion of the driver seat airbag device is primarily stored in the central hub of the steering wheel and cleaves a resin cover, and the like by the expansion pressure so as to expand and deploy toward the front of a passenger.

[0003] More efficient restraint of an occupant is desired for the airbag cushion described above. The inventors of the present application focused on the fact that, based on body structure, rotation of a head of the occupant tends to cause strain on the body, and have developed an airbag cushion that enables efficient restraint while suppressing rotation of the head of the occupant.

[0004] For example, it has been found that in the case of an oblique collision that is a collision at an angle relative to the direction of travel, the occupant enters the airbag cushion at an angle and the head easily rotates. In light of this, the applicant of the present application has developed a technique of forming a recess part **114** using an internal tether **116** at the center of an airbag cushion **104** on the occupant side as disclosed in FIG. 2 of Patent Document 1, for example.

RELATED ART DOCUMENTS

Patent Documents

[0005] Patent Document 1: Japanese Unexamined Patent Application Publication 2020-37382

SUMMARY OF THE INVENTION

Problem to be Solved by the Invention

[0006] With the technique of Patent Document 1, a center base material **118** and three internal tethers **116** and the like components are used to form the recess part **114**. Apart from this technology, a technology to form a concavity equivalent to the recess part **114** with an even more concise component configuration is currently under development.

[0007] In light of these problems, an object of the present invention is to provide a driver seat airbag device with a simple configuration that suppresses injury value of the driver.

Means for Solving the Problem

[0008] In order to resolve the problem described above, a typical configuration of a driver seat airbag device according to the present invention, comprises: [0009] an inflator installed in a steering wheel of a vehicle; and [0010] an airbag cushion stowed together with the inflator in the steering wheel that receives gas from the inflator and expands and deploys toward the driver, wherein [0011] the airbag cushion includes: [0012] a rear panel positioned on the steering wheel side, [0013] a front panel positioned on the driver side for restraining the driver, and [0014] a side panel that connects the edge of the rear panel and the edge of the front panel and constitutes a side part of the airbag cushion, [0015] the front panel is a combination of a plurality of sub-panels that gradually narrow from the outer peripheral edge thereof towards the center, and [0016] the airbag

cushion further includes an internal tether that pulls near the center of the front panel toward the rear panel inside the airbag cushion.
[0017] With this configuration, the internal tether pulling on the front panel enables efficiently forming the recess part in the center region of the front panel. With this recess part, rotation of the head can be suppressed compared to restraining the driver with a simple flat surface when the driver moves forward at an angle in an oblique collision. Therefore, with the above-described configuration, it is possible to restrain the driver and suppress injury value.
[0018] In addition, with the configuration described above, the recess part can be formed with a simple configuration using the front panel composed of a plurality of sub-panels and the internal tether. Therefore, with the configuration described above, the amount of materials used for the panels and the like is low enabling weight reduction and increase in material yield, thereby achieving low cost and further the airbag cushion can also be folded and stowed in a more compact manner.
[0019] The recess part formed by pulling on and depressing the center region of the front panel with the internal tether may have an elongated shape at the bottom portion.
[0020] With the recess part having the configuration described above as well, rotation of the head can be suppressed while restraining when the driver moves forward at an angle such as in an oblique collision.
[0021] The main portions of the plurality of sub-panels are polygonal; each of the polygonal sub-panels has a long side, that is the longest side, which together form the periphery of the front panel, and a portion on another side other than the longest side that connects with the other sub-panels.
[0022] The recess part in the center of the front panel can also be efficiently formed by using a plurality of polygonal sub-panels.
[0023] The polygon described above may be a pentagon. The recess part in the center region of the front panel can be efficiently formed by using a plurality of pentagonal sub-panels.
[0024] The plurality of sub-panels may be fan shaped and the fan shaped sub-panels have an arc forming the periphery of the front panel, and two sides other than this arc may be connected to other sub-panels.
[0025] A conical depressed recess part can be efficiently formed by using the plurality of fan shaped panels described above.
[0026] The number of the plurality of sub-panels may be four. The recess part can be efficiently formed by forming the front panel combining the four sub-panels, and pulling the center where the apex of each sub-panel intersects using the internal tether.
[0027] A first end of the internal tether described above may be connected to the center of the front panel at the apex of two opposing sub-panels.
[0028] The structure described above also enables efficient forming of the recess part.
[0029] The internal tether described above may be integrally formed with the sub-panel.
[0030] The internal tether described above enables efficient pulling of the sub-panel toward the real panel.
Effect of the Invention
[0031] With the present invention, a driver seat airbag device for the driver having a simple configuration and that suppresses injury value of the driver can be provided.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0032] FIG. **1** is a diagram depicting the outline of a driver seat airbag device according to an embodiment of the present invention.
[0033] FIG. **2** is a perspective view of an airbag cushion when expanded and deployed in FIG.

1(*b*).
[0034] FIG. **3** is a diagram depicting each panel configuring an airbag cushion in FIG. **2**(*a*).
[0035] FIG. **4** is a cross-sectional view of the airbag cushion in FIG. **1**(*b*) along A-A.
[0036] FIG. **5** is a diagram depicting the process of the airbag cushion of FIG. **1**(*b*) restraining the driver in an oblique collision.
[0037] FIG. **6** is a diagram depicting a modified example of the sub-panels depicted in FIG. **3**.
[0038] FIG. **7** is a modified example of the rear panel and side panel depicted in FIG. **3**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0039] Preferred embodiments according to the present invention will hereinafter be described in detail with reference to the attached drawings. Dimensions, materials, other specific numerical values, and the like indicated in the embodiments are merely examples for ease of understanding of the invention and do not limit the present invention unless otherwise noted. Note that in the present specification and drawings, elements having essentially identical functions and configurations are labeled with identical symbols in order to omit redundant descriptions along with an illustration of elements not directly related to the present invention.
[0040] FIG. **1** is a diagram depicting an overview of a driver seat airbag device (hereinafter referred to as airbag device **100**) according to an embodiment of the present invention. FIG. **1**(*a*) is a diagram depicting a state of the airbag device **100** before activation. As depicted in FIG. **1**(*b*), the vehicle airbag device **100** is implemented as a frontal airbag of a driver seat **102** on a front row left side in a left hand drive vehicle.
[0041] In the present embodiment, when a driver **166** (see FIG. **5**(*a*)) is seated in a regular posture in the driver seat **102**, the direction the driver **166** is facing is referred to as forward, the opposite direction is referred to as rearward, and the directions are referred to as the front-to-back direction when axes on coordinates are depicted. In addition, when the driver **166** is seated in the driver seat **102** in a regular posture, the right side of the driver **166** is referred to as the right direction, the left side of the driver **166** is referred to as the left direction, and the directions are referred to as the left-right direction when axes on coordinates are depicted. Furthermore, when the driver **166** is seated in a regular posture, the head direction of the driver **166** is referred to as up, the waist direction of the driver **166** is referred to as down, and the directions are referred to as the up-down direction when axes on coordinates are depicted.
[0042] In the drawings used in the description of embodiments of the present invention below, as necessary, the front, back, left, right, up, and down directions with reference to the driver **166** described above are indicated by arrows F (Forward), B (Back), L (Left), R (Right), U (up), and D (down).
[0043] The airbag device **100** is installed in a steering wheel **106**, and the driver **166** (see FIG. **5**(*a*), and the like) seated in the driver seat **102** is restrained and protected by an airbag cushion **108** (see FIG. **1**(*b*)) during emergencies, such as an impact to the vehicle, or the like. The airbag cushion **108** is a bag shaped member that can be expanded using gas, that is made compact for stowing by being rolled or folded, and is then stowed together with an inflator **112** (see FIG. **2**(*a*)) in a stowing part **110** in the center of the steering wheel **106**.
[0044] The stowing part **110** is provided more to the center than a rim **114** of the steering wheel **106** and the surface thereof is covered with a cover **111**. The cover **111** is provided with grooved tear line on the inside that is designed to cleave in the event the airbag cushion **108** expands and deploys (see FIG. **1**(*b*)).
[0045] FIG. **1**(*b*) is a diagram depicting a state of the airbag device **100** after activation. A cushion **104** expands and deploys in a bag shape towards the driver **166** (see FIG. **5**(*a*)) in the driver seat **102**, cleaving the cover **111** (see FIG. **1**(*a*)) using expansion pressure of gas from the inflator **112** (see FIG. **2**(*a*)) and restrains the upper body and head of the driver **166** from moving forward.
[0046] The airbag cushion **108** is a round shape from the perspective of the driver seat and expands and deploys in a shape with a recess part **126** formed near the center. The airbag cushion **108** is

formed by overlaying and sewing or adhering a plurality of base fabrics forming a surface thereof.
[0047] FIG. **2** is a perspective view of an airbag cushion **108** when expanded and deployed in FIG. **1**(*b*). FIG. **2**(*a*) is a diagram depicting the airbag cushion **108** of FIG. **1** (*b*) viewed from slightly above the left side of the vehicle in the width direction. In FIG. **2**(*a*), a portion of the panel configuring the airbag cushion **108** is cut out to expose the internal inflator **112**.
[0048] The airbag cushion **108** of the present embodiment expands and deploys in a shape that conforms to a truncated cone. The airbag cushion **108** is formed from a plurality of panels and contains a front panel **120** positioned on the driver side, a rear panel **122** positioned on the steering wheel **106** side (see FIG. **1**(*a*)), and a side panel **124** connecting the front panel **120** and the rear panel **122** to form a side portion of the airbag cushion **108**. The front panel **120** has a recess part **126** formed near the center. The side panel **124** is also provided with a vent hole **128***a* for discharging gas.
[0049] The inflator **112** is a gas generating device secured to a bottom of the stowing part **110**. Upon receiving a detection signal sent from a sensor (not depicted), the inflator **112** is activated, and thereby supplies gas to the airbag cushion **108**. The inflator **112** is disc shaped and includes a main body part **130**, a gas emitting hole **132** provided on the side surface of the main body part **130**, and a flange **134** provided on the outer circumference of the main body part **130**.
[0050] The inflator **112** is provided with a plurality of stud bolts **136**. The stud bolts **136** pass through the rear panel **122** of the airbag cushion **108** and connect to a bottom part of the stowing part **110** of the steering wheel **106** (see FIG. **1**(*a*)). The airbag cushion **108** is also secured inside the stowing part **110** by fastening of the stud bolts **136**.
[0051] Note that examples of currently prevailing inflators include: types which are filled with a gas generating agent and burn the agent to generate gas; types which are filled with compressed gas and supply gas without generating heat; hybrid types which utilize both combustion gas and compressed gas; and the like. Any of these types can be used for the inflator **112**.
[0052] FIG. **2**(*b*) is a diagram depicting the recess part **126** through the side panel **124** and the like of FIG. **2**(*a*). The airbag cushion **108** of the present embodiment has a concave shaped recess part **126** near the center of the front panel **120** on the driver side.
[0053] The front panel **120** is formed by assembling four sub-panels **120***a* to **120***d*. The recess part **126** is formed by an internal tether **144** pulling the front panel **120** toward the rear panel **122**. This recess part **126** is used to suppress rotation of a head **168** of the driver **166** (see FIG. **5**(*a*)) when restraining an occupant, as depicted in FIG. **5** below.
[0054] FIG. **3** is a diagram depicting each panel configuring an airbag cushion **108** in FIG. **2**(*a*). In FIG. **3**, each panel is depicted in a state spread out on a plane.
[0055] FIG. **3**(*c*) is a diagram depicting the sub-panel **120***a* of FIG. **2**(*a*). The sub-panels **120***a* and **120***b* are panels arranged in a position facing each other on the left and right of the front panel **120** and have the same configuration.
[0056] The airbag device **100** utilizes sub-panels with polygonal shapes for the main portion. For example, in the present embodiment, other than the internal tether **144**, the main portion of the sub-panel **120***a* is pentagonal. For the sub-panel **120***a*, the longest of the five sides (long side **200**) forms a periphery of the front panel **120**. Furthermore, sides **202** and **204** extend perpendicular to the long side **200**, and oblique sides **206** and **208** extend obliquely therefrom. These four sides composed of sides **202** and **204** and oblique sides **206** and **208**, other than long side **200**, are used as portions to connect with other sub-panels **120***c* and **120***d* (see FIG. **2**(*c*)).
[0057] The sub-panel **120***a* can be broadly divided into rectangular region **210** and a triangular region **212**. The rectangular region **210** is a region surrounded by the long side **200** and the sides **202** and **204**. Here, a boundary W**1** between the sides **202** and **204** and the oblique sides **206** and **208** is formed with the same width dimension as the long side **200**. When the other sub-panels **120***b* to **120***d* are combined to form the front panel **120** (see FIG. **2**(*c*)), the rectangular region **210** forms a peripheral portion **138** of the front panel **120**. The triangular region **212** forms the inner wall of

the recess part **126**.
[0058] The sub-panel **120***a* has an integral internal tether **144**. The internal tether **144** is a strip of material that pulls the front panel **120** toward the rear panel **122** inside the airbag cushion **108**. Internal tethers **144** are provided on each of the sub-panels **120***a* and **120***b* that face each other that mutually overlap and are joined together.
[0059] A first end **144***a* of the internal tether **144** is connected to an apex **214** positioned in the center of the front panel **120** within the triangular region **212**, and a second end **144***b* is connected to the periphery of a securing region **156** (see FIG. **3**(*c*)) of the rear panel **122**. With this configuration, the internal tether **144** pulls the center of the front panel toward the rear panel **122** enabling efficient forming of the concave recess part **126**.
[0060] In other aspects, the second end **144***b* of the internal tether **144** can be suitably connected to a portion on the vehicle side of the airbag cushion **108** such as the inflator **112**, a retainer (not depicted) used when securing the inflator **112**, or to the bottom of the stowing part **110** (see FIG. **1**(*a*)).
[0061] FIG. **3**(*b*) is a diagram depicting the sub-panel **120***b* of FIG. **2**(*a*). The sub-panels **120***b* are panels arranged in a position facing each other on the left and right of the front panel **120** and have the same configuration.
[0062] The sub-panel **120***b* has the same configuration as the sub-panel **120***a* except for not including the internal tether **144** (see FIG. **3**(*a*)). For example, for the sub-panel **120***b* as well, the long side **200** forms a periphery of the front panel **120** (see FIG. **2**(*b*)) and the sides composed of the sides **202** and **204** and oblique sides **206** and **208** are connected to the other sub-panels **120***a* and **120***b*. The sub-panel **120***a* also has a rectangular region **210** that forms the peripheral portion **138** of the front panel **120** and a triangular region **212** that forms the inner wall of the recess part **126**.
[0063] As indicated, the front panel **120** of FIG. **2**(*b*) is a combination of pentagonal sub-panels **120***a* to **120***d* that gradually narrow from the periphery to the center of the front panel **120**. In particular, the four pentagonal sub-panels **120***a* to **120***d* are combined and the center where the apex **214** of each sub-panel intersects (see FIG. **3**(*a*)) is pulled using the internal tether **144** so the concave shaped recess part **126** can be efficiently formed near the center of the front panel **120**.
[0064] Note that with other aspects, a polygon configured with more sides than a pentagon may be used for the sub-panel. For example, the rectangular region **210** of FIG. **3**(*a*) may be hexagonal and combining with the triangular region **212**, the sub-panel overall may be heptagonal. With this configuration, for example, the dimension of the long side **200** can be set longer than boundary W**1** enabling achieving a sub-panel with a shape that gradually widens from the apex **214** to the boundary W**1** and further to the long side **200**.
[0065] FIG. **3**(*c*) is a diagram depicting the rear panel **122** of FIG. **2**(*a*). The rear panel **122** is circular and forms a reaction surface that captures reaction forces from the steering wheel **106** (see FIG. **1**(*a*)) when the airbag cushion **108** is expanded and deployed. The airbag cushion **108** expands and deploys in a shape of a truncated cone spreading toward the driver side, and therefore, the rear panel **122** has a narrower diameter than the front panel **120** (see FIG. **2**(*a*)).
[0066] The inflator **112** (see FIG. **2**(*a*)) is inserted in the center of the rear panel **122** and the securing region **156** is formed as a region for securing the stowing part **110**.
[0067] FIG. **3**(*d*) is a diagram depicting the side panel **124** in FIG. **2**(*a*). The side panel **124** has an annular fan shaped configuration. The side panel **124** is also provided with two vent holes **128***a* and **128***b*.
[0068] Of two arcs **158** and **160** of the side panel **124**, the large diameter side arc **158** is sewn to the long side **200** of the sub-panel **120***a* (see FIG. **3**(*a*)) serving as an edge of the front panel **120** and the small diameter arc **160** is sewn to an edge of the rear panel **122** (see FIG. **3**(*c*)). Both ends **162** and **164** of the side panel **124** are sewn together. The annular fan shaped side panel **124** connects the edge of the rear panel **122** and the edge of the front panel **120** and forms a side part of the

airbag cushion **108**, suppressing unnecessary swelling and enabling implementation of an airbag cushion **108** with a shape that gradually broadens in diameter towards the driver **166** (see FIG. **5**(*a*)).

[0069] FIG. **4** is a cross-sectional view of the airbag cushion **108** in FIG. **1**(*b*) along A-A. A dimension L**1** from the first end **144***a* of the internal tether **144** to the second end **144***b* is formed with a dimension to generate tension between the sub-panel **120***a* and the rear panel **122** during expansion and deployment of the airbag cushion **108** and pull the sub-panel **120***a* toward the rear panel **122**. With this configuration, pulling the internal tether **144** toward the rear panel **122** enables forming the concave recess part **126**.

[0070] The internal tether **144** is not limited to a configuration of being integrally formed with the sub-panel **120***a* and may be formed as a separate member and then connected to the sub-panel **120***a* and either configuration enables pulling the sub-panel **120***a* toward the rear panel **122**.

[0071] FIG. **5** is a diagram depicting the process of the airbag cushion **108** of FIG. **1**(*b*) restraining the driver **166** in an oblique collision. Each of the diagrams in FIG. **5** are schematic cross-sectional views corresponding to the A-A cross-sectional view of the airbag cushion **108** in FIG. **4**(*b*), depicting the airbag cushion **108** and the driver **166** from above the vehicle.

[0072] FIG. **5**(*a*) is a diagram depicting the appearance of the airbag cushion **108** immediately after expansion and deployment. As depicted in FIG. **5**(*a*), when the vehicle is in an oblique collision, the airbag cushion **108** expands and deploys to the front of the driver seat **102** in the vehicle (see FIG. **1**(*b*)).

[0073] FIG. **5**(*b*) depicts a state of the driver **166** of FIG. **5**(*a*) moving towards the front of the vehicle. There are cases where the driver **166** moves diagonally to the left in the vehicle width direction from the state of FIG. **5**(*a*) due to inertia during an oblique collision.

[0074] FIG. **5**(*c*) depicts a state of the driver **166** of FIG. **5**(*b*) moving further towards the front of the vehicle. The left shoulder of the driver **166** that moved diagonally forward may come into contact with the peripheral portion of a front panel **138** and the head **168** may come into contact with the sub-panel **120***a* of the recess part **126**.

[0075] The front panel **120** that forms a recess part **126** is able to restrain the head **168** from an oblique frontal angle by means of the recess part **126** while suppressing the tension force on the peripheral portion **138**, as compared to conventional front panel **120** spread in a single flat shape. Therefore, the airbag cushion **108** minimizes rotation **172** of the head **168** with respect to a shoulder **170** of the driver **166**, and coinciding with movement of the shoulder **170**, can restrain movement of the head **168**.

[0076] In this manner, the airbag cushion **108** is able to greatly reduce or eliminate rotation **172** of the head **168** of the driver **166** in an oblique collision in addition to occupant restraint in a normal collision and by reducing angular velocity of the head **168**, is able to suppress injury value of the driver **166** associated with rotation **172** of the head **168**.

[0077] As described above, with the present embodiment, the internal tether **144** pulls the front panel **120**, enabling efficient forming of a concave shaped recess part **126** near the center of the front panel **120**. With this recess part **126**, rotation **172** of the head **168** can be suppressed compared to restraining the driver **104** with a simple flat surface when the driver **104** moves forward at an angle in an oblique collision. Therefore, with the above-described configuration, it is possible to restrain the driver **104** and suppress injury value.

[0078] In addition, with the present embodiment, the recess part **126** is formed with a simple structure utilizing the front panel **120** composed of the plurality of sub-panels **120***a* to **120***d* and the internal tether **144**. Therefore, with the present embodiment, the amount of materials used for the panels and the like is low enabling weight reduction and increase in material yield, thereby achieving low cost, and further the airbag cushion **108** can also be folded and stowed in a more compact manner.

[0079] In addition, as depicted in FIG. **3**(*a*), the internal tether **144** is configured in a strip shape

with a prescribed width. Therefore, when the internal tether **144** of the left and right sub-panels **120***a* and **120***b* in FIG. **1**(*b*) are pulled to the rear panel **122** side, the bottom portion **174** of the recess part **126** is formed in an elongated oval shape in the width direction of the internal tether **144**, in other words, the vertical direction. A human head is an elongated shape, and the position of the head varies vertically from person to person, so the recess part **126** having an elongated bottom portion **174** is more suitably able to restrain the head **168** of the driver **166** (see FIG. **5**(*c*)).

[0080] Note that with the description with reference to FIG. **5**(*c*) described above, clockwise rotation was used as an example of rotation **172** that occurs with the head **168**. However, depending on the conditions of the emergency, the driver **166** may move obliquely to the right in the vehicle width direction and the head **168** may rotate counterclockwise centered on the neck as viewed from above. The airbag cushion **108** of the present embodiment is able to reduce or eliminate rotation of the head **168** using the recess part **126** for this counterclockwise rotation as well and is able to reduce angular velocity of the head **168**. In this manner, the airbag cushion **108** of the present embodiment is able to achieve the same effect regardless of which direction in the vehicle width direction the driver **166** moves towards.

[0081] FIG. **6** is a modified example of the sub-panels **120***a* and **120***c* depicted in FIG. **3**. FIG. **6**(*a*) depicts a modified example (sub-panel **140***a*) of the sub-panel **120***a* of FIG. **3**(*a*). The sub-panel **140***a* can be formed in, for example, a fan shape.

[0082] The fan shaped sub-panel **140***a* includes an arc **146** that forms the periphery of the front panel **120** and in addition to the arc **146**, two sides **150** and **152** that connect to other sub-panels. The dimensions of the fan can be set so that the length of arc S**1**, which is concentric with arc **146** and passes through the center of sides **150** and **152**, is about ⅔ the length of arc **146**, for example.

[0083] The sub-panel **140***a* is formed with an integral internal tether **144**. The first end **144***a* of the internal tether **144** is connected to a center angle **154** of the sub-panel **140***a* and the second end **144***b* is connected to the periphery of the securing region **156** (see FIG. **3**(*c*)) of the rear panel **122**. With this configuration, the internal tether **144** pulls the center angle **154** portion of the sub-panel **140***a* toward the rear panel **122**, enabling efficient forming of the cone shaped recess part **126**.

[0084] FIG. **6**(*b*) depicts a modified example (sub-panel **140***b*) of the sub-panel **120***c* of FIG. **3**(*b*). The sub-panels **140***b* are panels arranged in a position facing each other on the left and right of the front panel **120** (see FIG. **2**(*b*)) and have the same configuration. The sub-panel **140***b* has the same configuration as the sub-panel **140***a* except for not including the internal tether **144** (see FIG. **6**(*b*)).

[0085] As indicated, the front panel **120** of FIG. **2**(*b*) can be formed as a combination or the like of fan shaped sub-panels **140***a* and **140***b* that gradually narrow from the periphery to the center of the front panel **120**. The four fan shaped sub-panels **140***a* and the like are combined and the center angle **154** (see FIG. **6**(*a*)) is pulled using the internal tether **144** so the cone shaped recess part **126** can be efficiently formed near the center of the front panel **120**.

[0086] Note that in each of the embodiments described above, the front panel **120** is formed using four sub-panels (see FIG. **2**(*b*)), but the number of sub-panels is not limited to this. For example, other aspects of front panels that can form a recess part **126** near the center can be suitably achieved by combining three sub-panels or five or more sub-panels.

[0087] FIG. **7** is a modified example of the rear panel **122** and the side panel **124** depicted in FIG. **3**. FIG. **7**(*a*) is a diagram depicting a rear panel **180** of the modified example. The rear panel **180** is formed in a rectangular shape. The rear panel **180** of this configuration is also able to function as a reaction surface, that is able to receive a reaction force from the steering wheel **106** (see FIG. **1**(*a*)) during an emergency of the airbag cushion **108** (see FIG. **1**(*b*)).

[0088] FIG. **7**(*b*) is a diagram depicting modified side panels (side panels **182** and **184**). The side panels **182** and **184** are trapezoidal in shape and are mutually joined together to form the side surface of the airbag cushion.

[0089] The sub-panel **182** can be sewn to the peripheral portion of the front panel **138** (see FIG. **3**(*a*)) at a long side **186** corresponding to the lower edge of the trapezoid, for example, and to the

edge of the rear panel **180** (see FIG. **7**(*a*)) at a short side **188** corresponding to the upper edge. Furthermore, connecting the sides **190** and **192** with the side panels **184** enables suitably forming the side part of the airbag cushion **108**.

[0090] Preferred embodiments of the present invention were described with reference to the appended drawings, but it goes without saying that the present invention is not limited to such examples. It is clear that a person of ordinary skill in the art could conceive of various modifications or revisions within the scope set forth by the claims, and it would be understood that these modifications or revisions would belong to the technical scope of the present invention.

[0091] Moreover, the example in which the airbag device according to the present invention is applied to an automobile has been described in the embodiments described above. However, in addition to automobiles, the present invention can be applied to aircrafts, ships, and the like, with the same operation and effects capable of being achieved.

INDUSTRIAL APPLICABILITY

[0092] The present invention can be used in a driver seat airbag device installed in a vehicle steering wheel.

EXPLANATION OF CODES

[0093] **100**. Airbag device, **102**. Driver seat, **104**. Cushion, **106**. Steering wheel, **108**. Airbag cushion, **110**. Stowing part, **111**. Cover, **112**. Inflator, **114**. Rim, **120**. Front panel, **120***a* to **120***d*. Sub-panel, **122**. Rear panel, **124**. Side panel, **126**. Recess part, **128***a*, **128***b*. Vent hole, **130**. Main body part, **132**. Gas emitting hole, **134**. Flange, **136**. Stud bolt, **138**. Peripheral portion, **140***a*, **140***b*. Sub-panel, **144**. Internal tether, **144***a*. First end, **144***b*. Second end, **146**. Arc, **150**, **152**. Side, **154**. Center angle, **156**. Securing region, **158**. Arc, **160**. Arc, **162**, **164**. Both ends, **166**. Driver, **168**. Head, **170**. Shoulder, **172**. Rotation, **174**. Bottom portion, **180**. Rear panel, **182**, **184**. Side panel, **186**. Long side, **188**. Short side, **190**, **192**. Side, **200**. Long side, **202**, **204**. Side, **206**, **208**. Oblique side, **210**. Rectangular region, **212**. Triangular region, **214**. Apex, L**1**. Dimension, S**1**. Arc, W**1**. Boundary.

Claims

1. A driver seat airbag device, comprising: an inflator installed in a steering wheel of a vehicle; and an airbag cushion stowed together with the inflator in the steering wheel that receives gas from the inflator and expands and deploys toward the driver, wherein the airbag cushion includes: a rear panel positioned on the steering wheel side, a front panel positioned on the driver side for restraining the driver, and a side panel that connects the edge of the rear panel and the edge of the front panel and constitutes a side part of the airbag cushion, the front panel is a combination of a plurality of sub-panels that gradually narrow from the outer peripheral edge thereof towards the center, and the airbag cushion further includes an internal tether that pulls near the center of the front panel toward the rear panel inside the airbag cushion.

2. The driver seat airbag device according to claim 1, wherein a recess part formed by the internal tether pulling on near the center of the front panel has a longitudinal shape at the bottom portion.

3. The driver seat airbag device according to claim 1, wherein the main portions of the plurality of sub-panels are polygonal and these polygonal sub-panels have: a long side, that is a longest side, that form the periphery of the front panel; and a portion on another side other than the longest side, that connects with other sub-panels.

4. The driver seat airbag device according to claim 3 where the polygon is a pentagon.

5. The driver seat airbag device according to claim 1, wherein the plurality of sub-panels are fan shaped and the fan shaped sub-panels have an arc forming the periphery of the front panel and two sides other than this arc are connected to other sub-panels.

6. The driver seat airbag device according to claim 4 or 5, wherein there are four sub-panels provided.

7. The driver seat airbag device according to claim 6, wherein, of the four sub-panels, a first end of the internal tether is connected to the apex of two opposing sub-panels at the center of the front panel.

8. The driver seat airbag device according to anyone of claim 1 to 7, wherein the internal tether is integrally formed with the sub-panel.