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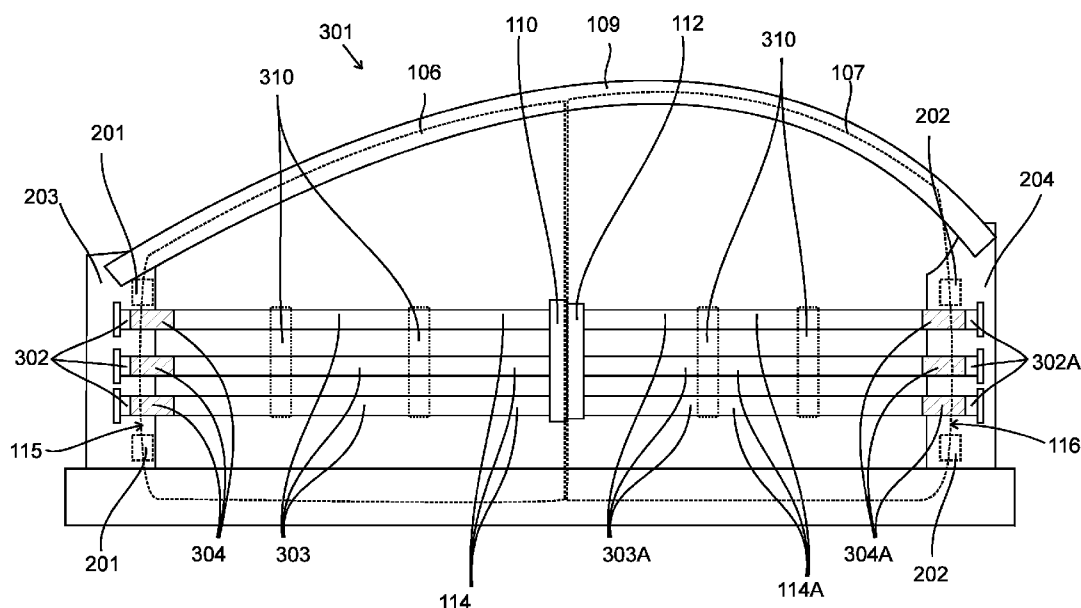


Fig. 3

(57) Abstract: Aspects of the present invention relate to a door arrangement (301) for providing access to a cabin (103) within a body (101) of a vehicle and a vehicle (100). The door arrangement (301) comprises a first door (106) and a first hinge (201) configured to support the first door (106) and to enable the first door (106) to move between a closed position and an open position. The door arrangement also includes a first connection means (110) for connecting with a second connection means (112), the first connection means (110) being mounted on the first door (106), and at least one first-door belt (114). The first-door belt (114) comprises a first body portion (302) for connection to the body (101) of the vehicle (100), a first door portion (303) connected to the first connection means (110), and a first hinge portion (304) configured to enable the first door portion (304) to rotate with respect to the first body portion (302) as the first door (106) moves between its closed position and its open position.

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A DOOR ARRANGEMENT AND A VEHICLE

TECHNICAL FIELD

5 The present disclosure relates to a door arrangement and a vehicle. In particular, but not exclusively, it relates to a door arrangement for a road vehicle and a road vehicle, such as a car.

BACKGROUND

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The safety of occupants of road vehicles, such as cars, depends partly upon the strength of the structure of the vehicle that surrounds the occupants. This includes the strength of the sides of the vehicle, which is of importance during a side impact on the vehicle. Consequently, road vehicles are known to have doors that include additional structural members to increase the ability of the doors to withstand impacts from other vehicles, thereby increasing occupant safety. However, the additional structure adds to the weight of the doors and the overall weight of the vehicle.

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On conventional road vehicles, such as cars, passengers are able to obtain access to front seats of the cabin of the vehicle by a front door mounted on an A-pillar at the front end of the front door and may be able to obtain access to rear seats by a rear door, typically mounted on a B-pillar at the front end of the rear door, or possibly mounted on a C-pillar at the rear end of the rear door. In the event of a side impact on such a vehicle, the B-pillar positioned between the front and rear door plays a significant part in providing structural reinforcement for side impact events.

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In recent times, vehicle designs have been proposed that eliminate the B-pillar between front and rear doors to provide easier access into the cabin of the vehicle. However, the disadvantage of this arrangement is that it results in the front and rear doors extending across a relatively wide single opening, without the support that a B-pillar would provide to the doors in the event of a side impact on the vehicle.

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It is an aim of the present invention to address one or more of the disadvantages associated with the prior art.

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SUMMARY OF THE INVENTION

Aspects and embodiments of the invention provide a door arrangement and a vehicle as claimed in the appended claims.

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According to an aspect of the invention there is provided a door arrangement for providing access through an opening to a cabin within a body of a vehicle, the door arrangement comprising: a first door; a second door; a first support mechanism configured to support the first door and to enable the first door to move between a closed position and an open position; and a second support mechanism configured to support the second door and to enable the second door to move between a closed position and an open position, wherein the arrangement closes the opening to the cabin when both the first door and the second door are in the closed position, the arrangement further comprising: a first connection means mounted on the first door; a second connection means mounted on the second door; at least one first-door belt comprising a first body portion for connection to the body of the vehicle, a first door portion connected to the first connection means, and a first support portion configured to enable the first door portion to move between its closed position and its open position; and at least one second-door belt comprising a second body portion for connection to the body of the vehicle, a second door portion connected to the second connection means, and a second support portion configured to enable the second door portion to move between its closed position and its open position, wherein the first connection means is connectable directly to the second connection means when both the first and second doors are in the closed position.

The term an opening should be understood to define a single opening to the cabin space. That is to say an opening which does not have a pillar or other such structure intersecting any part of the opening. The cabin may have several single openings each separated by pillars or other body structures. The first and second connection means being connectable directly to each other should be understood to define that the connection means do not connect to each other through a part of the vehicle body which is not part of the door arrangement.

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Each of the first and/or second support mechanisms which support the doors on the vehicle body may be referred to as a hinge. It should be understood, however, that a hinge may enable the doors to pivot with respect to the vehicle body and/or may enable the doors to slide with respect to the body. The term support mechanism is used to encapsulate these and other door mounting arrangements.

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This provides the advantage that by attaching the first body portion of the first-door belt to a body of a vehicle and connecting the first connection means to a second connection means, so that the first-door belt extends across the first door, the first-door belt may assist in preventing access of an object impacting against the first door. It may also assist in preventing the first door from being pushed into the cabin.

Optionally, the first hinge portion of the at least one first-door belt comprises flexible elements extending between the first door portion and the first body portion, and the flexible elements are arranged to bend to enable the first door portion to rotate with respect to the first body portion as the first door moves between its closed position and its open position. This provides the advantage that the first-door belt may have a simple structure, as it does not require any hinge mechanism itself.

Optionally, the flexible elements extend along the first door portion of the at least one first-door belt to the first connection means.

Optionally, the flexible elements extend between the first connection means and the body of the vehicle. This provides the advantage that the flexible elements providing the first-door belt with a required tensile strength are able to extend the whole length of the belt between the body of the vehicle and the first connection means.

Optionally, the flexible elements comprise a plurality of fibres.

Optionally, the flexible elements are formed of a polymer. This provides the advantage that the first-door belt may have a lightweight structure but which provides a required high tensile strength.

Optionally, the polymer is poly(p-phenylene-2,6-benzobisoxazole). This provides the advantage the first-door belt may have a lightweight structure but which provides a required high tensile strength.

Optionally, the flexible elements are covered in first protective material to protect the flexible elements from the environment. This provides the advantage that the required physical properties of the flexible elements may be maintained over a longer period of time.

Optionally, the first hinge portion of the at least one first-door belt is formed of a composite comprising the flexible elements embedded within the first protective material. This provides the advantage that the required physical properties of the flexible elements may be maintained over a longer period of time.

Optionally, the first door portion of the at least one first-door belt is formed of a composite comprising the flexible elements embedded within second protective material. This provides the advantage that the physical properties of the door portion and the hinge portion may be tuned for their particular purpose.

Optionally, the second protective material is less flexible than the first protective material.

Optionally, the first body portion of the at least one first-door belt comprises a fixing device configured to retain one end of the flexible elements, the fixing device having a connection portion for connection to the body of the vehicle. This provides the advantage that the position at which the fixing device is attached may be adjusted to ensure that there is no undue slack in the first-door belt.

Optionally, the first door comprises a panel formed of a composite and the flexible elements forming the door portion of the at least one first-door belt are included within the composite that forms the panel. This provides the advantage that a reduced number of components are required when assembling the first door belt onto a vehicle.

Optionally, the panel is the outermost panel of the first door.

Optionally, the first connection means is connected to a second connection means and the first body portion is connected to a body of the vehicle, the second connection means and the body of the vehicle are configured to retain the at least one first-door belt to enable the at least one first-door belt to be put in tension. This provides the advantage that, in the event of an object impacting against the first door, tension force produced in the first-door belt is able to act against the force of the impacting object to keep it out of the cabin of the vehicle.

Optionally, the door arrangement comprises a plurality of first-door belts.

Optionally, the first door comprises a first number of first-door belts and the second door comprises a second number of second-door belts, and the second number is equal to the first number.

- 5 Optionally, the second hinge portion comprises flexible elements extending between the second door portion and the second body portion.

Optionally, the second hinge portion of the at least one second-door belt is formed of the same types of material(s) as the first hinge portion of the at least one first-door belt.

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Optionally, a sill belt having a first end connected to the first connection means or the second connection means and a connector at a second end; the connector configured to locate in a socket on the body of the vehicle. This provides the advantage that additional strength may be provided to the arrangement of belts.

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Optionally, the sill belt comprises a composite material including flexible elements and the connector is formed from the composite material as an end part of the sill belt.

- 20 Optionally, the first connection means comprises one or more connection devices and the second connection means comprises one or more connection devices.

Optionally, the second connection means defines a space for receiving the first connection means and a socket on each of two opposing sides of the space, and the first connection means comprises: two latching members, each latching member having a first end configured to slide into a corresponding one of the sockets of the second connection means to latch the first connection means to the second connection means; and a cam member defining a cam surface in contact with the latching members, the cam surface being configured to cause the latching members to slide apart and into the sockets of the second connection means as the cam member is moved from an unlatching position to a latching position. This provides the advantage of a secure mechanism for ensuring the strength of the latching together of the first-door belt(s) and the second-door belts(s).

Optionally, the first connection means comprise a main body in which the cam member is pivotally mounted and in which the latching members are arranged to slide.

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According to an aspect of the invention there is provided a door arrangement for providing access to a cabin within a body of a vehicle, the door arrangement comprising: a first door; a first hinge configured to support the first door and to enable the first door to move between a closed position and an open position; a first connection means for connecting with a second connection means, the first connection means being mounted on the first door; at least one first-door belt comprising: a first body portion for connection to the body of the vehicle, a first door portion connected to the first connection means, and a first hinge portion configured to enable the first door portion to rotate with respect to the first body portion as the first door moves between its closed position and its open position.

This provides the advantage that by attaching the first body portion of the first-door belt to a body of a vehicle and connecting the first connection means to a second connection means, so that the first-door belt extends across the first door, the first-door belt may assist in preventing access of an object impacting against the first door. It may also assist in preventing the first door from being pushed into the cabin.

Optionally, the first hinge portion of the at least one first-door belt comprises flexible elements extending between the first door portion and the first body portion, and the flexible elements are arranged to bend to enable the first door portion to rotate with respect to the first body portion as the first door moves between its closed position and its open position. This provides the advantage that the first-door belt may have a simple structure, as it does not require any hinge mechanism itself.

Optionally, the flexible elements extend along the first door portion of the at least one first-door belt to the first connection means.

Optionally, the flexible elements extend between the first connection means and the body of the vehicle. This provides the advantage that the flexible elements providing the first-door belt with a required tensile strength are able to extend the whole length of the belt between the body of the vehicle and the first connection means.

Optionally, the flexible elements comprise a plurality of fibres.

Optionally, the flexible elements are formed of a polymer. This provides the advantage that the first-door belt may have a lightweight structure but which provides a required high tensile strength.

- 5 Optionally, the polymer is poly(p-phenylene-2,6-benzobisoxazole). This provides the advantage the first-door belt may have a lightweight structure but which provides a required high tensile strength.

- 10 Optionally, the flexible elements are covered in first protective material to protect the flexible elements from the environment. This provides the advantage that the required physical properties of the flexible elements may be maintained over a longer period of time.

- 15 Optionally, the first hinge portion of the at least one first-door belt is formed of a composite comprising the flexible elements embedded within the first protective material. This provides the advantage that the required physical properties of the flexible elements may be maintained over a longer period of time.

- 20 Optionally, the first door portion of the at least one first-door belt is formed of a composite comprising the flexible elements embedded within second protective material. This provides the advantage that the physical properties of the door portion and the hinge portion may be tuned for their particular purpose.

Optionally, the second protective material is less flexible than the first protective material.

- 25 Optionally, the first body portion of the at least one first-door belt comprises a fixing device configured to retain one end of the flexible elements, the fixing device having a connection portion for connection to the body of the vehicle. This provides the advantage that the position at which the fixing device is attached may be adjusted to ensure that there is no undue slack in the first-door belt.

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Optionally, the first door comprises a panel formed of a composite and the flexible elements forming the door portion of the at least one first-door belt are included within the composite that forms the panel. This provides the advantage that a reduced number of components are required when assembling the first door belt onto a vehicle.

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Optionally, the panel is the outermost panel of the first door.

Optionally, the first connection means is connected to a second connection means and the first body portion is connected to a body of the vehicle, the second connection means and the body of the vehicle are configured to retain the at least one first-door belt to enable the at least one first-door belt to be put in tension. This provides the advantage that, in the event of an object impacting against the first door, tension force produced in the first-door belt is able to act against the force of the impacting object to keep it out of the cabin of the vehicle.

Optionally, the door arrangement comprises a plurality of first-door belts.

Optionally, the door arrangement comprises: a second door mounted next to the first door; a second hinge configured to support the second door and to enable the second door to move between a closed position and an open position; a second connection means mounted on the second door and configured to connect with the first connection means; at least one second-door belt comprising: a second body portion for connection to the body of the vehicle, a second door portion connected to the second connection means, and a second hinge portion configured to enable the second door portion to rotate with respect to the second body portion as the second door moves between its closed position and its open position. This provides the advantage that the first door and the second door are able to span a large opening to provide improved ease of access into the cabin of the vehicle, while the first-door belt and the second-door belt provide a barrier to prevent objects impacting against the doors from entering the cabin.

Optionally, the first door comprises a first number of first-door belts and the second door comprises a second number of second-door belts, and the second number is equal to the first number.

Optionally, the second hinge portion comprises flexible elements extending between the second door portion and the second body portion.

Optionally, the second hinge portion of the at least one second-door belt is formed of the same types of material(s) as the first hinge portion of the at least one first-door belt.

Optionally, a sill belt having a first end connected to the first connection means or the second connection means and a connector at a second end; the connector configured to locate in a socket on the body of the vehicle. This provides the advantage that additional strength may be provided to the arrangement of belts.

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Optionally, the sill belt comprises a composite material including flexible elements and the connector is formed from the composite material as an end part of the sill belt.

Optionally, the first connection means comprises one or more connection devices and the second connection means comprises one or more connection devices.

Optionally, the second connection means defines a space for receiving the first connection means and a socket on each of two opposing sides of the space, and the first connection means comprises: two latching members, each latching member having a first end configured to slide into a corresponding one of the sockets of the second connection means to latch the first connection means to the second connection means; and a cam member defining a cam surface in contact with the latching members, the cam surface being configured to cause the latching members to slide apart and into the sockets of the second connection means as the cam member is moved from an unlatching position to a latching position. This provides the advantage of a secure mechanism for ensuring the strength of the latching together of the first-door belt(s) and the second-door belts(s).

Optionally, the first connection means comprise a main body in which the cam member is pivotally mounted and in which the latching members are arranged to slide.

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According to another aspect of the invention there is provided a vehicle comprising the door arrangement according to any one of the previous paragraphs.

Optionally, the vehicle comprises an opening to enable access into the cabin of the vehicle when the first door and/or the second door are in their open position; the first door is supported on the first hinge at a first side of the opening; and the second door is supported on the second hinge at an opposite second side of the opening.

Within the scope of this application it is expressly intended that the various aspects, embodiments, examples and alternatives set out in the preceding paragraphs, in the claims

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and/or in the following description and drawings, and in particular the individual features thereof, may be taken independently or in any combination. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination, unless such features are incompatible. The applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner.

BRIEF DESCRIPTION OF THE DRAWINGS

One or more embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 shows a vehicle embodying the present invention with doors of the vehicle open;

Fig. 2 shows the vehicle of Fig. 1 with doors of the vehicle closed;

Fig. 3 shows components of the vehicle of Fig. 1 that are associated with its door arrangement;

Fig. 4 shows a cross-sectional view of a belt within the front door of the vehicle, at a horizontal plane through the belt;

Fig. 5 shows a belt of the rear door of the vehicle;

Fig. 6 shows an alternative structure for the front door of the vehicle and an associated belt;

Figs. 7 and 8 show belts of the front door and belts of the rear door with their connection means unconnected and connected, respectively;

Figs. 9 and 10 show a connection device in its unlatched position and latched position respectively;

Fig. 11 shows an alternative vehicle embodying the present invention;

Fig. 12 shows belts of the front and rear doors of the vehicle of Fig. 11, with an additional sill belt; and

Fig. 13 shows a cross-sectional view of the sill belt 1101 and a lower part of the second connection device.

DETAILED DESCRIPTION

A door arrangement 301 and a vehicle 100 in accordance with an embodiment of the present invention are described herein with reference to the accompanying Figs. 1 to 10.

With reference to Figs. 1 and 2, the vehicle 100 is a road vehicle comprising a body 101 supported on road wheels 102. The vehicle 100 has a cabin 103 within the body 101 of the

vehicle 100, which contains seats 104 (shown in Fig. 1) to enable users of the vehicle to be seated.

An opening 105 in the side of the body 101 enables users to obtain access into the cabin 103.

5 The vehicle 100 also includes a front door 106 and a rear door 107 that may be moved to an open position, as shown in Fig. 1, to enable users to enter or leave the cabin 103, or moved to a closed position, as shown in Fig. 2, in which the combination of the front door 106 and the rear door 107 extend across the entire width of the opening 105.

10 The front door 106 is mounted on hinges 201 (shown in Fig. 2) at a first side of the opening 105 and the rear door 107 is mounted on hinges 202 at a second side of the opening 105, opposite to the first side. In embodiments of the invention the hinges form a pivot for the doors to move with respect to the body 101. In other embodiments the hinges form a slide mechanism for the doors to move with respect to the body 101. Other arrangements may be
15 useful. Throughout the specification the term hinge may therefore be interchanged with the term support mechanism for clarity that component in question may permit the doors to pivot and/slide with respect to the body. The hinges 201 of the front door 106 are fixed to a first pillar 203 and the hinges 202 of the rear door 107 are fixed to a second pillar 204. A sill 108 extends along the vehicle 100 beneath the opening 105, and the pillars 203 and 204 are rigidly
20 fixed to the sill 108. A cant rail 109 is rigidly fixed at each of its two ends to upper ends of the pillars 203 and 204, over the top of the opening 105, so that the sill 108, the cant rail 108 and the pillars 203 and 204 combine to form a frame that defines the opening 105.

It may be noted that there is no additional pillar extending between the sill 108 and the cant
25 rail 109 mid-way between the two pillars 203 and 204, as is usually the case on conventional vehicles. The opening 105 therefore enables users to obtain access to both the front seats 104A of the vehicle 100 and the rear seats 104B.

The front door 106 comprises a first connection means 110 adjacent to its rear edge 111 and
30 the rear door 107 comprises a second connection means 112 adjacent to its front edge 113. The first connection means 110 is configured to releasably connect to the second connection means 111 as will be described in further detail below, with reference to Figs. 9 and 10.

In the present embodiment, three first-door belts 114 (shown in Fig. 2) each have a first end
35 attached to the first connection means 110 and a second end attached to the first pillar 203.

The first-door belts 114 therefore extend across the width of the front door 106 from the first connection means 110 at the rear edge 111 of the front door 106, and past a front edge 115 of the front door 106 to the first pillar 203. Similarly, three second-door belts 114A each have a first end attached to the second connection means 112 and a second end attached to the second pillar 204. The second-door belts 114A therefore extend across the width of the rear door 107 from the second connection means 112 at the front edge 113 of the rear door 107, and past a rear edge 116 of the rear door 107 to the second pillar 204.

In the present embodiment, there are three first-door belts 114 and three second-door belts 114A, but in alternative embodiments there are fewer than three first-door belts 114 and fewer than three second-door belts 114A, while in other alternative embodiments there are more than three belts 114 and 114A on each door 106 and 107. In the present embodiment the number of first-door belts 114 is the same as the number of second-door belts 114A. However, in alternative embodiments, one of the doors 106 or 107 may have fewer belts 114 or 114A than the other door, but the belts 114 of the first door 106 may be configured to have a combined tensile strength that is equal to that of the belts 114A of the second door 107.

The first-door belts 114 are anchored to the first pillar 203, the second-door belts 114A are anchored to the second pillar 204 and, with the doors 106 and 107 in their closed positions, the first connection means 110 is latched to the second connection means 112. The first-door belts 114 and the second-door belts 114A therefore provide a continuous belt extending between the first pillar 203 and the second pillar 204 across the opening 105.

In normal use the belts 114 and 114A are not subjected to any substantial stresses. It may be noted that the weight of the doors 106 and 107 is supported by the hinges 201 and 202 and not by the belts 114 and 114A.

During use of the vehicle 100, in the event of an impact on one or both of the doors 106 and 107 by an object, such as another vehicle, the first-door belts 114 and the second-door belts 114A are put in tension between the two pillars 203 and 204 as the object pushes against the belts 114 and/or the belts 114A. The pillars 203 and 204 are formed of strong material, such as steel, and provided with a structure, such as by casting, that resists their deformation by the forces applied to them by the first-door belts 114 and the second-door belts 114A. The first-door belts 114 and the second-door belts 114A are formed of materials that are able to withstand large tension forces, and therefore in the event of an impact by another vehicle, the

continuous belt provided by the first-door belts 114 and the second-door belts 114A provides a barrier to the entry of that other vehicle into the cabin 103. Instead of entering the cabin 103, the other vehicle may push against the first-door belts 114 and/or the second-door belts 114A and thereby push the whole vehicle 100 sideways. It should therefore be understood that the first-door belts 114 and the second-door belts 114A provide occupants of the cabin 103 with improved protection in the event of a side impact on the vehicle 100.

In an alternative vehicle embodying the present invention, the vehicle has a single door that is moveable to close the opening 105. The single door comprises first-door belts 114 attached to the pillar 203 and to the first connection means 110. The second connection means 112 is fixed to the body 101 of the vehicle 100, for example on the second pillar 204.

Components of the vehicle 100 of Figs. 1 and 2 that are associated with its door arrangement 301 are shown in Fig. 3. The various components of the door arrangement 301 have been labelled with the same reference signs as used in Figs. 1 and 2. The position of the doors 106 and 107 are shown in dashed outline in Fig. 3 for the purposes of clarity.

Each of the first-door belts 114 comprise a first body portion 302 connected to the first pillar 203, a first door portion 303 connected to the first connection means 110, and a first hinge portion 304 (shown hatched) that connects the first body portion 302 to the first door portion 303. The first hinge portion 304 extends from the first door 106 past the front edge 115 of the first door 106 and it has a composition that enables it to bend to enable the first door portions 303 to rotate with respect to the first body portions 302. Thus, as the first door 106 moves on its hinges 201 between its closed position and its open position, the first door portions 303 of the first-door belts 114 rotate with the door 106 with respect to the first body portions 302.

Similarly, each of the second-door belts 114A comprise a second body portion 302A connected to the second pillar 204, a second door portion 303A connected to the second connection means 112, and a second hinge portion 304A (shown hatched) that connects the second body portion 302A to the second door portion 303A. The second hinge portion 304A extends from the second door 107 past the rear edge 116 of the second door 107 and it has a composition that enables it to bend to enable the second door portions 303A to rotate with respect to the second body portions 302A. Thus, as the second door 107 moves on its hinges 202 between its closed position and its open position, the second door portions 303A of the

second-door belts 114A rotate with the door 107 with respect to the second body portions 302A.

It will be appreciated that where the door hinge (support mechanism) provides for the door to slide with respect to the body, the hinge portions of the first and/or second belts is arranged to permit the sliding motion of the respective door.

In the embodiment of Figs. 1 and 2, the three first-door belts 114 and the three second-door belts 114A are only connected via their connection to a pillar 203 or 204 at one end and via the connection means 110 or 112 at the opposite end. However, in an alternative embodiment, the body portions 303 of the three belts 114 may be connected, for example by strap connectors 310 (shown in dotted outline in Fig. 3) that extend substantially perpendicular to the length of the belts 114 and 114A. The strap connectors 310 may be formed of the same type of composite material as the belts themselves, or may be formed of another material suitable for maintaining the separation distance between the first-door belts 114 and between the second-door belts 114A. Two strap connectors 310 are shown on each of the doors 106 and 107 of Fig. 3, but in alternative embodiments fewer or more than two strap connectors 310 may be provided on each of the doors.

In the embodiment of Fig. 3, when the doors 106 and 107 are in their closed positions, the three first-door belts 114 extend substantially parallel to each other, and along the same lines as the three second-door belts 114A of the second door 107. I.e., when the doors 106 and 107 are in their closed positions, each of the first-door belts 114 and the second-door belts 114a extend within a plane that is within a few degrees (e.g. 3 degrees) of the other belts 114 and 114A. In alternative embodiments at least one of the first-door belts 114 may be arranged at an angle to one of the other first-door belts 114 and/or the second-door belts 114A of the second door 107. However, in either case, the arrangement of the belts 114 and 114A is such that when the doors 106 and 107 are in their closed positions, the belts 114 and 114A are not slack, and so in the event of an impact against the doors 106 and 107, each of the belts 114 and 114A is immediately placed in tension to repel the impacting object.

A cross-sectional view of the front door 106 and one of the first-door belts 114, at a horizontal plane through the belt 114, is shown in Fig. 4. In the present embodiment the front door 106 comprises an outer panel 401 and an inner panel 402, which generally extends approximately parallel to the outer panel 401 to define a void 403, in which the first door portions 303 of the

first-door belts 114 are located. The inner panel 402 comprises an end wall portion 409 that is fixed to the outer panel 401. The end wall portion 409 comprises one or more slots 410 to enable the hinge portion 304 of the first-door belts 114 to pass through.

- 5 The first connection means 110 comprises a post 404 (also shown in Figs. 9 and 10) to which the first door belt 114 is anchored. The first-door belt 114 is formed of a length of material that is looped around the post 404 at its midpoint. The two ends of the length of material forming the first-door belt 114 pass through a slot in a first clamping plate 405 (shown in Fig. 4) and each of the two ends are then separately clamped between the first clamping plate 405 and a
10 second clamping plate 406, for example by bolting the first clamping plate 405 to the second clamping plate 406. The second clamping plate 406 may be configured, for example with holes, to enable it to be anchored to the first pillar 203, and therefore the first plate 405 and the second plate 406 provide a fixing device for fixing the first-door belt 114 to the body 101 of the vehicle 100. Alternatively, the first pillar 203 itself may provide either the first clamping
15 plate 405 or the second clamping plate 406.

In the present embodiment, the first-door belt 114 comprises a composite material including flexible elements 407 (shown schematically by dotted lines) formed of a polymer. In the present embodiment, the flexible elements 407 are fibres and the polymer is poly(p-phenylene-2,6-benzobisoxazole). However, other polymeric materials may be used, such as a
20 high molecular weight polyethylene, that are capable of providing the required tensional strength to the composite material. In the present embodiment the fibres are formed into yarn, which is then formed into tape. However, in alternative embodiments, the first-door belt 114 may comprise a composite material in the form of a rope.

25

In some embodiments, the whole of the length of the first-door belt 114 may comprise a composite comprising the flexible elements 407 encased within a synthetic rubber. However, in the present embodiment the flexible elements 407 are encased in a more rigid epoxy compound along the first door portion 303 and the first body portion 302, while in the hinge
30 portion 304 the flexible elements 407 are encased in a more flexible synthetic rubber compound. In addition, the hinge portion may be covered by a flexible protective sleeve 408, for example, formed of a synthetic rubber. The tensile strength of the flexible elements 407 could reduce over time with exposure to various environmental factors, such as light, ultraviolet, oxygen, etc. However, the epoxy compound and the synthetic rubber compound

encasing the flexible elements and/or the protective sleeve 408 protect the flexible elements 407 from the environment in order to prolong the useful life of the first-door belt 114.

It may be noted that, although the material used to encase the flexible elements 407 may differ over their length, the flexible elements themselves extend continuously along the whole length of the belt 114.

In Fig. 4, the door portion 303 of the first-door belt 114 is shown in the void 403 between the outer panel 401 and the inner panel 402. However, in an embodiment, as shown in Fig. 6, the first door 106 may comprise a panel, such as the outer panel 401 that is formed from a composite material, and the door portion 303 of the first-door belt 114 is incorporated into the composite structure forming the outer panel 401. For example, the flexible elements 407 of the belts 114 may be encased in a material that is used to form the outer panel 401 at the same time that the outer panel 401 is formed. The outer panel 401 may be provided with a nonplanar shape, and the door portion of the belt 114 may be moulded to be included in the shape of the outer panel 401.

The second-door belt 114A and the second door 107 may have the same type of construction as the first-door belt 114 and the first door 106. However, one of the second door belts 114A is shown in Fig. 5, which illustrates the manner in which it may differ from the first-door belts 114. In a similar manner to the first door belts 114, the second door belt 114A comprises an elongated length of material that is looped around a post 501 of the second connection means 112 at its midpoint. The elongated length of material may comprise a composite as described above for the first-door belt 114.

However, unlike those of the first-door belt 114, the ends of the elongate length of material forming the second-door belt 114A are clamped alongside each other between a first clamping plate 502 and a second clamping plate 503. The second clamping plate 503 is provided with means for attachment to the second pillar 204 that allows the position of the second clamping plate 503 to be adjusted at the time of its attachment. For example, the second clamping plate 503 may be provided with slots 504 to enable its attachment to the second pillar 204 by bolts (not shown). This allows the exact position of the second clamping plate 503 on the second pillar 204 to be adjusted to compensate for variations in the exact distance between the first and second pillars 203 and 204 due to an allowed tolerance in the design of the vehicle. This ensures that the combination of the first-door belt 114 and the second-door belt 114A may be

held taut between the first pillar 203 and the second pillar 204 when their connection means 110 and 112 are connected together.

5 The first-door belts 114 and the second-door belts 114A are shown in Figs. 7 and 8 with their connection means 110 and 112 unconnected and connected respectively. The first connection means 110 comprises three first connection devices 701, so that each of the three first-door belts 114 has a respective one of the first connection devices 701. In the present embodiment, the second connection means 112 comprises a single second connection device 702 that is shared between the three second-door belts 114A. The connection device 702 comprises
10 three clevises through which the post 501 passes to retain the looped ends of the second-door belts 114A. The second connection device 702 also comprises four catch plates 704 that are arranged in parallel with one another to define three spaces 705 for receiving the three first connection devices 701. Each of the catch plates 704 defines a hole 505 (shown in Fig. 5) providing a socket into which the latching members 706 of the first connection devices 701
15 are configured to slide to connect the first connection devices 701 to the second connection device 702.

The three first connection devices 701 are similarly configured to each other and one of the three connection devices 701 is shown in its unlatched position and latched position
20 respectively in Figs. 9 and 10. The first connection device 701 comprises a latching mechanism comprising a pair of latching members 706 arranged on opposing sides of a cam member 901. The latching members 706 are located within holes 902 formed in a main body 903 of the first connection device 701 so that they are able to slide within the holes 902 between the unlatched position shown in Fig. 9 and the latched position shown in Fig. 10.

25 The cam member 901 has a cam surface 905 defined by an elliptical profile of the cam member 901. The cam member 901 is mounted on a shaft 904 that is arranged to pivot within the main body 903, so that the cam member 901 is able to pivot while its cam surface 905 pushes against the latching members 706. The shaft 904 and therefore the cam member 901 are
30 caused to pivot between the latched position of Fig. 10 and the unlatched position of Fig. 9 by a motor (not shown).

When the latching members 706 are separated by the minor axis of the elliptical profile of the cam member 901, the latching members 706 are able to retract back into their unlatched

position as shown in Fig. 9. The first connection device 701 may be provided with springs (not show) within the main body 903 to cause the retraction of the latching members 706.

When the cam member 901 is rotated so that the major axis of its elliptical profile separates the latching members 706, the latching members 706 are pushed into their latching positions as shown in Fig. 10 in which ends 1001 of the latching members 706 extend from the main body 903. The ends 1001 of the latching members 706 are configured to fit within the holes 505 formed in the catch plates 704 to latch the first connection devices 701 to the second connection device 702.

A second vehicle 100 embodying the present invention is shown in Fig. 11. The vehicle 100 of Fig. 11 comprises all of the features of the vehicle 100 of Fig. 1, and the features labelled in Fig. 11 have been given the same reference signs. However, in addition to the first door belts 114 and second-door belts 114A, the vehicle 100 of Fig. 11 includes a sill belt 1101 that has a first end connected to the second connection means 112 and a connector 1102 at a second end. The connector 1102 is configured to locate in the body 101 of the vehicle 100, for example in a socket 1103 formed in the sill 108 or alternatively fixed to the sill. The sill belt 1101, like the second-door belts 114A may be located between the outer panel and the inner panel of the second door 107, with just the connector 1102 extending inwards from the second door 107 to locate within the socket 1103 when the second door 107 is in its closed position.

In an alternative embodiment, the sill belt 1101 may be arranged to be connected to the first connection means 110 instead of the second connection means 112 and to be located within the first door 106. Alternatively, both the first door 106 and the second door 107 may each comprise a sill belt 1101 having a connector 1102 configured to locate within a socket 1103 on the body of the vehicle 100 when the respective door 106, 107 is in its closed position.

The first door belts 114 and the second door belts 114A of the vehicle 100 of Fig. 11 are shown in Fig. 12 with the sill belt 1101 attached to the second connection means 112. The second connection means 112 comprises a second connection device 702 like that of Fig. 7, but it includes an additional clevis 1201 that retains a pin 1202 about which the sill belt 1101 is looped. Like the first-door belts 114 and the second-door belts 114A, the sill belt 1101 may be formed of a composite material comprising polymer fibres encased in an epoxy or other protective material, such as a synthetic rubber. Alternatively the sill belt 1101 may be formed of a metal.

A cross-sectional view of the sill belt 1101 and a lower part of the second connection device 702 is shown in Fig. 13. In the present embodiment, the sill belt 1101 is formed of polymer fibres encased in an epoxy. The fibres extend from the free end 1302 around the pin 1202 in the clevis 1201 and back down to the end 1302. The fibres are encased in an epoxy so that the whole of the sill belt 1101 is substantially rigid. A main portion 1301 of the sill belt 1101 extends between the clevis pin 1202 and an end portion 1303 of the sill belt 1101 that extends at an angle of about 90 degrees to the main portion 1301. The end portion 1303 is therefore arranged at an angle that allows it to be inserted into the socket 1103 in the sill 108 as the second door 107 is closed.

In the event of an object impacting against the doors 106 and 107 of the vehicle 100 of Fig. 11 and the first-door belts 114 and the second door belts 114A being placed in tension, the sill belt 1101 is also placed in tension between the socket 1103 and the second connection means 112. Thus, the sill belt 1101 provides additional force to withstand the force of the impacting object.

Although embodiments of the present invention have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the invention as claimed.

Features described in the preceding description may be used in combinations other than the combinations explicitly described.

Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not.

Although features have been described with reference to certain embodiments, those features may also be present in other embodiments whether described or not.

Whilst endeavoring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

CLAIMS

1. A door arrangement for providing access through an opening to a cabin within a body of a vehicle, the door arrangement comprising:

5 a first door;

a second door;

a first support mechanism configured to support the first door and to enable the first door to move between a closed position and an open position; and

10 a second support mechanism configured to support the second door and to enable the second door to move between a closed position and an open position,

wherein the arrangement closes the opening to the cabin when both the first door and the second door are in the closed position,

the arrangement further comprising:

a first connection means mounted on the first door;

15 a second connection means mounted on the second door;

at least one first-door belt comprising a first body portion for connection to the body of the vehicle, a first door portion connected to the first connection means, and a first support portion configured to enable the first door portion to move between its closed position and its open position; and

20 at least one second-door belt comprising a second body portion for connection to the body of the vehicle, a second door portion connected to the second connection means, and a second support portion configured to enable the second door portion to move between its closed position and its open position,

wherein the first connection means is connectable directly to the second connection means
25 when both the first and second doors are in the closed position.

2. A door arrangement according to claim 1, wherein the first support portion of the at least one first-door belt comprises flexible elements extending between the first door portion and the first body portion, and the flexible elements are arranged to bend to enable the first
30 door portion to translate with respect to the first body portion as the first door moves between its closed position and its open position.

3. A door arrangement according to claim 2, wherein the first support portion of the at least one first-door belt is formed of a composite comprising the flexible elements embedded
35 within a first protective material to protect the flexible elements from the environment.

4. A door arrangement according to claim 2 or 3, wherein the first door portion of the at least one first-door belt is formed of a composite comprising the flexible elements embedded within a second protective material.

5

5. A door arrangement according to any one of claims 2 to 4, wherein the first body portion of the at least one first-door belt comprises a fixing device configured to retain one end of the flexible elements, the fixing device having a connection portion for connection to the body of the vehicle.

10

6. A door arrangement according to any one of claims 2 to 5, wherein the first door comprises a panel formed of a composite and the flexible elements forming the door portion of the at least one first-door belt are included within the composite that forms the panel.

15

7. A door arrangement according to claim 6, wherein the panel is the outermost panel of the first door.

20

8. A door arrangement according to any preceding claim, wherein the second support portion comprises flexible elements extending between the second door portion and the second body portion.

25

9. A door arrangement according to claim 8 when depending through claim 2, wherein the second support portion of the at least one second-door belt is formed of the same types of material(s) as the first support portion of the at least one first-door belt.

30

10. A door arrangement according to any preceding claim, comprising a sill belt having a first end connected to the first connection means or the second connection means and a connector at a second end; the connector configured to locate in a socket on the body of the vehicle.

11. A door arrangement according to claim 10, wherein the sill belt comprises a composite material including flexible elements and the connector is formed from the composite material as an end part of the sill belt.

12. A door arrangement according to any preceding claim, wherein the first connection means comprises one or more first connection devices, each first connection means connected to at least one of the first-door belts, and the second connection means comprises one or more second connection devices, each second connection means connected to at least one of the second-door belts.

13. A door arrangement according to any preceding claim, wherein the door arrangement comprises a plurality of first-door belts and a plurality of second-door belts, and wherein the plurality of corresponding first connection means are latchable to the plurality of corresponding second connection means by a single latch mechanism.

14. A door arrangement according to any preceding claim, wherein the second connection means defines a space for receiving the first connection means and a socket on each of two opposing sides of the space, and the first connection means comprises:

two latching members, each latching member having a first end configured to slide into a corresponding one of the sockets of the second connection means to latch the first connection means to the second connection means; and

a cam member defining a cam surface in contact with the latching members, the cam surface being configured to cause the latching members to slide apart and into the sockets of the second connection means as the cam member is moved from an unlatching position to a latching position.

15. A vehicle comprising the door arrangement of any one of claims 1 to 14.

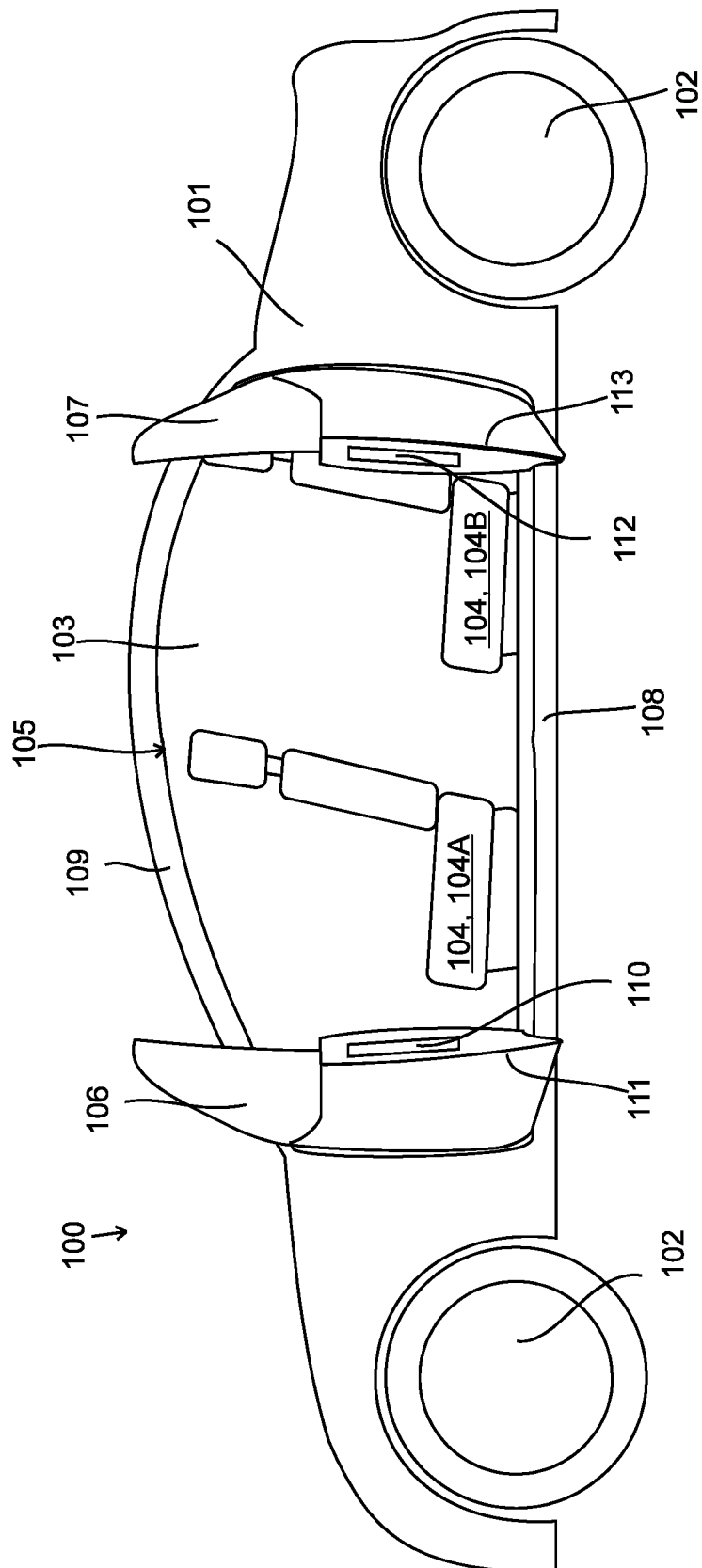


Fig. 1

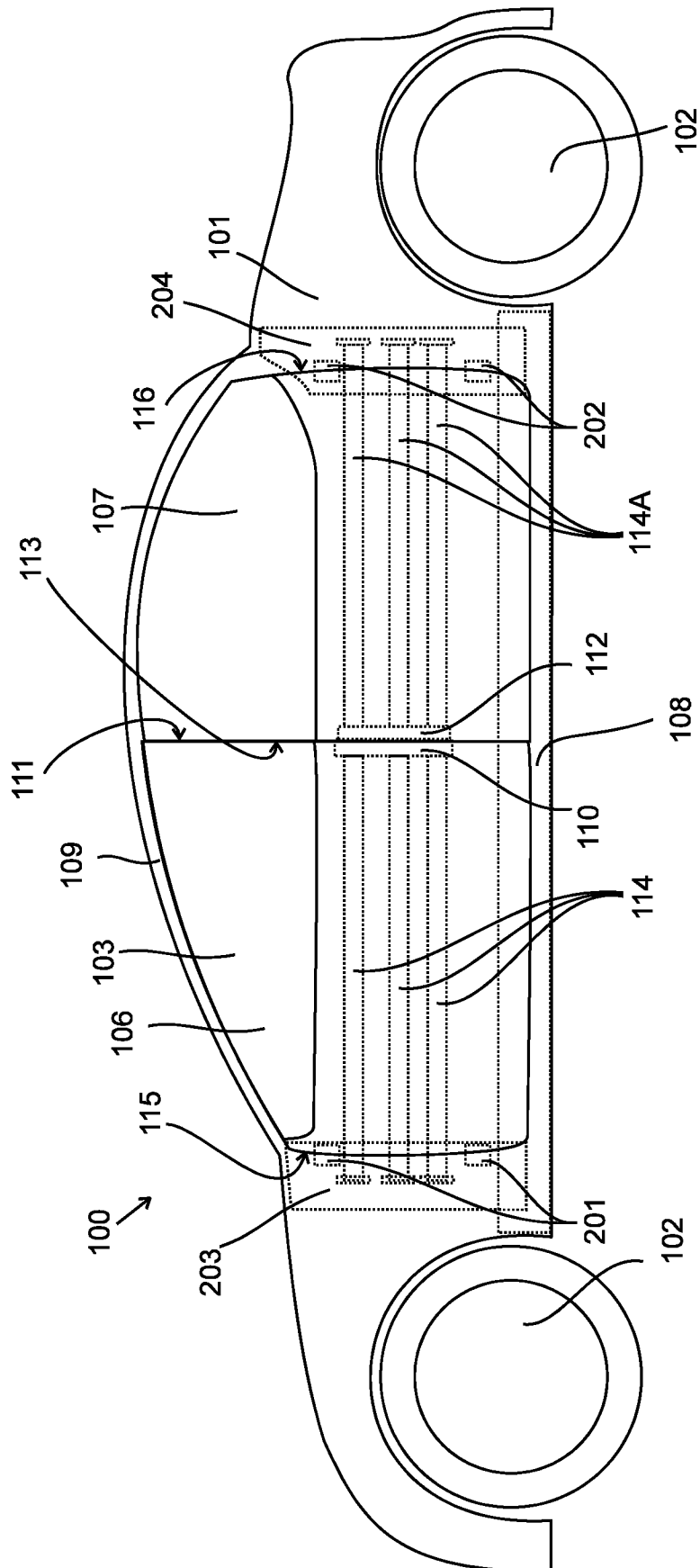


Fig. 2

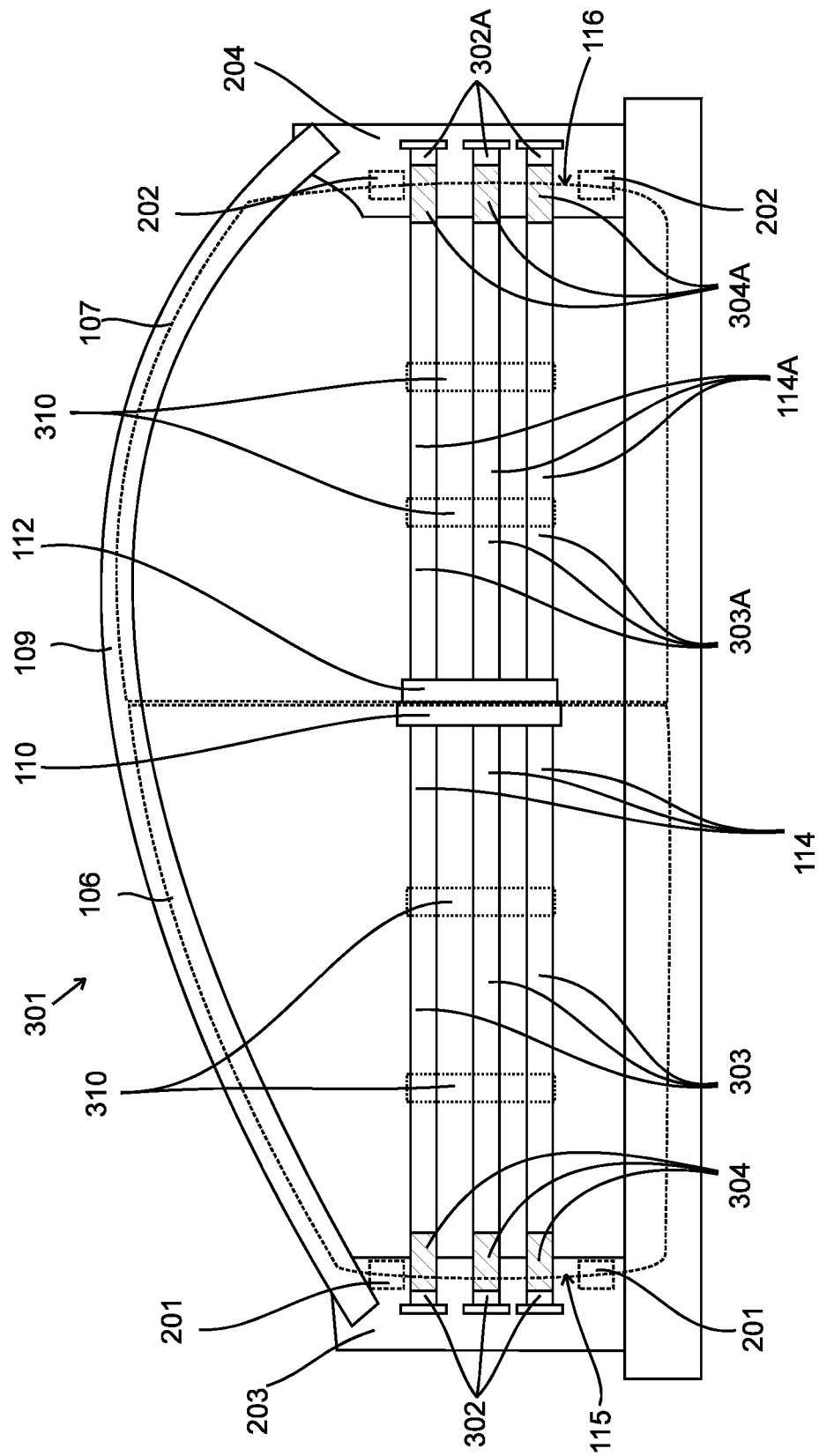


Fig. 3

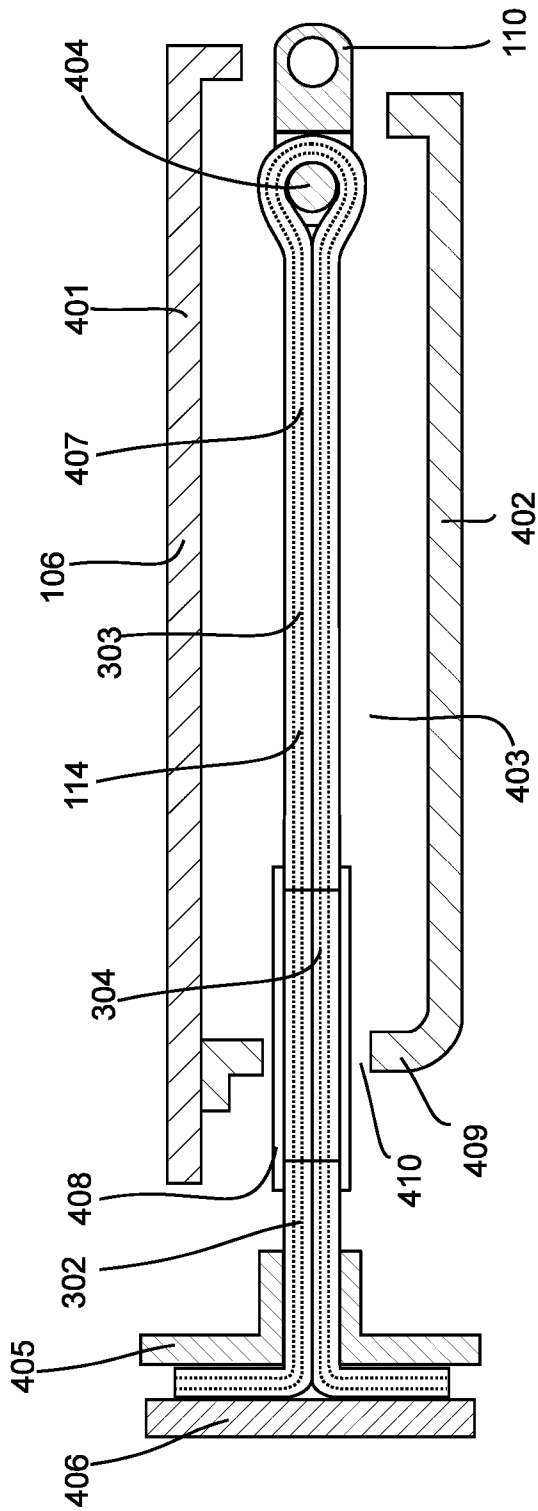


Fig. 4

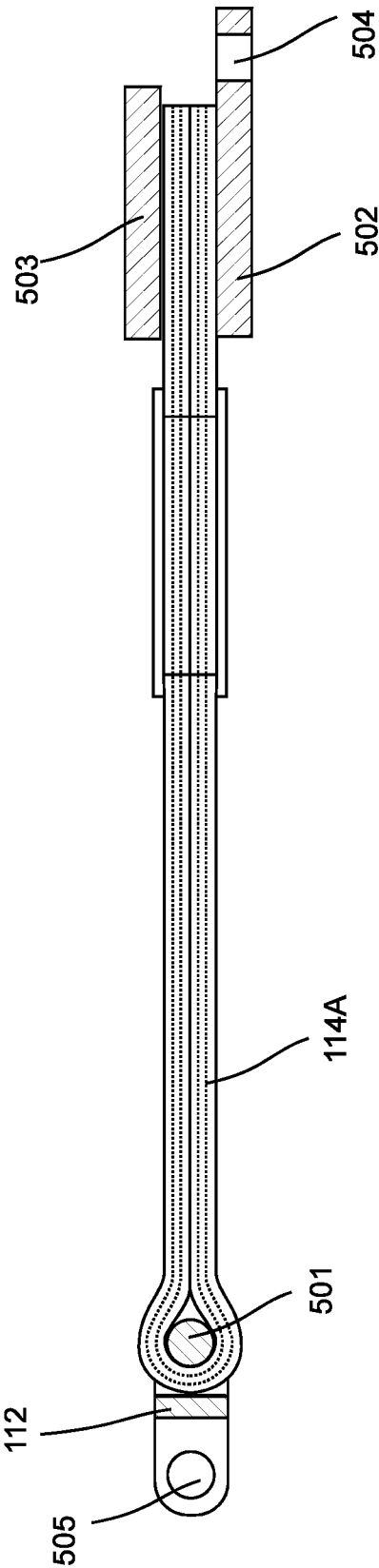


Fig. 5

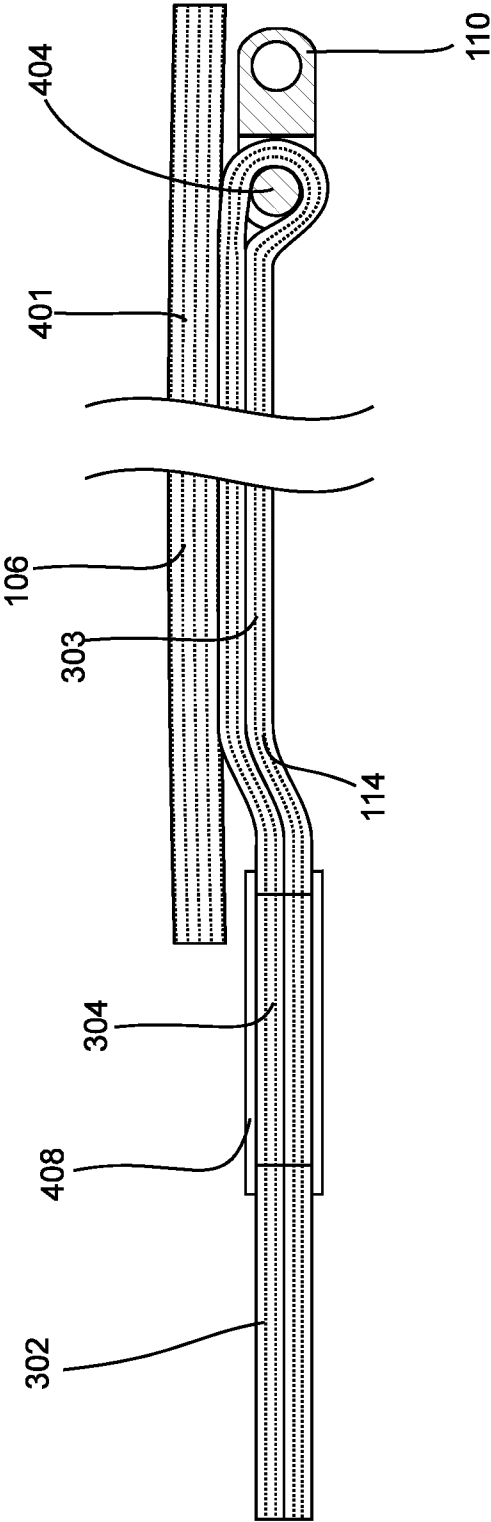
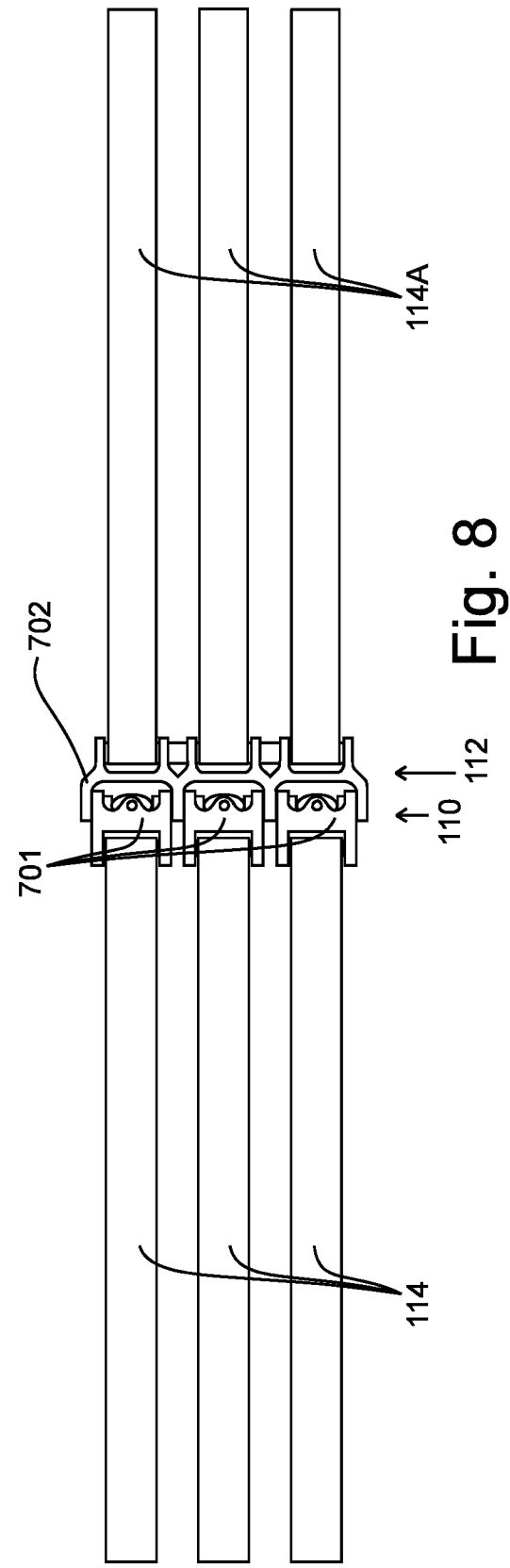
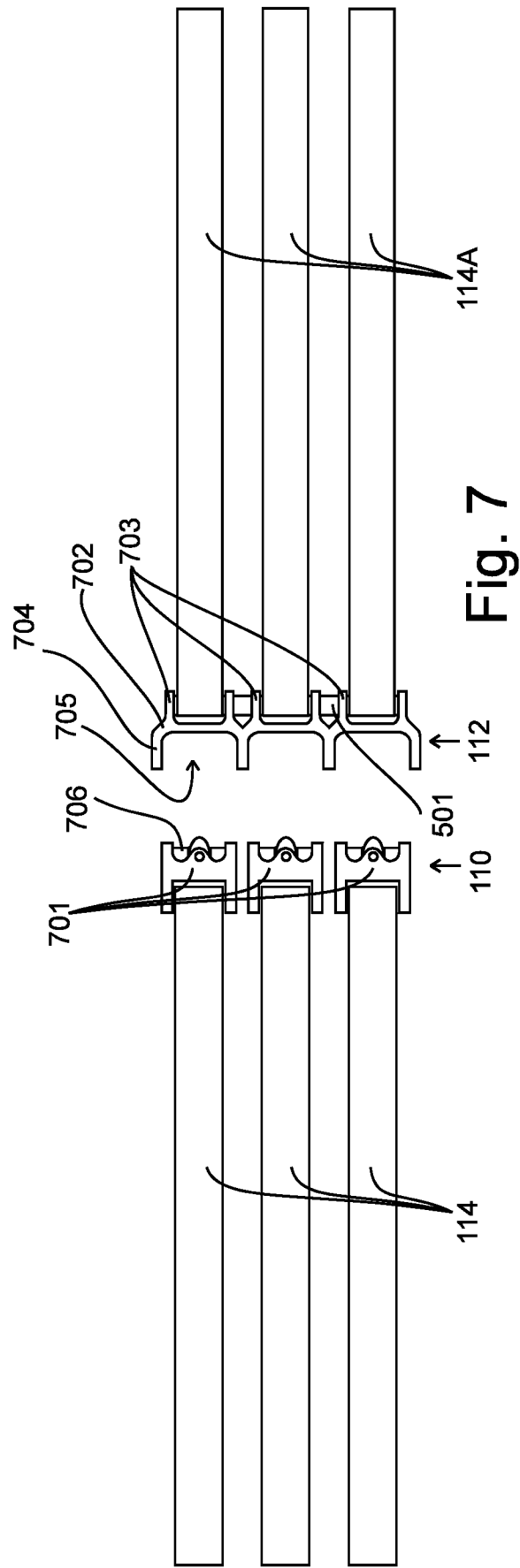


Fig. 6



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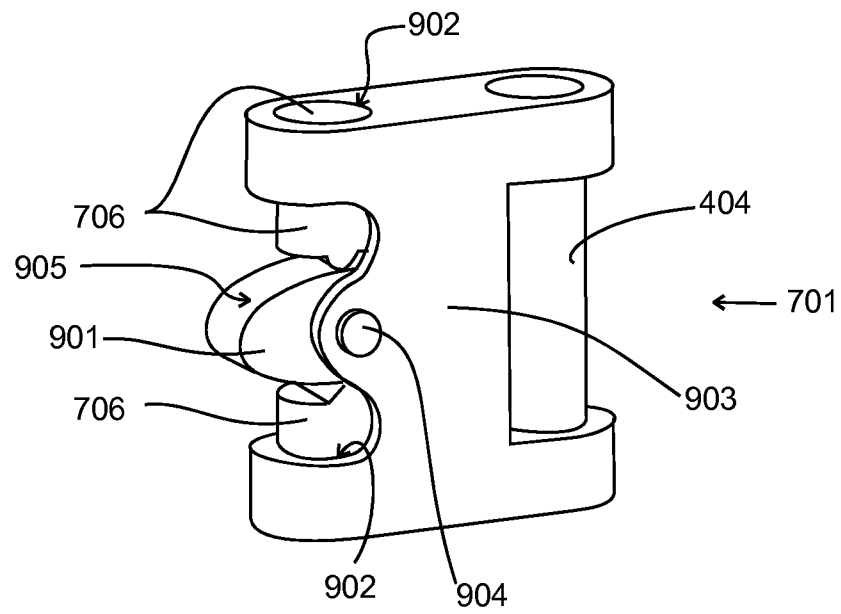


Fig. 9

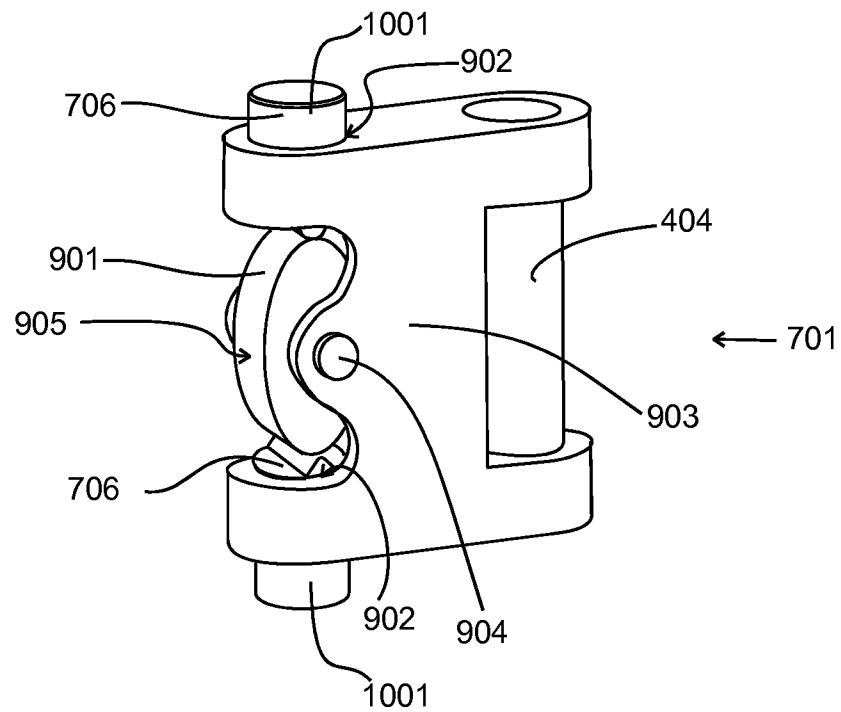


Fig. 10

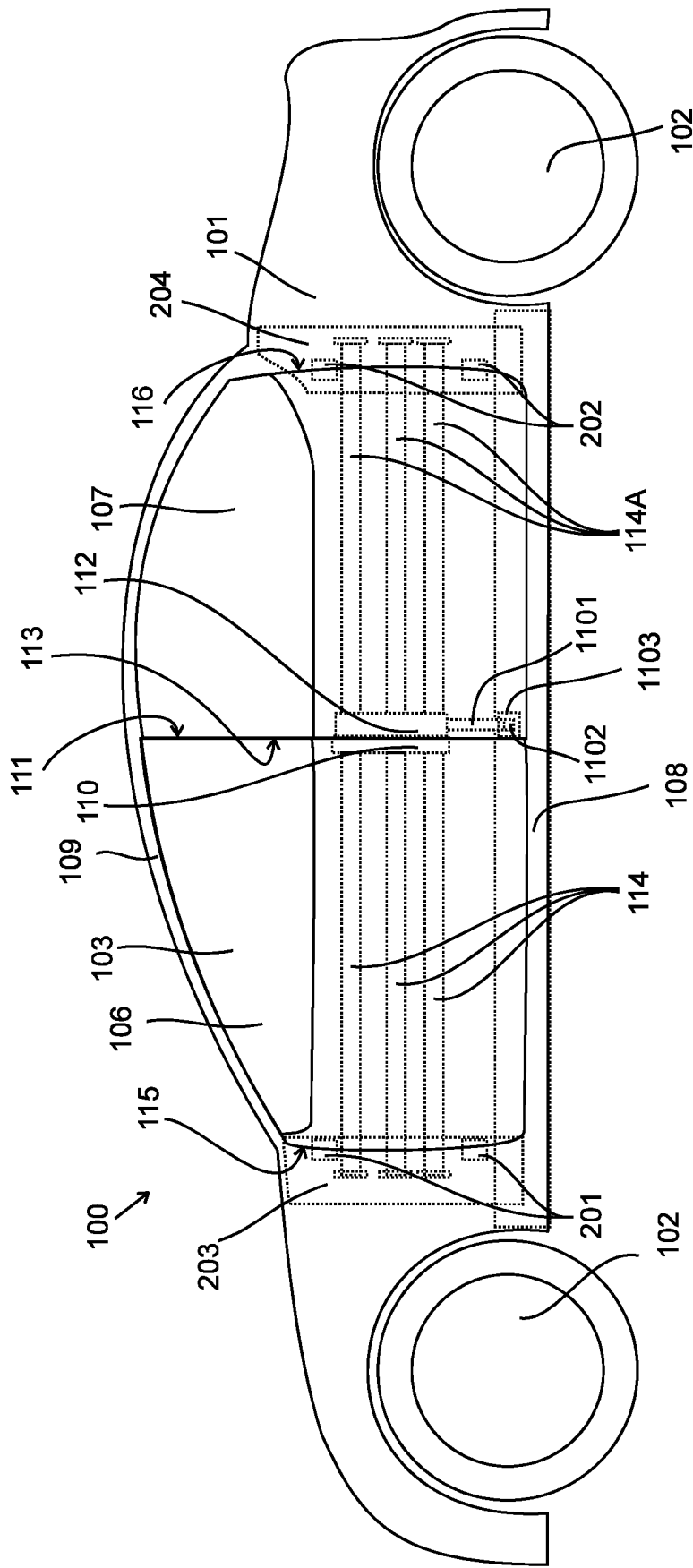


Fig. 11

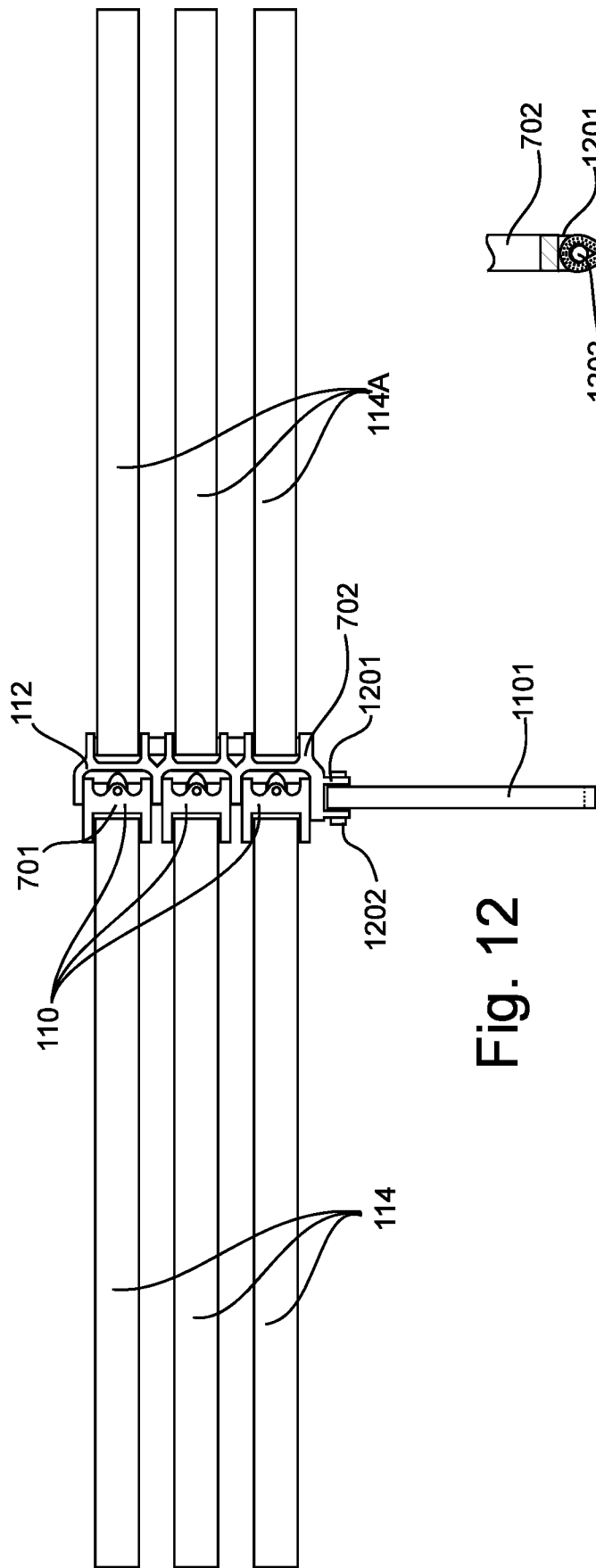


Fig. 12

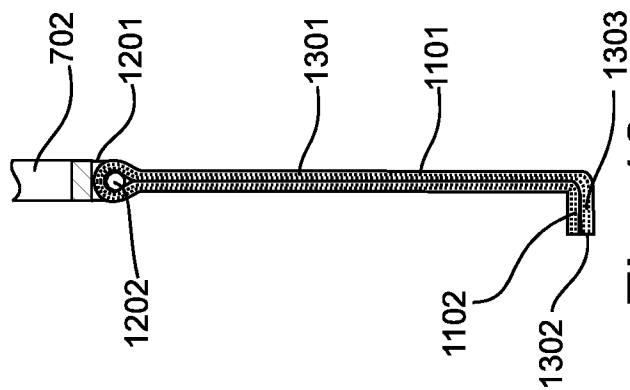


Fig. 13

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/082952

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60J5/04 E05B83/38
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60J E05C E05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 4 239283 B2 (MAZDA MOTOR) 18 March 2009 (2009-03-18) figures 1-16	1-5,8,9, 12,13,15 6,7,10, 11,14
Y A	----- GB 1 292 011 A (GEN MOTORS CORP [US]) 11 October 1972 (1972-10-11) figures 1-5	1-5,8,9, 12,13,15 6,7,10, 11,14
Y A	----- US 5 431 476 A (TORIGAKI TOSHIKAZU [JP]) 11 July 1995 (1995-07-11) figures 1-23	1-5,8,9, 12,13,15 6,7,10, 11,14
A	----- FR 2 917 048 A1 (PEUGEOT CITROEN AUTOMOBILES SA [FR]) 12 December 2008 (2008-12-12) figures 1-6 -----	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 February 2020

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2019/082952

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