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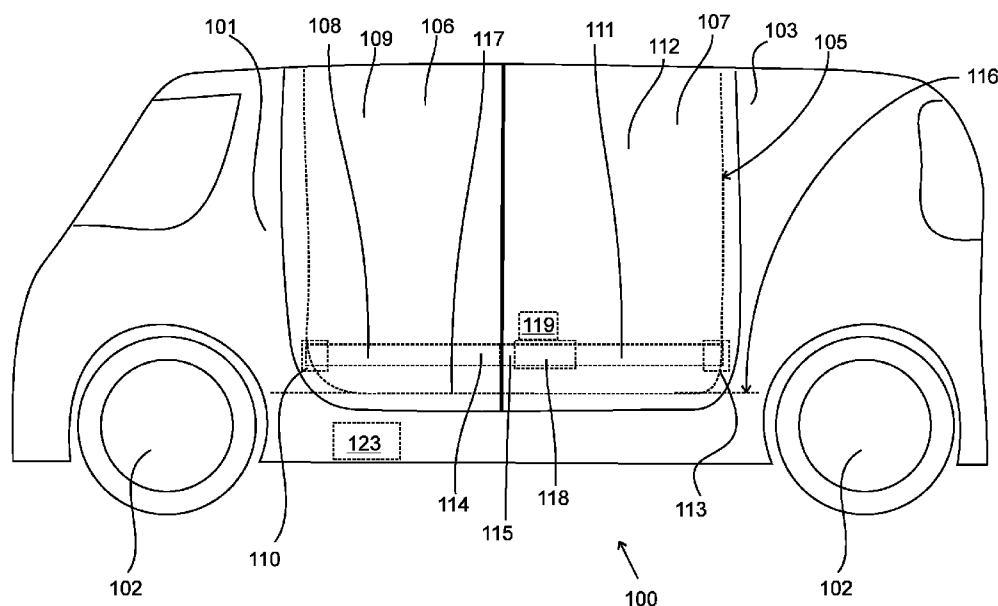


Fig. 2

(57) Abstract: Aspects of the present invention relate to a door arrangement for providing access into a cabin (103) within a body (101) of a vehicle (100), a door system, a vehicle (100) and a method. The door arrangement comprises a first door (106) comprising a first crosspiece (108) extending across the width of the first door (106), and a second door (106) comprising a second crosspiece (111) extending across the width of the second door (106). The door arrangement also comprises a barrier member (118) and an actuator (119) configured to move the barrier member (118) between a retracted position and a barrier position. When the first door (106) and the second door (106) are in closed positions, a first end portion of the first crosspiece (108) is aligned with a first end portion of the second crosspiece (111), and in the barrier position the barrier member (118) extends along the first end portions (114, 115) of the first crosspiece (108) and the second crosspiece (111) to resist external forces acting to misalign the first end portions (114, 115).



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A DOOR ARRANGEMENT, A DOOR SYSTEM AND A VEHICLE

TECHNICAL FIELD

- 5 The present disclosure relates to a door arrangement, a door system, a vehicle and a method of providing a barrier to entry into a cabin of a vehicle. In particular, but not exclusively it relates to a door arrangement and a door system in 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.

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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. 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.

SUMMARY OF THE INVENTION

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

According to an aspect of the invention there is provided a door arrangement for providing
5 access into a cabin within a body of a vehicle, the door arrangement comprising: a first door comprising a first crosspiece extending across the width of the first door; a second door comprising a second crosspiece extending across the width of the second door; a barrier member; and an actuator configured to move the barrier member between a retracted position and a barrier position; wherein, when the first door and the second door are in closed positions,
10 a first end portion of the first crosspiece is aligned with a first end portion of the second crosspiece, and in the barrier position the barrier member extends along the first end portions of the first crosspiece and the second crosspiece to resist external forces acting to misalign the first end portions.

15 This provides the advantage that, for a vehicle that does not have a B-pillar, the first crosspiece and the second crosspiece in combination with the barrier member provide a continuous barrier that is able to span the entire width of an opening in a body of a vehicle between an A-pillar supporting the first door and a C-pillar supporting the second door. Therefore occupants of the cabin of the vehicle are provided with improve protection in the event of a side impact.

20 Optionally, the first crosspiece comprises a first rail for enabling the first door to slide and the second crosspiece comprises a second rail for enabling the second door to slide. This provides the advantage that rails which are already used for enabling the doors to slide are given with a second function of providing a barrier to entry of objects impacting against the doors.

25 Optionally, when the first door and the second door are in closed positions, the end portions of the first crosspiece and the second crosspiece are part way up the doors above a level of a floor of the cabin. This provides the advantage that the barrier is at a height where it provides protection against objects that hit the doors above the level of the floor of the cabin.

30 Optionally, the actuator is configured to move the barrier member by moving the barrier member along the first end portions to the retracted position in which the barrier member is separated from one of the first crosspiece and the second crosspiece. This provides the advantage that the retracted barrier member may remain on or in one of the crosspieces.

Consequently the barrier member and the actuator may be part of a door module and do not need to be accommodated in another part of the vehicle.

5 Optionally, the barrier member comprises a sleeve configured to slide over the first crosspiece and the second crosspiece.

10 Optionally, the actuator is configured to move the barrier member to the retracted position in which the barrier member is separated from both the first crosspiece and the second crosspiece. This provides the advantage that the doors do not have to accommodate the barrier member or the mechanism for moving the barrier member.

15 Optionally, the first crosspiece and the second crosspiece are arranged to extend substantially horizontally when the vehicle is on a horizontal surface and the actuator is configured to lower the barrier member from the barrier position to the retracted position.

Optionally, the retracted position is below a level of a floor of the cabin. This provides the advantage that the barrier member does not hinder access through the opening.

20 According to another aspect of the invention there is provided a door system comprising the door arrangement of any one of the previous paragraphs and a control system configured to cause the actuator to move the barrier member to the barrier position only when the first door and the second door are in closed positions. This provides the advantage that the barrier member does not hinder access through the opening when the doors are open.

25 Optionally, the control system is configured to receive a sensor signal from at least one sensor indicative of an impact and/or an expected impact on the first door, and to cause the actuator to move the barrier member to the barrier position in dependence on receiving the sensor signal. This provides the advantage that the barrier member does not have to be moved each time the doors are opened or closed.

30 Optionally, the at least one sensor is configured to detect an impact on the first door. This provides the advantage that the barrier member only needs to be actuated in the event of an impact.

Optionally, the at least one sensor is configured to detect movement of objects external to the vehicle. This provides the advantage of more time for moving the barrier member to its barrier position, when compared to a system which relies solely on detecting when the impact has occurred.

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Optionally, the control system is configured to cause the actuator to move the barrier member to the barrier position each time the first door is moved to its closed position so that both the first door and the second door are in their closed position. This provides the advantage that the system does not rely on a system for detecting impacts and rapidly deploying the barrier member.

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According to a further aspect of the invention there is provided a vehicle comprising a cabin having an opening to enable access into the cabin, and a door system according to any one of the previous claims.

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According to yet another aspect of the invention there is provided a method of providing a barrier to entry into a cabin in a body of a vehicle, the method comprising: moving to a closed position a first door comprising a first crosspiece; moving to a closed position a second door comprising a second crosspiece, so that a first end portion of the first crosspiece is aligned with a first end portion of the second crosspiece; moving a barrier member from a retracted position, in which the barrier member is separated from the second crosspiece, to a barrier position in which the barrier member extends along the first end portions of the first crosspiece and the second crosspiece for resisting external forces acting to misalign the first end portions. This provides the advantage that for a vehicle that does not have a B-pillar, the first crosspiece and the second crosspiece in combination with the barrier member provide a continuous barrier that is able to span the entire width of an opening in a body of a vehicle between an A-pillar supporting the first door and a C-pillar supporting the second door. Therefore occupants of the cabin of the vehicle are provided with improve protection in the event of a side impact.

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Optionally, the first crosspiece comprises a first rail and the second crosspiece comprises a second rail and the method comprises: sliding the first door to a closed position by moving the first rail over a first guiding device mounted on the body of the vehicle; sliding the second door to a closed position by moving the second rail over a second guiding device mounted on the body of the vehicle.

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Optionally, said moving a barrier member comprises moving the barrier member along the first end portions from the retracted position.

5 Optionally, the barrier member comprises a sleeve and said moving a barrier member comprises moving the sleeve over the first crosspiece and the second crosspiece.

Optionally, said moving a barrier member comprises moving the barrier member from the retracted position in which the barrier member is separated from both the first crosspiece and the second crosspiece.

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Optionally, the first crosspiece and the second crosspiece are arranged to extend substantially horizontally when the vehicle is on a horizontal surface and said moving a barrier member comprises raising the barrier member from the retracted position to the barrier position.

15 Optionally, the first end portion of the first crosspiece is aligned with a first end portion of the second crosspiece at a height above the height of a floor of the cabin.

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
20 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
25 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,
30 with reference to the accompanying drawings, in which:

Fig. 1 shows a vehicle embodying the present invention with its front and rear door in an open position;

Figs. 2 and 3 show the vehicle of Fig. 1 with its front and rear door in a closed position and its barrier member in a retracted position and a barrier position respectively;

Figs. 4 and 5 show the inner sides of the door panels, the crosspieces, and the actuator of the vehicle of Fig. 1 with the barrier member in the retracted position and barrier position respectively;

Figs. 6 and 7 show a second vehicle embodying the present invention with its barrier member in a retracted position and a barrier position respectively;

Figs. 8 and 9 show the barrier member of Fig. 6 in a retracted position and a barrier position respectively;

Fig. 10 shows a third vehicle embodying the present invention;

Figs. 11 and 12 show the crosspieces mounted on the inside of the outer panels of the doors of the vehicle of Fig. 10 and the barrier member in a retracted position and a barrier position respectively;

Fig. 13 shows a schematic diagram of the control system included in the vehicle of Fig. 1, 6 and 10;

Fig. 14 shows a flowchart of a method performable by the control system of the vehicle of Fig. 1 or Fig. 6; and

Fig. 15 shows a flowchart of a method performable by the control system of the vehicle of Fig. 10.

DETAILED DESCRIPTION

A door arrangement, a door system, a vehicle 100 and a method in accordance with an embodiment of the present invention is described herein with reference to the accompanying Figs. 1 to 5.

With reference to Figs. 1, 2 and 3, the vehicle 100 is a road vehicle comprising a body 101 supported on road wheels 102. The body 101 defines a cabin 103 which, in the present embodiment, contains seating 104 to enable users of the vehicle to be seated and an opening 105 to enable users to enter and exit the cabin 103.

The vehicle 100 also comprises a front door 106 and a rear door 107. The two doors 106 and 107 in combination extend across the width of the opening 105 when the doors 106 and 107 are in a closed position, as shown in Figs. 2 and 3. The doors are shown in their open positions in Fig. 1, in which they allow access through the opening 105.

A first crosspiece 108 (shown in Figs. 2 and 3) is fixed to the front door 106 so that it extends across its width. The first crosspiece 108 is positioned on the inside of an outer panel 109 of the front door 106. The front door 106 is mounted on the body 101 of the vehicle 100 by a first support mechanism 110 that is attached to the body 101 at the front side of the opening 105.

5 Other support mechanisms (not shown) may provide additional support to the first door 106. In the present embodiment the crosspiece 108 extends directly from the first support mechanism 110.

Similarly a second crosspiece 111 is fixed to the rear door 107 so that it extends across its width. The second crosspiece 111 is positioned on the inside of an outer panel 112 of the rear door 107. The rear door 107 is mounted on the body 101 of the vehicle 100 by a second support mechanism 113 that is attached to the body 101 at the rear side of the opening 105. Other support mechanisms (not shown) may provide additional support to the second door 107. The crosspiece 111 extends directly from the second support mechanism 113.

The crosspieces 108 and 111 extend across the widths of the doors 106 and 107 at a constant height above the level 116 of the floor 117 of the cabin. I.e. when the vehicle 100 is on a horizontal surface, the first crosspiece 108 and the second crosspiece 111 are arranged to extend substantially horizontally above the floor 117. When the doors 106 and 107 are in their closed positions, as shown in Fig. 2, the first crosspiece 108 has an end portion 114 that is aligned with an adjacent end portion 115 of the second crosspiece 111.

A barrier member 118 is shown in Fig. 2 in its retracted position, positioned along the second crosspiece 111. An actuator 119 is mounted on the second door 107 and configured to move the barrier member 118 between the retracted position and a barrier position, shown in Fig. 3. In alternative embodiments the actuator 119 may be arranged to operate in response to a user input, for example at a switch (not shown) or other user input device, to cause the actuator to move the barrier member 118 from the retracted position to the barrier position. However, in the present embodiment the vehicle 100 comprises a control system 123 configured to control the operation of the actuator 119 in dependence on a signal received from one or more sensors (not shown). The one or more sensors provide a signal to the control system 123 indicating when a door 106 and 107 has been moved to its closed position, so that the control system 123 is informed of when both doors are in their closed position, and in response to both doors having been moved to their closed positions, it provides a signal to the actuator 119 to cause it to move the barrier member 118 to its barrier position. The control system 123

also receives signals indicative of a request for a door 106 and/or 107 to be opened, and in response, the control system 123 provides a signal to the actuator 119 to cause it to move the barrier member 118 to its retracted position.

5 A method 1400 performed by the control system of Fig. 1 is summarised in the flowchart of Fig. 14. At block 1401, it is determined whether a signal has been received indicative of a door having been moved to its closed position, and if so it is determined at block 1402 whether both doors 106 and 107 are in their closed position. If they are not then the process at block 1401 is repeated. If it is determined at block 1402 that both doors 106 and 107 are in their closed
10 position then a signal is provided to the actuator 119 at block 1403 to cause the barrier member 118 to be moved to its barrier position.

At block 1404 it is determined whether a signal has been received indicating that one or both doors 106 and 107 is to be opened, and if so then the control system provides an output signal
15 to the actuator 119 to cause it to move the barrier member 118 to the retracted position, at block 1405. The process at block 1401 is then repeated.

The vehicle 100 is shown in Fig. 3 with its barrier member 118 moved to its barrier position, where it extends along both the end portion 115 of the second crosspiece 111 and the end
20 portion 114 of the first crosspiece 108. In this position the barrier member 118 joins the two crosspieces 108 and 111 together to provide a continuous barrier 122 extending between the first support mechanism 110 at one side of the opening 105 and the second support mechanism 113 the opposite side. The barrier member 118 is configured to resist external forces acting to misalign the end portions 114 and 115 of the crosspieces 108 and 113.
25 Consequently, in the event of an object, such as another vehicle, impacting against one or both of the doors 106 and 107, the continuous barrier 122 supported by the sides of the opening 105 and/or the support mechanisms 110 and 113, resists penetration of the impacting object into the cabin 103 of the vehicle 100. In addition, the continuous barrier 122 provides support to the panels 109 and 112 of the doors 106 and 107 to resist their movement into the
30 cabin 103. Thus, the continuous barrier 122 provides the occupants of the cabin 103 with increased protection.

In the present embodiment, the doors 106 and 107 are sliding doors which may be supported in part by guide rails 120 and 121 (shown in Fig. 1) extending across the top and across the
35 bottom of the opening 105. Actuators (not shown) may be provided for causing movement of

the doors along the rails 120 and 121 between the open position of Fig. 1 and the closed position of Figs. 2 and 3, for example, under the control of the control system 123. Alternatively the doors 106 and 107 may be configured to be slid open and closed under manual force. In the present embodiment the crosspieces 108 and 111 comprise rails and the support mechanisms 110 and 113 comprise guiding devices over which the rails 108 and 111 are configured to move.

In some alternative embodiments, the crosspieces 110 and 113 do not provide a function relating to movement of the doors 106 and 107, and are only provided to give additional protection to the occupants of the cabin 103 in the event of an object impacting against one or both of the doors 106 and 107. For example, in some embodiments, the support mechanisms 110 and 113 are hinges defining axes about which the doors 106 and 107 rotate between their open and closed positions, and a portion of the hinge that attaches to the door 106 or 107 may be attached to the respective crosspiece 108 or 113.

The inner side of the door panels 109 and 112, the crosspieces 108 and 111, the barrier member 118 and the actuator 119 are shown in Figs. 4 and 5. The barrier member 118 is in its retracted position in Fig. 4 and its barrier position in Fig. 5. In the present embodiment, crosspieces 108 and 111 comprise rails having similar cross-sections and the barrier member 118 comprises a sleeve configured to slide along the crosspieces 108 and 111. The actuator 119 comprises an electric motor 401 and a gear mechanism 402 driven by the motor 401. The gear mechanism 402 is configured to engage with the barrier member 118 to cause its linear movement between the retracted position of Fig. 4 and the barrier position of Fig. 5. For example, the gear mechanism 402 comprises a drive gear (not shown) configured to engage a toothed surface 403 of the barrier member 118.

In alternative embodiments, the end portions 114 and 115 of the crosspieces 108 and 111 are provided with a bore, or a channel, in which the barrier member 118 is arranged to slide between a retracted position, in which it is solely located in one of the crosspieces 108 and 111 and a barrier position in which it extends through part of the bore, or channel, in each of the crosspieces 108 and 111.

In further alternative embodiments, the barrier member 118 is supported on a hinge so that in its retracted position it resides alongside the outer panel 109 or 112 of one of the doors 106 and 107, and it is moveable to its barrier position by rotation about the hinge to lay alongside

the end portions 114 and 115 of the crosspieces 108 and 111. In some such embodiments, the end portions 114 and 115 are provided with a U-shaped channel that receives the barrier member 118 in its barrier position, while in other such embodiments, the barrier member 118 is provided with a U-shaped channel for receiving parts of the end portions 114 and 115 when it is in its barrier position.

A second vehicle 100 embodying the present invention is shown in Figs. 6 and 7. The second vehicle 100 has many features in common with the vehicle 100 of Fig. 1 and those features have been provided with the same reference signs as in Figs. 1 to 3. However, the vehicle 100 of Figs. 6 and 7 differs in the arrangement of its barrier member 118A, which is shown in its retracted position in Fig. 6 and its barrier position in Fig. 7.

In its retracted position, the barrier member 118A is positioned within a support structure 601 within a sill 602 of the vehicle 100. The sill 602 forms the side of the body 101 along the bottom of the doors 106 and 107. In this position, the barrier member 118A is positioned below the level 116 of the floor 117 of the cabin 103, so that it does not provide any hindrance to users of the vehicle 100 during their entry to, or exit from, the cabin 103.

The barrier member 118A is configured to slide up to its barrier position shown in Fig. 7 under the action of an actuator 119A. In its barrier position, an upper portion 701 of the barrier member 118A is positioned alongside the end portions 114 and 115 of the crosspieces 108 and 111, so that the end portions 114 and 115 located between the upper portion 701 and the outer panels 109 and 112 of the doors 106 and 107. A lower portion 702 of the barrier member 118A remains below the level 116 of the floor 117 and is retained within the support structure 601. The support structure 601 is rigidly fixed to the body 101 of the vehicle 100 and is configured to securely hold the barrier member 118A in its barrier position.

The barrier member 118A supports the end portions 114 and 115 of the crosspieces 108 and 111 to maintain their alignment and stop them being forced into the cabin 103, in the event of an object, such as another vehicle, impacting one or both of the doors 106 and 107. The first crosspiece 108 is therefore supported at one end by the body 101 and the first support mechanism 110 and supported at its other end by the barrier member 118A, to resist movement of the impacting object into the cabin 103. Similarly the second crosspiece 108 is supported at one end by the body 101 and the second support mechanism 113 and supported

at its other end by the barrier member 118A, to resist movement of the impacting object into the cabin 103.

A cross-sectional view of the barrier member 118A, the sill 602 and neighbouring portions of the closed doors 106 and 107 is shown Figs. 8 and 9. The barrier member 118A is shown in its retracted position in Fig. 8 and its barrier position in Fig. 9. In the retracted position, the upper surface 801 of the barrier member 118A is level with the floor 117, while in the barrier position the upper surface 801 is at a level above that of the crosspieces 108 and 111.

The barrier member 118A is mounted on a support structure 601 rigidly fixed within the sill 602. The support structure 601 comprises a linear-motion bearing 802 on which the barrier member 118A is mounted to enable the barrier member 118A to slide between its access and barrier positions. In the present embodiment, the barrier member 118A comprises a toothed track 805 and the actuator 119A comprises an electric motor 803 and an associated gear mechanism 804, which has a drive gear (not shown) configured to engage the toothed track 805. The gear mechanism 804, powered by the electric motor 803, is configured to drive the toothed track 805 and thereby slide the barrier member 118A between the access position and barrier position as required.

A third vehicle 100 embodying the present invention is shown in Fig. 10. The third vehicle 100 comprises many of the features of the vehicle 100 of Fig. 1, and those features have been provided with the same reference signs as those of Figs. 1 to 3. The vehicle 100 of Fig. 10 differs from that of Fig. 1 in that it has a different type of actuator 119B for actuating the barrier member 118, additional sensors 1001 and a control system 123A that is configured to control the actuator 119B in a different manner to that of Fig. 1. Specifically, the control system 123 of Fig. 10 is configured to only cause the barrier member 118 to be moved from the retracted position to the barrier position when an impact against one or both of the doors 106 and 107 has occurred or when an impact against one or both of the doors 106 and 107 is expected to occur. Thus, in the normal operation of the vehicle 100 and its doors 106 and 107, the barrier member 118 is kept in its retracted position, as shown in Fig. 10.

In its barrier position, the barrier member 118 extends across the end portions 114 and 115 of the crosspieces 108 and 111 as shown for the vehicle 100 of Fig. 3.

The control system 123 of Fig. 10 is configured to receive a sensor signal indicative of an impact and/or an expected impact on the front door 106 and/or the rear door 107 from one or more sensors 1001 and, in dependence on receiving such a sensor signal, provide an output signal to cause the movement of the barrier member 118 to the barrier position.

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One or more of the sensors 1001 may be mounted within the sill 602 and configured to detect objects that are very likely to impact on one or both of the doors 106 and 107. In the present embodiment, one of the sensors 1001A, which is mounted within the sill 602, is a radar sensor 1001A capable of tracking objects in the vicinity of the vehicle 100. The radar sensor 1001A may be configured to provide the processing necessary to track objects, determine when such objects are very likely to impact against the side of the vehicle 100, and then notify the control system 123 when an impact is imminent. Alternatively, the radar sensor 1001A may be configured to provide a signal to the control system 123 providing information relating to objects being tracked and the determination of when such an object is very likely to impact against the side of the vehicle 100 may be determined by the control system 123. In dependence on receiving a signal from the radar sensor 1001A indicating that an object is very likely to impact against one of the doors 106 and 107, the control system 123 causes the barrier member 118 to be moved to its barrier position.

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In an alternative embodiment, the sensors 1001A configured to detect objects external to the vehicle 100 may comprise a lidar sensor, an ultrasonic sensor or other sensor capable of remotely sensing external objects.

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In the present embodiment, the vehicle 100 also includes sensors 1001 in the form of microphones 1001B mounted on each of the doors 106 and 107 and which provide electronic signals to the control system 123 indicative of acoustic signals they receive. The control system 123 is configured to process signals received from the microphones 1001B and detect when they have generated a signal indicative of an impact on one or both of the doors 106 and 107. In the event of such an impact being detected from the signals received from the microphones 1001B, the control system 123 is configured to cause the barrier member 118 to be deployed.

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A method 1500 performable by the control system of Fig. 10 is summarised in the flowchart of Fig. 15. At block 1501, of the method 1500, it is determined whether a sensor signal indicative of an impact and/or an expected impact on a door 106, 107 that covers an opening 105 into

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the cabin 103 of the vehicle 100 has been received, and if not then the process at block 1501 is repeated. If it is determined that such a signal has been received at block 1501 a signal is output to the actuator 119B at block 1502 to cause the barrier member to be moved to its barrier position.

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Figs. 11 and 12 show the crosspieces 108 and 111 mounted on the inside of the outer panels 109 and 112 of the doors 106 and 107 of the vehicle 100 of Fig. 10. In this embodiment, the barrier member 118 comprises a sleeve that has an inner surface configured to be a good fit around, and to slide along, the crosspieces 108 and 111 of the doors 106 and 107. In the retracted position, shown in Fig. 11, the barrier member 118 is positioned over an end portion 115 of the second crosspiece 111 of the rear door 107 so that the barrier member 118 does not extend past the front edge 1101 of the rear door 107.

The barrier member 118 has an associated actuator 119B that is configured to drive the barrier member 118 along the crosspiece 108 and 111 of the rear door 107 to its barrier position shown in Fig. 12. In the barrier position, the barrier member 118 is positioned partly over each of the end portions 114 and 115 of the two crosspieces 108 and 111. The actuator 119B illustrated in Figs. 11 and 12 is mounted on the outer door panel 112 of the rear door 107 alongside the crosspiece 111 and moves the barrier member 118 via an arm 1102 that is operatively connected to the barrier member 118.

In the event of an object impacting or being expected to impact against one of both of the doors 106 and 107, the end portions 114 and 115 of the crosspieces 108 and 111 are maintained in alignment by the deployed barrier member 118. Consequently, the two crosspieces 108 and 111 in combination with the barrier member 118 provide an elongate barrier 122. The elongate barrier 122 is supported at each of its ends by the support mechanisms 110 and 113, and so it is able to provide resistance to the entry into the cabin 103 of the impacting object.

In an alternative, but similar, arrangement to that of Figs. 11 and 12, the barrier member 118 is located within a bore or channel in the end portion 114 and 115 of one of the crosspieces 108 and 111 when it is in its retracted position, and the other crosspiece 108 and 111 has a bore providing a socket for receiving a part of the barrier member 118 when it is in its barrier position.

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It will be appreciated that due to the high speed with which vehicles may impact against the doors 106 and 107, the periods of time between a determination that a vehicle is very likely to impact against the doors 106 and 107 and the time at which that vehicle reaches the barrier provided by the crosspieces 108 and 111 and the barrier member 118 is short. Also the period of time between a vehicle hitting one of the doors 106 and 107 and pushing the crosspieces out of alignment is even shorter. However, the barrier member 118 is provided with an actuator 119B capable of deploying the barrier member 118 from the retracted position of Fig. 11 to the barrier position of Figs. 12 sufficiently rapidly.

The actuator 119B comprises a cylinder 1103 having a closed end 1104 and a piston 1105 spaced from the closed end to define a volume 1106. The piston 1105 is attached to the arm 1102 and thereby connected to the barrier member 118.

In an embodiment, the volume 1106 contains a pyrotechnic device configured to force the barrier member 118 from its retracted position to the barrier position, on receipt of an electrical signal from the control system 123, by forcing the piston 1105 and the arm 1102 along the length of the cylinder 1103.

In an alternative embodiment, the volume 1106 contains a compressed spring and the piston 1105 is latched in position by a latch means (not shown) that is configured to be released in dependence on a signal from the control system 123. For example, the latch means may comprise a pyrotechnically actuated latch or a pyrotechnic fastener, such as a nut or bolt. When the latch means releases the piston 1105, it is forced along the cylinder 1103 and pushes the barrier member 118 to its barrier position.

In another alternative embodiment, the cylinder 1103 is a pneumatic cylinder connected to a high pressure gas container via an electrically operable valve. The valve is configured to remain in its closed position until it receives an electrical signal from the control system 123 causing it to open and thereby cause the actuation of the piston 1105 and therefore the deployment of the barrier member 118.

A schematic diagram of the control system 123 shown in Figs. 1, 6 and 10 is shown in Fig. 13. In the present embodiment the control system 123 comprises a single processor 1301 but, in other embodiments of the invention the control system 123 may comprise more than one processor 1301. The control system 123 comprises at least one electronic memory device

1302, having instructions 1303 stored therein, and the electronic processor 1301 is electrically coupled to the at least one electronic memory device 1302, so that it can access the instructions 1303.

- 5 The control system 123 comprises an electrical input 1304 for receiving signals from the sensors (not shown) configured to detect when the doors 106 and 107 are fully closed and also, in the embodiment of Fig. 10, the sensors 1001. The control system 123 also comprises an electrical output 1305 for providing output signals to the actuator 119 (or 119A in the embodiment of Fig. 6 or 119B in the embodiment of Fig. 10) to cause actuation of the barrier
10 member 118 (or 118 A in the embodiment of Fig. 6).

The processor 1301 is configured to access the instructions 1303 stored in the memory device 1302 and execute the instructions so that it is operable to perform the functions as described previously and as summarised in the flowchart of Fig. 14 or Fig. 15.

15

- For purposes of this disclosure, it is to be understood that the control system described herein can comprise a control unit or computational device having one or more electronic processors. A vehicle and/or a system thereof may comprise a single control unit or electronic controller or alternatively different functions of the control system may be embodied in, or hosted in,
20 different control units or controllers. A set of instructions could be provided which, when executed, cause said control system or control unit(s) to implement the control techniques described herein (including the described method(s)). The set of instructions may be embedded in one or more electronic processors, or alternatively, the set of instructions could be provided as software to be executed by one or more electronic processor(s). For example,
25 a first controller may be implemented in software run on one or more electronic processors, and one or more other controllers may also be implemented in software run on or more electronic processors, optionally the same one or more processors as the first controller. It will be appreciated, however, that other arrangements are also useful, and therefore, the present disclosure is not intended to be limited to any particular arrangement. In any event, the set of
30 instructions described above may be embedded in a computer-readable storage medium (e.g., a non-transitory computer-readable storage medium) that may comprise any mechanism for storing information in a form readable by a machine or electronic processors/computational device, including, without limitation: a magnetic storage medium (e.g., floppy diskette); optical storage medium (e.g., CD-ROM); magneto optical storage medium; read only memory (ROM);
35 random access memory (RAM); erasable programmable memory (e.g., EPROM and

EEPROM); flash memory; or electrical or other types of medium for storing such information/instructions.

5 It will be appreciated that various changes and modifications can be made to the present invention without departing from the scope of the present application.

10 The blocks illustrated in Figs. 14 and 15 may represent steps in a method and/or sections of code in the computer program 1303. The illustration of a particular order to the blocks does not necessarily imply that there is a required or preferred order for the blocks and the order and arrangement of the block may be varied. Furthermore, it may be possible for some steps to be omitted.

15 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.

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

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

30 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 into a cabin within a body of a vehicle, the door arrangement comprising:

5 a first door comprising a first crosspiece extending across the width of the first door ;
a second door comprising a second crosspiece extending across the width of the second door ;

a barrier member ; and

10 an actuator configured to move the barrier member between a retracted position and a barrier position;

wherein, when the first door and the second door are in closed positions, a first end portion of the first crosspiece is aligned with a first end portion of the second crosspiece , and in the barrier position the barrier member extends along the first end portions of the first crosspiece and the second crosspiece to resist external forces acting to misalign the first end portions .

2. A door arrangement according to claim 1, wherein the first crosspiece comprises a first rail for enabling the first door to slide and the second crosspiece comprises a second rail for enabling the second door to slide.

3. A door arrangement according to claim 1 or claim 2, wherein when the first door and the second door are in closed positions, the end portions of the first crosspiece and the second crosspiece are part way up the doors above a level of a floor of the cabin .

4. A door arrangement according to any one of claims 1 to 3, wherein the actuator is configured to move the barrier member by moving the barrier member along the first end portions to the retracted position in which the barrier member is separated from one of the first crosspiece and the second crosspiece .

5. A door arrangement according to claim 4, wherein the barrier member comprises a sleeve configured to slide over the first crosspiece and the second crosspiece .

6. A door arrangement according to any one of claims 1 to 3, wherein the actuator is configured to move the barrier member to the retracted position in which the barrier member is separated from both the first crosspiece and the second crosspiece .

7. A door arrangement according to claim 6, wherein the first crosspiece and the second crosspiece are arranged to extend substantially horizontally when the vehicle is on a horizontal surface and the actuator is configured to lower the barrier member from the barrier position to the retracted position.

8. A door arrangement according to claim 7, wherein the retracted position is below a level of a floor of the cabin .

9. A door system comprising the door arrangement of any one of the previous claims and a control system configured to cause the actuator to move the barrier member to the barrier position only when the first door and the second door are in closed positions.

10. A door system according to claim 9, wherein the control system is configured to receive a sensor signal from at least one sensor indicative of an impact and/or an expected impact on the first door , and to cause the actuator to move the barrier member to the barrier position in dependence on receiving the sensor signal.

11. A door system according to claim 10, wherein the at least one sensor is configured to detect an impact on the first door .

12. A door system according to claim 10, wherein the at least one sensor is configured to detect movement of objects external to the vehicle .

13. A door system according to claim 9, wherein the control system is configured to cause the actuator to move the barrier member to the barrier position each time the first door is moved to its closed position so that both the first door and the second door are in their closed position.

14. A vehicle comprising a cabin having an opening to enable access into the cabin , and a door system according to any one of the previous claims.

15. A method of providing a barrier to entry into a cabin in a body of a vehicle , the method comprising:

moving to a closed position a first door comprising a first crosspiece ;

moving to a closed position a second door comprising a second crosspiece , so that a first end portion of the first crosspiece is aligned with a first end portion of the second crosspiece ;

moving a barrier member from a retracted position, in which the barrier member is separated from the second crosspiece , to a barrier position in which the barrier member extends along the first end portions of the first crosspiece and the second crosspiece for resisting external forces acting to misalign the first end portions .

16. A method according to claim 15, wherein the first crosspiece comprises a first rail and the second crosspiece comprises a second rail and the method comprises:

sliding the first door to a closed position by moving the first rail over a first guiding device mounted on the body of the vehicle ;

sliding the second door to a closed position by moving the second rail over a second guiding device mounted on the body of the vehicle .

17. A method according to claim 15 or 16, wherein said moving a barrier member comprises moving the barrier member along the first end portions from the retracted position.

18. A method according to claim 17, wherein the barrier member comprises a sleeve and said moving a barrier member comprises moving the sleeve over the first crosspiece and the second crosspiece .

19. A method according to claim 15 or 16, wherein said moving a barrier member comprises moving the barrier member from the retracted position in which the barrier member is separated from both the first crosspiece and the second crosspiece .

20. A method according to claim 19, wherein the first crosspiece and the second crosspiece are arranged to extend substantially horizontally when the vehicle is on a horizontal surface and said moving a barrier member comprises raising the barrier member from the retracted position to the barrier position.

21. A method according to claim 19 or 20, wherein the first end portion of the first crosspiece is aligned with a first end portion of the second crosspiece at a height above the height of a floor of the cabin .

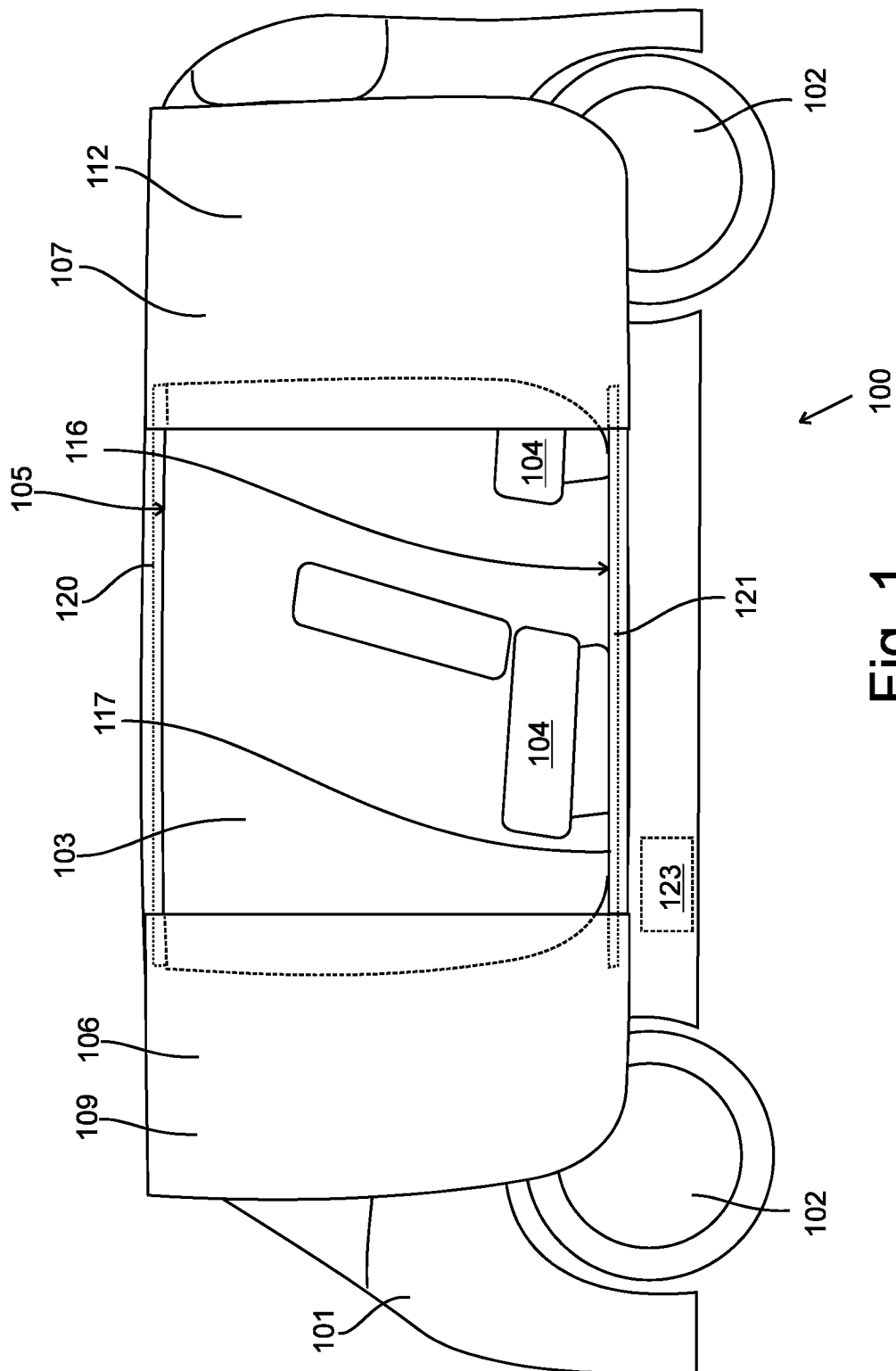


Fig. 1

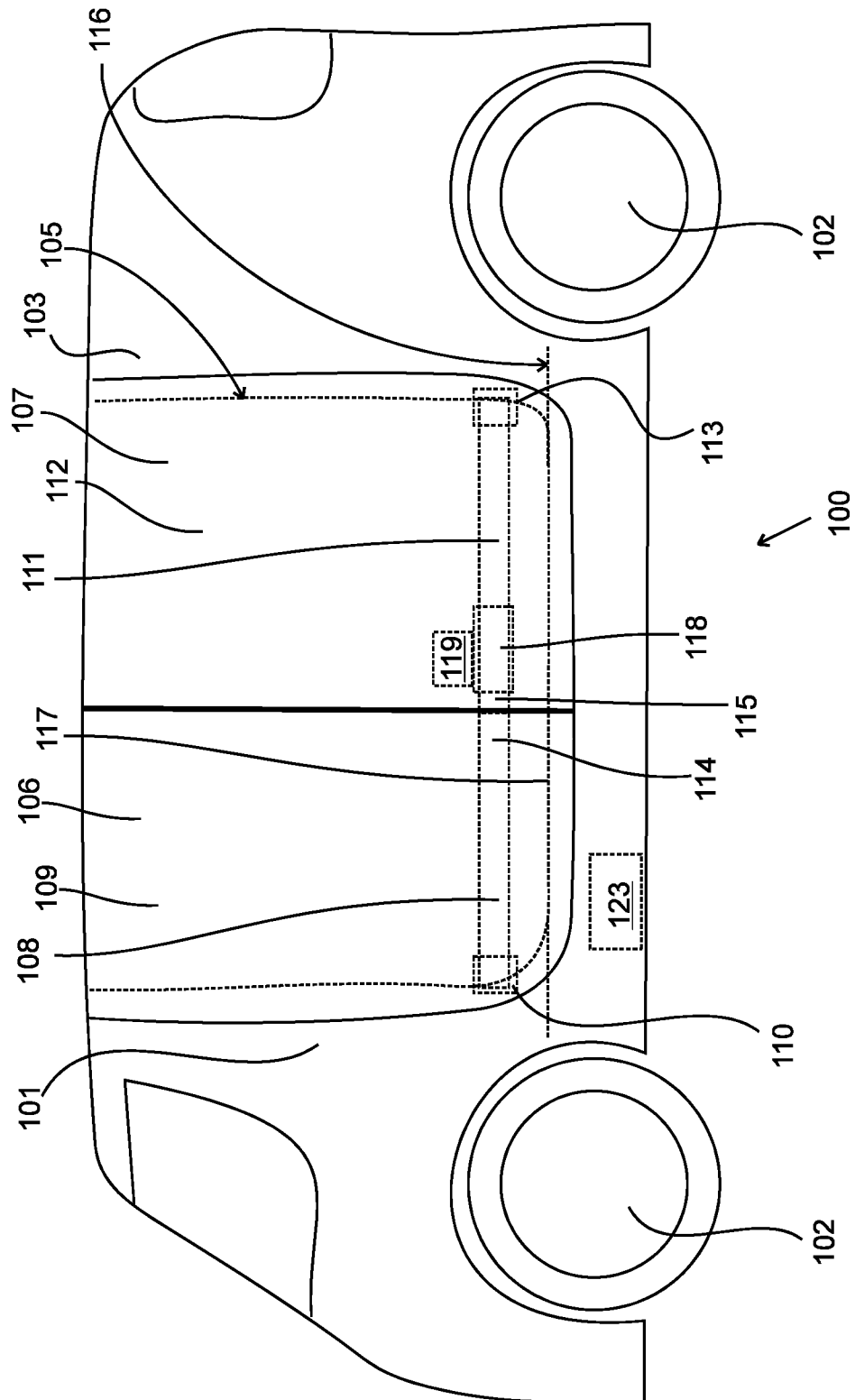


Fig. 2

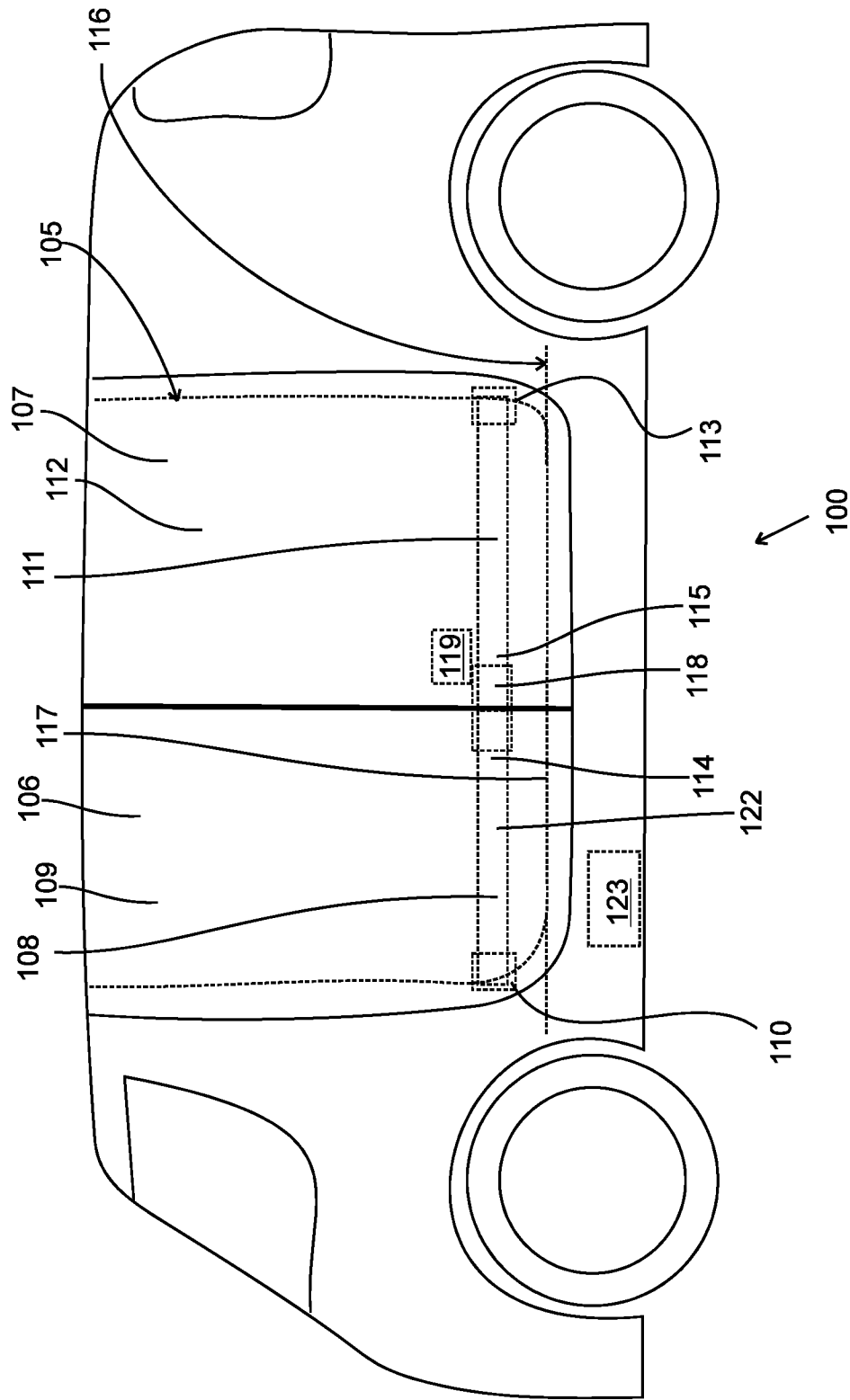


Fig. 3

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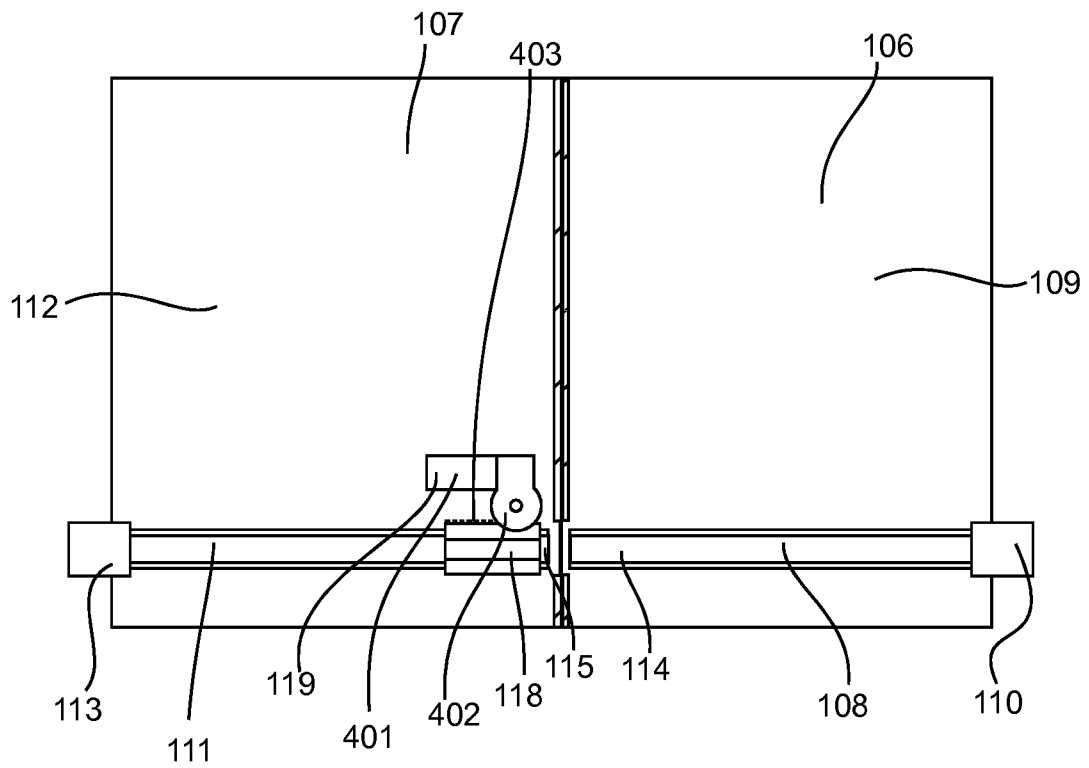


Fig. 4

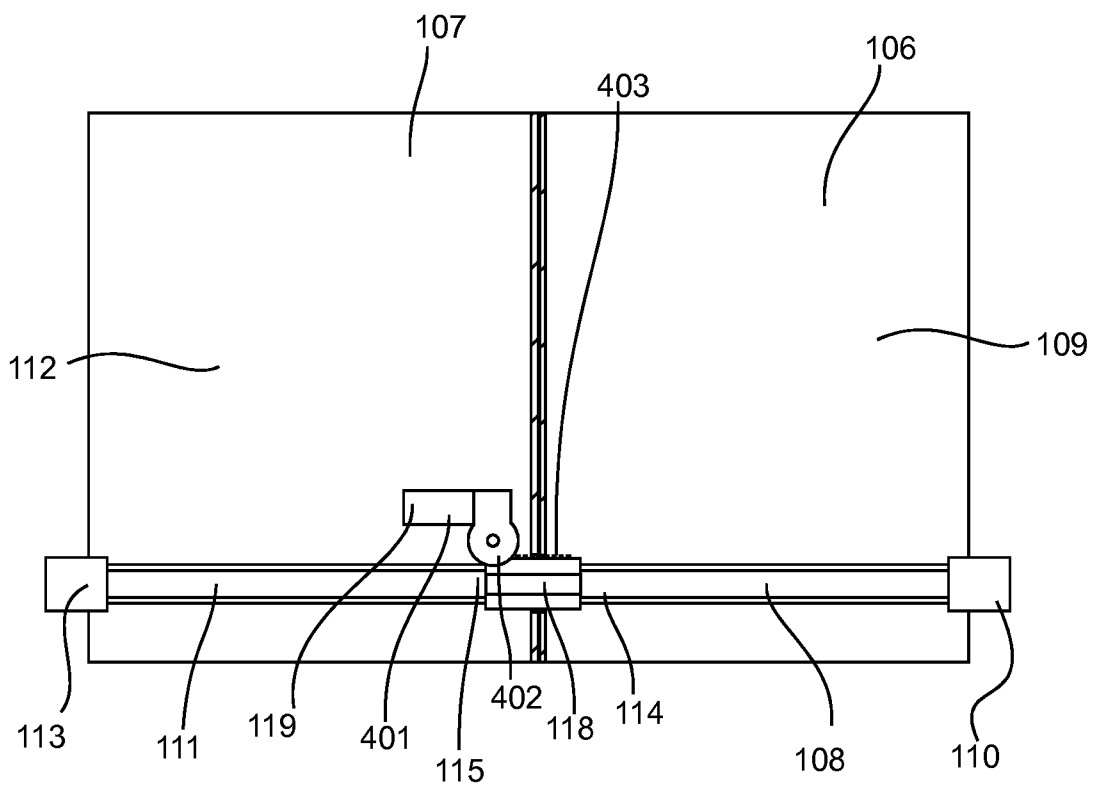


Fig. 5

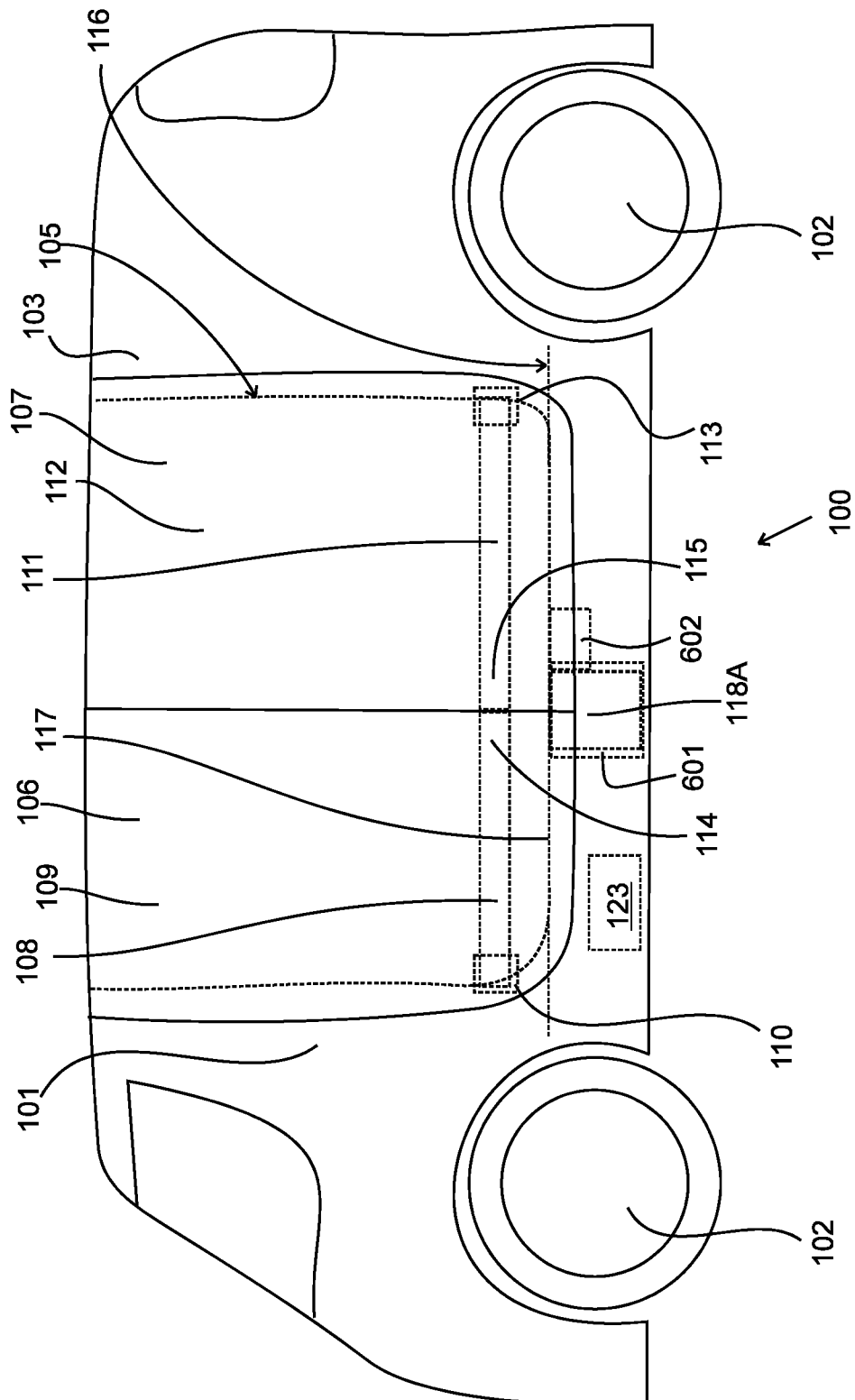


Fig. 6

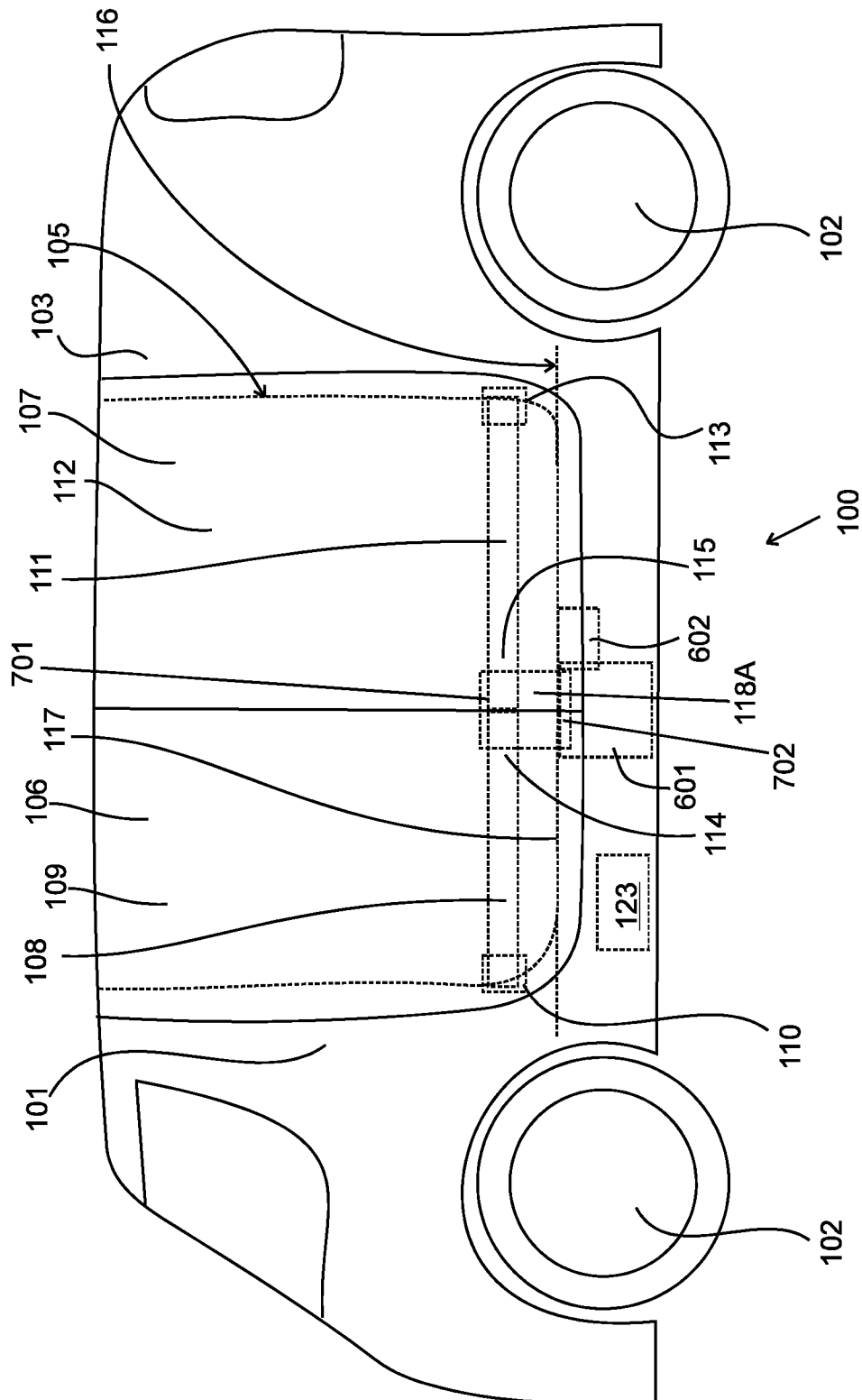


Fig. 7

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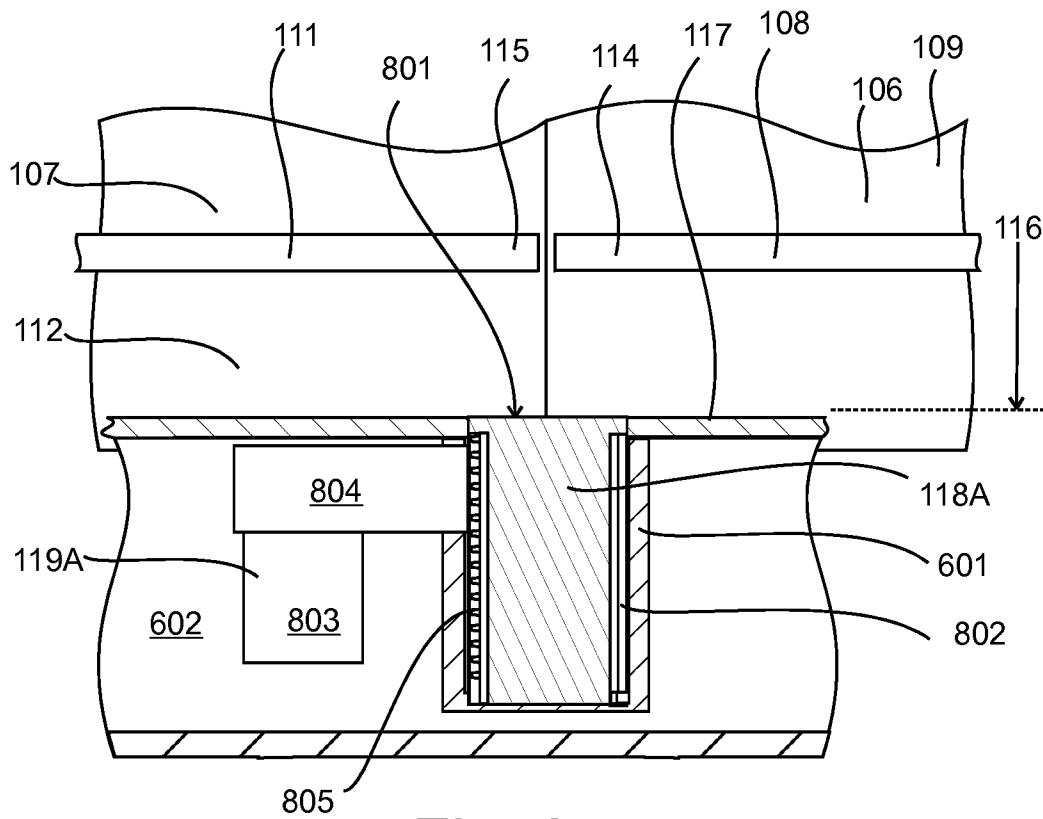


Fig. 8

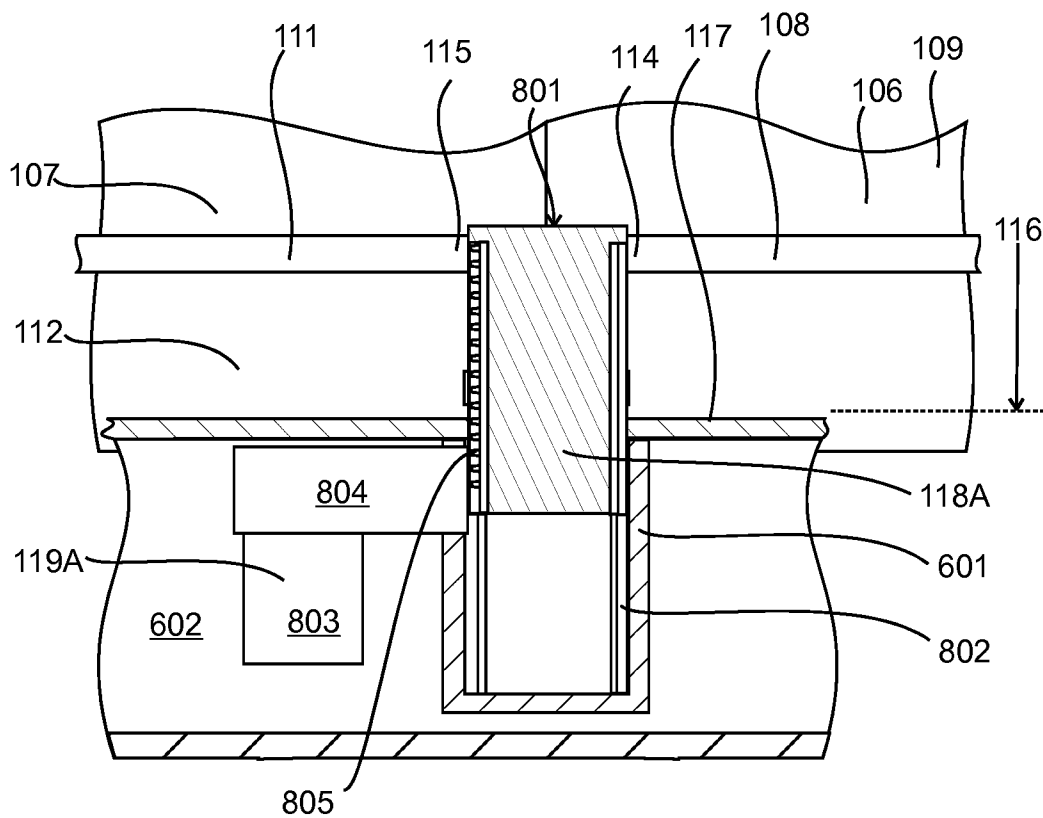


Fig. 9

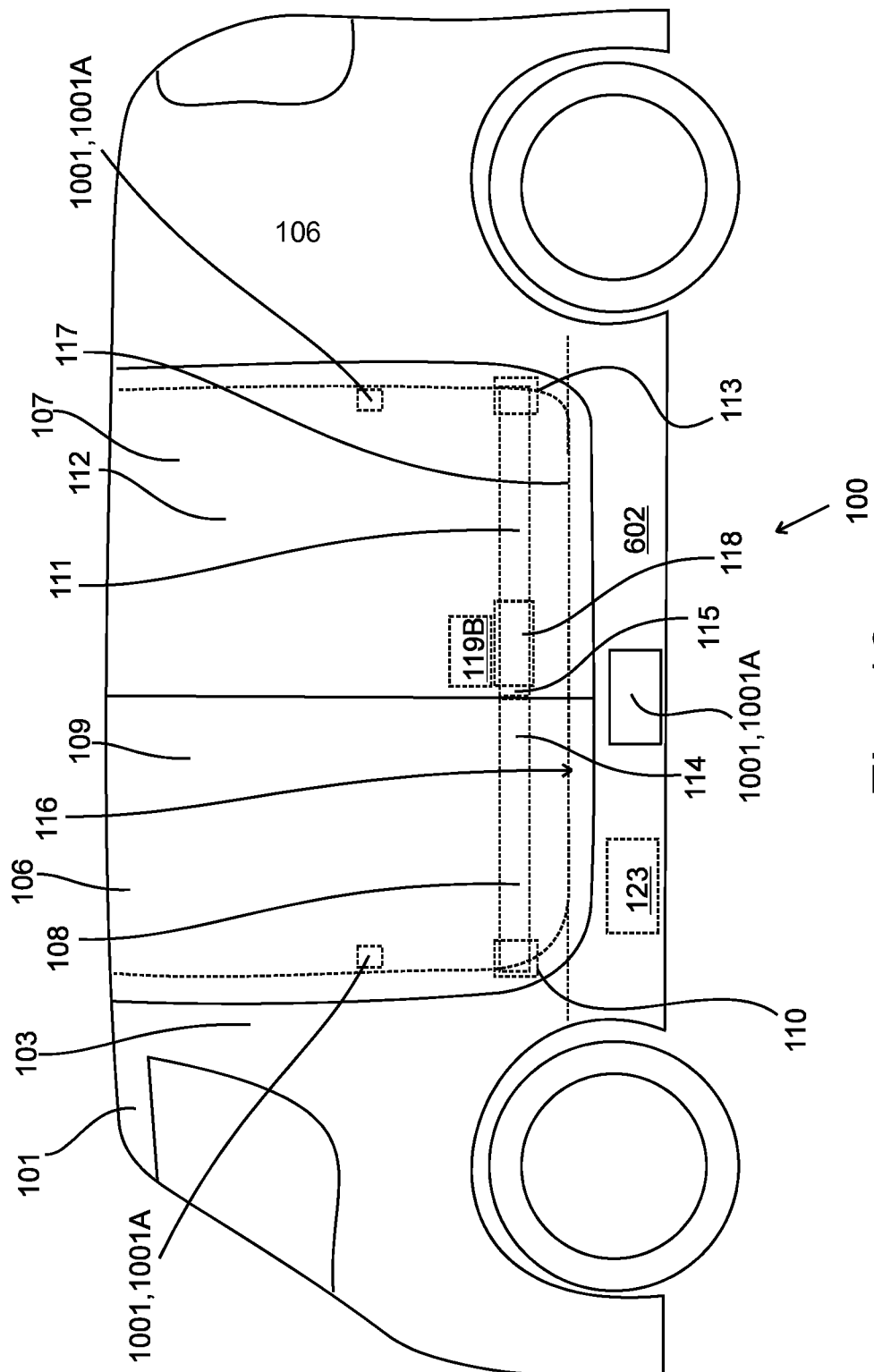


Fig. 10

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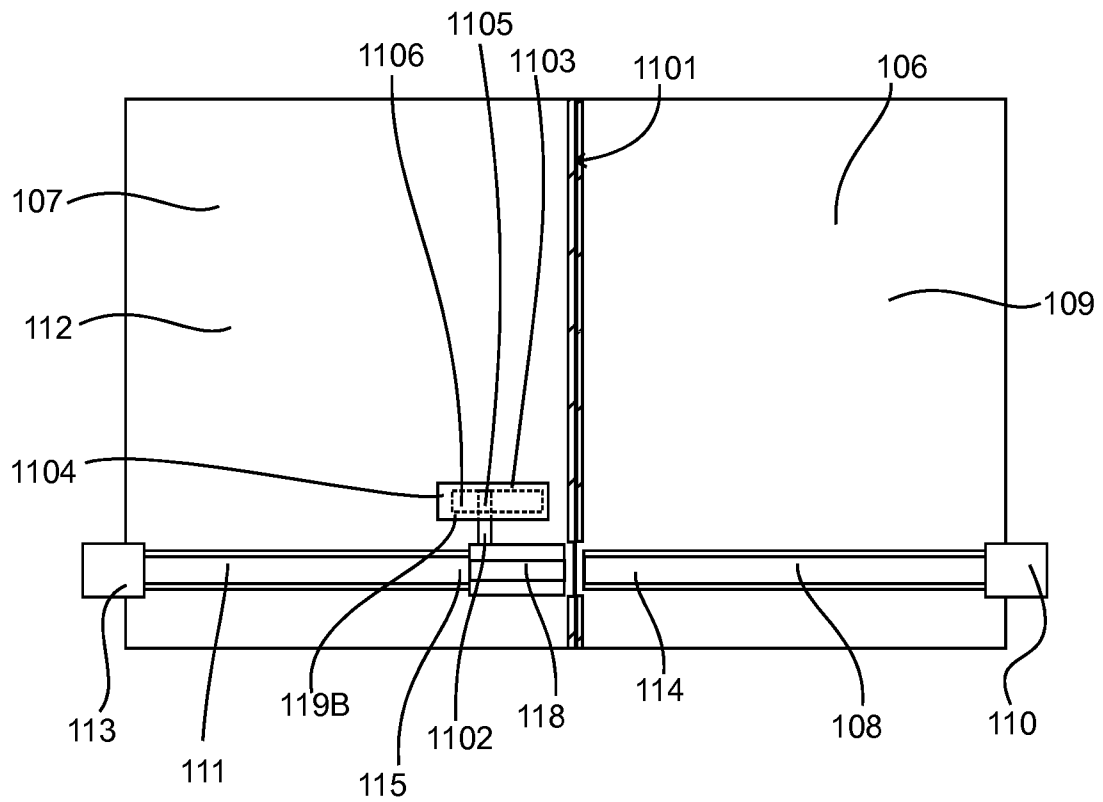


Fig. 11

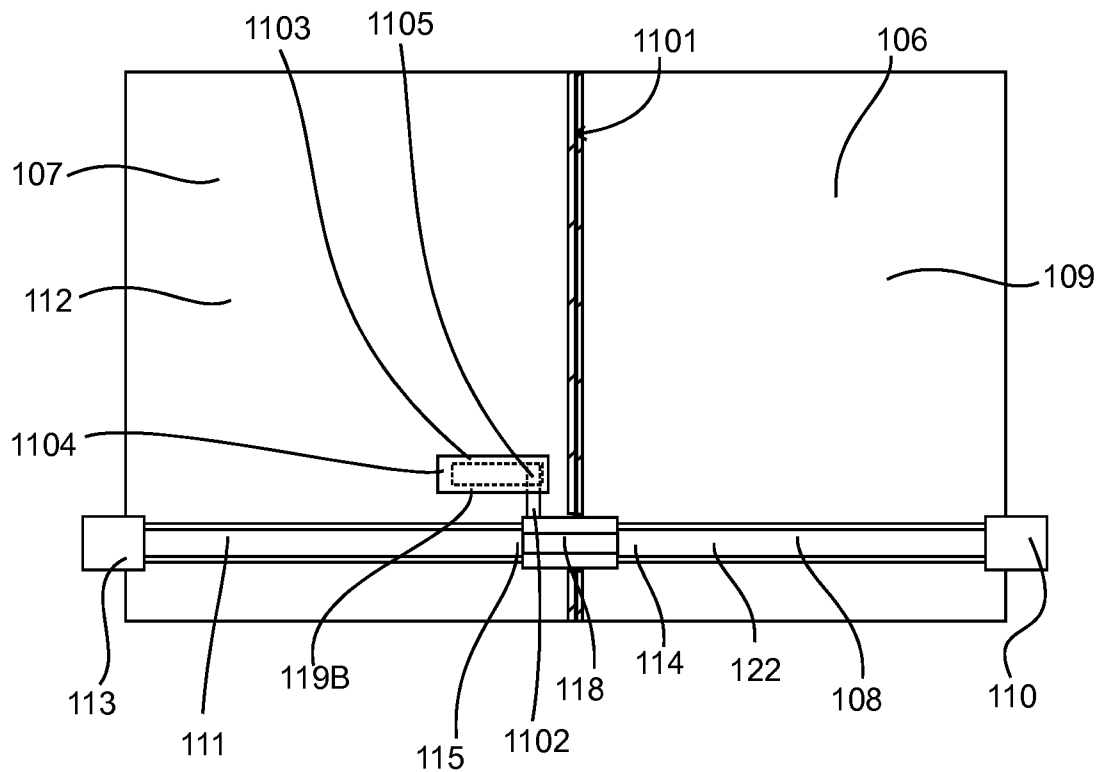


Fig. 12

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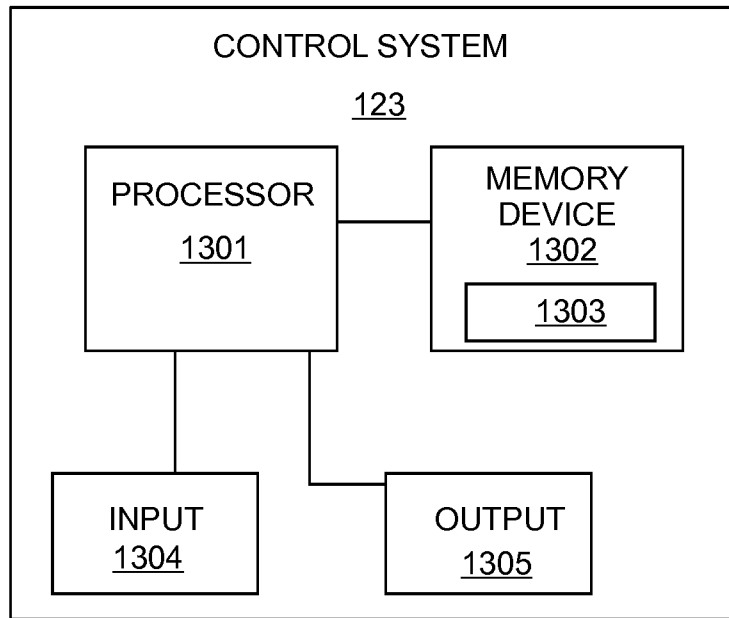


Fig. 13

11/12

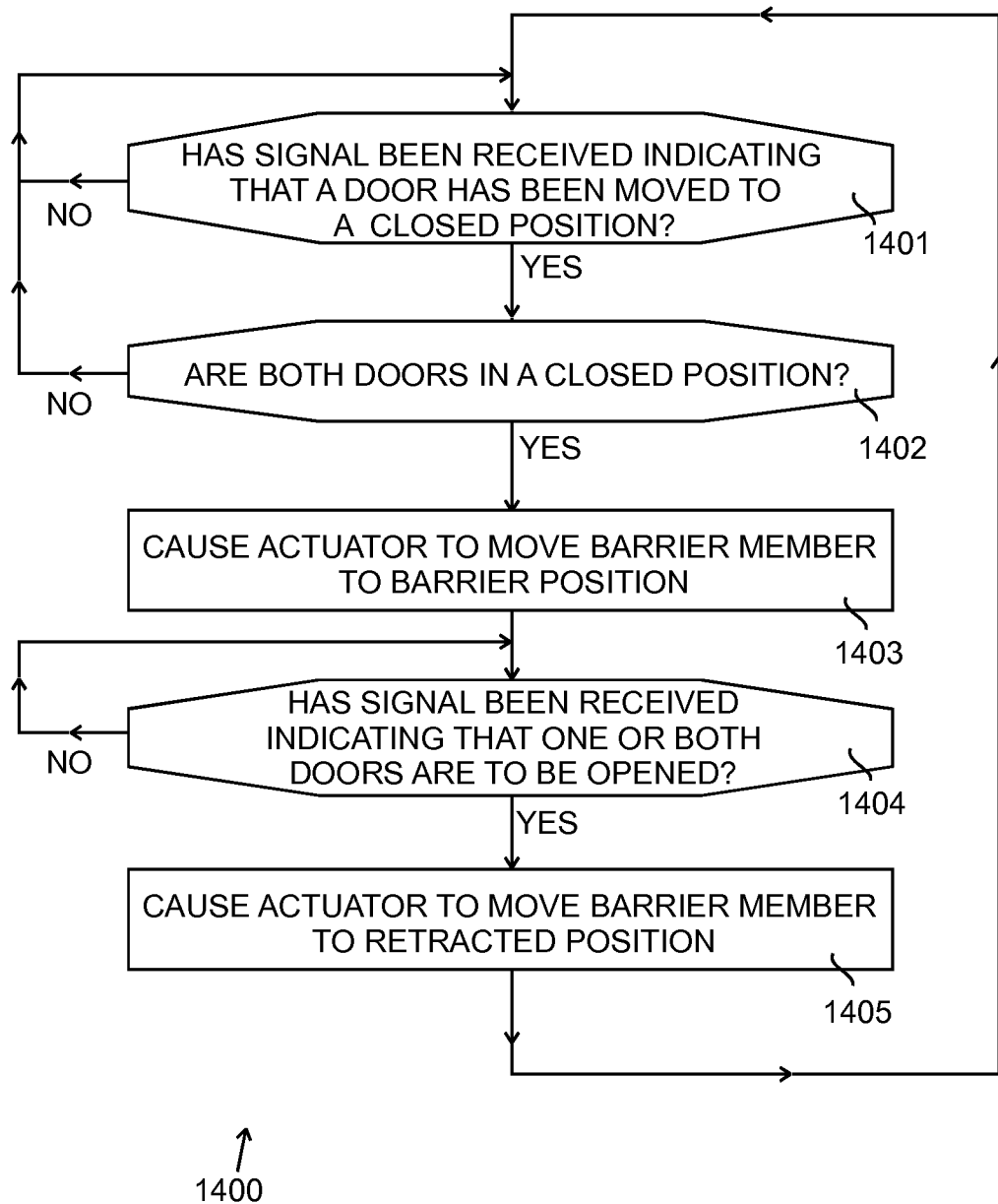


Fig. 14

12/12

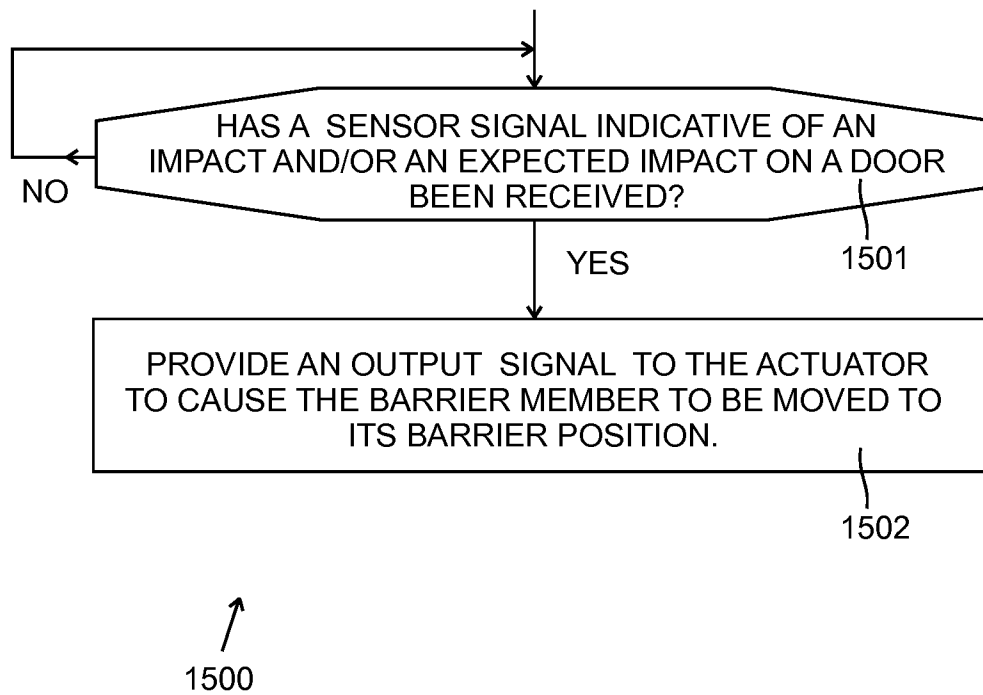


Fig. 15

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/078316

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60J5/04
ADD. B60J5/06

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

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

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A	column 2, line 49 - column 4, line 38 figures 1-5	2,5,8, 16,18
X	US 2018/265027 A1 (NUSIER SAIED [US] ET AL) 20 September 2018 (2018-09-20) paragraph [0045] - paragraph [0051] paragraph [0059] - paragraph [0068] figures 1-5, 10-14 ----- -/-	1,3, 9-12,14, 15,17, 19-21

☒ 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

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"&" document member of the same patent family

Date of the actual completion of the international search

23 January 2020

Date of mailing of the international search report

31/01/2020

Name and mailing address of the ISA/

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Authorized officer

Heijnen, Philip

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/078316

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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