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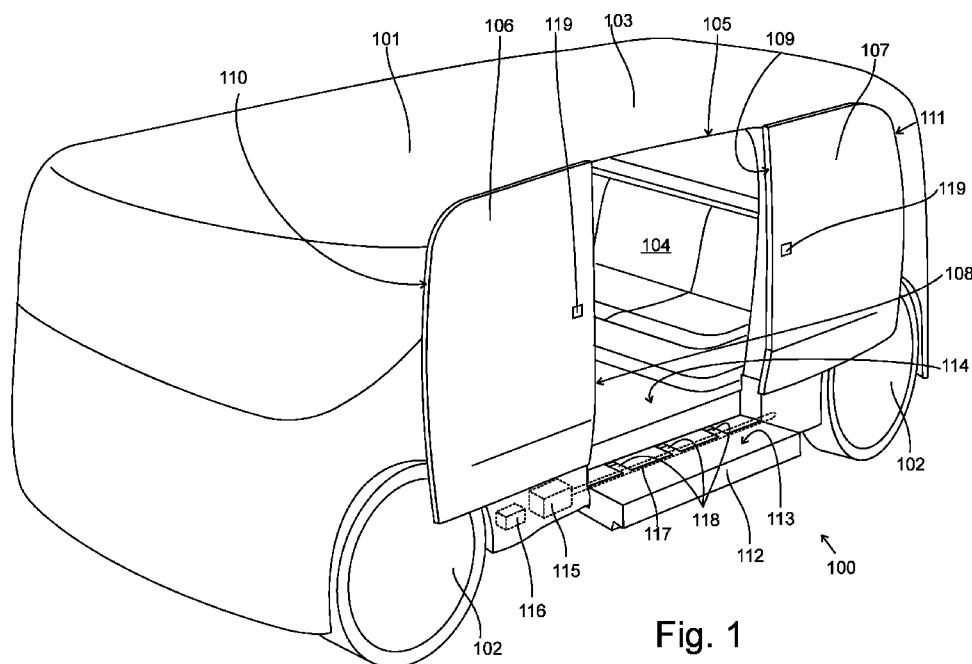


Fig. 1

(57) **Abstract:** Aspects of the present invention relate to a door system (120) for a vehicle (100), a vehicle (100) and a method (2100, 2200, 2300) of providing a barrier. The door system (120) comprises a door (106) configured to move between a closed position, in which it covers at least a portion of an opening (105) of a cabin (103) in a body of a vehicle (100), and an open position allowing access through the opening (105). The door system also comprises a barrier member (112) comprising a first portion (403) and a second portion (405). The barrier member (112) is moveable between an access position in which the first portion (403) and the second portion (405) are disposed below a level (404) of a floor (114) of the cabin (103) and a barrier position. In the barrier position, at least the second portion (405) of the barrier member (112) extends up to an elevated level (406) above the level (404) of the floor (114), adjacent to a panel (1002, 1201) of the door (106), for resisting entry into the cabin (103) of objects impacting against the door (106).



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A DOOR SYSTEM, A VEHICLE AND A METHOD OF PROVIDING A BARRIER

TECHNICAL FIELD

- 5 The present disclosure relates to a door system, a vehicle and a method of providing a barrier. In particular, but not exclusively it relates to a door system, a vehicle and a method of providing a barrier in 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 system for a vehicle, a vehicle, and a method as claimed in the appended claims.

According to an aspect of the invention there is provided a door system for a vehicle, the door system comprising: a first door configured to move between a closed position, in which it covers at least a portion of an opening of a cabin in a body of a vehicle, and an open position allowing access through the opening; and a first barrier member comprising a first portion and a second portion, the first barrier member being moveable between an access position in which the first portion and the second portion are disposed below a level of a floor of the cabin and a barrier position in which at least the second portion extends up to an elevated level above the level of the floor, adjacent to a panel of the first door, for resisting entry into the cabin of objects impacting against the first door.

This provides the advantage that occupants of the vehicle are provided with improved protection in the event of a side impact on the vehicle.

Optionally, with the first barrier member in the barrier position, the first portion resides below the level of the floor and the second portion extends up to an elevated level above the level of the floor, adjacent to the first door. This provides the advantage that the first portion may be anchored below the level of the floor when supporting the second portion, which extends up above the level of the floor.

Optionally, the first barrier member is pivotally mounted to enable the first barrier member to rotate between the barrier position and the access position. This provides the advantage that the barrier member may be stored in a space in its access position that has a smaller height than the height of the barrier member in the barrier position. i.e. by rotating the barrier member down to its access position, the relatively tall height of the barrier member is able to lay along a storage space that may have a relatively small height.

Optionally, the first barrier member is mounted to slide between the barrier position and the access position.

Optionally, the first barrier member has a step surface arranged to be upward facing and below the level of the floor when the first barrier member is in the access position, for providing a step to support a user when entering and/or leaving the cabin. This provides the advantage

that the barrier member performs two separate functions; firstly it provides protection for users of the vehicle in the event of a side impact and secondly it provides a step to assist the users when entering and exiting from the vehicle.

5 Optionally, with the first barrier member in the barrier position, at least the second portion of the first barrier member resides between a part of the first door and the cabin. This provides the advantage that the barrier member is able to provide support to the first door to resist forces that would push it into the cabin of the vehicle.

10 Optionally, with the first barrier member in the barrier position, a part of the door resides between at least the second portion of the first barrier member and the cabin.

Optionally, the door system comprises a second door configured to move between a closed position, in which it covers a portion of the opening of the cabin of the vehicle, and an open
15 position allowing access through the opening; and the first door in combination with the second door extend across the width of the opening when the first door and the second door are in their closed positions. This provides the advantage that the opening may be relatively large and enable users to easily access the cabin of the vehicle.

20 Optionally, at least the second portion of the first barrier member extends alongside the first door and the second door when the first barrier member is in the barrier position. This provides the advantage that both the first door and the second door are assisted in preventing objects entering into the cabin through the opening.

25 The phrase “extends alongside”, “extending alongside”, or similar phrases as used herein mean extends in the same horizontal plane. Thus, when a portion of a barrier member extends alongside a door, that portion of the barrier member and the door overlap each other where they extend in the same horizontal plane.

30 Optionally, the first portion of the first barrier member extends below the first door when the first barrier member is in the barrier position.

Optionally, the door system comprises a control system configured to cause the actuator to move the first barrier member to the barrier position in dependence on receiving a request to
35 move the first door to its closed position so that both the first door and the second door are in

their closed position. This provides the advantage that whenever the doors are closed, the barrier member is moved to a position in which it protects the occupants of the cabin.

Optionally, the door system comprises a control system configured to cause the actuator to move the first barrier member to the barrier position in dependence on receiving a request to move the first door to its closed position. This provides the advantage that whenever the first door is closed, the barrier member is moved to a position in which it assists the first door to prevent objects that hit the first door from entering into the cabin of the vehicle.

Optionally, the door system comprises a control system configured to receive a sensor signal indicative of an impact and/or an expected impact on the first door, and to cause an actuator to move the first barrier member to the barrier position in dependence on receiving the sensor signal. This provides the advantage that the barrier member provides protection to the occupants of the cabin by moving to the barrier position in emergency situations, but the barrier member is generally maintained in its access position, so the process of opening and closing the first door does not have to be complicated by the presence of the barrier member.

Optionally, the control system is configured to receive the sensor signal from a sensor configured to detect an impact on the first door. This provides the advantage that the barrier member is only moved to its barrier position in the event of an impact on the first door.

Optionally, the control system is configured to receive the sensor signal from a sensor configured to detect an impact on the second door.

Optionally, the control system is configured to receive the sensor signal from a sensor configured to detect movement of objects external to the vehicle. This provides the advantage that impacts on the on the door may be detected early providing more time for the deployment of the barrier member.

Optionally, the first door comprises a first crosspiece extending across the width of the first door, and in the barrier position the first barrier member is configured to provide support to the first crosspiece to resist lateral movement of the crosspiece into the cabin. This provides the advantage that the first barrier member in combination with the crosspiece is able to provide a barrier extending across the entire width of the first door.

Optionally, the first crosspiece comprises a rail and the first door is moveable between the closed position and the open position by the rail sliding on a guiding device. This provides the advantage that a rail, which is used to support the door to slide, may provide some protection to occupants of the vehicle in the event of an impact against the door, but the protection that it provides is increased by being supported by the barrier member.

Optionally, the first door comprises a first crosspiece extending across the width of the first door; the second door comprises a second crosspiece extending across the width of the second door; in the barrier position the first barrier member is configured to provide support to the first crosspiece to resist lateral movement of the first crosspiece into the cabin; and the door system comprises a second barrier member configured to be movable to a barrier position in which it is configured to provide support to the second crosspiece.

Optionally, in the barrier position, the second portion of the first barrier member is positioned adjacent to the first door.

Optionally, in the barrier position, the second portion of the first barrier member is positioned between an outer panel and an inner panel of the first door.

According to another 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.

According to further 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 a first door from an open position that allows access through an opening into the cabin to a closed position in which the first door covers at least a portion of the opening; and moving a barrier member from an access position in which both a first portion and a second portion of the first barrier member are disposed below a level of a floor of the cabin to a barrier position in which at least the second portion extends up to an elevated level above the level of the floor; wherein after said moving of the first door and said moving of the first barrier member, the first barrier member is adjacent to a panel of the first door at a position for resisting entry into the cabin of objects impacting against the first door. This provides the advantage that occupants of the vehicle are provided with improved protection in the event of a side impact on the vehicle.

Optionally, said moving the first door to the closed position is performed with the first barrier member in the barrier position.

5 Optionally, said moving the first barrier member is performed with the first door in the closed position.

Optionally, the first barrier member has a step surface arranged to be upward facing and below the level of the floor when the first barrier member is in the access position, for providing a step to support a user when entering and/or leaving the cabin. This provides the advantage
10 that the barrier member is arranged to perform two separate functions; firstly it provides protection for users of the vehicle in the event of a side impact and secondly it provides a step to assist the users when entering and exiting from the vehicle.

According to another aspect of the invention there is provided a door system for a vehicle, the
15 door system comprising: a first door configured to move between a closed position, in which it covers at least a portion of an opening of a cabin in a body of a vehicle, and an open position allowing access through the opening; and a first barrier member moveable between an access position in which the barrier member is disposed below a level of a floor of the cabin and a barrier position in which at least a portion of the barrier member extends above the level of
20 the floor, where it is positioned to resist entry into the cabin of objects impacting against the first door.

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
25 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
30 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 its doors open and a barrier member in an access position;

5 Fig. 2 shows the vehicle with its doors open and the barrier member in its barrier position;

Fig. 3 shows the vehicle with its doors closed and the barrier member in its barrier position;

Fig. 4 shows a cross-sectional view of the barrier member in its barrier position, the rear door and an under part of the body to which the barrier member is attached;

10 Fig. 5 shows a cross-sectional view of the barrier member in its access position, the rear door and an under part of the body to which the barrier member is attached;

Fig. 6 shows another vehicle embodying the present invention with its doors closed and a barrier member in its barrier position;

Fig. 7 shows a cross-sectional view of the barrier member in the barrier position, the rear door in its closed position and an under part of the body of the vehicle of Fig. 6;

15 Fig. 8 shows a cross-sectional view of the barrier member in the access position, the rear door in its closed position and the under part of the vehicle of Fig. 6

Fig. 9 shows a cross-sectional view of the barrier member in the access position, the rear door in its open position and the under part of the vehicle of Fig. 6;

20 Fig. 10 shows yet another vehicle embodying the present invention with its doors open and barrier members in their access position;

Fig. 11 shows the vehicle of Fig. 10 with its doors closed and barrier members in their barrier position;

Fig. 12 shows the rear door and a barrier member of the vehicle of Fig. 10 in its access position;

Fig. 13 shows the barrier member of Fig. 12 in its barrier position;

25 Fig. 14 shows a further vehicle embodying the present invention;

Figs. 15 and 16 show yet another vehicle embodying the present invention;

Fig. 17 shows schematically a first example of an actuator for deploying one of the barrier members of Figs. 15 and 16;

30 Fig. 18 shows schematically a second example of an actuator for deploying one of the barrier members of Figs. 15 and 16;

Fig. 19 shows schematically a third example of an actuator for deploying one of the barrier members of Figs. 15 and 16;

Fig. 20 shows schematic diagram of the control system of Fig. 1;

35 Fig. 21 shows a flowchart illustrating an example of a method of controlling the doors and the barrier member of a vehicle;

Fig. 22 shows a flowchart illustrating another example of a method of controlling the doors and the barrier member of a vehicle; and

Fig. 23 shows a flowchart illustrating a further example of a method of controlling the barrier member of a vehicle.

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DETAILED DESCRIPTION

A door system 120, a vehicle 100 and a method 2100 in accordance with an embodiment of the present invention is described herein with reference to the accompanying Figs. 1 to 5 and
10 21.

With reference to Fig. 1, the vehicle 100 is a road vehicle 100 comprising a body 101 supported on road wheels 102. The body 101 defines a cabin 103 for receiving users of the vehicle 100, and seats 104 are provided in the cabin 103 to allow the users to be seated. An opening 105
15 in the side of the body 101 provides the users with access into the cabin 103 when a front door 106 and/or a back door 107 of the vehicle 100 are in an open position, as shown in Fig. 1.

In the present embodiment, the opening 105 is sufficiently wide to enable access to the seats
20 104 at the rear of the vehicle 100 and other seats (not shown) at the front of the vehicle 100. When the doors 106 and 107 are in their closed positions (illustrated in Fig. 3) a rear edge 108 of the front door 106 butts up against a front edge 109 of the back door 107 and the combination of the front door 106 and the rear door 107 extends across the full width of the opening 105.

25 In the present embodiment, the doors 106 and 107 are sliding doors, but in alternative embodiments they are hinged doors, the front door 106 being mounted on hinges at its front edge 110 and the rear door 107 being mounted on hinges at its rear edge 111.

The vehicle 100 also comprises a barrier member 112 that, in the present embodiment, is
30 moveable to an access position, as illustrated in Fig. 1, where it provides a step to make access into the cabin 103, and exiting from the cabin 103, easier for users of the vehicle 100. In its access position shown in Fig. 1, the barrier member 112 has a step surface 113 that is arranged to be substantially horizontal when the vehicle 100 is on a horizontal road, so that users may step down from a floor 114 of the cabin 103 onto the step surface 113 and then
35 down onto the ground.

The barrier member 112 is moveable between its access position and a barrier position (illustrated in Figs. 2 and 3) by an actuator 115 (shown in Fig. 1) under the control of a control system 116. The actuator 115 comprises an electric motor and gearing which are arranged to rotate a shaft 117 to which the barrier member 112 is operationally connected. In the present embodiment, the shaft 117 is rigidly fixed to hinge parts 118 of the barrier member 112 so that the barrier member 112 rotates along with the shaft 117. The shaft 117 is supported within bearings (401, shown in Fig. 4) in the body 101 of the vehicle 100 to enable it to rotate with respect to the body 101.

The vehicle 100 is shown in Fig. 2 with the barrier member 112 in its barrier position and with the doors 106 and 107 still in their open position. In the present embodiment, the doors must be in their open position while the barrier member 112 is rotated between the access position shown in Fig. 1 and its barrier position shown in Figs. 2 and 3, but in alternative embodiments as will be described below, this is not the case.

Having rotated the barrier member 112 to its barrier position, the doors 106 and 107 may then be moved to their closed position as shown in Fig. 3.

The vehicle 100 may comprise sensors (not shown) configured to provide signals to the control system 116 indicative of when the doors 106 and 107 have been moved to their fully open position shown in Figs. 1 and 2 and their closed position, shown in Fig. 3. The vehicle may also comprise other sensors (not shown) configured to provide signals to the control system 116 indicative of when the barrier member 112 has been moved to its access position, shown in Fig. 1, and its barrier position, shown in Figs. 2 and 3.

The control system 116 is configured to receive signals indicating that closing of the doors 106 and 107 has been requested, for example from a user input device (not shown) in the cabin 103, or from a user input device 118 on one of the doors 106 and 107, or from a wireless user input device (not shown) configured to communicate wirelessly with the control system 116. In dependence on receiving such a signal, the control system 116 is configured to provide an output signal to the actuator 115 to cause it to move the barrier member 112 to the barrier position.

The control system 116 may also be configured to cause the doors 106 and 107 to be closed by actuators associated with the doors, when the barrier member 112 has reached its barrier position. The control system 116 may also be configured to cause the doors 106 to be opened in dependence on receiving a request that the doors 106 and 107 be opened. The control system 116 is also configured to receive signals indicative that the doors 106 and 107 have been moved to their fully open position and, in dependence on receiving such a signal, to provide an output signal to the actuator 115 to cause it to move the barrier member 112 to the access position.

An example of a method 2100 of controlling the doors and the barrier member 112, which may be performed by the control system 116 of Figs. 1 to 3, is summarised in the flowchart of Fig. 21. At block 2101 of the method 2100 it is determined whether a signal has been received requesting that the doors 106 and 107 be closed. If such a signal has been received, an output signal is provided to the actuator 116 at block 2102 to cause the barrier member 112 to be moved to its barrier position. It is then determined at block 2103 whether a signal has been received indicating that the barrier member 112 is in its barrier position.

When it is determined that the barrier member 112 is in its barrier position at block 2103, the control system may then provide an output signal at block 2104 to a door mechanism (not shown) to cause the doors 106 and 107 to close.

The doors 106 and 107 will then remain closed until a request for the doors to be opened is received at block 2105. When such a signal is received, an output signal is provided to the door mechanism at block 2106 to cause the doors to be opened. At block 2107, it is then determined whether a signal has been received from door sensors (not shown) indicating that the doors 106 and 107 are in their open position, and if they are, an output signal is provided to the actuator at block 2108 to cause the barrier member 112 to be moved to its access position.

Cross-sectional views of the barrier member 112, the rear door 107 and an under part 402 of the body 101 to which the barrier member 112 is attached are provided in Figs. 4 and 5. In Fig. 4 the barrier member is in its barrier position and the rear door 107 is in its closed position, while in Fig. 5 the barrier member 112 is in its access position and the rear door 107 is open.

In the barrier position, shown in Fig. 4, the barrier member 112 has a first portion 403 that is below the level 404 of the floor 114 of the cabin 103 and a second portion 405 that extends up to an elevated level 406 above the level 404 of the floor 114. A lower edge portion 415 of the rear door 107 extends down below the elevated level 406, so that it overlaps the second portion 405 of the barrier member 112.

In the present embodiment, the under part 402 of the body 101 has a hinge portion 407 having an upper surface 408 below the level 404 of the floor of the cabin 103, so that the under part 402 has a stepped profile. The hinge portion 407 comprises bearings 401 which support the shaft 117 to enable it to rotate with respect to the under part 402 of the body 101. The barrier member 112 has profile to match that of the under part 402, so that in the barrier position the step surface 113 butts up against an upper side surface 409 of the under part 402 while a lower surface 410 butts up against an end surface 411 of the hinge portion 407.

In Fig. 5, the rear door 107 has been moved to its open position and the barrier member 112 has been rotated through 90 degrees to its access position where its lower surface 410 butts up against a bottom surface 412 of the under part 401, so that further rotation is prevented. In the access position, both the first portion 403 and the second portion 405 of the barrier member 112 are located below the level 404 of the floor 114 of the cabin 103. Also, the step surface 113 of the barrier member 112 is level with the upper surface 408 of the hinge portion 407, so that the step surface 113 and the upper surface 408 of the hinge portion 407 effectively provide a broad step on which the users of the vehicle 100 may step during entry and exit of the cabin 103.

It may be noted that the outer surface 413 of the barrier member 112 is provided with a recess 414 (labelled in Fig. 5) so that when the barrier member 112 is returned to its barrier position, shown in Fig. 4, the lower edge portion 415 of the doors 106 and 107 may be received in the recess 414.

In the event of a side impact on the vehicle 100 by another vehicle, because the barrier member 112 extends up above the level 404 of the floor 114, it provides a barrier to resist entry into the cabin 103 of the other vehicle. In addition, the second portion 405 of the barrier member 112 extends alongside the lower edge portion 415 of the rear door 107 and alongside a similar edge portion of the front door 106 and so it is able to provide support to those lower edge portions 415. Therefore, when the doors 106 and 107 are resisting the force of impact

from the other vehicle, the barrier member 112 assists the doors to maintain their position and not be forced into the cabin 103. The barrier member 112 therefore provides additional protection to occupants of the cabin 103 in the event of a side impact.

- 5 In the embodiment of Figs. 1 to 5, the front door 106, the back door 107 and the barrier member 112 provide a door system 120 that gives additional protection for occupants of the vehicle 100. However, it should be appreciated that in alternative embodiments, the opening 105 may be closed by a single door 106, and, in which case, the door system 120 may comprise the single door 106 and an associated barrier member 112.

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A second vehicle 100 embodying the present invention is shown in Fig. 6. Like the first vehicle 100 of Figs. 1 to 3, the second vehicle 100 has a cabin 103 formed in its body 101 and a large opening at 105 at the side of the vehicle 100 to enable users to enter and exit the cabin 103 when doors 106 and 107 are open. However, the doors 106 and 107 are shown in their closed positions in Fig. 6.

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The vehicle 100 of Fig. 6 also has a moveable barrier member 112, which is shown in its barrier position in Fig. 6. The vehicle 100 of Fig. 2 differs from that of Figs. 1 to 3 in that in its barrier position the barrier member 112 extends up the outside of the doors 106 and 107, whereas the barrier member 112 of Figs. 1 to 3 extends up the inside of the doors 106 and 107.

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Like the barrier member 112 of Fig. 1, the barrier member 112 of Fig. 6 is mounted on a shaft 117 that is rotatable by an actuator 115 under the control of a control system 116, so that the barrier member 112 may be moved between the barrier position shown in Fig. 6 and an access position.

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Cross-sectional views of the barrier member 112, the rear door 107 and the under part 402 of the vehicle 100 of Fig. 6 are shown in Figs. 7, 8 and 9. The door 107 is in its closed position and the barrier member 112 is in its barrier position in Fig. 7. The outer surface 701 of the door 107 is contoured so that it extends parallel to an upper surface 702 and a part of the step surface 113 of the barrier member 112. In the barrier position, shown in Fig. 7, the barrier member 112 has a first portion 403 below the level 404 of the floor 114 of the cabin 103 while a second portion 405 extends up from the level 404 of the floor 114 to an elevated level 406.

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The barrier member 112 is mounted on the shaft 117 so that it rotates with the shaft 117. The shaft is mounted on bearings 401 located in the under part 402 of the body 101 of the vehicle 100.

- 5 When the doors 106 and 107 of the vehicle 100 of Fig. 6 are to be opened, the barrier member 112 is firstly moved to its access position, as shown in Fig. 8. This is achieved by rotation by the barrier member 112 of about 90 degrees by the shaft 117, until a lower surface 401 of the barrier member 112 butts up against an under surface 703 of the under part 402, which prevents further rotation. The step surface 113 of the barrier member 112 is then positioned
10 in a horizontal plane to provide a step for users entering and exiting the cabin 103.

With the barrier member 112 in its access position, the doors 106 and 107 may then be moved to their open position as shown in Fig. 9.

- 15 Like that of Figs. 1 to 3, the vehicle 100 of Fig.6 may also be provided with sensors (not shown) for sensing the position of the doors 106 and 107 and the position of the barrier member 112.

An example of a method 2200 of controlling the doors and the barrier member 112, which may be performed by the control system 116 of Fig. 6, is summarised in the flowchart of Fig. 22. At
20 block 2201 of the method 2200 it is determined whether a signal has been received requesting that the doors 106 and 107 be closed. If such a signal has been received, an output signal is provided to a door mechanism (not shown) at block 2202 to cause the doors 106 and 107 to be moved to their closed positions. It is then determined at block 2203 whether a signal has been received indicating that the doors are in their closed positions.

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When it is determined that the doors are in their closed positions at block 2203, the control system may then provide an output signal at block 2204 to the actuator 115 to cause the barrier member 112 to be moved to its barrier position.

- 30 The doors 106 and 107 will then remain closed until a request for the doors to be opened is received at block 2205. When such a signal is received, an output signal is provided to actuator 115 at block 2206 to cause the barrier member 112 to be moved to its access position. At block 2207, it is then determined whether a signal has been received from sensors (not shown) indicating that the barrier member 112 is in its barrier position, and if it is, an output signal is

provided to the door mechanism at block 2208 to cause the doors 106 and 107 to be moved to their open position.

A third vehicle 100 embodying the present invention is shown a side views of Figs. 10 and 11.

5 Like the first vehicle 100 of Figs. 1 to 3, the third vehicle 100 has a cabin 103 formed in its body 101 and a large opening at 105 at the side of the vehicle 100 to enable users to enter and exit the cabin 103 when doors 106 and 107 are open as shown in Fig. 10.

10 Unlike the vehicle 100 of Fig. 1, the vehicle 100 of Figs. 10 and 11 does not have a barrier member in the form of a deployable step. Instead, it has two barrier members 112 that are mounted within a sill 1001 that extends along the body 101 of the vehicle 100 below its doors 106 and 107. In the access position, shown in Fig. 10, the barrier members 112 are located within the sill 1001 below the level 404 of the floor 114 of the cabin 103. Consequently they do not provide any hindrance to users entering or exiting the vehicle 100.

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The third vehicle 100 is shown in Fig. 11 with its doors closed and with its barrier members 112 in their barrier positions, in which the barrier members 112 have a first portion 403 remaining below the level of the floor 114 and a second portion 405 extending up to an elevated level 406. In their barrier positions, one of the barrier members 112 extends up and alongside the front door 106 and the other barrier member 112 extends up and alongside the rear door 107. In some alternative embodiments, the barrier members 112 extend upwards inside the cabin 103, just on the inside of the doors 106 and 107. However, in the present embodiment, the doors 106 and 107 each comprise an outer panel 1002 and an inner panel 1201 (shown in Figs. 12 and 13) and each of the barrier members 112 is arranged to extend up between the inner panel 1201 and the outer panel 1002 of a respective one of the doors 106 and 107.

25

In the event of a side impact on the vehicle 100 by another vehicle, the barrier members 112 in their barrier positions are configured to resist entry of the other vehicle into the cabin 103. Rather than the other vehicle entering the cabin 103, the other vehicle may, for example, push the vehicle 100 sideways by its action against the barrier members 112. The barrier members 112 also provide support to the doors 106 and 107 to resist their movement into the cabin 103. Thus, the barrier members 112 provide protection for the occupants of the cabin 103.

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The barrier members 112 are moveable between the access positions and the barrier positions by actuators 115 operating in response to signals from a control system 116. The barrier members 112 may be controlled to move to their barrier positions immediately after the doors 106 and 107 have been moved to their closed positions and to lower to their access positions immediately before the doors 106 and 107 have been moved to their open positions.

Further details of the barrier member 112 of the rear door 107 of Figs. 10 and 11 are shown in Figs. 12 and 13. It should be understood that the barrier member 112 of the front door 106 may be similarly configured. The barrier member 112, the sill 1001 and the rear door 107 are shown in cross-sectional views in Figs. 12 and 13. The barrier member 112 is shown in its access position in Fig. 12 and in its barrier position in Fig. 13.

The barrier member 112 is mounted on a support structure 1202 rigidly fixed within the sill 1001. The support structure 1202 comprises a linear-motion bearing 1206 on which the barrier member 112 is mounted to enable the barrier member 112 to slide between its access and barrier positions. In the present embodiment, the actuator 115 comprises an electric motor 1204 and an associated gear mechanism 1205, and the barrier member 112 comprises a toothed track 1203. The gear mechanism 1205, powered by the electric motor 1204, is configured to drive the toothed track 1203 and thereby slide the barrier member 112 between the access position and barrier position as required.

In its access position, an uppermost surface 1207 of the barrier member 112 is at the level 404 of the floor 114. However, in the barrier position the first portion 403 of the barrier member 112 remains anchored within the support structure 1202, while the second portion 405 of the barrier member 112 extends up above the level 404 of the floor 114.

In an alternative embodiment to that of Figs. 10 and 11, the barrier members 112 are attached to the sill 1001 by hinges at the level 404 of the floor 114, and when the barrier members 112 are in their access positions they have an upper surface that extends at the level 404 of the floor 114. When the barrier members 112 are rotated up into their barrier positions, the whole of the barrier members are positioned above the level 404 of the floor 114.

In another alternative embodiment, a single barrier member 112 extends across the entire width of the opening 105 and is supported on two linear-motion bearings that extend upwards on either side of the opening 105. In the barrier position the whole of the barrier member 112

extends alongside the door 106 and 107, and when it is slid back down to its access position its upper surface is positioned at the level 404 of the floor 114, so that it does not impede users from entering or leaving the cabin 103 when the doors are opened.

5 A further vehicle 100 embodying the present invention is shown in Fig. 14. The vehicle 100 of Fig. 14 has all of the features described above for the vehicle 100 shown in Figs. 10 and 11. In addition the vehicle 100 of Fig. 14 comprises doors 106 and 107 that each has a respective crosspiece 1401 extending horizontally across its width. The crosspieces 1401 extend substantially horizontally above the level of the floor 114 of the cabin 103 at equal
10 heights so that they are substantially aligned with each other. The crosspieces 1401 may be rigidly attached to the outer panels 1002 of the doors 106 and 107 and formed of a material that provides additional strength to the doors. For example, the crosspieces 1401 may be formed of a metal, such as steel, or a fibre composite material.

15 The doors 106 and 107 are attached to the body 101 of the vehicle 100 by mechanisms 1402 that enable the doors to move between their closed positions shown in Fig. 14 and their open positions allowing access into the cabin 103. The crosspieces 1401 extend across the doors from the mechanisms 1402.

20 In some embodiments, in which the doors 106 and 107 are sliding doors, the crosspieces 1401 are rails and the mechanisms 1402 comprise guides that locate within the rails so that the rails are able to slide over the guides. In such embodiments, the mechanisms 1402 may also comprise electric motors configured to drive the rails with respect to the body 101 in order to open and close the doors 106 and 107.

25

In alternative embodiments, the mechanisms 1402 comprise hinges defining axes about which the doors 106 and 107 can rotate to open and close. In such embodiments, the crosspiece 1401 of each door 106 and 107 extends from the hinge 1402 of that door and across its width to provide it with additional strength.

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The vehicle 100 of Fig. 14 also comprises barrier members 112 as described previously for the vehicle 100 of Figs. 10 and 11. The barrier members 112 are shown in their barrier positions in Fig. 14 having been deployed by the control system 116. In their barrier positions, the barrier members 112 extend from below the level of the floor 114 up to an elevated level
35 406 that is above a lower edge 1403 of the crosspieces 1401, so that the crosspieces 1401

are sandwiched between the outer panel 1002 of the doors 106 and 107 and one of the barrier members 112. Consequently, in the event of a side impact on the vehicle 100 of Fig. 14, the crosspieces 1401 are supported by the barrier members 112 and the mechanisms 1402 (whether hinges or rail guides) to resist lateral movement of the crosspieces 1401 into the cabin 103. Thus, the crosspieces 1401 provide an extended barrier for preventing objects from entering through the opening 105 into the cabin 103.

In an alternative arrangement, a single deployable barrier member 112A may be provided which extends along end portions of the crosspieces 1401, where the doors 106 and 107 meet, to provide support to both doors. The single barrier member 112A may be deployed from its retracted position in the sill 1001 of the vehicle 100 as described above for barrier members 112 to its barrier position illustrated in Fig. 14. The single barrier member 112A may be provided in place of the two barrier members 112, or alternatively it may be provided in addition to the two barrier members 112.

Yet another vehicle 100 embodying the present invention is shown in Figs. 15 and 16. Like previously described vehicles 100, the vehicle 100 of Figs. 15 and 16 has an opening 105 to provide access into a cabin 103 for users of the vehicle 100. Access through the opening 105 is provided when one or both of the doors 106 and 107 is open, but in Fig. 15 they are shown in a closed position in which the combined width of the two doors 106 and 107 extends across the full width of the opening 105.

Unlike the vehicles of Figs. 1, 6, 10 and 14, the vehicle 100 of Figs. 15 and 16 has barrier members 112 that are only deployed in the event of an impact on the doors 106 and 107 or an expected impact on the doors. The barrier members 112 are shown in their access positions in Fig. 15 and their barrier positions in Fig. 16. Like those of Figs. 10 and 14, the barrier members 112 of Figs. 15 and 16 are located in the sill 1001 of the vehicle 100 in their access positions, so that they do not provide any hindrance to the movement of the doors 106 and 107 or to users when they are entering or exiting through the opening 105. In their barrier positions, upper portions 405 of the barrier members 112 extend up from the floor 114 of the cabin 103 to resist objects impacting against the outside of the doors 106 and 107.

The control system 116 of Figs. 15 and 16 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 1501 and, in dependence on receiving such a sensor signal, provide an output signal to cause the deployment of the barrier members 112.

One or more of the sensors 1501 may be mounted within the sill 1001 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 1501, which is mounted within the sill 1001, is a radar sensor 1501A capable of tracking objects in the vicinity of the vehicle 100. The radar sensor 1501A 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 116 when an impact is imminent. Alternatively, the radar sensor 1501A may be configured to provide a signal to the control system 116 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 116. In dependence on receiving a signal from the radar sensor 1501A indicating that an object is very likely to impact against one of the doors 106 and 107, the control system 116 causes the barrier members 112 to be deployed.

In an alternative embodiment, the sensors 1501A 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.

In the present embodiment, the vehicle 100 also includes sensors 1501 in the form of microphones 1501B mounted on each of the doors 106 and 107 and which provide electronic signals to the control system 116 indicative of acoustic signals they receive. The control system 116 is configured to process signals received from the microphones 1501B 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 1501B, the control system 116 is configured to cause the barrier members 112 to be deployed.

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 members 112 is short. Also the period of time between a vehicle hitting one of the doors 106 and 107 reaching the barrier members 112 is even shorter. However, the barrier members

112 are provided with actuators 115 (shown in Figs. 17 to 19) capable of deploying the barrier members 112 sufficiently rapidly.

5 A first example of an actuator 115 for deploying one of the barrier members 112 of Figs. 15 and 16 is shown schematically in Fig. 17. (It will be appreciated that both barrier members 112 may be deployed by similar means.) In this example, the support structure 1202 provides a close fitting sleeve around the barrier member 112 and the actuator 115 comprises pyrotechnic device 115A located between the barrier member 112 and a closed end 1702 of the sleeve. The pyrotechnic device 115A is configured to force the barrier member 112 from
10 its access position (shown in solid outline) to its barrier position (shown in dashed outline) on receipt of an electrical signal from the control system 116.

A second example of an actuator 115 for deploying the barrier member 112 is shown schematically in Fig. 18. In this example, the actuator 115 comprises a loaded spring 115B
15 configured to force the barrier member 112 from its retracted position (shown in solid outline) to its barrier position (shown in dashed outline) when the energy stored in the spring 115B is released. The spring 115B is maintained in its loaded configuration by a latching means 1801 that is configured to allow the energy stored in the spring 115B to be released on receipt of an electrical signal from the control system 116. The latching means 1801 may comprise a
20 pyrotechnically actuated latch or a pyrotechnic fastener, such as a nut or bolt.

A third example of an actuator 115 for deploying the barrier member 112 is shown schematically in Fig. 19. In this example, the actuator 115 comprises a pneumatic cylinder 115C comprising a piston 1903 configured to push the barrier member 112 from its barrier
25 position (shown in solid outline) to its barrier position (shown in dashed outline) when operated. The pneumatic cylinder 115C is connected to a high pressure gas container 1901 via an electrically operable valve 1902. The valve 1902 is configured to remain in its closed position until it receives an electrical signal from the control system 116 causing it to open and thereby cause the actuation of the pneumatic cylinder 115C.

30 Fig. 23 shows a flowchart illustrating a method 2300 of providing a barrier to entry into a cabin 103 of a vehicle 100. The method 2300 is performable by the control system 116 of Figs. 15 and 16. At block 2301 of the method 2300, a sensor signal indicative of an impact and/or an expected impact on a first door 106 and/or a second door 107 that covers an opening 105 into
35 the cabin 103 of the vehicle 100 is received.

As described above, the sensor signal may for example comprise an electrical signal representative of an audio signal received by a microphone 1501B that is configured to sense noise in the first door 106 and/or the second door 107. In such an arrangement, the method additionally comprises analysing the electrical signal to detect a waveform indicative of an impact on the door. Alternatively, the analysis may be performed by another processing device associated with the sensor 1501B, and the sensor signal received at block 2301 (for example by the control system 116) may simply indicate that an impact has occurred.

As a further alternative, the received sensor signal may be from a sensing device 1501A, such as a radar device, that is arranged to sense and track objects that are external to the vehicle 100. The signals received at block 2301 may therefore provide information defining paths of tracked objects, and the method additionally comprises determining when a path of a tracked object is very likely, i.e. expected, to impact the door. Alternatively, a processing device associated with the sensing device may be configured to analyse the detected paths of the tracked objects and determine if such an impact is expected to occur, and the sensor signal received at block 2301 may simply indicate that an impact is expected.

At block 2302 of the method 2300, in dependence on receiving the sensor signal at block 2301, an output signal is provided to an actuator 501 to cause the actuator to move a first barrier member 112 from an access position to a barrier position where the first barrier member is configured to resist entry into the cabin 103 of objects impacting against the first door 106.

A schematic diagram of the control system 116 shown in Figs. 1, 6, 10, 14 and 15 is shown in Fig. 20. In the present embodiment the control system 116 comprises a single processor 2001 but, in other embodiments of the invention the control system 116 may comprise more than one processor 2001. The control system 116 comprises at least one electronic memory device 2002, having instructions 2003 stored therein, and the electronic processor 2001 is electrically coupled to the at least one electronic memory device 2002, so that it can access the instructions 2003.

The control system 116 comprises an electrical input 2004 for receiving signals from the user input devices (such as input device 118), sensors for sensing positions of the doors 106 and 107 and barrier member(s) 112, and in the case of the vehicle of Fig. 15, the sensors 1501 for detecting impacts or expected impacts on the doors. The control system 116 also

comprises an electrical output 2005 for providing output signals to the actuator 115 to cause actuation of the barrier members 112. The electrical output 2005 may also be used to provide output signals to cause opening and closing movement of the doors 106 and 107.

- 5 The processor 2001 is configured to access the instructions 2003 stored in the memory device 2002 and execute the instructions so that it is operable to perform the functions as described previously and/or as summarised in the flowchart of Fig. 21 or the flowchart of Fig. 22 or the flowchart of Fig. 23.
- 10 For purposes of this disclosure, it is to be understood that the control systems described herein may 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 systems may be embodied in, or hosted in, different control units or controllers. A set of instructions could be provided which,
- 15 when executed, cause said controller(s) 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, a first controller may be implemented in software run on one or more electronic processors,
- 20 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 instructions described above may be embedded in a computer-readable storage medium (e.g.,
- 25 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); random access memory (RAM); erasable programmable memory (e.g., EPROM and
- 30 EEPROM); flash memory; or electrical or other types of medium for storing such information/instructions.

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.

The blocks illustrated in the Figs. 21, 22 and 23 may represent steps in a method and/or sections of code in the computer program 2003. 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.

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 system for a vehicle, the first door system comprising:
a first door configured to move between a closed position, in which it covers at least a
5 portion of an opening of a cabin in a body of a vehicle, and an open position allowing access
through the opening; and
a first barrier member comprising a first portion and a second portion, the first barrier
member being moveable between an access position in which the first portion and the second
portion are disposed below a level of a floor of the cabin and a barrier position in which at least
10 the second portion extends up to an elevated level above the level of the floor, adjacent to a
panel of the first door, for resisting entry into the cabin of objects impacting against the first
door.
2. A door system according to claim 1, wherein, with the first barrier member in the barrier
15 position, the first portion resides below the level of the floor and the second portion extends
up to an elevated level above the level of the floor.
3. A door system according to claim 1 or claim 2, wherein the first barrier member is
pivotally mounted to enable the first barrier member to rotate between the barrier position and
20 the access position.
4. A door system according to claim 1 or claim 2, wherein the first barrier member is
mounted to slide between the barrier position and the access position.
- 25 5. A door system according to any one of claims 1 to 4, wherein the first barrier member
has a step surface arranged to be upward facing and below the level of the floor when the first
barrier member is in the access position, for providing a step to support a user when entering
and/or leaving the cabin.
- 30 6. A door system according to any one of claims 1 to 5, wherein, with the first barrier
member in the barrier position, at least the second portion of the first barrier member resides
between a part of the first door and the cabin.

7. A door system according to any one of claims 1 to 4, wherein, with the first barrier member in the barrier position, a part of the first door resides between at least the second portion of the first barrier member and the cabin.

8. A door system according to any one of claims 1 to 7, wherein:

the door system comprises a second door configured to move between a closed position, in which it covers a portion of the opening of the cabin of the vehicle, and an open position allowing access through the opening; and

the first door in combination with the second door extend across the width of the opening when the first door and the second door are in their closed positions.

9. A door system according to claim 8, wherein at least the second portion of the first barrier member extends alongside the first door and the second door when the first barrier member is in the barrier position.

10. A door system according to claim 9, wherein the first portion of the first barrier member extends below the first door when the first barrier member is in the barrier position.

11. A door system according to any one of claims 8 to 10, wherein the door system comprises a control system configured to cause the actuator to move the first barrier member to the barrier position in dependence on receiving a request to move the first door to its closed position so that both the first door and the second door are in their closed position.

12. A door system according to any one of claims 1 to 7, wherein the door system comprises a control system configured to cause the actuator to move the first barrier member to the barrier position in dependence on receiving a request to move the first door to its closed position.

13. A door system according to any one of claims 1 to 10, wherein the door system comprises a control system configured to receive a sensor signal indicative of an impact and/or an expected impact on the first door and/or a second door, and to cause an actuator to move the first barrier member to the barrier position in dependence on receiving the sensor signal.

14. A door system according to claim 13, wherein the control system is configured to receive the sensor signal from a sensor configured to detect an impact on the first door.

15. A door system according to claim 13 when dependent on claim 8, wherein the control system is configured to receive the sensor signal from a sensor configured to detect an impact on the second door.

5

16. A door system according to claim 13, wherein the control system is configured to receive the sensor signal from a sensor configured to detect movement of objects external to the vehicle.

10

17. A door system according to any one of claims 1 to 16, wherein the first door comprises a first crosspiece extending across the width of the first door, and in the barrier position the first barrier member is configured to provide support to the first crosspiece to resist lateral movement of the crosspiece into the cabin.

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18. A door system according to claim 17, wherein the first crosspiece comprises a rail and the first door is moveable between the closed position and the open position by the rail sliding on a guiding device.

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19. A door system according to any one of the previous claims when dependent on claim 8, wherein: the first door comprises a first crosspiece extending across the width of the first door; the second door comprises a second crosspiece extending across the width of the second door; in the barrier position the first barrier member is configured to provide support to the first crosspiece to resist lateral movement of the first crosspiece into the cabin; and the first door system comprises a second barrier member configured to be movable to a barrier position in which it is configured to provide support to the second crosspiece.

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20. A door system according to any one of claims 1 to 19, wherein in the barrier position, the second portion of the first barrier member is positioned adjacent to the first door.

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21. 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.

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

moving a first door from an open position that allows access through an opening into the cabin to a closed position in which the first door covers at least a portion of the opening; and

moving a barrier member from an access position in which both a first portion and a second portion of the first barrier member are disposed below a level of a floor of the cabin to a barrier position in which at least the second portion extends up to an elevated level above the level of the floor;

wherein after said moving of the first door and said moving of the first barrier member, the first barrier member is adjacent to a panel of the first door at a position for resisting entry into the cabin of objects impacting against the first door.

23. A method according to claim 22, wherein said moving the first door to the closed position is performed with the first barrier member in the barrier position.

24. A method according to claim 22, wherein said moving the first barrier member is performed with the first door in the closed position.

25. A method according to any one of claims 22 to 24, wherein the first barrier member has a step surface arranged to be upward facing and below the level of the floor when the first barrier member is in the access position, for providing a step to support a user when entering and/or leaving the cabin.

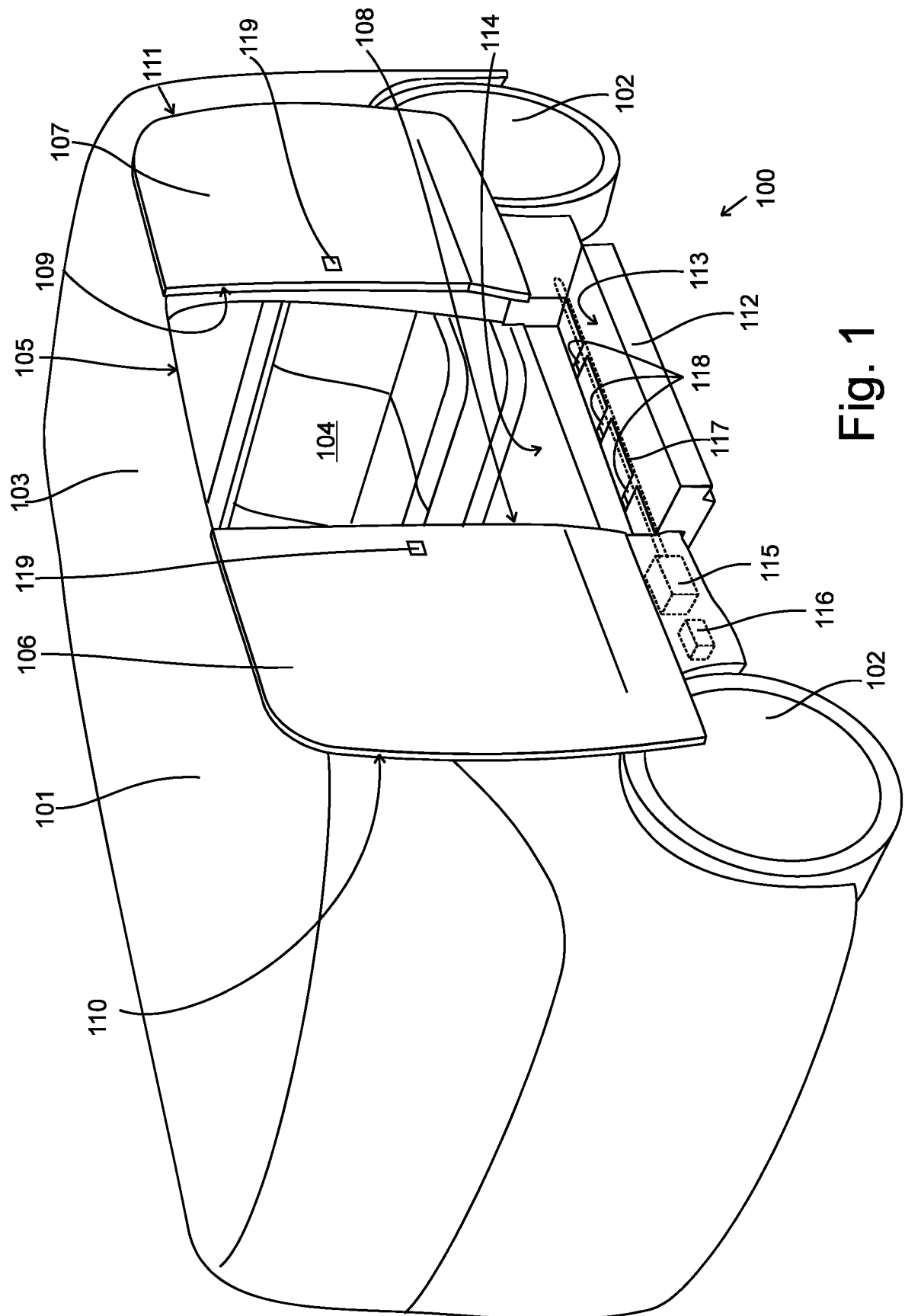


Fig. 1

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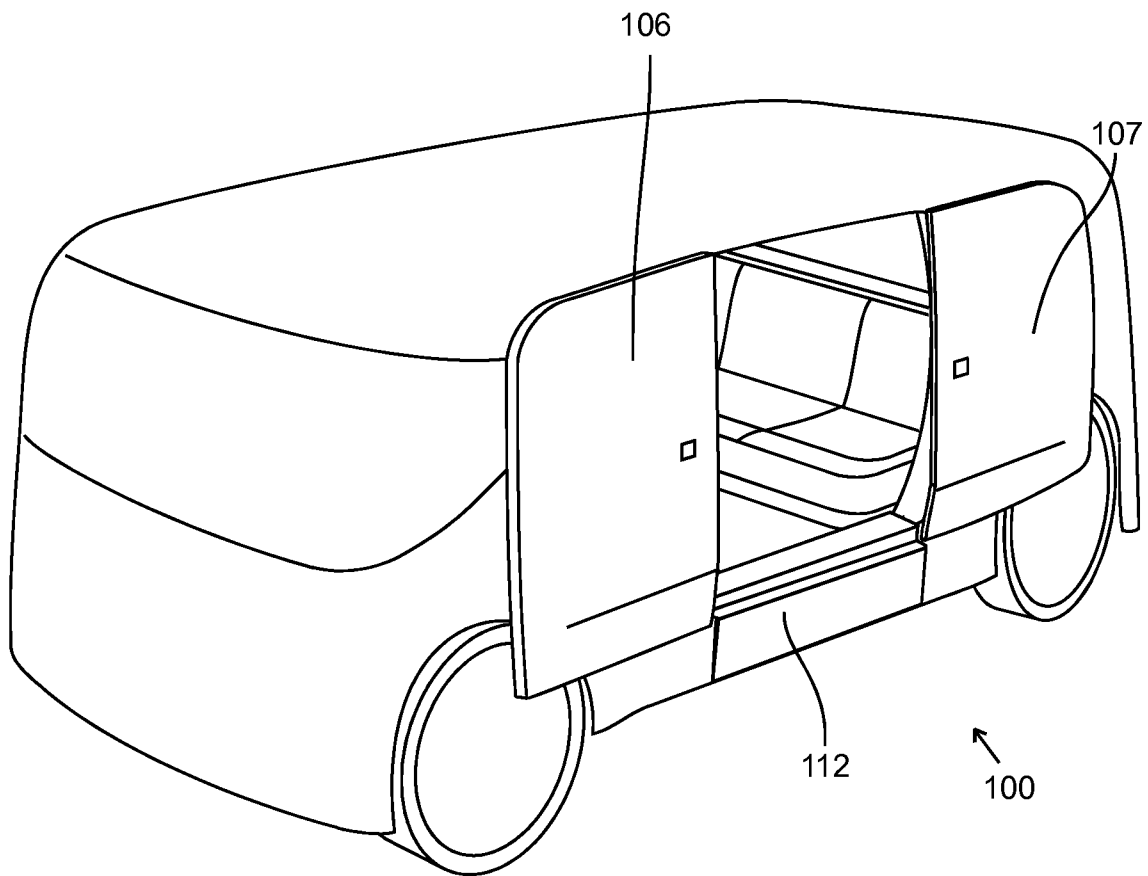


Fig. 2

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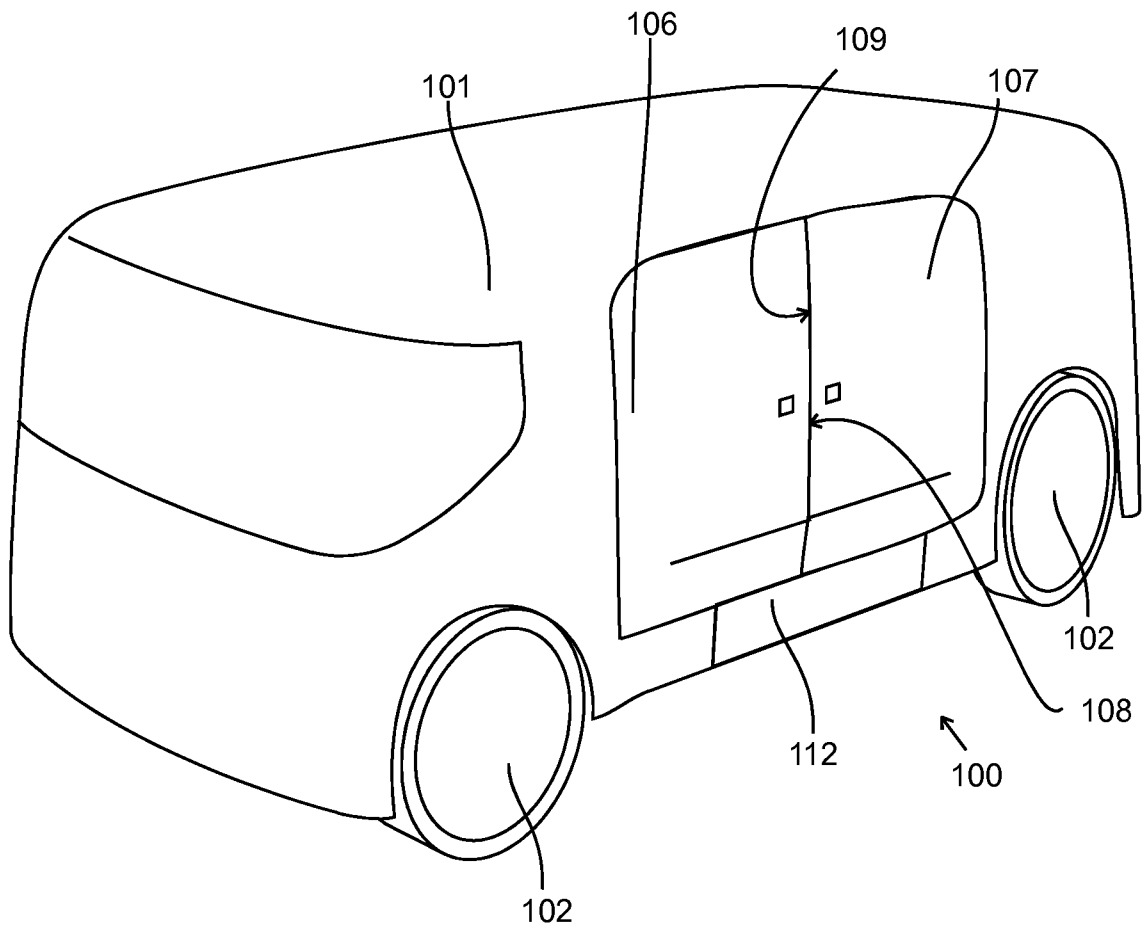


Fig. 3

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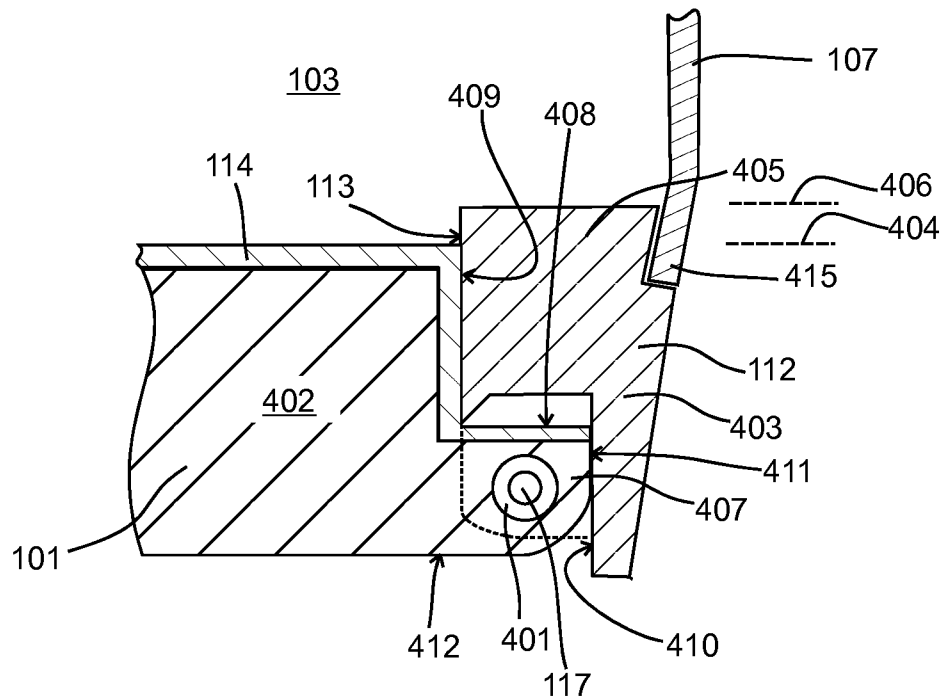


Fig. 4

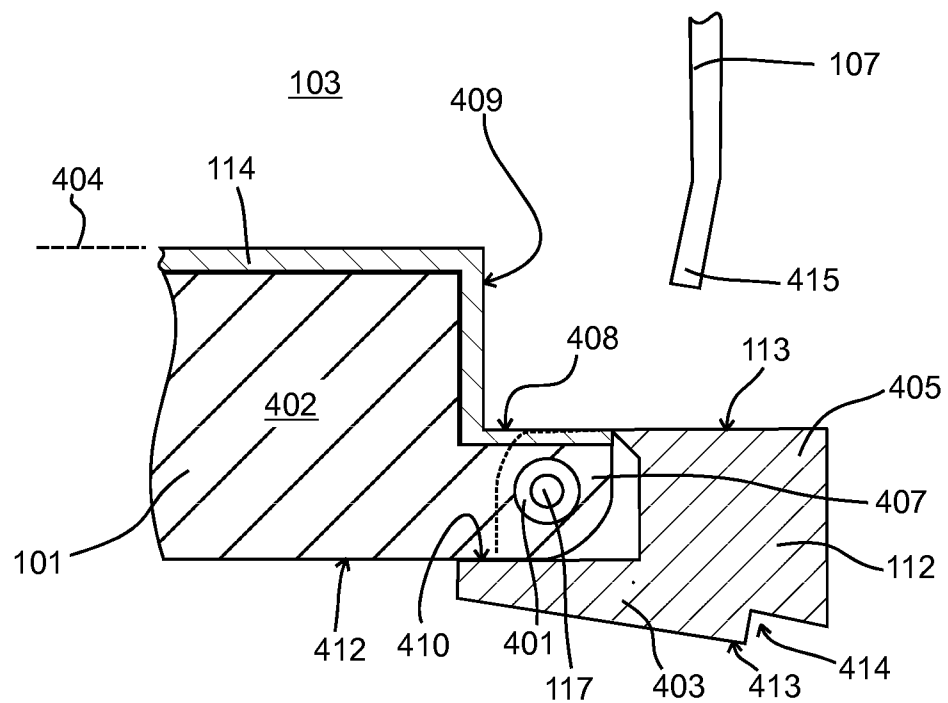


Fig. 5

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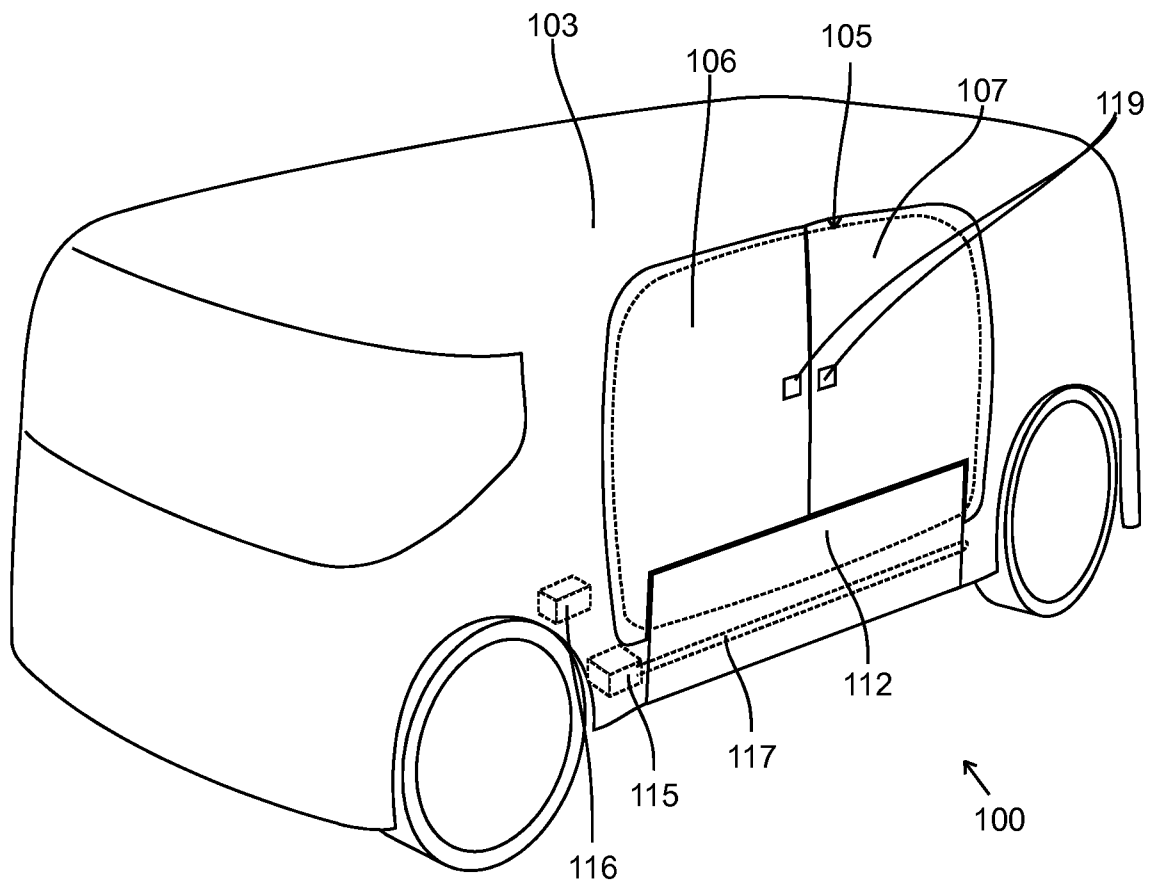


Fig. 6

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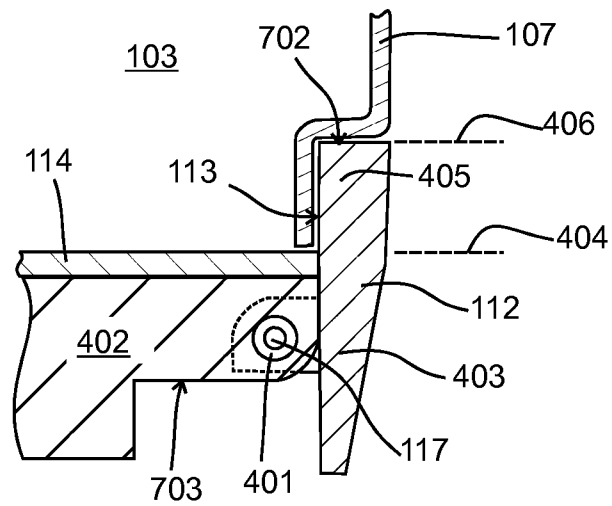


Fig. 7

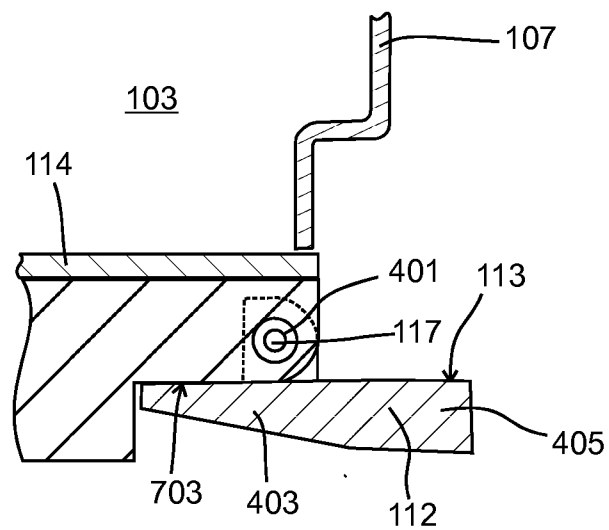


Fig. 8

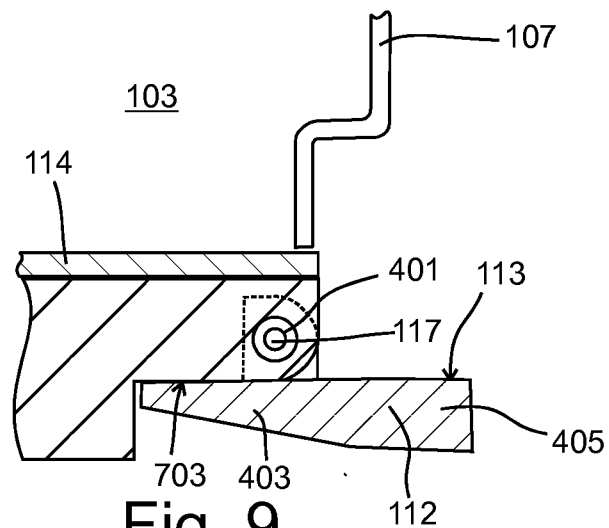


Fig. 9

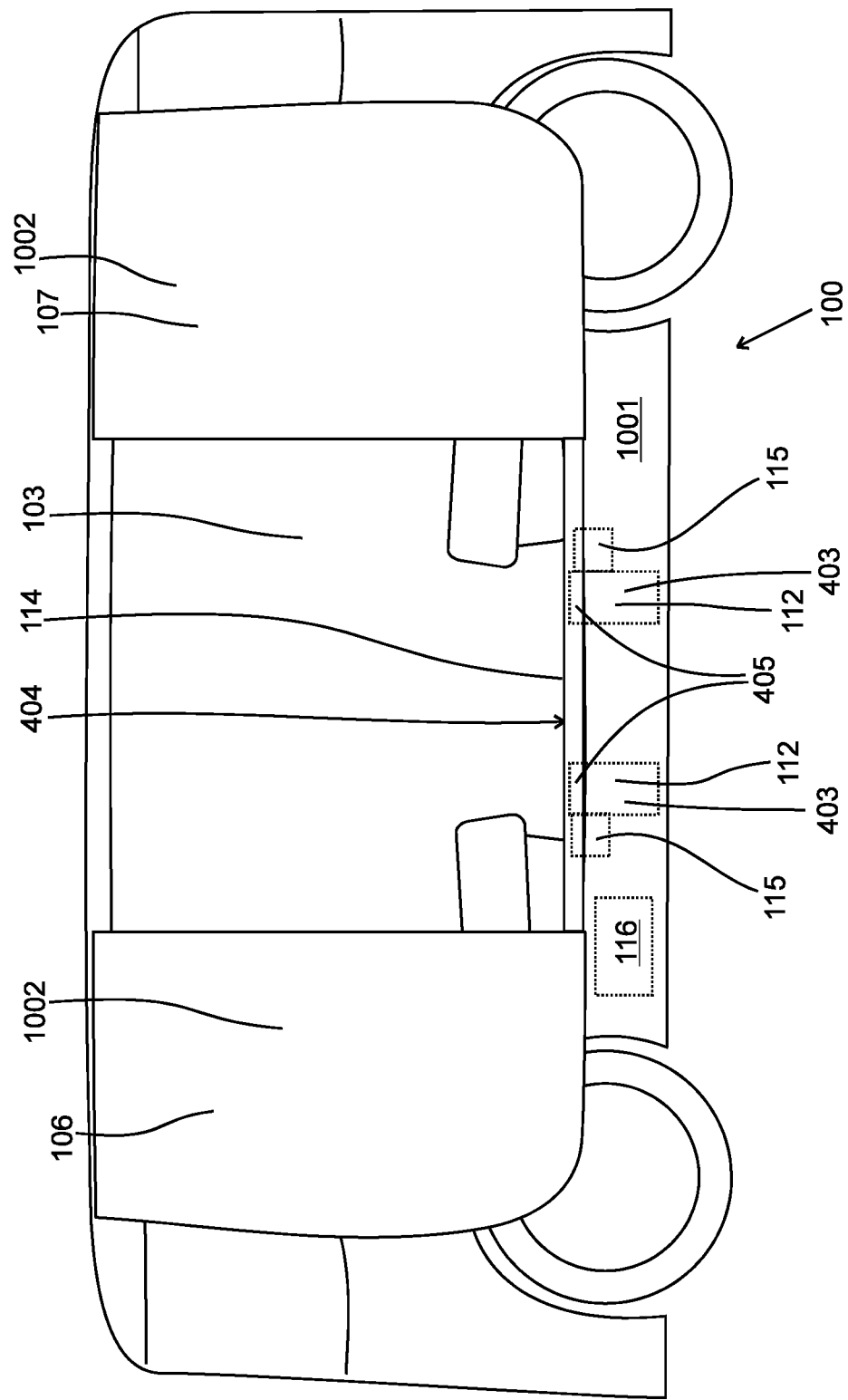


Fig. 10

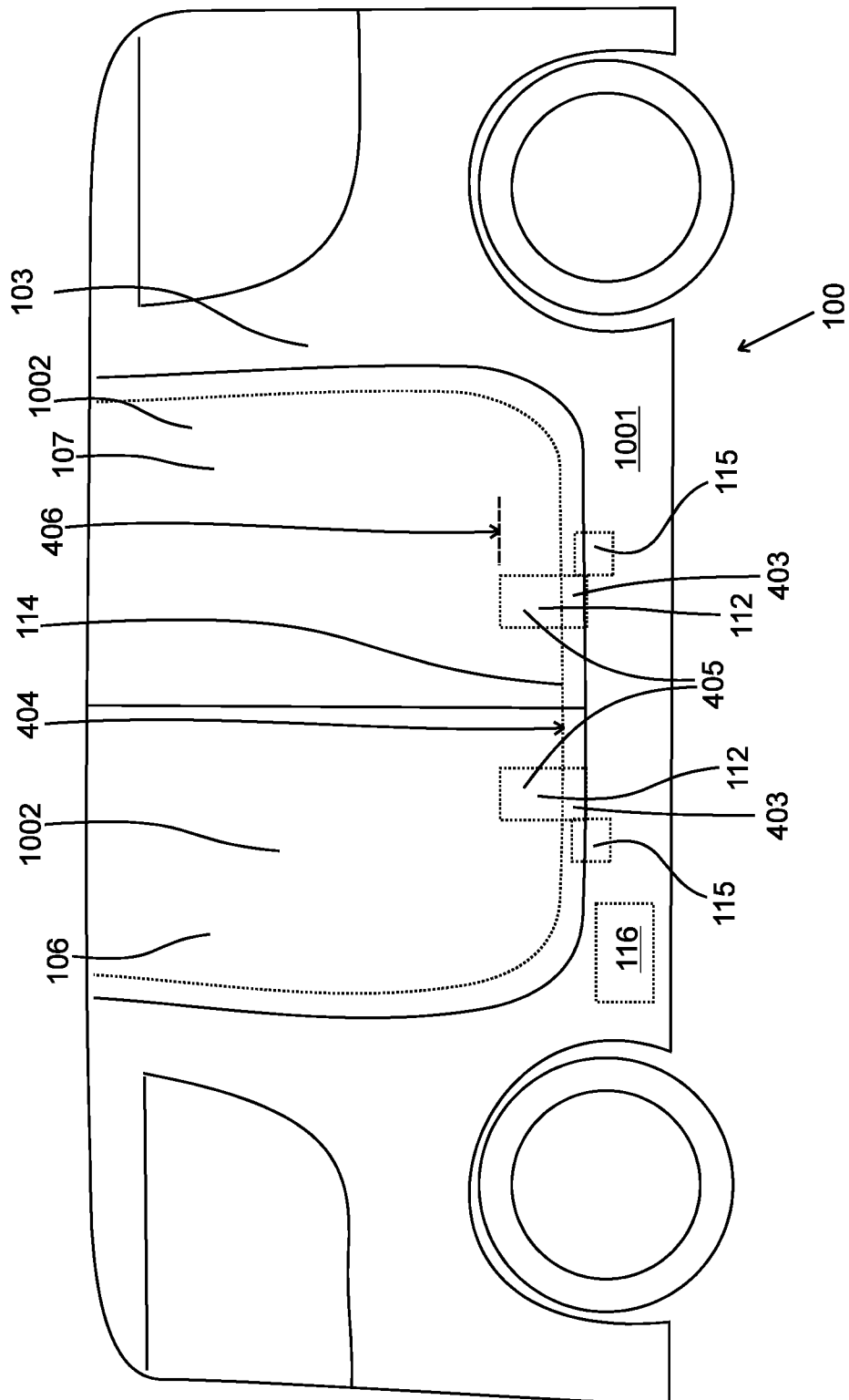


Fig. 11

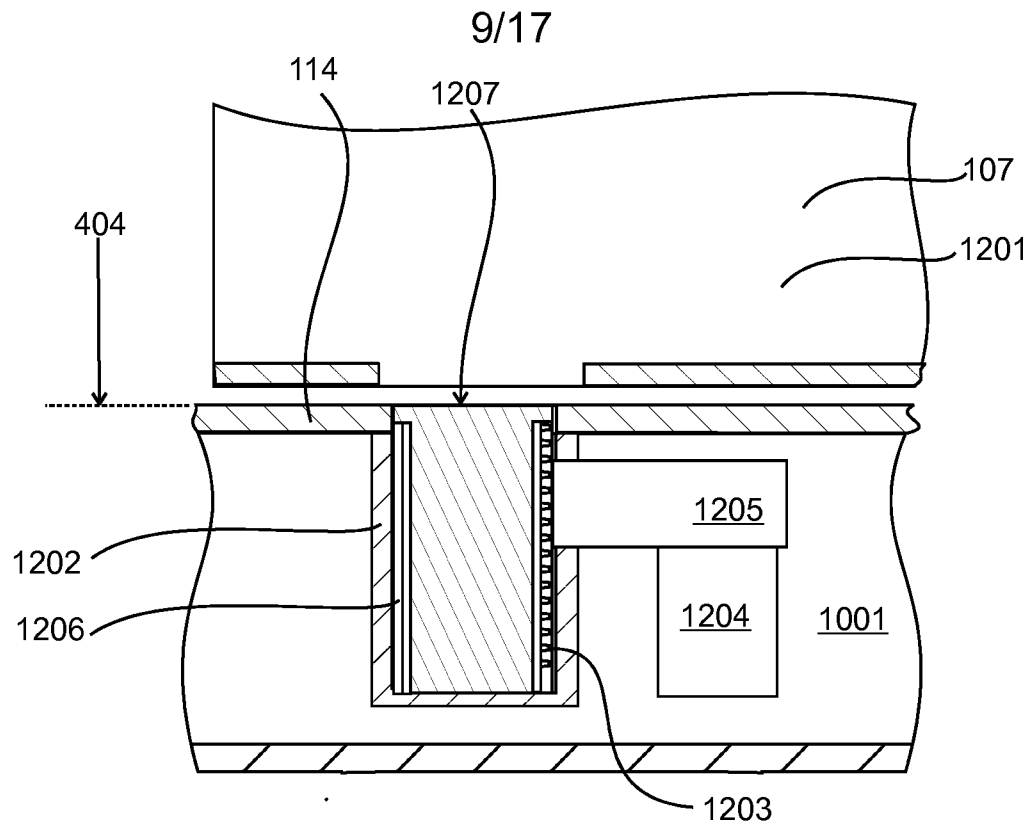


Fig. 12

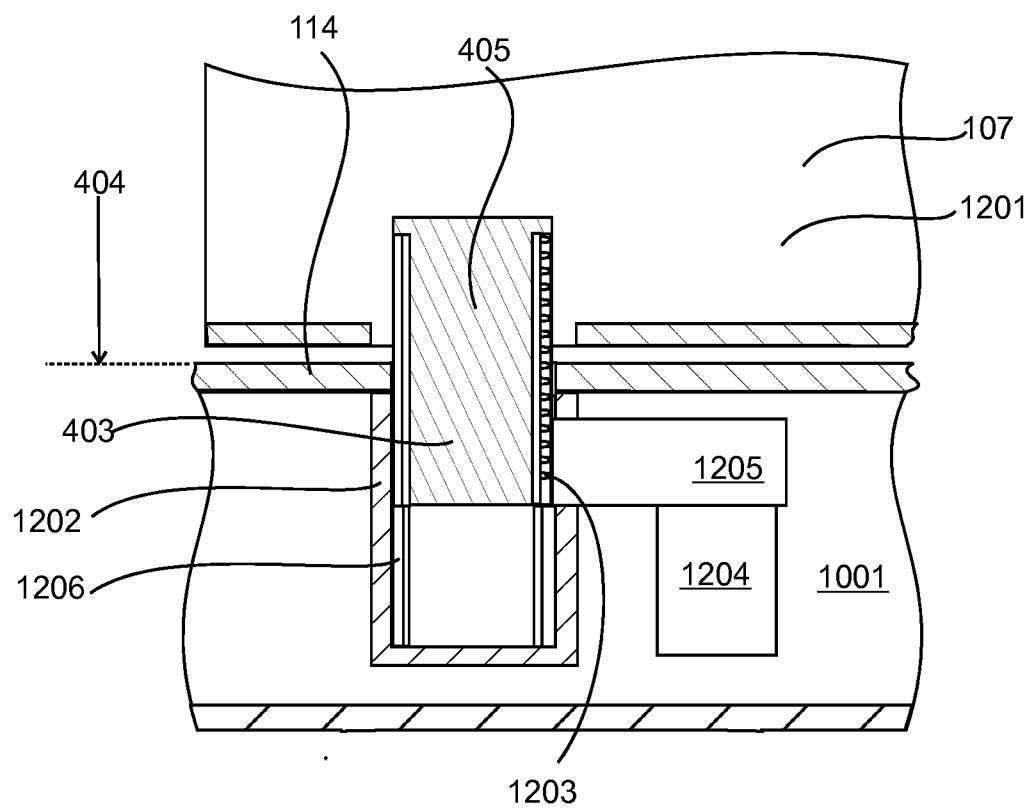


Fig. 13

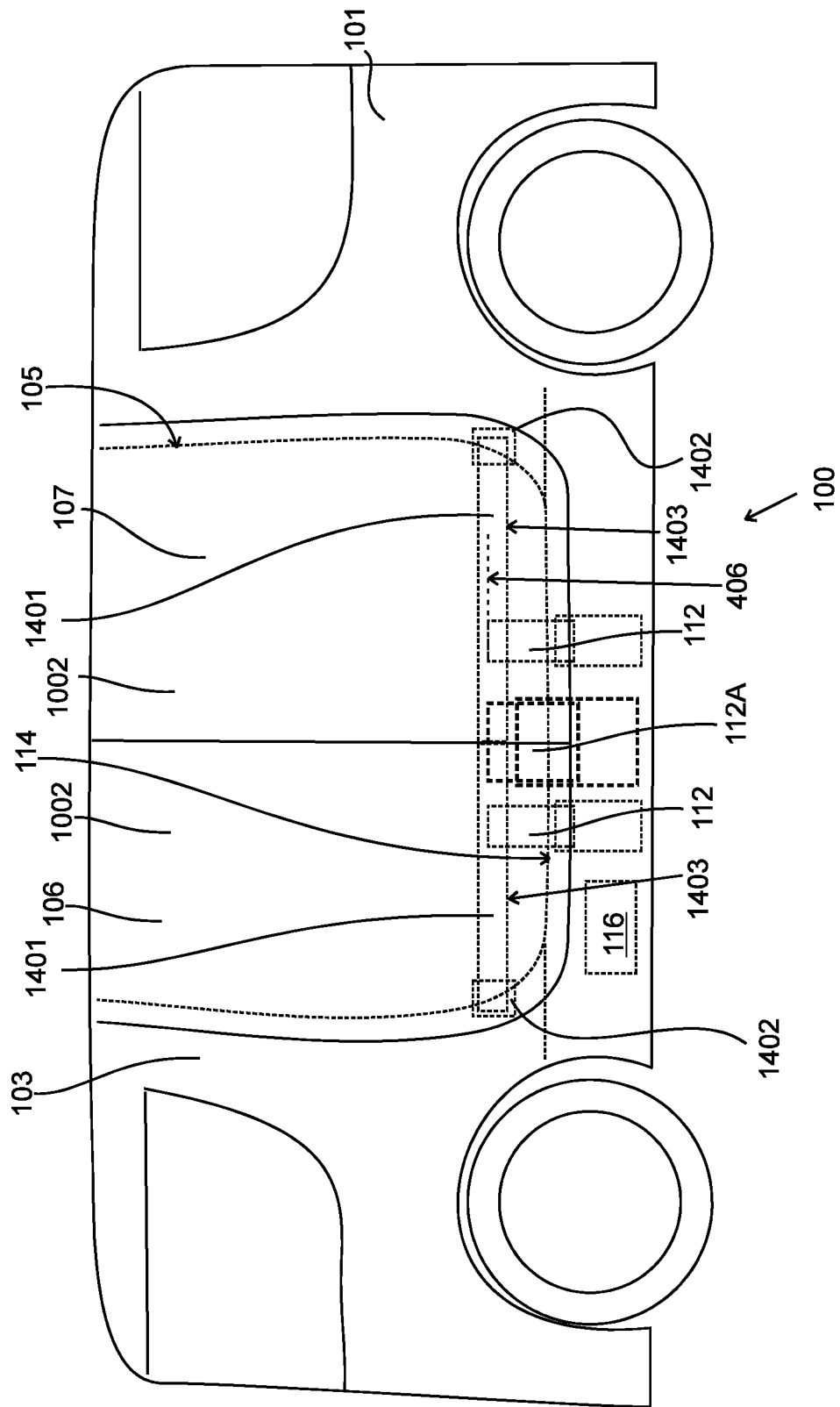


Fig. 14

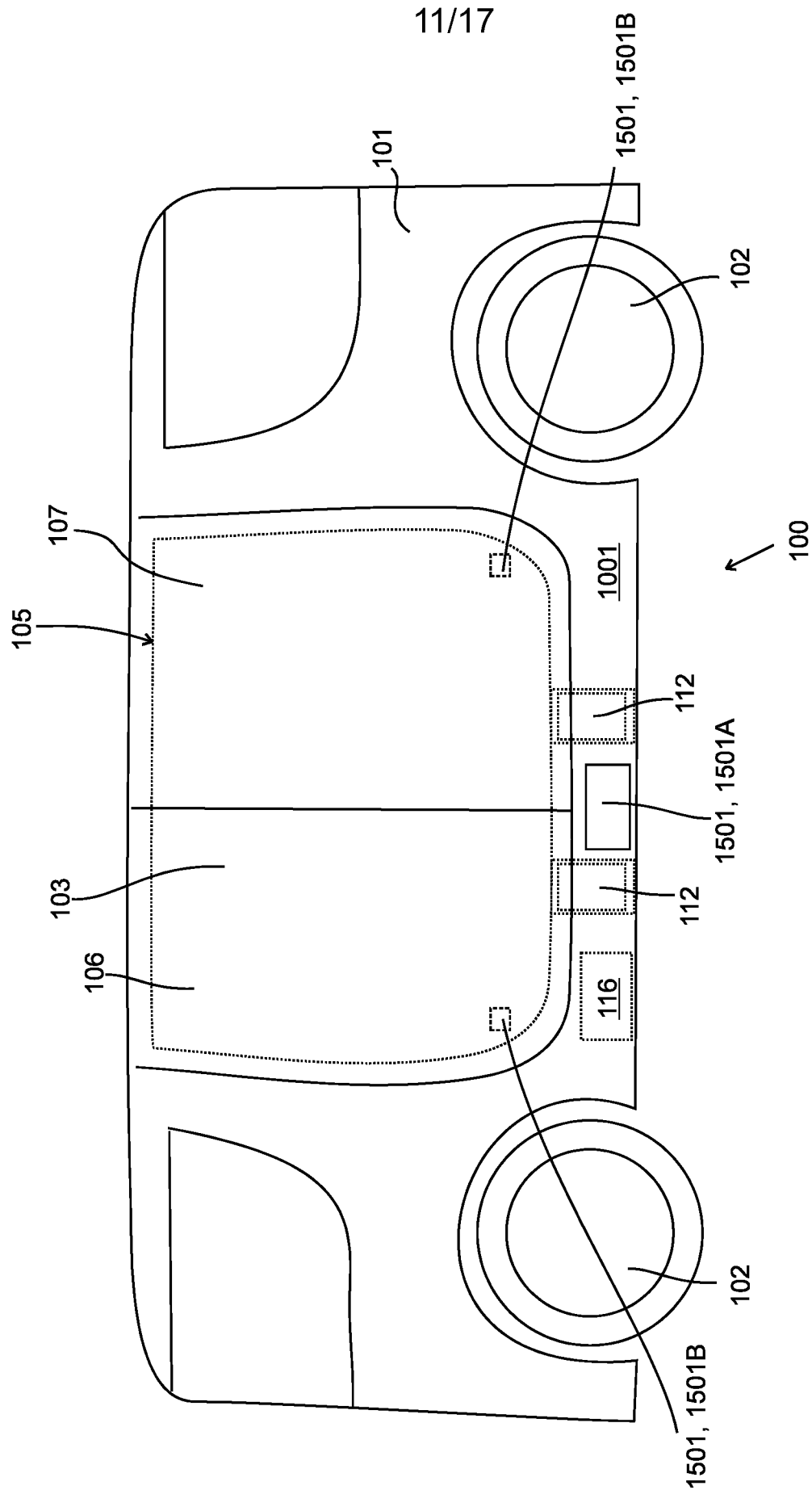


Fig. 15

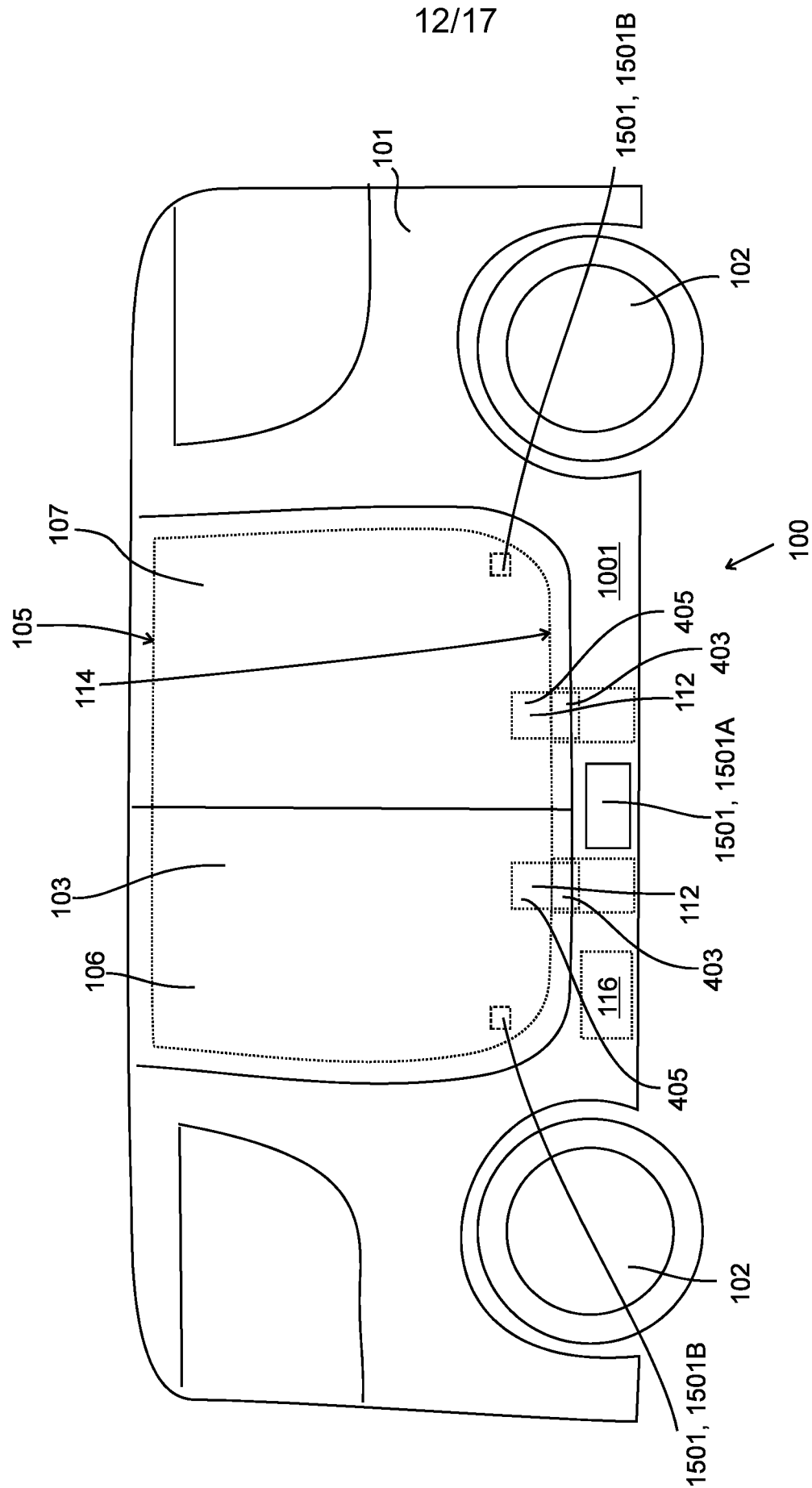


Fig. 16

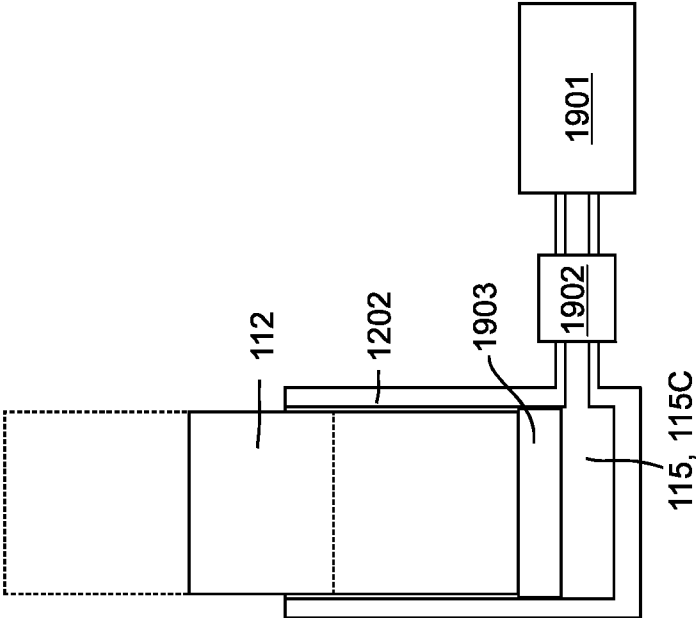


Fig. 17

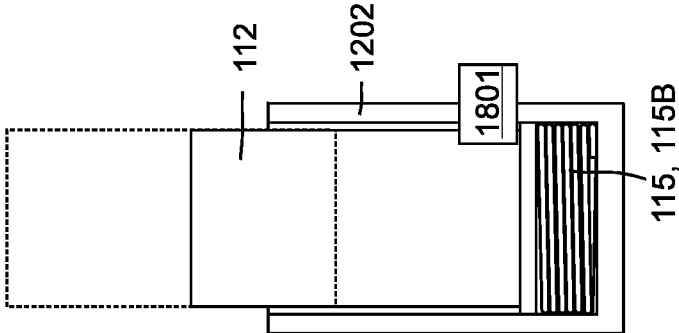


Fig. 18

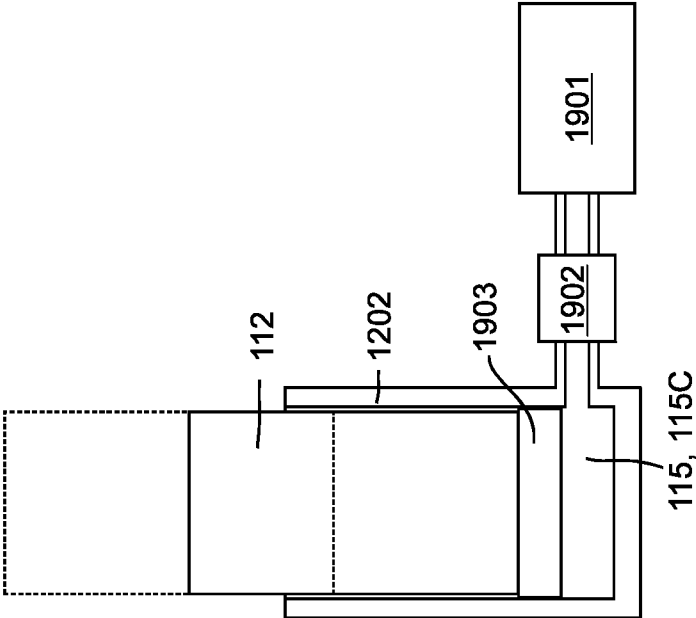


Fig. 19

14/17

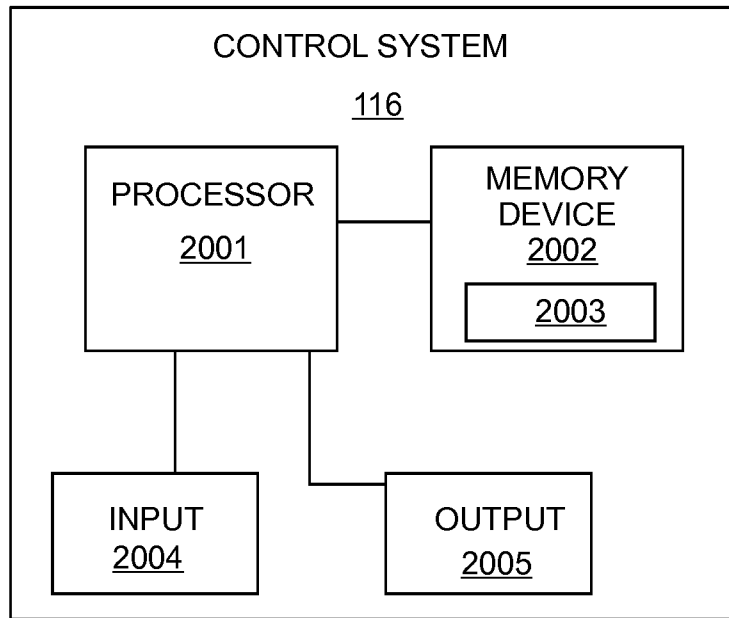


Fig. 20

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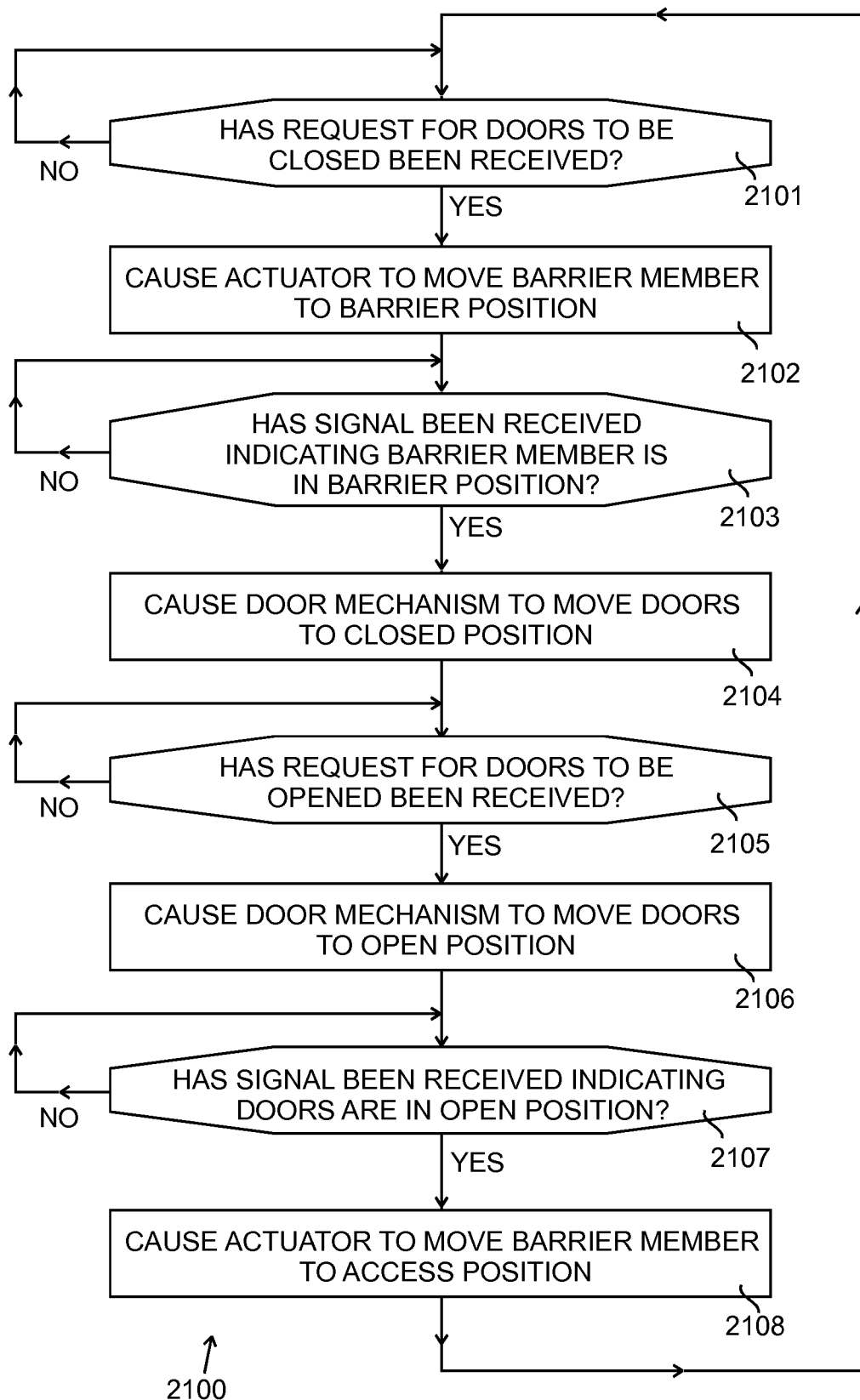


Fig. 21

16/17

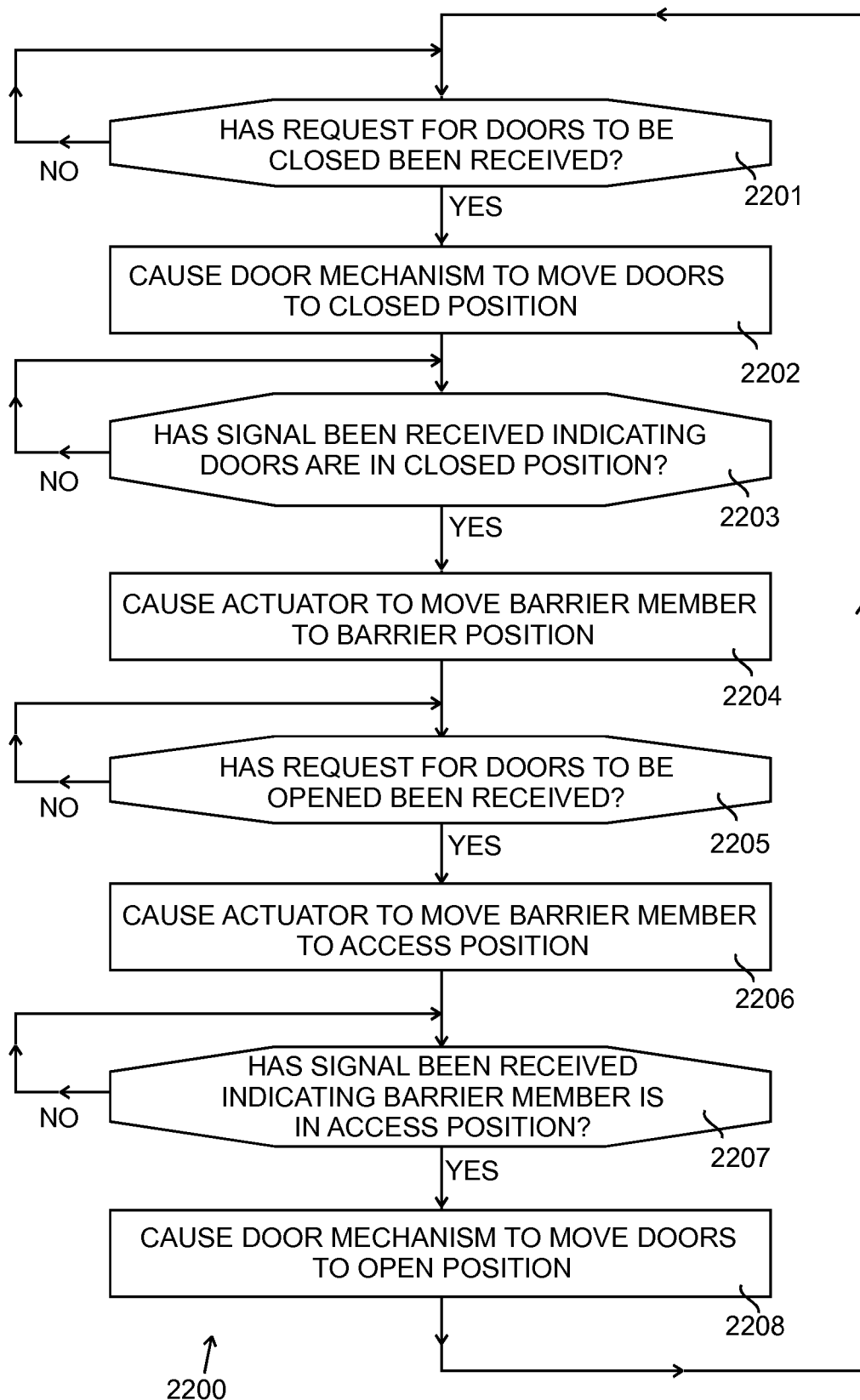


Fig. 22

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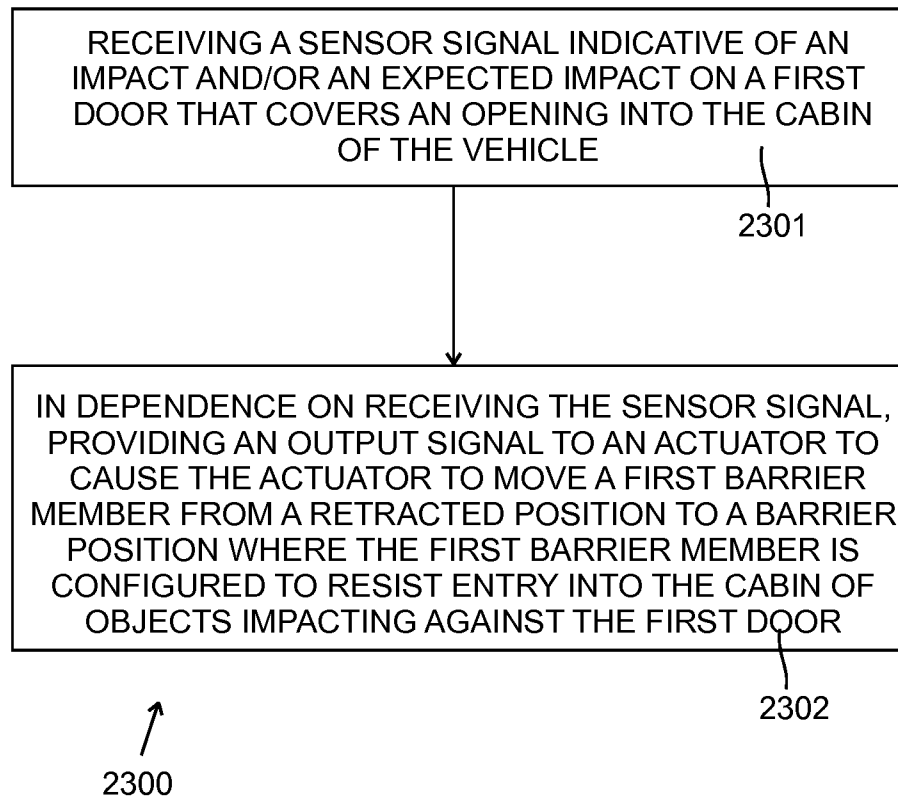


Fig. 23

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/078315

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60J5/04 B60J5/06
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 B60R

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.
X	US 2018/265027 A1 (NUSIER SAIED [US] ET AL) 20 September 2018 (2018-09-20)	1-4,6,8, 9,13-17, 19-22,24 18,23
A	paragraph [0047] - paragraph [0049] figures 1-5,10-14 paragraph [0060] - paragraph [0068] -----	
X	JP H11 48887 A (MITSUBISHI MOTORS CORP) 23 February 1999 (1999-02-23) figures 1-5 paragraph [0014] - paragraph [0022] -----	1,3,5,7, 12,21, 22,24,25
X	US 5 358 268 A (HAWKINS CLIVE A [GB]) 25 October 1994 (1994-10-25) the whole document ----- -/-	1-3,5, 7-12,21, 22,24,25



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"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

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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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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2019/078315

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2017 005759 A1 (DAIMLER AG [DE]) 14 December 2017 (2017-12-14) figures 1-5 paragraph [0023] - paragraph [0027] -----	1,2,4,6, 12-14, 16,17, 20-22,24
A	Anonymous: "Ford B-Max preview Expert Reviews", 23 February 2012 (2012-02-23), pages 1-9, XP055659128, Retrieved from the Internet: URL:https://www.expertreviews.co.uk/cars/5 1585/ford-b-max-preview [retrieved on 2020-01-17] figure 5 -----	17,19
A	GB 1 332 739 A (VEHICULES IND ET DEQUIPMENTS M) 3 October 1973 (1973-10-03) figure 6 -----	18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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