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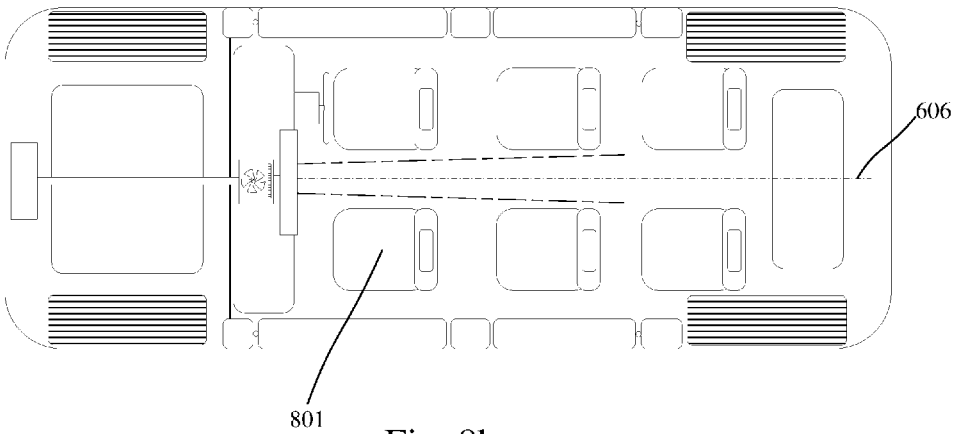


Fig. 8b

(57) **Abstract:** A vehicle comprising a passenger cabin, a row of seats comprising a left-hand seat and a right-hand seat located in the passenger cabin, and a vent assembly located forwardly of the seats, wherein the vent assembly comprises at least one outlet for discharging air into the passenger cabin, the vent assembly is adapted to direct a jet of air through the at least one outlet along a jet axis (606) that projects rearwards between the left-hand seat and the right-hand seat towards a region of the passenger cabin located rearwardly of the seats.

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VEHICLE VENT ASSEMBLY

Field of the Invention

The present invention relates to a vehicle comprising a vent assembly for discharging air into a passenger cabin of the vehicle.

Background of the Invention

Vehicles, such as passenger cars, usually include a ventilation system for supplying heated or cooled air to the passenger cabin of a vehicle to improve occupant comfort. Typically such ventilation systems include a fan unit located at a front of the passenger cabin behind an instrument panel, which draws air in from outside the vehicle over heating and cooling elements and discharges the airflow through vents located in the instrument panel into the passenger cabin. It is known also to provide additional vents for the fan unit in remote regions of the cabin, for example, in the vicinity of the second row of seating. These additional vents may advantageously provide increased airflow to the second row seating region, thereby facilitating more effective heating or cooling of the second row passengers.

Published United States patent 4,783,115 shows a passenger car fitted with vents in the B-pillars for directing air towards the second row passengers. In US 4,783,115 the B-pillar vents (29, 30) are supplied with air from a fan unit located at the front of the passenger cabin behind the instrument panel (20) by ducts (26) which extend through the front doors (10) of the vehicle. The ducts disadvantageously occupy space within the doors and add mass and complexity to the ventilation system assembly. Furthermore, the flow of air through the ducts is interrupted when the doors are opened thereby disadvantageously disrupting the supply of air to the B-pillar vents.

Summary of the Invention

According to an aspect of the present invention, there is provided a vehicle comprising a passenger cabin, a row of seats comprising a left-hand seat and a right-hand seat located in the passenger cabin, and a vent assembly located forwardly of the seats comprising at least one outlet for discharging air into the passenger cabin, wherein the vent assembly is

adapted to direct a jet of air through the outlet along a jet axis that projects rearwards between the left-hand seat and the right-hand seat towards a region of the passenger cabin located rearwardly of the seats.

The vent assembly is thus located forwardly of the seats but is used to provide ventilation to a region of the passenger cabin located behind the seats. By way of example, the row of seats could form a front row of seating in a vehicle, a second row of seating could be located in the passenger cabin rearwardly of the front row of seating, and the vent assembly could direct the jet of air beyond the first row of seating towards the second row of seating to thereby facilitate improved ventilation of the occupants of the second row seats.

Because the vent assembly is located forwardly of the seats the task of ducting airflow from a front end of the vehicle to the vent assembly is simplified. In particular, locating the vent assembly forwardly of the seats obviates the need to install ducts within the vehicle extending past the seats for ducting airflow from a front end of the vehicle to the vent assembly. As a result packaging of the vent assembly and associated ducts is simplified.

Moreover, because the vent assembly directs the jet of air between the seats, rather than for example directly at the seats, the degree of buffeting of occupants of the seats by the jet of air may be acceptably low. Consequently, ventilation of the rearward region of the cabin may be achieved by the forwardly located vent assembly without excessively discomforting occupants of the seats.

The jet axis along which the vent assembly directs the jet of air may be fixed. That is to say, the configuration of the vent assembly cannot be readily altered by a user of the vehicle to direct the jet of air into the cabin in an alternative direction. Consequently, the vent assembly cannot be reconfigured by a user of the vehicle to direct the jet of air into the passenger cabin in an alternative direction. As a result, the risk of a user inadvertently redirecting the jet of air in a way which might negatively affect cabin occupant comfort,

for example, by adjustment of the vent assembly to direct a jet of air directly at a seat, is avoided. Thus, the risk of improper adjustment of the vent assembly negatively affecting passenger comfort is reduced.

The vent assembly may be adapted to shape the jet to have a height-width ratio at a position between the left-hand seat and the right-hand seat greater than 1:1, and preferably a ratio of at least 2:1.

The area of a gap between the left-hand seat and the right-hand seat may typically be greater in height than in width. Shaping the jet of air to have a height-width ratio greater than 1:1, i.e. to be greater in its height dimension that its width dimension, and more preferably a ratio of at least 2:1, may best utilise the area of the gap between the seats such that a maximal volume of airflow may be supplied to the rearward region of the cabin with minimal buffeting of occupants of the seats.

The vent assembly may be adapted to shape the jet to have a width at a position between the left-hand seat and the right-hand seat that is at least 80% of the width of a gap between the left-hand seat and the right-hand seat. Shaping the jet of air to have a width between the seats that is at least 80% of the width of a gap between the seats may best utilise the area of the gap between the seats such that a maximal volume of airflow may be supplied to the rearward region of the cabin.

The vent assembly may be adapted to shape the jet to have a width at a position between the left-hand seat and the right-hand seat that is no greater than 120% of the width of a gap between the left-hand seat and the right-hand seat. Shaping the jet of air to have a width between the seats that is no greater than 120% of the width of a gap between the seats may reduce the degree of collision of the jet of air with the seats and the occupants thereof and so reduce buffeting of the occupants by the jet of air.

The outlet may be located directly forward of a gap between the left-hand seat and the right-hand seat. Consequently, the jet of air may flow directly rearwardly between the

seats, thereby minimising the distance travelled by the jet prior to passing between the seats and so minimising the degree of diffusion of the jet. As a result, buffeting of the occupants of the seats by the jet of air may be further reduced.

The jet axis may project parallel to a longitudinal centreline of the passenger cabin. Consequently lateral movement of air within the cabin caused by the jet of air may be reduced, so reducing buffeting of cabin occupants. The jet of air may even project along the longitudinal centreline. Consequently the movements of air generated by the jet of air may be symmetric about the longitudinal centreline. As a result excessive buffeting of occupants seated to one or the other side of the longitudinal centreline may be reduced.

The jet axis may project at an angle relative to the horizontal plane of no more than 30 degrees, and preferably of no more than 10 degrees. By orienting the jet axis at a relatively shallow angle to the horizontal plane upward or downward movement of air in the cabin may be reduced, which may thereby further reduce buffeting of the occupants of the cabin.

The jet axis may project between the left-hand seat and the right-hand seat at a height no greater than 50 centimetre, or preferably no greater than 40 centimetre, or more preferably no greater than 30 centimetre, or even no greater than 20 centimetre, higher than a centre-point on the upper surface of a base cushion of the left-hand seat or the right-seat when that seat is set in its lowermost adjustment position. It is advantageous that the jet of air passes between the seats at a height below the upper torso, neck or head of passengers seated in the seats as the upper regions of the body of the seated passengers may be more sensitive to buffeting by the jet of air than the lower regions of the body. The seat in its lowermost position of adjustment, i.e. set to the lowest height of any range of positions through which the seat is adapted to be adjusted by a vehicle user in normal use of the vehicle, represents a worst case scenario in this respect, inasmuch that with the seat lower the seated occupants upper body regions may be expected to be correspondingly at a lower height. Consequently, by directing the jet of air at the specified heights, the jet of air may be expected to pass between the seats at a height corresponding to the height of

lower body regions of occupants seated in the seats, for example, at the height of the occupants' abdomen, and the degree of buffeting by the jet of air of the upper body regions occupants seated in the seats may be further reduced.

The vehicle may comprise a second row of seats located in the passenger cabin rearwardly of the row of seats comprising a rear left-hand seat and a rear right-hand seat, and the jet axis may project between the rear left-hand seat and the rear right-hand seat. The vent assembly may thus be used to direct air towards the second row of seats to provide improved ventilation to the occupants of the second row seats.

The vent assembly may be located in an instrument panel of the vehicle. Consequently ducts suppling airflow to the vent assembly may conveniently be obscured from the view of occupants of the passenger cabin by the instrument panel.

The at least one outlet may form an elongate slit extending transversely of the passenger cabin. An outlet in the form of an elongate slit may best utilise an area available for the outlet to allow maximal airflow through the outlet into the cabin.

The vehicle may further comprise an electric fan for supplying air to the vent assembly.

The vent assembly may be adapted to direct a second jet of air through the at least one outlet along a second jet axis projecting rearwardly and upwardly over the left-hand seat or the right-hand seat towards a region of the passenger cabin located rearwardly of the seat.

The second jet of air may thus provide further increased airflow to the rearward region of the cabin so improving ventilation of that region. Because the vent assembly directs the jet of air upwardly and over the seat, rather than for example directly at the seat, the degree of buffeting of occupants of the seat by the second jet of air may be acceptably low. Consequently, improved ventilation of the rearward region of the cabin may be

achieved by the forwardly located vent assembly without excessively discomforting an occupant of the seat.

The second jet axis may be fixed. Consequently, the vent assembly cannot be reconfigured by a user of the vehicle to direct the second jet of air into the passenger cabin in an alternative direction. As a result, the risk of a user inadvertently redirecting the second jet of air in a way which might negatively affect cabin occupant comfort, for example, by adjustment of the vent assembly to direct the second jet of air directly at a seat, is avoided. Thus, the risk of improper adjustment of the vent assembly negatively affecting passenger comfort is reduced.

The vent assembly may be adapted to shape the second jet to have a width-height ratio at a position above the seat greater than 1:1, and more preferably a ratio of at least 2:1.

The area of a gap above an upper extent of the seat may typically be greater in width than in height. Shaping the second jet of air to have a width-height ratio greater than 1:1, i.e. to be greater in its width dimension that its height dimension, and more preferably a ratio of at least 2:1, may best utilise the area of the gap above the seat such that a maximal volume of airflow may be supplied to the rearward region of the cabin with minimal buffeting of occupant of the seat.

The vehicle may comprise a roof over the passenger cabin.

The vent assembly may be adapted to shape the second jet to have a height at a position above the seat that is at least 80% of the height of a gap between the seat and the roof when the seat is set in an uppermost position of adjustment. Shaping the jet of air to have a height at a position above the seats that is at least 80% of the height of a minimum gap between an upper extent of the seat and the roof may best utilise the area of the gap such that a maximal volume of airflow may be supplied to the rearward region of the cabin.

The vent assembly may be adapted to shape the second jet to have a height at a position above the seat that is no greater than 120% of the height of a gap between the seat and

the roof when the seat is set in an uppermost position of adjustment. Shaping the jet of air to have a height above the seat that is no greater than 120% of the height of a minimum gap between an upper extent of the seat and the roof may reduce the degree of collision of the jet of air with the seat and the occupant thereof and so reduce buffeting of the occupant by the jet of air.

The second jet axis may project at an angle relative to the horizontal plane of at least 45 degrees, but preferably of less than 80 degrees. By directing the second jet of air at an angle of at least 45 degrees it can be expected that a majority of air of the jet will be directed over the top of the seat rather than directly at the seat. Consequently, the degree of impact of the jet of air with occupant of the seat may be minimised. Maintaining the angle of the second jet below 80 degrees relative to the horizontal plane avoids the jet of air colliding with the roof at too steep an angle of incidence. Consequently, attachment of the jet of air to the roof may be improved. As a result, a greater volume of airflow may be directed over the seat without excessively buffeting the occupant of the seat.

The second jet axis may intersect the roof of the vehicle at a position above the seat when the seat is set in a forward-most position of adjustment.

The seat in its forward-most position of adjustment, i.e. set to the most forward position of any range of positions through which the seat is adapted to be adjusted by a vehicle passenger in normal use of the vehicle, represents a worst case scenario in this respect, inasmuch that with the seat moved forward an occupant seated in the seat is closer to the outlet and so the likelihood of the jet of air impacting the occupant if directed at a shallow angle is increased. Accordingly, by directing the second jet of air at a position above the seat in the forward-most position it can be assured that in the worst-case scenario excessive buffeting of the seat occupant will not be caused by the jet of air.

The at least one outlet may be a single outlet and the vent assembly may be adapted to discharge the jet through a first region of the outlet and the second jet through a second

region of the outlet. Discharging the jet and the further jet through different regions of a single outlet may simplify the construction of the vent assembly.

The first region of the outlet may be located directly in front of a mid-point between the left-hand seat and the right-hand seat and the second region of the outlet may be offset to a side of the first region.

Consequently, each jet of air may flow directly rearwardly between the seats and over one of the seats respectively, thereby minimising the distance travelled by the jets prior to passing between or over the seats and so minimising the degree of diffusion of the jets. As a result, buffeting of the occupants of the seats by the jet of air may be further reduced.

The vent assembly may be adapted to direct a third jet of air through the at least one outlet, the second jet may be directed rearwardly and upwardly over the left-hand seat towards a region of the passenger cabin located rearwardly of the left-hand seat, and the third jet may be directed along a third jet axis projecting rearwardly and upwardly over the right-hand seat towards a region of the passenger cabin located rearwardly of the right-hand seat.

The third jet axis may be fixed. Consequently, the vent assembly cannot be reconfigured by a user of the vehicle to direct the third jet of air into the passenger cabin in an alternative direction. As a result, the risk of a user inadvertently redirecting the third jet of air in a way which might negatively affect cabin occupant comfort, for example, by adjustment of the vent assembly to direct a jet of air directly at a seat, is avoided. Thus, the risk of improper adjustment of the vent assembly negatively affecting passenger comfort is reduced.

The third jet of air may thus provide further increased airflow to the rearward region of the cabin so improving ventilation of that region. Because the vent assembly directs the third jet of air upwardly and over the right-hand seat, rather than for example directly at the right-hand seat, the degree of buffeting of an occupant of the seat by the third jet of

air may be acceptably low. Consequently, improved ventilation of the rearward region of the cabin may be achieved by the forwardly located vent assembly without excessively discomforting an occupant of the right-hand seat.

The vent assembly may be adapted to shape the third jet to have a width-height ratio at a position above the right-hand seat-greater than 1:1, and more preferably a ratio of at least 2:1. The area of a gap above an upper extent of the right-hand seat may typically be greater in width than in height. Shaping the thrid jet of air to have a width-height ratio greater than 1:1, i.e. to be greater in its width dimension that its height dimension, and more preferably a ratio of at least 2:1, may best utilise the area of the gap above the seat such that a maximal volume of airflow may be supplied to the rearward region of the cabin with minimal buffeting of occupant of the seat.

The vent assembly may be adapted to shape the third jet to have a height at a position above the seat that is at least 80% of the height of a gap between the seat and the roof when the seat is set in an uppermost position of adjustment. Shaping the third jet of air to have a height at a position above the seat that is at least 80% of the height of a gap between an upper extent of the seat and the roof may best utilise the area of the gap such that a maximal volume of airflow may be supplied to the rearward region of the cabin.

The vent assembly may be adapted to shape the third jet to have a height at a position above the seat that is no greater than 120% of the height of a gap between the seat and the roof when the seat is set in an uppermost position of adjustment. Shaping the jet of air to have a height above the seat that is no greater than 120% of the height of a gap between an upper extent of the seat and the roof may reduce the degree of collision of the jet of air with the seat and the occupant thereof and so reduce buffeting of the occupant by the jet of air.

The third jet axis may project at an angle relative to the horizontal plane of at least 45 degrees, but preferably of less than 80 degrees. By directing the third jet of air at an angle of at least 45 degrees it can be expected that a majority of air of the jet will be directed over the top of the seat rather than directly at the seat. Consequently, the degree of impact

of the jet of air with occupant of the seat may be minimised. Maintaining the angle of the third jet below 80 degrees relative to the horizontal plane avoids the jet of air colliding with the roof at too steep an angle of incidence. Consequently, attachment of the jet of air to the roof may be improved. As a result, a greater volume of airflow may be directed over the seat without excessively buffeting the occupant of the seat.

The third jet axis may intersect the roof at a position above the right-hand seat when the seat is set in a forward most position of adjustment. The seat in its forward-most position of adjustment, i.e. set to the most forward position of any range of positions through which the seat is adapted to be adjusted by a vehicle passenger in normal use of the vehicle, represents a worst case scenario in this respect, inasmuch that with the seat moved forward an occupant seated in the seat is closer to the outlet and so the likelihood of the jet of air impacting the occupant if directed at a shallow angle is increased. Accordingly, by directing the second jet of air at a position above the seat in the forward-most position it can be assured that in the worst-case scenario excessive buffeting of the seat occupant will not be caused by the jet of air.

The vent assembly may be adapted to discharge the third jet through a third region of the single outlet, the second region of the outlet may be offset to a left-side of the first region and the third region may be offset to a right-side of the first region. Consequently, each jet of air may flow directly rearwardly between the seats and over one of the seats respectively, thereby minimising the distance travelled by the jets prior to passing between or over the seats and so minimising the degree of diffusion of the jets. As a result, buffeting of the occupants of the seats by the jet of air may be further reduced.

Brief Description of the Drawings

In order that the present invention may be more readily understood, embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic aerial view of a passenger car embodying the present invention, comprising a ventilation system for ventilating a passenger cabin of the car;

Figure 2 is a schematic side view of the passenger car;

Figure 3 is an illustrative view of an instrument panel of the passenger car showing a vent assembly of the ventilation system mounted thereto;

Figures 4a, 4b, 4c and 4d are front perspective, rear perspective, front elevation and rear elevation views of the vent assembly in isolation;

Figure 5 is a perspective cutaway view of the vent assembly in isolation;

Figures 6a, 6b and 6c are schematic end-sectional views taken along lines A, B and C as identified in Figure 4 respectively;

Figures 7a and 7b are schematic side-sectional and aerial views respectively of the car showing the path of a first airflow directed by the vent assembly along a first airflow axis into the passenger cabin;

Figures 8a and 8b are schematic side-sectional and aerial views respectively of the car showing the path of a second airflow directed by the vent assembly along a second airflow axis into the passenger cabin; and

Figures 9a and 9b are schematic side-sectional and aerial views respectively of the car showing the path of a third airflow directed by the vent assembly along a third airflow axis into the passenger cabin

Detailed Description of the Invention

A vehicle, in the form of a passenger car 101, according to an exemplary embodiment of the present invention is shown in Figures 1, 2 and 3.

Referring to the Figures, vehicle 101 comprises a body structure 102 defining internally a passenger cabin 103 for accommodating passengers, an instrument panel 104 carrying vehicle controls located at a front end of the passenger cabin 103, a plurality of seats 105 to 110 for seating passengers located in a seating region of the passenger cabin, and a ventilation system 112 for ventilating the passenger cabin to improve occupant comfort.

The body structure 103 comprises left and right side structures indicated generally at 113 and 114 respectively, and roof and floor structures 115, 116 respectively. The instrument panel 104 is installed at a front end of the passenger cabin 103 forwardly of the seating region 111 and extends transversely, i.e. in the width dimension, of the passenger cabin 103 between the left and right side structures 113, 114.

The plurality of seats 105 to 110 are arranged in three transverse rows of two seats. Thus, a first row of seating 117 is formed by seats 105 and 106, a second row of seating 118 by seats 107 and 108, and a third row of seating 119 by seats 109 and 110. Each of the rows of seats 119, 120 and 121 comprises a left-hand seat 105, 107, 109 respectively, positioned to a left-side of a longitudinal centreline, L, of the passenger cabin, and a right-hand seat 106, 108, 110 respectively, positioned to a right-side of the longitudinal centreline L, leaving a transverse gap 122, 123, 124 between the seats of each row pair. Each of the seats 105 to 110 is substantially identical and comprises a base cushion 125 and a back support 126 upstanding from the base cushion 125.

Ventilation system 112 comprises an air-handling unit 127, a vent assembly 128, and duct assemblies 129, 130.

Air-handling unit 127 comprises a housing 131 defining an inlet 132 and an outlet 133. The housing contains an electrically driven fan unit 134 and a heating element 135. The fan unit 134 is operable by conventional control circuitry to generate an airflow in through the inlet 132, over the heating element 135, and out through the outlet 133. In the example the heating element 135 is a conventional liquid-air heat exchanger through which a heated liquid is circulated by a remote source. The air-handling unit 127 is installed at a front end of the passenger cabin 103 forwardly of the instrument panel 104.

Vent assembly 128 comprises a body 136 defining an inlet 137 and an outlet 138. The vent assembly is arranged with the inlet 137 facing forwardly towards the air-handling unit 127 and the outlet 138 facing rearwardly towards the seating region of the passenger cabin 103. The outlet 138 is open into the passenger cabin 103 through the instrument panel 104. The outlet 138 is elongate and arranged with its long dimension extending transversely of the passenger cabin along the instrument panel 104, i.e. width-wise of the passenger cabin 103. The vent assembly 128 is mounted to the instrument panel 104 approximately centrally with respect to the transverse dimension, i.e. the width, of the passenger cabin 103. Thus, a width-wise centre of the outlet 138 is approximately aligned with the longitudinal centreline L of the passenger cabin 103, so as to be positioned directly in front of the gap 122 between the seats 105, 106 of the first row of seating 117.

Duct assemblies 129, 130 communicate the inlet 132 of the air-handling unit 127 with atmosphere surrounding the vehicle and the outlet 133 of the air-handling unit with the inlet 137 of the vent assembly 128 respectively. The ventilation system 112 is thus operable to draw air in from atmosphere, over the heating element 135, and discharge the air through the vent assembly 128 into the passenger cabin 103 towards the seated passengers. As will be described with reference to later figures, in the example the vent assembly 128 is adapted to direct a plurality of airflows beyond the first row of seats 105 towards the second row of seats 107 to improve ventilation for the occupants of the second row seating 118.

Referring collectively to Figures 4a to 4d, the body 136 of the vent assembly 128 is approximately cuboid in shape and comprises rear wall 401, upper and lower walls 402, 403, and end walls 404, 405.

Rear wall 401 extends vertically and defines inlet 137 therethrough. Upper and lower walls 402, 403 extend generally horizontally from rear wall 401 in a gradually convergent manner, such that the outlet 138 is defined between the opposed free edges 139, 140 of the upper and lower walls 402, 403 respectively. Side walls 404, 405 extend vertically generally orthogonally from rear wall 401 to cap left and right width-wise ends respectively of the body 136. The walls 401, 402, 403, 404 and 405 of the body 136 thus

define a closed volume between the inlet 137 and the outlet 138. In the example the walls of the body 136 are formed of a rigid plastic material.

The outlet 138 has a high width-height ratio thereby defining an elongate slit extending transversely of the body 136. In the example the outlet 138 has a width W of approximately 1000 millimetre, and a height H of approximately 30 millimetre that is substantially uniform with respect to the width of the body 136. P

Referring next collectively to Figure 5 and to Figures 6a, 6b and 6c, the body 136 of the vent assembly 128 defines internally a cavity 501 communicating the inlet 137 and the outlet 138, and comprises a flow divider 502 located within the cavity 501 in the path of air flowing therethrough between the inlet 137 and the outlet 138.

A first stage of the cavity 501, located immediately downstream of the inlet 137, defines a plenum 601 extending the full width of the body 136 between the end walls 404, 405. The inlet 137 is open to the plenum 601 such that air admitted through the inlet 137 enters the plenum 601.

The flow divider 502 is located in a second stage of the cavity 501 downstream of the plenum 601. Flow divider 502 comprises a horizontal wall portion 503 and a bulbous end portion 504. The wall portion 503 extends in a horizontal plane at approximately half the height of the cavity 501 from an upstream end closest the plenum 601 rearwardly to a downstream end joined to the bulbous portion 504. The bulbous portion 504 extends continuously from the downstream end of the wall portion 503 further towards the outlet 138 and upwardly and downwardly from the horizontal plane of the wall portion 503. The bulbous portion 504 has a width-wise cross-sectional form that is generally tear-drop shaped. The wall 503 and bulbous portion 504 of the flow divider 502 extend the full width of the cavity 501 between the end walls 404, 405 of the body 136 with a substantially uniform width-wise cross-sectional form.

The flow divider 502 interrupts the flow of air through the cavity 501 between the inlet 137 and the outlet 138, in the sense that air flowing through the cavity 501 encounters the

flow divider 502. An upper passage 602 is defined between an upper surface of the flow divider 502 and a lower surface of the upper wall 402 and a lower passage 603 is defined between a lower surface of the flow divider 502 and an upper surface of the lower wall 403. Each of the passages 602, 603 is open to and receives air from the plenum 601, and extends towards the outlet 138. The flow divider 502 extends rearwardly in the cavity 501 to a distance just short of the outlet 138, such that a third stage 604 is defined immediately prior to the outlet 138 where the upper and lower passages 602, 603 meet. Consequently airflows conveyed by each of the upper and lower passages 602, 603 are combined in the third stage 604 for discharge through the outlet 138 as a single jet of air. Accordingly, the characteristics of the resultant jet of air, for example, the flow rate and direction of flow, are products of the characteristics of the constituent airflows conveyed by the upper and lower passages 602, 603.

The flow divider 502 further comprises left and right wall structures 505, 506 respectively, each extending upwardly from the upper surface of the flow divider and joining to the lower surface of the upper wall 402 of the body 136. The left and right wall structures 505, 506 act to occlude left and right width-wise regions of the upper passage 602 of the body 136 such that air flowing through the inlet 137 towards the outlet 138 is prevented from flowing through left and right width-wise sections respectively of the upper passage 602. In the example the flow divider 502 is formed of the same rigid plastics material as the walls 401, 402, 403, 404, 405 of the body 136.

It can thus be seen in the Figures that the vent assembly 128 comprises three distinct width-wise sections. A left-hand section 507, as shown in cross section in Figure 5a, is provided by a left-hand third of the width of the vent assembly 128, a middle section 508, as shown in cross-section in Figure 5b is provided by a middle third of the width of the vent assembly 128, and a right-hand section 509, as shown in cross section in Figure 5c, is provided by a right-hand third of the width of the vent assembly 128. As will be understood, the left-hand section 507 of the vent assembly 128 is characterised by the associated region of the upper passage 602 being occluded by the wall 505, and the right-hand region 509 by the associated region of the upper passage 602 being occluded by the wall 506. In contrast, as can be seen best in Figure 5b, the region of the upper passage

602 associated with the middle region 508 of the vent assembly is open to permit airflow therethrough between the inlet 137 and the outlet 138 of the body 136. The lower passage 603 is open, that is to say unobstructed, to permit airflow therethrough across its full width, i.e. for each of the first, second and third sections 507, 508 and 509 of the vent assembly 128.

The outlet 138 extends continuously along the length of the body 136. The outlet 138 is thus common to each of the left-hand, middle, and right-hand sections 507, 508, 509 of the vent assembly 128, in the sense that the airflows conveyed through each of the sections 507, 508, 509 are discharged through the common outlet 138. The outlet 138 can nevertheless be seen to be notionally divided into a left-hand region 138a that receives air predominately through the left-hand section 507 of the vent assembly 128, a middle region 138b that receives air predominately through the middle section 508 of the vent assembly 128, and a right-hand region 138c that receives air predominately through the right-hand section 509 of the vent assembly 128. In the example, each of the three regions 138a, 138b, 138c of the outlet 138 are substantially equal in width, that is to say, each extends approximately one-third the width of the body 136.

Referring firstly to the left-hand section 507 of the vent assembly 128 as depicted in Figure 6a, air admitted though the inlet 137 is received in the plenum 601 of the body 136. Across the width of the left-hand section 507, air from the plenum 601 is subsequently able to flow through the open lower passage 603 towards the outlet 138a, but airflow through the corresponding section of the upper passage 602 is prevented by the wall 505. Air thus flows through the lower passage 603 between an underside of the flow divider 502 and an upper surface of the lower wall 603. Just prior to the outlet 138 the direction of the airflow through the lower passage 603 is turned upwardly by the bulbous portion 504 and the lower wall 403. The airflow from the lower passage 603 is subsequently discharged, via the third stage 604, through the left-hand region 138a of the outlet 138 as a first jet of air directed along a first jet axis 605 that is upwardly inclined by an angle relative to the horizontal plane H of approximately 60 degrees.

Referring secondly to the middle section 508 of the vent assembly 128 depicted in Figure 6b, air from the plenum 601 of the body 136 is permitted to flow through each of the open lower passage 602 and the open upper passage 603 towards the outlet 138b. Air flowing through the lower passage 603 of the middle section 508 thus flows between an underside of the flow divider 502 and an upper surface of the lower wall 403, and arrives at the third stage 604 flowing in an upward direction. Conversely, air flowing through the upper passage 602 flows between an upper side of the flow divider 502 and an underside of the upper wall 402, and arrives at the third stage 604 flowing in a downward direction. The angles of inclination of the airflow from the lower passage 603 and from the upper passage 602 are convergent such that the axes intersect and the airflows collide in the third stage 604 immediately prior to the outlet 138b. On collision the two airflows coalesce to form a single airflow that is discharged as a second jet of air through the middle region 138b of the outlet along a second jet axis 606 that extends approximately parallel to the horizontal plane H.

Referring finally to Figure 6c, it can be seen that, similarly to the left-hand section 507, the upper passage 602 of the right-hand section 509 of the vent assembly 128 is occluded by the wall 506. Consequently flow occurs only through the lower passage 603. Air thus flows from the plenum 601 through the lower passage 603 between the upper surface of the lower wall 403 and the underside of the flow divider 502. The airflow through the lower passage 603 is similarly turned upwardly immediately prior to the outlet 138c and discharged through the right-hand region 138c of the outlet as a third jet of air directed along a third jet axis 607 that is upwardly inclined relative to the horizontal plane H by an angle of approximately 60 degrees.

In summary therefore, the vent assembly 128 is adapted to discharge through the outlet 138 three distinct jets of air rearwardly into the passenger cabin 103. The first jet is directed through the left-hand region 138a of the outlet in an upward direction, i.e. a direction upwardly inclined from the horizontal plane H, a second jet is directed through the middle region 138b of the outlet in a generally horizontal direction, i.e. a direction

approximately parallel to the horizontal plane H, and a third jet is directed through the right-hand region 138c of the outlet in another upwardly inclined direction.

Because the directions, dimensions, and relative flow rates of the constituent airflows through the upper and lower passages 602, 603 are fixed, both the direction of each jet axis and the shape of each jet of air is correspondingly fixed, i.e. not readily altered by a user in the ordinary course of use of the vehicle. Consequently, the directions of the jets discharged by the vent assembly 128 cannot be altered by a user in the course of ordinary use in a way which might negatively affect cabin occupant comfort, for example, by adjustment of the vent assembly to direct a jet of air directly at a seat. As a result the risk of improper adjustment of the vent assembly negatively affecting passenger comfort is reduced.

Referring next to Figures 7a, 7b, 8a, 8b, 9a and 9b, as previously described, the vent assembly is located in the instrument panel 104 approximately centrally with respect to the width of the passenger cabin 103. Accordingly, as indicated in the Figures, the middle section 508 of the vent assembly 128 and correspondingly the middle region 138b of the outlet is positioned directly in front of the gap 122 between seats 105 and 106 of the first row 117, aligned with, that is to say intersected by, the longitudinal centreline L of the cabin 103. The left-hand section 507 of the vent assembly 128 and correspondingly the left-hand region 138a of the outlet is offset to a left-hand side of the centreline L generally in front of the left-hand seat 105, and the right-hand section 509 of the vent assembly 128 and correspondingly the right-hand region 138c of the outlet is offset to a right-hand side of the centreline L generally in front of the right-hand seat 106.

Referring firstly in particular to Figures 7a and 7b, as previously described, the vent assembly 128 is adapted to discharge a first jet of air through the left-hand region 138a of the outlet along the first jet axis 605.

The first jet axis 605 projects from the outlet 138a, rearwardly of the passenger cabin and upwardly at an upward angle of inclination to the horizontal plane of approximately 60

degrees, and leftwards at a leftward angle to the longitudinal centreline L of approximately 20 degrees, over the left-hand seat 105. Consequently the first jet of air is directed over the seat 105 towards the seat 107 of the second row seating 118 to provide improved ventilation to an occupant of the seat 107.

Directed in this way the first jet of air thus collides with the roof 115, partially attaches to the roof underside surface, and flows therealong over the top of the left-hand seat 105 of the first row 117, i.e. through the gap 701 between the upper end 702 of the back support 126 and the underside of the roof 115, towards the region of the passenger cabin located rearwardly of the seat 105, i.e. towards the left-hand seat 107 of the second row 118 and/or the left-hand seat 109 of the third row 119. Because the first jet of air is directed upwardly and over the first row seat 105, the occupant of the seat 105 is not excessively buffeted by the jet.

The upward angle of inclination of the first jet of air relative to the horizontal plane H should preferably be at least 45 degrees. By directing the first airflow at an angle of at least 45 degrees it can be expected that a majority of air of the first jet will be directed over the top of the seat 105 rather than directly at the seat, and so buffeting of the occupant of the seat 105 by the jet of air will be minimised.

It is desirable however that, whilst the angle relative to the horizontal plane of the first jet axis 605 is sufficiently steeply inclined as to avoid excessively buffeting the occupant of the seat 105, it is not too steeply inclined as to cause the jet of air to collide with the underside of the roof 115 at too great an angle of incidence. It has been found in this respect that at higher angles of incidence attachment of the airflow to the underside of the roof is reduced, which may result in turbulence at the point of collision of the jet of air with the roof and accordingly increased buffeting of the occupant of the first row seat 105, and/or a reduction in the volume of air successfully passing over the first row seat 105 towards the second row seating region.

Rather, it has been found to be generally desirable to minimise the angle of incidence of the jet axis to the plane of the roof. This is because, at relatively low angles of incidence the airflow, attachment of the jet of air to the roof underside is improved and the air flows more cleanly along the roof underside through the gap between the top of the seat back support and the underside of the roof. As a result, the cleaner airflow over the first row seat 105 reduces buffeting of the first row seat occupant, and moreover tends to increase the airflow delivered to the rearward target region. In the example, it has been found that a relatively high degree of attachment of the airflow to the roof underside can be achieved when the axis of the airflow projects at an angle relative to the horizontal plane H, i.e. to a plane that is a good proxy for the plane of the roof underside, that is less than 80 degrees, and preferably less than 70 degrees, and preferably not more than 65 degrees.

It will be appreciated therefore that selection of the angle of inclination of the first jet axis 605 to the horizontal plane requires a balance to be found between two apparently competing factors, that is minimising impact of the first jet of air with the occupant of the first row seat 105 and aiding passage of the airflow over the first row seat towards the rearward target region. In the example, an angle of inclination relative to the horizontal plane H of the first jet axis 605 in the range of 55 to 65 degrees has been found to provide a particularly good balance between those competing factors.

It will be understood by the skilled person however that the optimum angle of inclination of the first jet axis is a function of various factors, notably the height of the vent relative to the height of the gap between the upper end of the seat and the underside of the roof, and the distance in the length of the passenger cabin between the vent outlet and the seats, and that consequently the optimum angle of inclination of the jet axis will be expected to be different for different vehicle configurations. More generally however it has been found that an optimum balance between the above two factors is typically achieved where the jet axis is directed so as to intersect the roof of the vehicle at a position directly above the first row seat 105 when the seat is set in a forward-most position of adjustment. It has been observed that when the jet axis follows this projection the degree of buffeting of the

seat occupant can typically be guaranteed to remain acceptably, and the passage of air over the seat acceptably clean and complete, for any position of adjustment of the seat.

The vent assembly 128 is adapted to shape the first jet of air to have a generally rectangular cross-section with a width-height ratio greater than 1:1, for example 2:1, 3:1, 4:1, 5:1, or even greater. Shaping the jet to this form is preferred because it approximates to the shape of the area of the gap 701 between the top end 702 of the seat 105 and the underside of the roof 115, which gap is generally rectangular. As a result the jet of air may be expected to best utilise the area of the gap above the seat such that a maximal volume of air can be delivered to the target region of the cabin with minimal buffeting to the front seat occupant.

For optimum use of the area of the gap 701 above the seat 105 the first jet of air may preferably be shaped such that the airflow has a width-height ratio of at least 2:1, that is to say, such that the cross-sectional area of the jet of air above the seat is at least twice as wide as it is tall. In the example, the vent assembly is adapted to shape the first jet of air to have a width-height ratio of approximately 3:1, such that at a position above the left-hand seat 105 the airflow has a width dimension of approximately 60 centimetre and a height dimension of approximately 20 centimetre.

Referring secondly in particular to Figures 8a and 8b, as previously described, the vent assembly 128 is adapted to discharge a second jet of air through the middle region 138b of the outlet along the second jet axis 606.

The second jet axis 606 projects from the outlet 138b, rearwardly of the passenger cabin generally along the longitudinal centreline L of the passenger cabin, through the gap 122 between the left-hand seat 105 and the right-hand seat 106, towards the second row 118 of seating to thereby provide further ventilation to the second row seating occupants. The axis 606 extends approximately parallel to the horizontal plane H of the vehicle, i.e. generally horizontally from the outlet 138b.

In the example, the axis 606 of the second jet extends through the gap 122 between the seats 105, 106 at a height that is approximately 25 centimetres above a centre-point 801 of the upper surface of the base cushion 125 of the seat 105 when the seat is set in its lowermost adjustment position. It has been observed in this respect that by directing the axis of the jet below the specified height, for an occupant of average height, even with the seat set in its lowest position, the jet of air is directed at a height lower than the height of the neck and/or face area of the seated occupant. Consequently, buffeting of the neck and/or face of the occupant is reduced.

The vent assembly 128 is adapted to shape the second jet of air to also have a generally rectangular cross-section, with a height-width ratio greater than 1:1 at a position between the seats 105, 106, for example, height-width ratio of 2:1, 3:1, 4:1, 5:1, or even greater. Thus, unlike the first jet of air, the vent assembly 128 is adapted to shape the second jet of air to have a height greater than its width. Shaping the jet to this form is preferred because it approximately matches the area of the gap 122 between the seat 105 and the seat 106, bounded by the roof 115 and the floor 116, which gap is generally rectangular and greater in its height than in its width. As a result, the second jet of air may be expected to best utilise the area of the gap 122 to allow a maximal volume of air to be channelled through the gap with minimal buffeting of the occupants of the seats 105, 106.

For optimal use of the area of the gap 122 between the seats 105, 106 the second jet of air should ideally be shaped such that the airflow has a height-width ratio of at least 2:1, that is to say, such that the cross-sectional area of the jet of air at a position between the seats is at least twice as wide as it is tall. In the example, the vent assembly is adapted to shape the second of air to have a height-width ratio of approximately 3:1, such that at a position between the seats 105, 106 the second jet has a height dimension of approximately 60 centimetre and a width dimension of approximately 20 centimetre.

Referring finally in particular to Figures 9a and 9b, as previously described, the vent assembly is adapted to discharge a third jet of air through the right-hand region 138c of the outlet along the third jet axis 607.

Similarly to the first jet axis 605, the third jet axis 607 projects from the outlet 138c, rearwardly of the passenger cabin and upwardly at an upward angle of inclination to the horizontal plane. However, unlike the first jet axis 605, the third jet axis 607 deviates rightwards from the longitudinal centreline L by a rightward angle of approximately 20 degrees, such that the jet axis 607 is directed over the right-hand seat 106. Thus, the third jet of air is directed over the seat 106 towards the seat 108 of the second row seating 118 to provide improved ventilation to an occupant of the seat 108.

The third jet of air is directed, similarly to the first jet of air, at an angle to the horizontal plane H of approximately 60 degrees, such that the third jet axis 607 intersects the roof 115 at a position approximately above the seat 106 to thereby encourage passage of the third jet of air through the gap 901 between the top 902 of the seat 106 and the underside of the roof 115. Again, similarly to the first jet of air, the vent assembly 128 is adapted to shape the third jet of air to have a width-height ratio of approximately 3:1 above the seat 106, such that at a point immediately prior to collision with the roof the jet of air has a width dimension of approximately 60 centimetre and a height dimension of approximately 20 centimetre.

In the specific example of the invention described in detail herein the vent assembly is adapted for discharging three distinct jets of air into the passenger cabin, namely the first and third jets of air directed upwardly and over the left and right-hand seats 105, 106 respectively of the first row 117, and the second jet directed between the seats 105, 106. As described, this arrangement has been found to advantageously maximise the airflow delivered by the vent 128 to regions of the passenger cabin behind the front row of seats 117 whilst inflicting minimal buffeting on the occupants of the front row of seats.

It should be appreciated however that the vent assembly could alternatively be configured to discharge only a single jet of air, for example, a single jet of air through the gap between the seats 105, 106 of the first row 117, or a single jet of air upwardly and rearwardly over

one or more of the seats 105, 106, or indeed any multiple of jets if the vent assembly is sufficiently large in dimension.

References in this specification to height and width dimensions of the jets of air are to diameters of the jet of air, in vertical and horizontal planes respectively, taken between diametrically opposed points of a cross-section through the jet of air depicting points where the (time-averaged) velocity of the jet has reduced to 10% of the local maximum velocity.

Thus, referring for example to the first jet of air directed along the first jet axis 605, jet envelope line pairs A, B and C, D map the locus of points where the velocity of the jet has reduced to approximately 10% of the local maximum velocity. The height of the jet according to this measure is thus represented by the distance between the lines A-B, and the width of the jet by the distance between the lines C-D.

Defining the dimensions of the jets of air with reference to points where the velocity of the jet has reduced to 10% of the local maximum velocity is considered appropriate in the context of the invention because it may typically be expected that velocities less than 10% of the local maximum will unlikely be perceived by an occupant in the path of the airflow, or conversely would not be expected to cause discomfort to the occupant.

Various methods of evaluating the velocity field of a jet of air are known in the art, for example, using the background oriented schlieren (BOS) imaging technique. As is known, using the BOS technique, the density field of the jet of air may be computed based on the light deflection created during the passage of light through the understudy jet. The velocity field may subsequently be derived from the density field using known relationships and methodology. Alternative known field velocity measuring techniques include hot wire anemometry.

Further, the references in this specification to the "jet axis" is to an axis extending from the outlet of the vent assembly in the average direction in which the jet of air is discharged

from the outlet. Whilst it is to be appreciated that, due for example to buoyancy of the jet and the force of gravity acting on the jet, the direction of the jet of air will typically deviate from the jet axis as it travels through the cabin environment, the jet axis may nevertheless typically be expected to represent a good approximation of the path of the jet of air through the cabin.

The jet axis of a jet of air may be derived by inspection of the velocity field of the jet. The jet axis may conveniently be derived with reference to the jet centreline of the jet, the jet centreline representing the locus of points at which the (time-averaged) velocity if the jet is a local maximum, i.e. plotting the actual average direction of the jet of air as it travels an infinitesimally short distance from the outlet through the cabin environment. The jet axis may thus be taken as the tangent of the jet centreline at the outlet of the vent assembly. The jet centreline and thus the jet axis may be determined using the aforementioned BOS or hot wire anemometry techniques.

References in this specification to "left-hand" or "left" and "right-hand" or "right" are directional definitions from the perspective of an observer facing forwardly of the vehicle, as is the conventional nomenclature in the field of the invention. Similarly references to "forwardly" or "forward" and "rearwardly" or "rearward" are, as is conventional, definitions relative to the front and rear of the vehicle respectively.

Further, the references in this specification to jet axes of the vent assembly being "fixed" means that the configuration of the vent assembly cannot be readily altered by a user of the vehicle in the ordinary course of use of the vehicle to change the direction of the jet axes. Because the jet axes are fixed the vent assembly cannot be readily reconfigured by a user in the ordinary course of use to redirect the various jets of air in alternative directions.

Further, the references in this specification to lowermost, uppermost, rearward-most, or forward-most positions of adjustment of the seats are definitions of the base cushion of that seat as being set to a lowest, highest, most forwardly, or most rearwardly position

respectively of any range of positions through which the seat is adapted to be adjustable by a vehicle user in the normal course of use of the vehicle. In the case of a vehicle embodying the invention comprising a seat that is not adapted to be repositionable by a user in the ordinary course of use of the vehicle, a reference to a specific position of adjustment of that seat should be understood as a reference simply to the position of that seat.

Claims

1. A vehicle comprising a passenger cabin, a row of seats comprising a left-hand seat and a right-hand seat located in the passenger cabin, and a vent assembly located forwardly of the seats comprising at least one outlet for discharging air into the passenger cabin, wherein the vent assembly is adapted to direct a jet of air through the outlet along a jet axis that projects rearwards between the left-hand seat and the right-hand seat towards a region of the passenger cabin located rearwardly of the seats.

2. A vehicle as claimed in claim 1, wherein the jet axis is fixed.

3. A vehicle as claimed in claim 1 or claim 2, wherein the vent assembly is adapted to shape the jet to have a height-width ratio at a position between the left-hand seat and the right-hand seat greater than 1:1.

4. A vehicle as claimed in any one of the preceding claims, wherein the vent assembly is adapted to shape the jet to have a height-width ratio at a position between the left-hand seat and the right-hand seat of at least 2:1.

5. A vehicle as claimed in any one of the preceding claims, wherein the vent assembly is adapted to shape the jet to have a width at a position between the left-hand seat and the right-hand seat that is at least 80% of the width of a gap between the left-hand seat and the right-hand seat.

6. A vehicle as claimed in any one of the preceding claims wherein the vent assembly is adapted to shape the jet to have a width at a position between the left-hand seat and the right-hand seat that is no greater than 120% of the width of a gap between the left-hand seat and the right-hand seat.

7. A vehicle as claimed in any one of the preceding claims, wherein the outlet is located directly forward of a gap between the left-hand seat and the right-hand seat.

8. A vehicle as claimed in any one of the preceding claims, wherein the jet axis projects parallel to a longitudinal centreline of the passenger cabin.

9. A vehicle as claimed in any one of the preceding claims, wherein the jet axis projects along a longitudinal centreline of the passenger cabin.

10. A vehicle as claimed in any one of the preceding claims, wherein the jet axis projects at an angle relative to the horizontal plane of no more than 30 degrees.

11. A vehicle as claimed in any one of the preceding claims, wherein the jet axis projects between the left-hand seat and the right-hand seat at a height no greater than 50 centimetre higher than a centre-point on the upper surface of a base cushion of the left-hand seat or the right-seat when that seat is set in its lowermost adjustment position.

12. A vehicle as claimed in any one of the preceding claims, wherein the vehicle comprises a second row of seats located in the passenger cabin rearwardly of the row of seats comprising a rear left-hand seat and a rear right-hand seat, and the jet axis projects between the rear left-hand seat and the rear right-hand seat.

13. A vehicle as claimed in any one of the preceding claims, wherein the vent assembly is located in an instrument panel of the vehicle.

14. A vehicle as claimed in any one of the preceding claims, wherein the at least one outlet forms an elongate slit extending transversely of the passenger cabin.

15. A vehicle as claimed in any one of the preceding claims, comprising an electric fan for supplying air to the vent assembly.

16. A vehicle as claimed in any one of the preceding claims, wherein the vent assembly is adapted to direct a second jet of air through the at least one outlet along a

second jet axis projecting rearwardly and upwardly over the left-hand seat or the right-hand seat towards a region of the passenger cabin located rearwardly of the seat.

17. A vehicle as claimed in claim 16, wherein the second jet axis is fixed.

18. A vehicle as claimed in claim 16 or claim 17, wherein the vent assembly is adapted to shape the second jet to have a width-height ratio at a position above the seat greater than 1:1.

19. A vehicle as claimed in any one of claims 16 to 18, wherein the vent assembly is adapted to shape the second jet to have a width-height ratio at a position above the seat of at least 2:1.

20. A vehicle as claimed in any one of claims 16 to 19, wherein the vehicle comprises a roof over the passenger cabin.

21. A vehicle as claimed in claim 20, wherein the vent assembly is adapted to shape the second jet to have a height at a position above the seat that is at least 80% of the height of a gap between the seat and the roof when the seat is set in an uppermost position of adjustment.

22. A vehicle as claimed in claim 20 or claim 21, wherein the vent assembly is adapted to shape the second jet to have a height at a position above the seat that is no greater than 120% of the height of a gap between the seat and the roof when the seat is set in an uppermost position of adjustment.

23. A vehicle as claimed in any one of claims 16 to 22, wherein the second jet axis projects at an angle relative to the horizontal plane of at least 45 degrees.

24. A vehicle as claimed in any one of claims 16 to 23, wherein the second jet axis projects at an angle relative to the horizontal plane of less than 80 degrees.

25. A vehicle as claimed in any one of claims 20 to 24, wherein the second jet axis intersects the roof at a position directly above the seat when the seat is set in a forward-most position of adjustment.

26. A vehicle as claimed in any one of claims 16 to 25, wherein the at least one outlet is a single outlet and the vent assembly is adapted to discharge the jet through a first region of the outlet and the second jet through a second region of the outlet.

27. A vehicle as claimed in claim 26, wherein the first region of the outlet is located directly in front of a mid-point between the left-hand seat and the right-hand seat and the second region of the outlet is offset to a side of the first region.

28. A vehicle as claimed in any one of claims 16 to 27, wherein the vent assembly is adapted to direct a third jet of air through the at least one outlet, the second jet is directed rearwardly and upwardly over the left-hand seat towards a region of the passenger cabin located rearwardly of the left-hand seat, and the third jet is directed along a third jet axis projecting rearwardly and upwardly over the right-hand seat towards a region of the passenger cabin located rearwardly of the right-hand seat.

29. A vehicle as claimed in claim 28, wherein the third jet axis is fixed.

30. A vehicle as claimed in claim 28 or claim 29, wherein the vent assembly is adapted to shape the third jet to have a width-height ratio at a position above the right-hand seat greater than 1:1.

31. A vehicle as claimed in any one of claims 28 to 30, wherein the vent assembly is adapted to shape the third jet to have a width-height ratio at a position above the right-hand seat of at least 2:1.

32. A vehicle as claimed in any one of claims 28 to 31, wherein the vent assembly is adapted to shape the third jet to have a height at a position above the seat that is at least

80% of the height of a gap between the seat and the roof when the seat is set in an uppermost position of adjustment.

33. A vehicle as claimed in any one of claims 28 to 32 wherein the vent assembly is adapted to shape the third jet to have a height at a position above the seat that is no greater than 120% of the height of a gap between the seat and the roof when the seat is set in an uppermost position of adjustment.

34. A vehicle as claimed in any one of claims 28 to 33, wherein the third jet axis projects at an angle relative to the horizontal plane of at least 45 degrees.

35. A vehicle as claimed in any one of claims 28 to 34, wherein the third jet axis projects at an angle relative to the horizontal plane of less than 80 degrees.

36. A vehicle as claimed in any one of claims 28 to 35 when dependent on claim 20, wherein the third jet axis intersects the roof at a position directly above the right-hand seat when the seat is set in a forward-most position of adjustment.

37. A vehicle as claimed in any one of claims 28 to 36 when dependent on claim 26, wherein the vent assembly is adapted to discharge the third jet through a third region of the single outlet, the second region of the outlet is offset to a left-side of the first region and the third region is offset to a right-side of the first region.

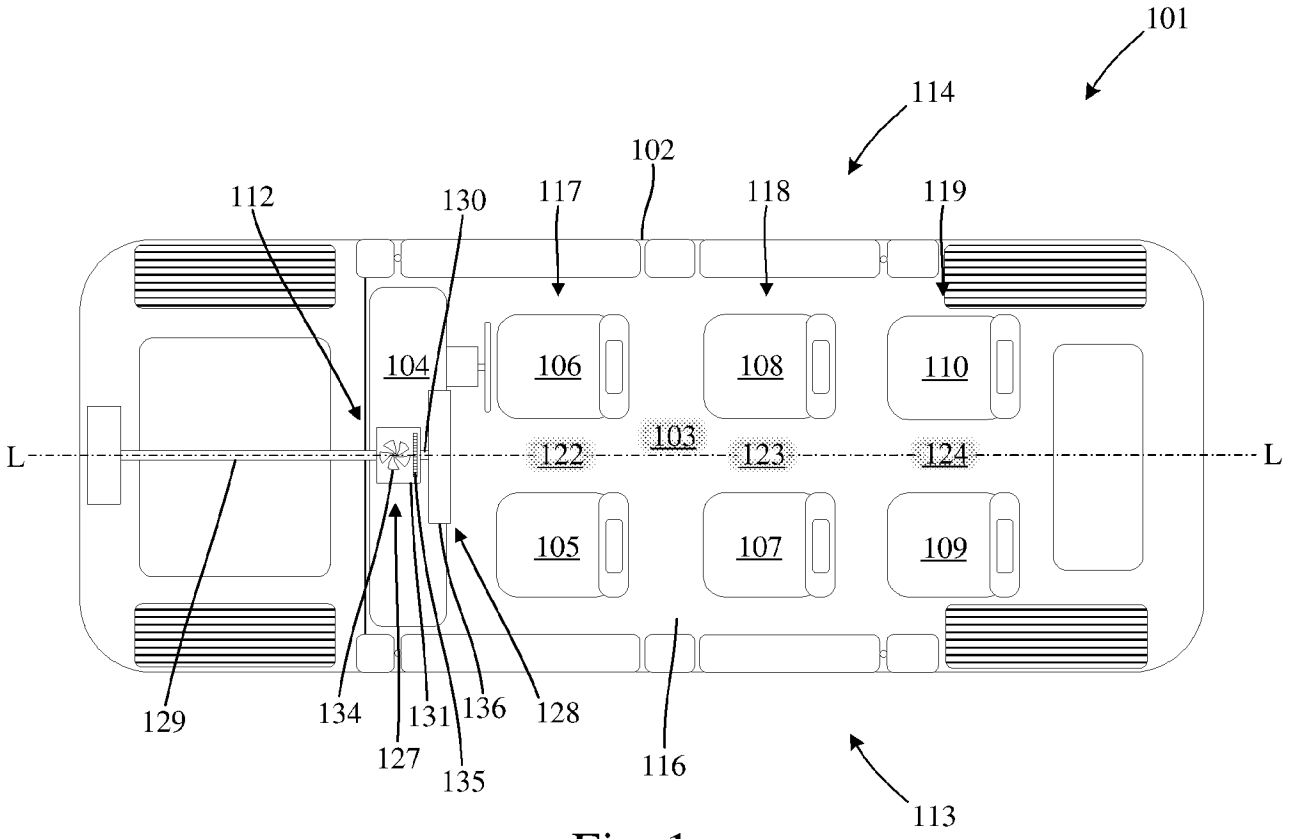

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Fig. 1

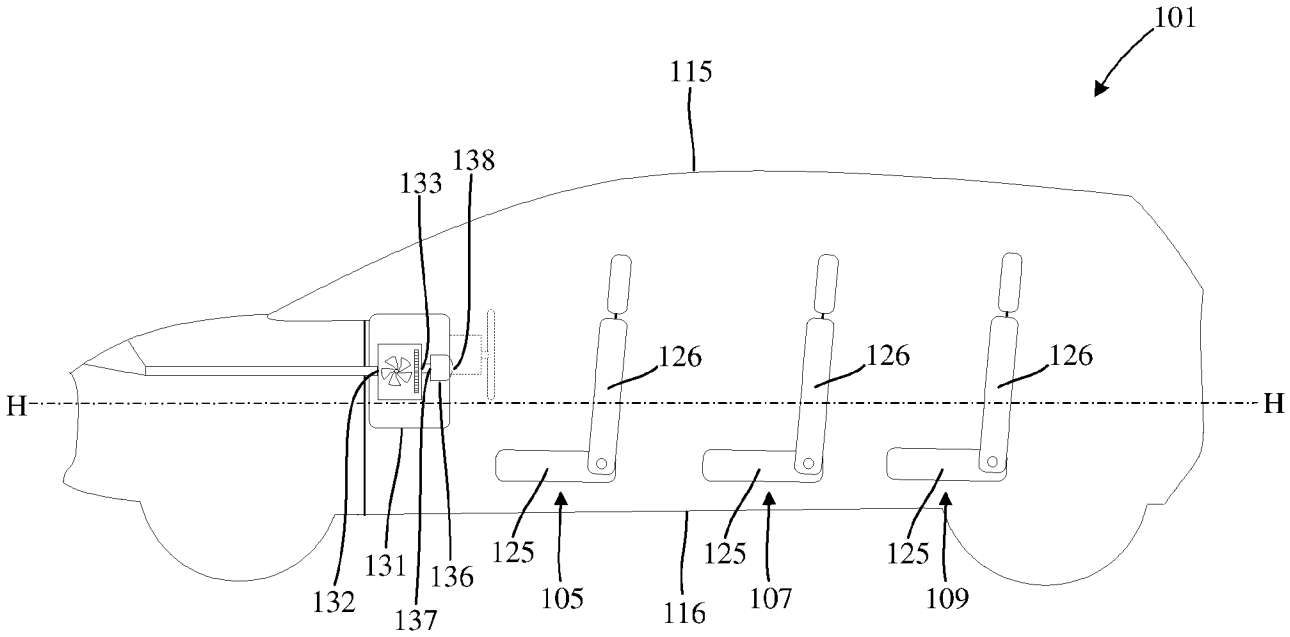

101
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Fig. 2

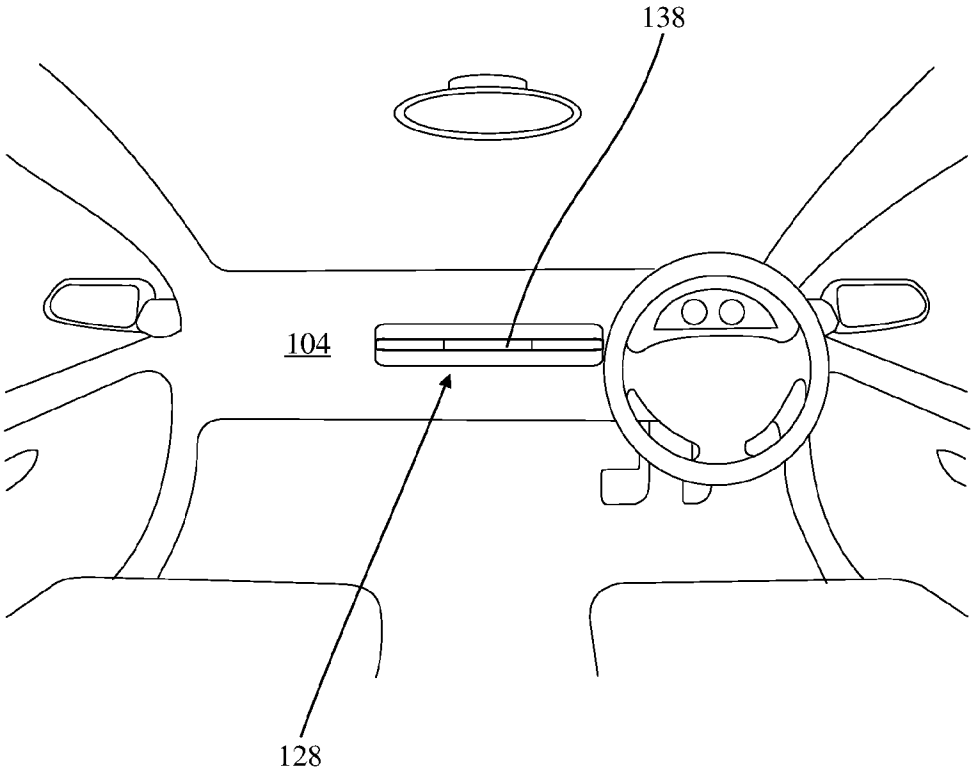


Fig. 3

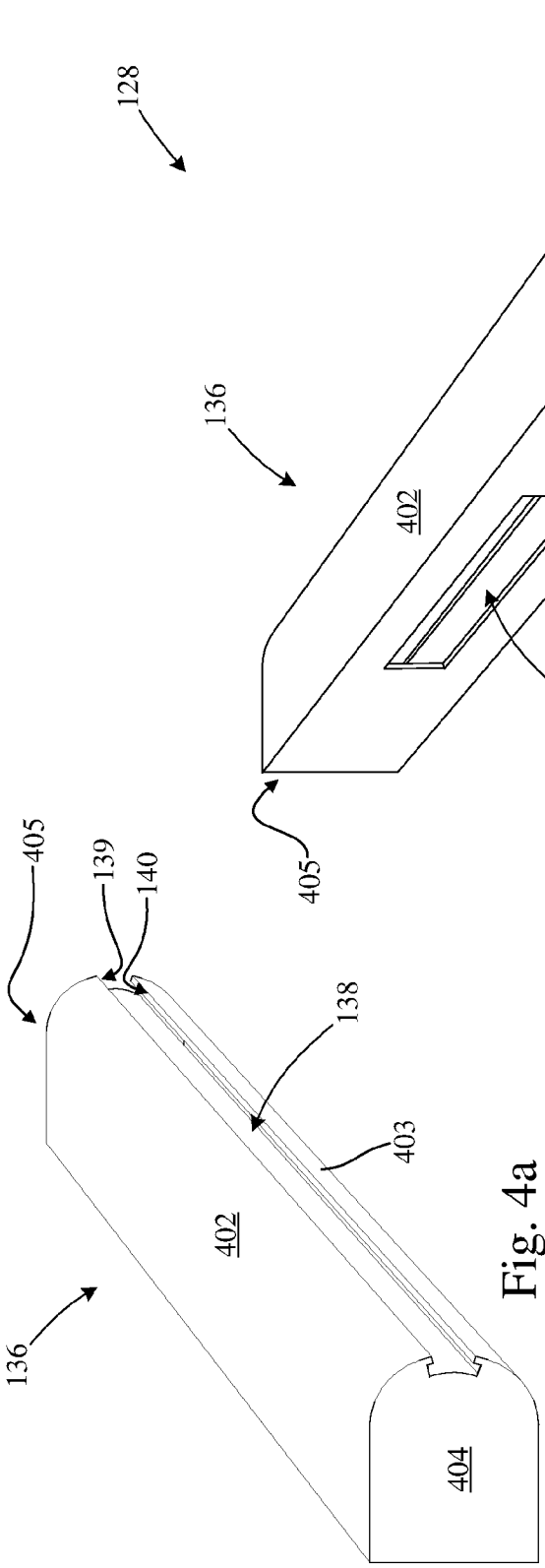


Fig. 4a

Fig. 4b

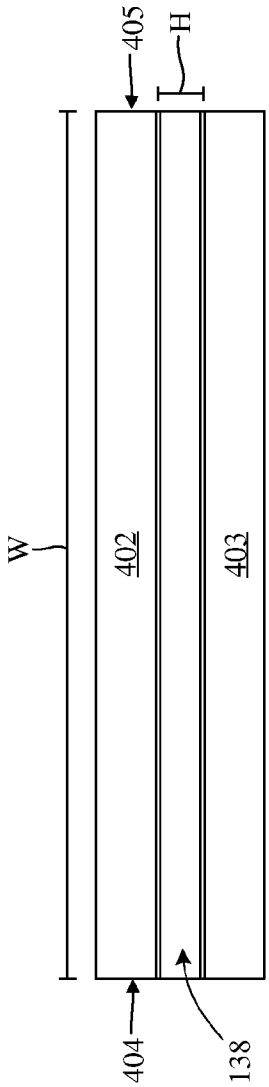


Fig. 4c

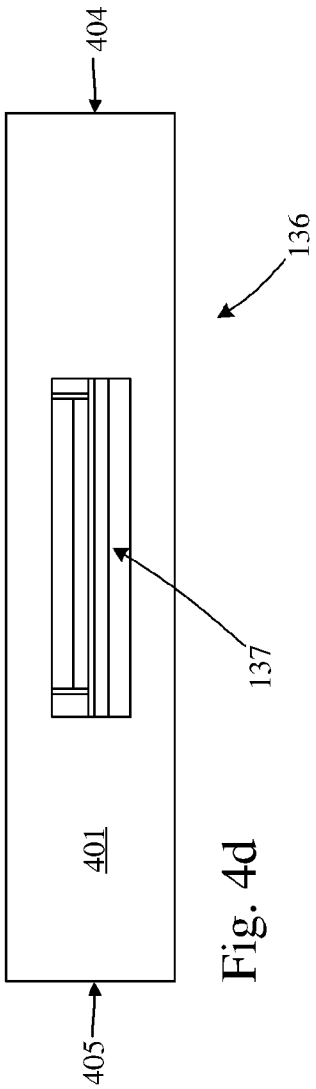


Fig. 4d

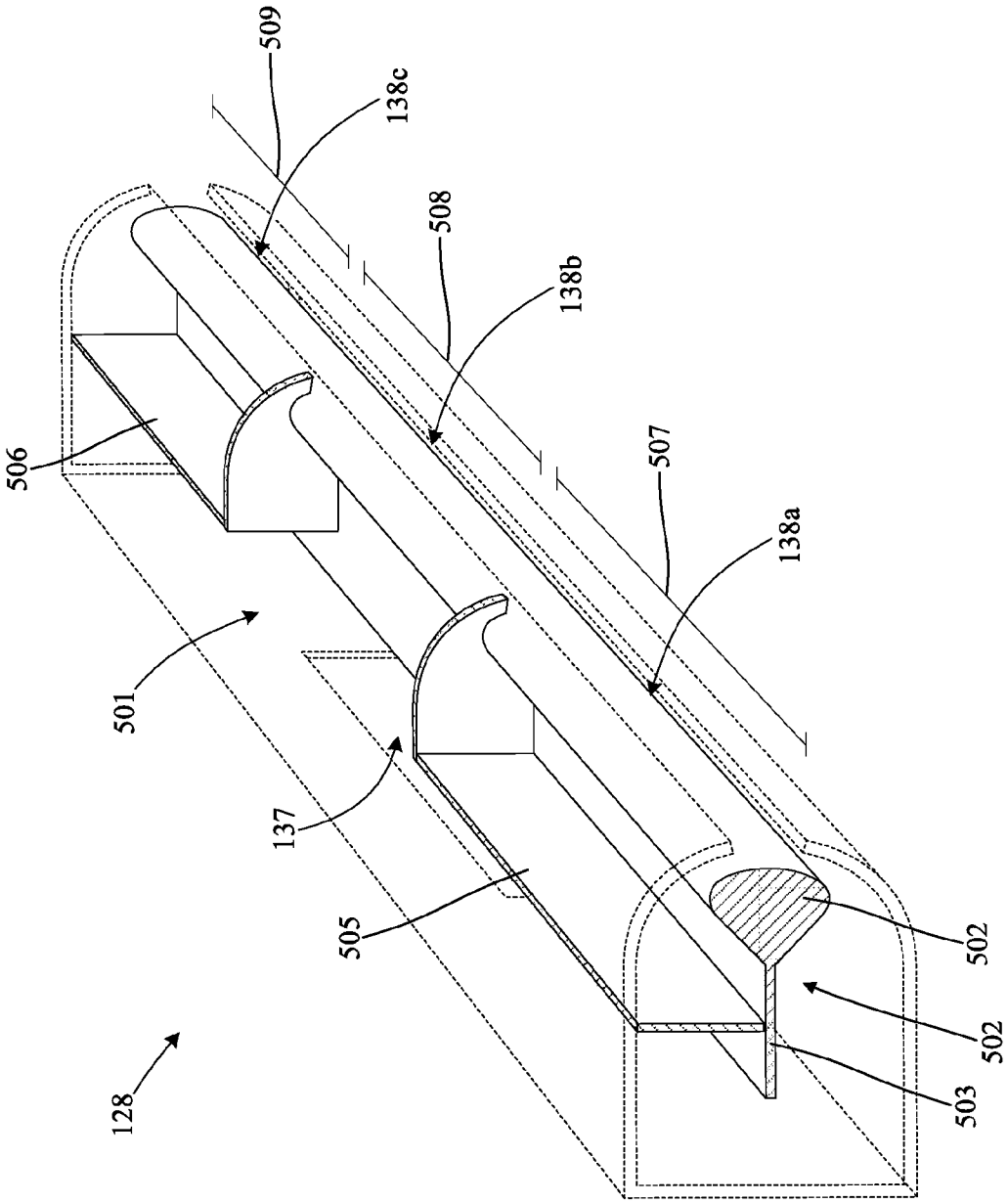


Fig. 5

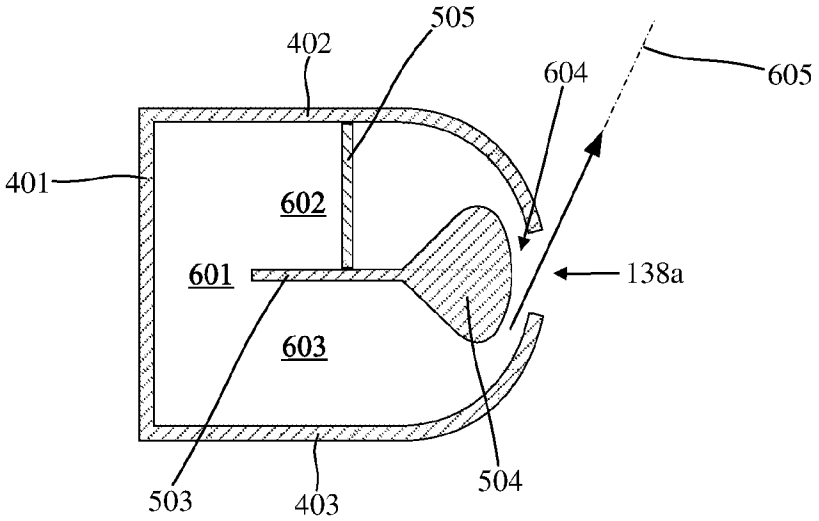


Fig. 6a

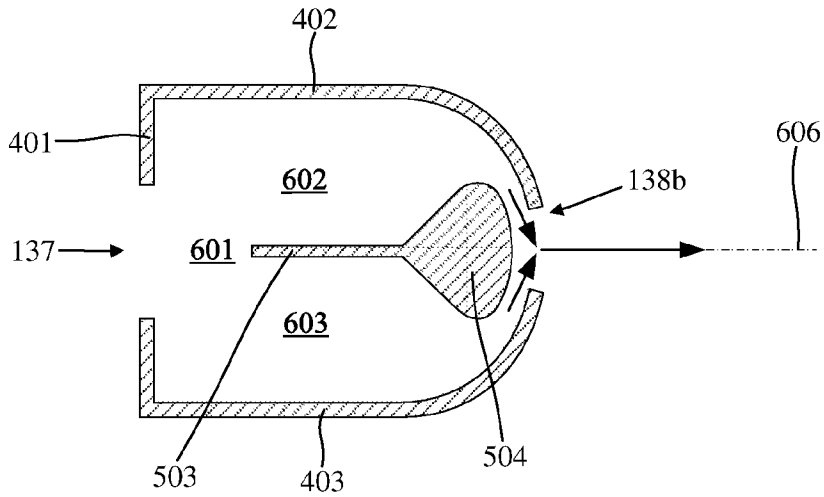


Fig. 6b

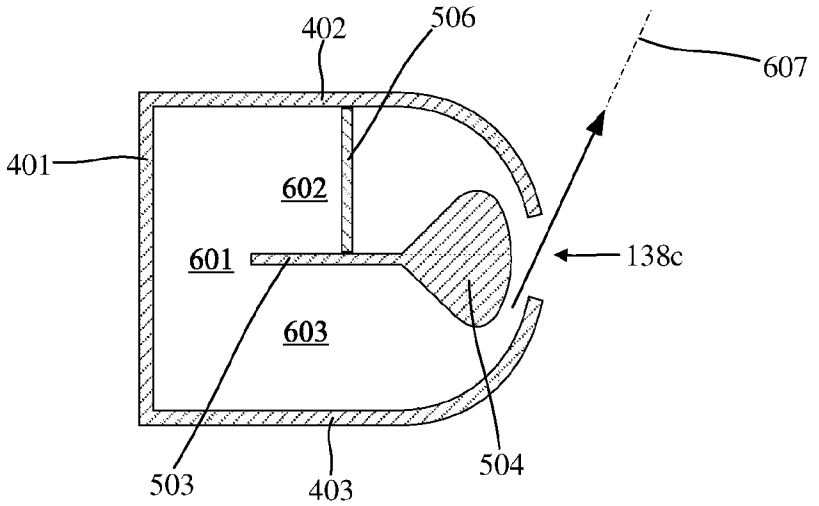


Fig. 6c

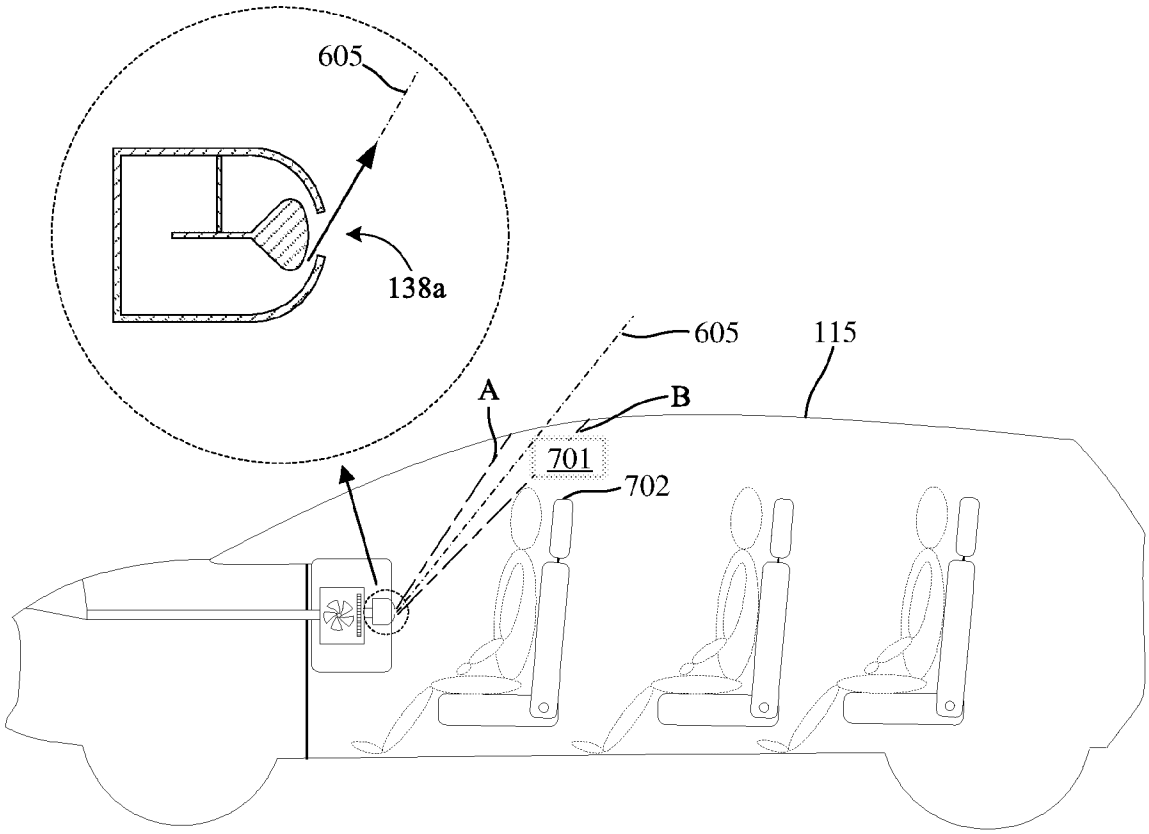


Fig. 7a

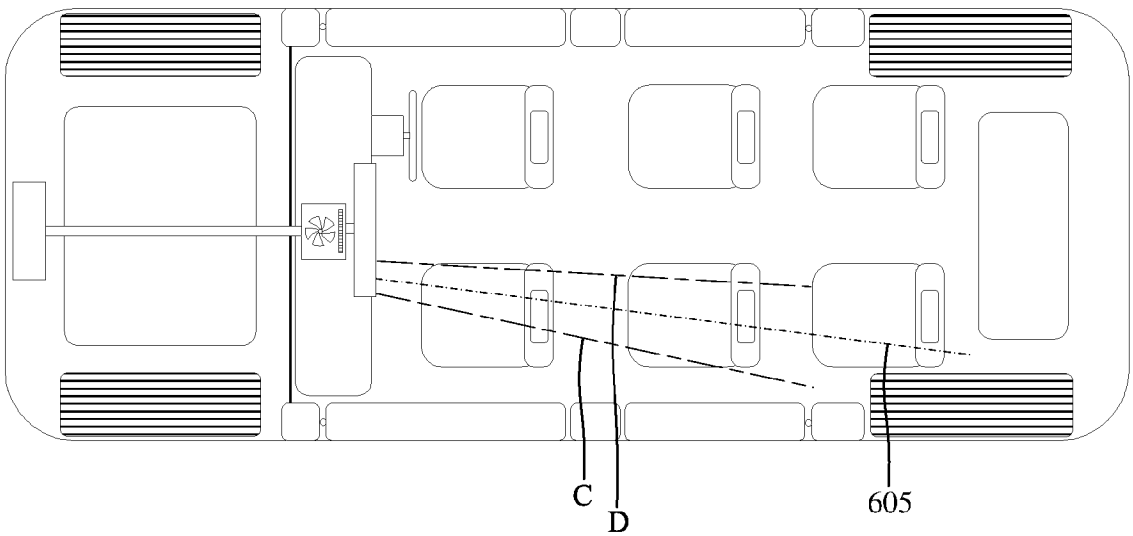


Fig. 7b

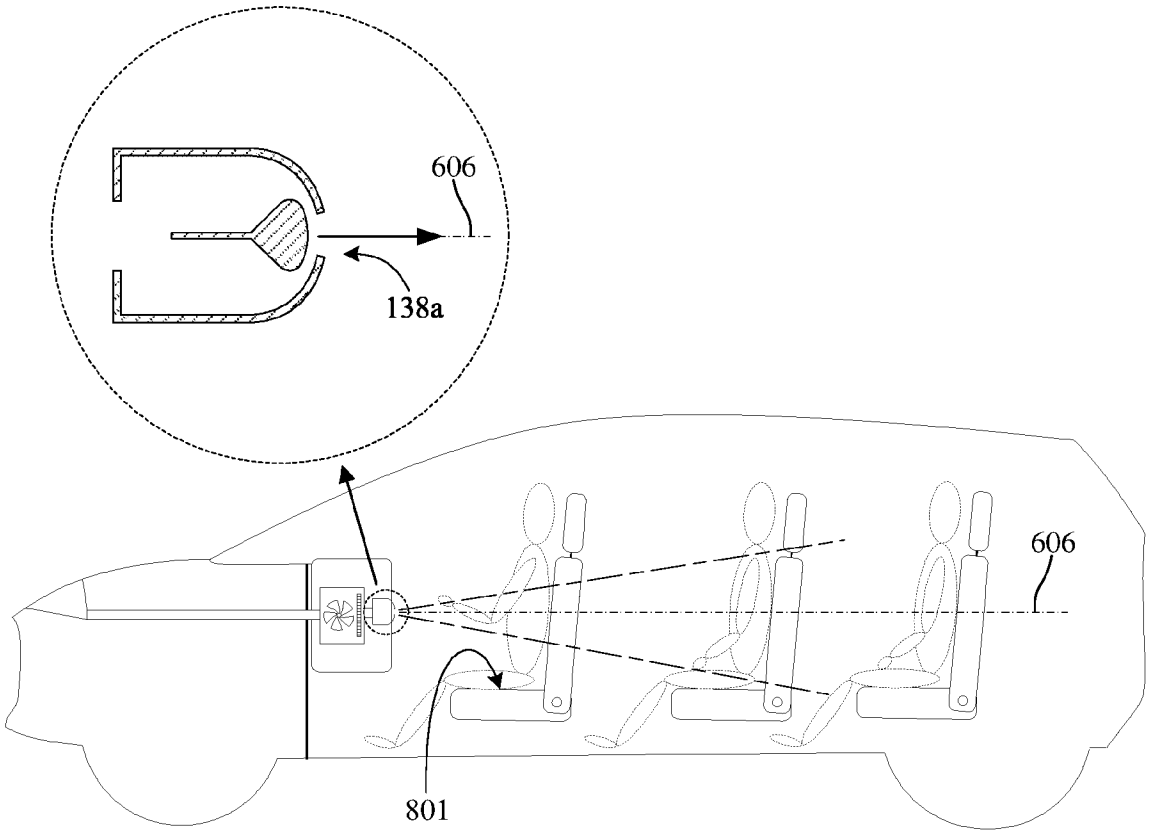


Fig. 8a

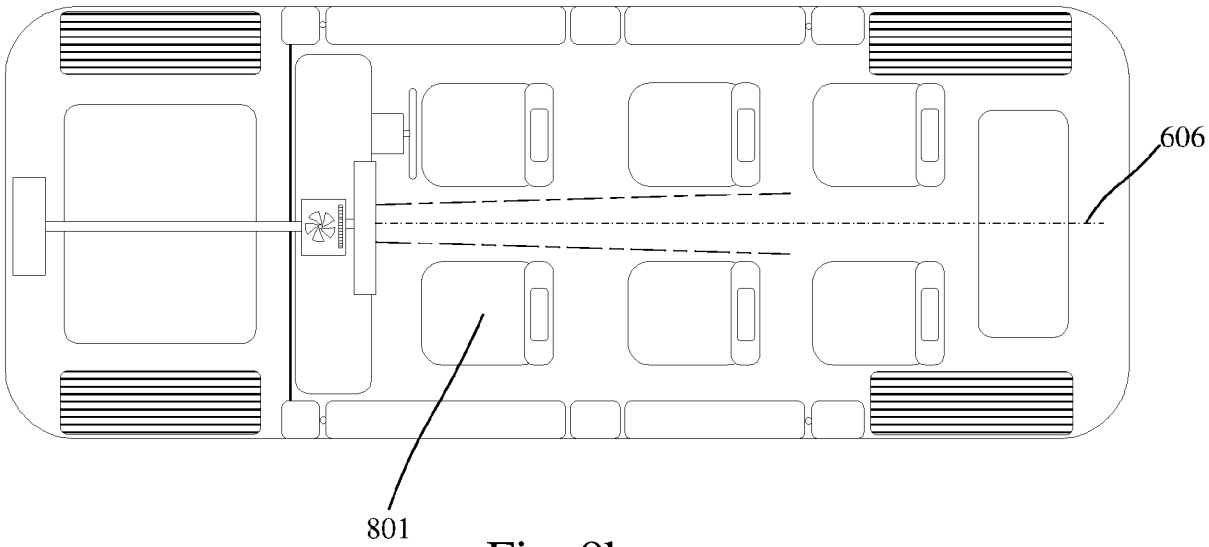


Fig. 8b

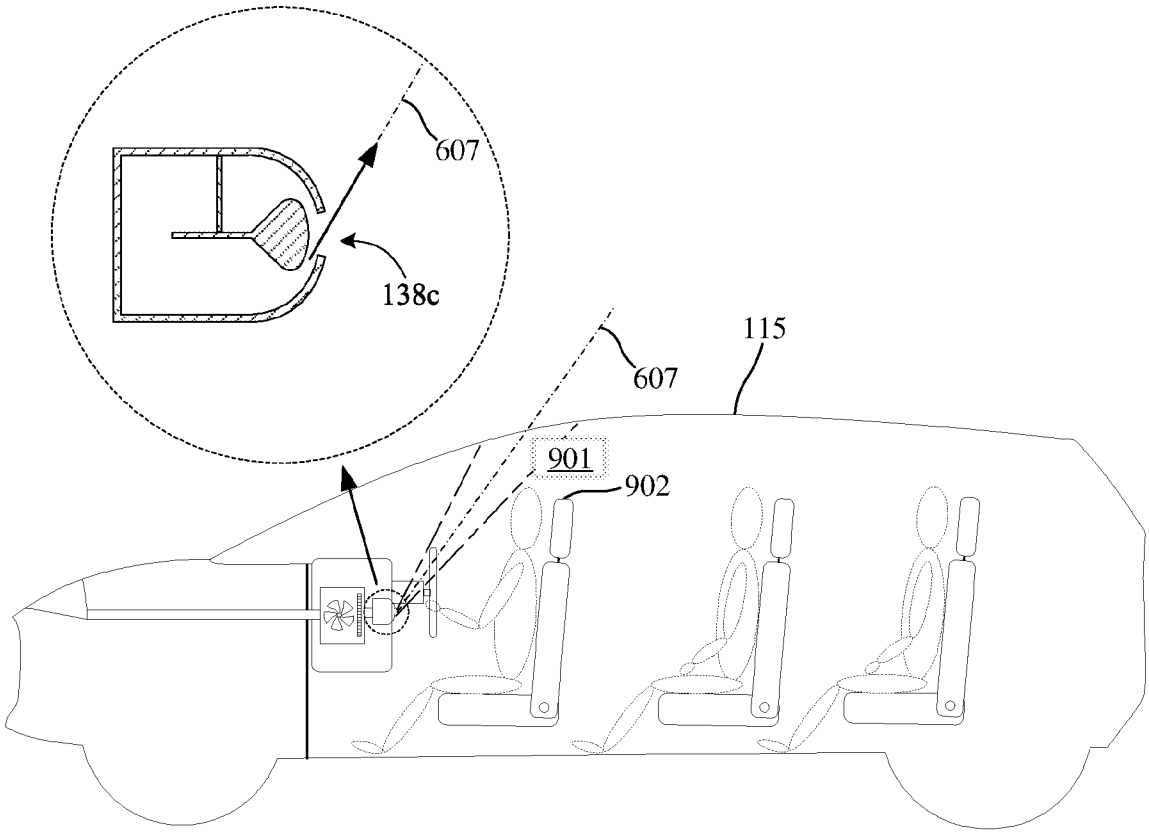


Fig. 9a

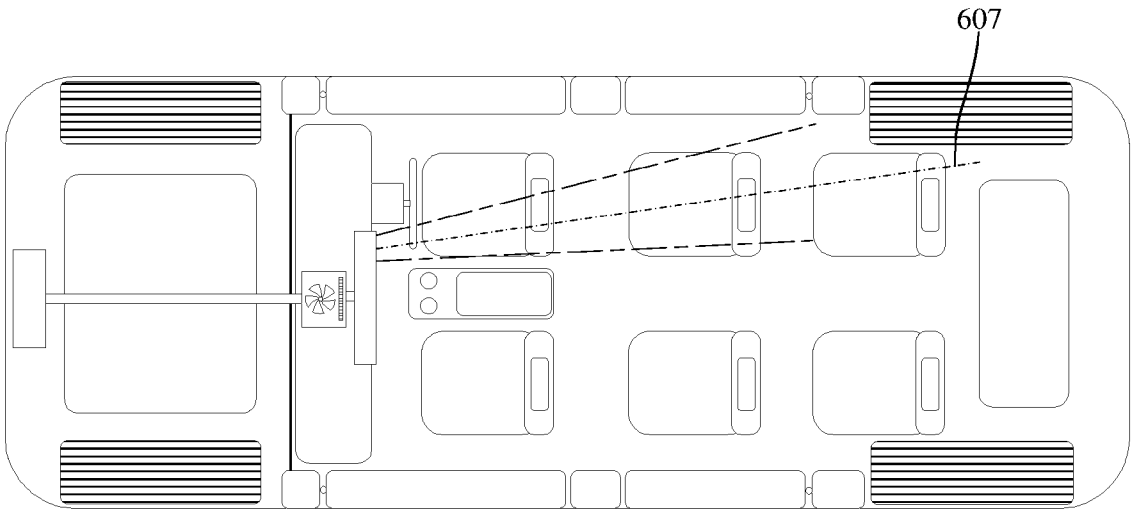


Fig. 9b

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2020/050055

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60H1/24 B60H1/34
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)
B60H

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2017/326938 A1 (MOTOMURA HIROHISA [JP]) 16 November 2017 (2017-11-16) paragraphs [0045] - [0183]; figures 1-24	1-37
X	JP 2006 240539 A (NISSAN MOTOR) 14 September 2006 (2006-09-14) paragraphs [0007] - [0027]; figures 1-7	1-37
X	DE 10 2015 221097 A1 (BAYERISCHE MOTOREN WERKE AG [DE]) 4 May 2017 (2017-05-04) paragraphs [0031] - [0062]; figures 1-2	1-37
X	US 2015/266404 A1 (SAKANE HIROYUKI [JP] ET AL) 24 September 2015 (2015-09-24) paragraphs [0050] - [0123]; figures 1-22	1-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 March 2020	06/05/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Flori, Massimiliano

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2020/050055

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