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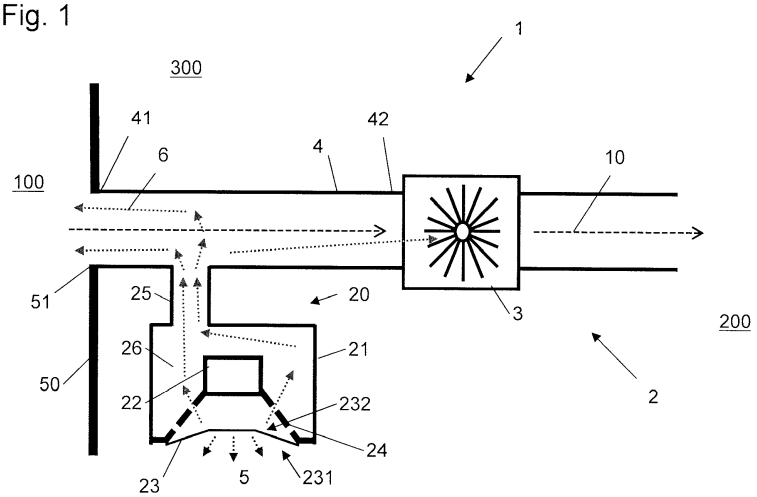
(54) VEHICLE INSTALLATION STRUCTURE COMPRISING A LOUDSPEAKER DEVICE AND VEHICLE STRUCTURE COMPRISING SAME

(57) A vehicle installation structure (1) with a loudspeaker device (20) comprises an air duct (4) configured to form part of a ventilation system (2) of a vehicle for introducing outside air (10) from an outside space (100) of the vehicle to an inside passenger space (200) of the vehicle. The air duct (4) comprises a first terminal (41) for coupling to an opening (51) in a partition panel (50) of the vehicle which separates the outside space (100) from an inner space (300) of the vehicle, and a second terminal (42) for coupling to a fan (3) causing the outside air (10) to flow from the outside space (100) to the inside passenger space (200). The loudspeaker device (20) comprises a driver (22) and a diaphragm (23), and is configured to emit sound (5) towards the passenger space (200) from a first side (231) of the diaphragm (23). The loudspeaker device (20) further comprises a housing (21) surrounding a second side (232) of the diaphragm (23) opposite the first side (231) and a communication channel (25) which is configured to allow a back chamber (26) of the housing (21) facing the second side (232) of the diaphragm (23) to communicate with the outside space (100). The communication channel (25) is connected to the air duct (4) between the first terminal (41) and the second terminal (42). The vehicle installation structure is capable of providing good sound quality while helping to reduce additional noise to enter the vehicle.

Fig. 1



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Description

[0001] The present invention relates to a vehicle installation structure for arranging at a vehicle partition panel and which comprises a loudspeaker device. The invention further relates to a vehicle structure comprising a vehicle partition panel and such vehicle installation structure, and to a vehicle comprising such vehicle structure.

[0002] In the automotive field, loudspeaker devices are commonly used for providing audio output to listeners situated in vehicles like cars. A loudspeaker device typically employs a magnetic driving unit causing a diaphragm connected to a frame of the loudspeaker device to move back and forth. This vibration creates sound that is produced by the loudspeaker. The frame is commonly enclosed by a housing of the loudspeaker device. When the loudspeaker device is a subwoofer, typically an air communication duct connects an inner space of the housing to an outside space.

[0003] In known arrangements, such loudspeaker device is installed at a vehicle panel (such as a vehicle body) which has a separate opening to an outside space of the vehicle. The loudspeaker device comprises a housing including an air volume which is communicated at a backside of the diaphragm through an air communication duct and the opening with the outside space of the vehicle. Such arrangement enables the loudspeaker device to be placed in small locations such as in a vehicle side space adjacent to a vehicle panel. For connecting the air communication duct to the outside, an opening needs to be provided in the vehicle panel, which may form part of the vehicle body. Typically, such opening is a dedicated hole in a vehicle structure, such as a vehicle panel, which may cause additional noise to enter the vehicle. Further, in a case in which such loudspeaker device is a customer option, when no loudspeaker device is installed, a plug or cover needs to cover such hole, which causes additional costs.

[0004] DE 101 44 786 A1 discloses a vehicle which has a loudspeaker for radiating sound waves into the passenger compartment and an air channel for air conditioning the passenger compartment. The air channel has an air channel opening facing the passenger compartment. The loudspeaker is mounted in the air channel so that the sound waves can be radiated through the air channel opening into the passenger compartment. In this configuration, the back space of the loudspeaker device is connected to the internal air duct of the air conditioning system arranged in or adjacent to the dashboard (i.e. after a ventilation system which introduces the outside air from the outside to the passenger compartment), so that the reversed back sound enters the passenger compartment through the internal air duct. This provides the disadvantage that the sound quality deteriorates, particularly if the loudspeaker device is configured to operate in the subwoofer range.

[0005] EP 2 858 377 A1 discloses an in-car audio system including a speaker unit. A frame of the speaker unit is fixed to a support plate serving as part of the structural member of a vehicle via a partition wall member. The support plate has an opening formed therein. A duct is connected to the opening, and the opening communicates with the outside of the vehicle. A space surrounded by the speaker unit, the support plate, and a partition wall member serves as a first acoustic resonance space, and a communication channel located inside the duct serves as a second acoustic resonance space. The opening is a dedicated hole in the vehicle partition wall member, which causes additional noise to enter the vehicle and decreases the strength of the vehicle partition wall member.

[0006] It is an object of the present invention to provide a vehicle installation structure including a loudspeaker device which is capable of providing good sound quality while helping to reduce additional noise to enter the vehicle and not decrease the strength of a vehicle partition wall member.

[0007] The present invention is related to a vehicle installation structure, a vehicle structure comprising such vehicle installation structure, and to a vehicle comprising such vehicle structure according to the features of the appended claims.

[0008] According to an aspect of the invention, there is provided a vehicle installation structure, comprising an air duct configured to form part of a ventilation system of a vehicle for introducing outside air from an outside space of the vehicle to an inside passenger space of the vehicle. The air duct comprises a first terminal for coupling to an opening in a partition panel of the vehicle which separates the outside space from an inner space of the vehicle, and a second terminal for coupling to a fan causing the outside air to flow from the outside space of the vehicle to the inside passenger space of the vehicle. A loudspeaker device comprises a driver and a diaphragm, and is configured to emit sound towards the passenger space of the vehicle from a first side of the diaphragm, the loudspeaker device comprising a housing surrounding a second side of the diaphragm opposite the first side and a communication channel which is configured to allow a back chamber of the housing facing the second side of the diaphragm to communicate with the outside space of the vehicle. In such configuration, the communication channel of the loudspeaker device is connected to the air duct between the first terminal and the second terminal.

[0009] Advantageously, the loudspeaker device can be arranged in an inside space of the vehicle, preferably close to an opening of the ventilation system to the outside. According to an embodiment, the ventilation system is or includes an air conditioning system. The port of the air communication channel of the loudspeaker device may be connected to the duct system of the ventilation system or air conditioning system, respectively. The acoustical impedance of the loudspeaker device from the port of the air communication channel to the outside may thus be quite low because the port may be arranged quite

close at the opening of the ventilation system or air conditioning system, respectively, to the outside of the vehicle.

[0010] If there are provided any recirculating ventilation flaps used in the ventilation system, the only connection from the front side of the loudspeaker device to the port of the air communication channel of the loudspeaker device at the back side is then through the air ducts of the ventilation system which are, however, quite long. While the front side of the loudspeaker device emits sound into the passenger compartment of the vehicle, the acoustical impedance from the front side of the loudspeaker device to the port of the air communication channel is quite high. Thus, the sound quality of the loudspeaker device is quite well, while a dedicated hole in a vehicle partition wall member, which causes additional noise to enter the vehicle and decreases the strength of the vehicle partition wall member, is not necessary, since the already existing opening of the ventilation system can be used.

[0011] According to an embodiment, the air duct is configured to form part of an air conditioning system of the vehicle. For example, the air communication channel of the loudspeaker device at the back side thereof could be integrated into air channels, boxes, or ducts of the air conditioning system.

[0012] According to an embodiment, the air duct is integrally formed with, or forms part of, a box of the ventilation system for accommodating the fan. This provides an efficient arrangement while maintaining the advantages as set out above.

[0013] According to an embodiment, the vehicle installation structure further comprises a recirculating air duct connected to the air duct at a third terminal arranged between the first terminal and the second terminal, a first gating device for regulating an air flow in the air duct between a closed position preventing air to flow in the air duct and an open position enabling air to flow in the air duct, the first gating device disposed in the air duct between the first terminal and the third terminal, and a second gating device disposed in the recirculating air duct for regulating an air flow in the recirculating air duct between a closed position preventing air to flow in the recirculating air duct and an open position enabling air to flow in the recirculating air duct. The communication channel of the loudspeaker device is connected to the air duct between the first terminal and the first gating device.

[0014] According to an embodiment, the diaphragm has a cone shape and is supported by an outer circumferential portion of a frame, wherein the concave side of the diaphragm forms the first side of the diaphragm.

[0015] Preferably, the loudspeaker device is configured such that the diaphragm vibrates at a frequency in a sub-woofer frequency range. Improved sound quality, and the advantages as described above can be observed particularly for such loudspeaker device.

[0016] The invention also relates to a vehicle structure comprising a vehicle partition panel and a vehicle installation structure as described herein, wherein the air duct is arranged to introduce outside air from the outside space of the vehicle to the inside passenger space of the vehicle through the opening in the vehicle partition panel. The invention also relates to a vehicle comprising such vehicle structure.

[0017] According to an embodiment, the vehicle partition panel forms an outer skin portion of a vehicle body.

[0018] According to an embodiment, the air duct is positioned in a vehicle compartment in front of the passenger space of the vehicle, in a part of the vehicle beneath or in front of a dashboard of the vehicle, or in the dashboard of the vehicle.

[0019] Aspects and embodiments of the invention will now be described with reference to the drawings, in which

Fig. 1 shows a vehicle installation structure comprising an air duct of a vehicle ventilation system and a loudspeaker device according to an embodiment of the invention,

Fig. 2 shows a vehicle installation structure with an air duct and a recirculating air duct of a vehicle ventilation system and a loudspeaker device according to a further embodiment of the invention in a first state of operation,

Fig. 3 shows a vehicle installation structure with an air duct and a recirculating air duct of a vehicle ventilation system and a loudspeaker device according to a further embodiment of the invention in a second state of operation.

[0020] Fig. 1 shows a vehicle installation structure 1 comprising an air duct 4 of a vehicle ventilation system 2 and a loudspeaker device 20 according to an embodiment of the invention. According to an embodiment, the vehicle installation structure 1 is configured to form a part of a vehicle ventilation system 2. Particularly, such vehicle ventilation system 2 is arranged for introducing fresh outside air from an outside space 100 of the vehicle to an inside passenger space 200 of the vehicle, and distributing it inside the passenger space 200, as commonly known in the art. For introducing the outside air into the passenger space (or passenger compartment) 200 which accommodates the seats for the driver and passenger(s), such ventilation system 2 comprises at least one fan 3 (typically in the front part of the vehicle body, e.g. in the dashboard) operating by rotation of blades blowing the air from the outside to the inside of the vehicle along one or more air ducts. Nowadays, a ventilation system typically is, or forms part of, a vehicle air conditioning system. In addition to a conventional ventilation system, an air conditioning system comprises a heat exchanger (not shown) by means of which the air moved in the air ducts may be cooled or heated, as is commonly known, but which is not essential for the purposes of the present

invention. In the present embodiment, the ventilation system 2 is such air conditioning system.

[0021] According to the schematic depiction according to Fig. 1, air duct 4 forms part of the ventilation system or air conditioning system 2 of the vehicle and is configured for introducing outside air 10 from the outside space 100 of the vehicle to the passenger space 200 of the vehicle. The air duct 4 comprises a first terminal 41 coupled to an opening 51 in a partition panel 50 of the vehicle. For example, the first terminal 41 is attached to the partition panel 50 such that it is connected to the opening 51 for suctioning outside air into the passenger compartment 200. According to another embodiment, the air duct 4 may be connected to another hollow body which is attached to the partition panel 50. The partition panel 50 separates the outside space 100 from an inner space 300 of the vehicle which may be, in principle, any space inside the vehicle body, for example a hollow installation space for any vehicle components or an inner space inside a dashboard. For example, the partition panel 50 forms an outer skin portion of the vehicle body. In an embodiment, it may be a partition panel separating the cabin from the outside of the vehicle. An outside space of the vehicle as described herein may encompass, in principle, any space outside the passenger compartment which has access to air outside of the vehicle body (such as the engine compartment which typically is open to the outside at its bottom) and which may be used by the ventilation or air conditioning system for air suctioning of outside air from it into the passenger compartment through an opening in a vehicle partition panel. For instance, the partition panel 50 may be a part of a multilayer panel structure with two side portions and a hollow space included in between the side portions, wherein the panel 50 as shown in Fig. 1 may form any of the side portions, i.e. an inner side (or skin) portion or an outer side (or skin) portion of such multiple layer panel structure.

[0022] The air duct 4 further comprises a second terminal 42 for coupling to a fan 3. The fan 3 causes the outside air 10 to flow from the outside space 100 of the vehicle to the inside passenger space 200 of the vehicle. For example, the air duct 4 houses the fan 3, such that the fan 3 is positioned inside the air duct 4 at the second terminal 42. For instance, the air duct 4 may be any hollow body (such as a circular or rectangular body, e.g. a tube) having a fan located therein at a particular position which is designated herein as the second terminal of the air duct. According to another embodiment, the air duct 4 may be a hollow body (such as a circular or rectangular body, e.g. a tube) having the second terminal 42 located at a position which is remote from the first terminal 41, wherein the second terminal 42 is coupled, e.g. connected, to another hollow body which houses or is connected to the fan 3. In principle, the air duct 4 between the first terminal 41 and second terminal 42 can be any structure which spans a hollow extension between a first location (first terminal 41) and a second location (second terminal 42) and which is appropriate for transporting an air flow in it along the hollow extension. With respect to the air flow of the outside air 10, the first terminal 41 is upstream of the second terminal 42. The air duct 4 is an air duct external to the passenger compartment 200. Particularly, it is an air duct which is upstream of the fan 3.

[0023] According to an embodiment, the air duct 4 forms part of the air conditioning system 2 of the vehicle and may be integrally formed with, or forms part of, a box (so-called climate box) of the air conditioning system 2 for accommodating the fan 3. As such, the air duct 4 has the function of a conventional air duct for introducing outside air which is commonly installed in vehicles. The opening 51 may be formed as commonly known in vehicle ventilation or air conditioning systems. For example, it has a cover on the outside (not shown) for preventing particles from entering into the air duct 4 and the fan 3. In the present embodiment, when installed in the vehicle structure of a vehicle, the vehicle installation structure 1, particularly the air duct 4, is attached to the vehicle panel 50 or otherwise fixed with respect to the vehicle panel 50.

[0024] The vehicle installation structure 1 further comprises a loudspeaker device 20. The loudspeaker device 20 may be a commonly available loudspeaker device and comprises a magnetic driving unit (so-called driver) 22 and a frame 24 connected to the magnetic driving unit 22. A housing 21 surrounds and encloses at least a part of the frame 24, to which a diaphragm 23 is attached which is operated by the magnetic driving unit 22 for emitting sound 5 to the inside passenger space 200 of the vehicle from a first side 231 of the diaphragm 23 in accordance with the operation of the magnetic driving unit 22. In the present embodiment, the diaphragm 23 has a cone shape and is supported by an outer circumferential portion of the frame 24, wherein the concave side of the diaphragm 23 forms the first side 231 of the diaphragm. The housing 21 surrounds a second side 232 (here: back side 232) of the diaphragm 23 which is opposite the first side 231 (here: front side 231) from which the sound 5 is emitted.

[0025] The diaphragm 23 delimits an inner space 26 of the housing 21 forming an air volume chamber or back chamber facing the back side 232 of the diaphragm 23. The back chamber 26 is communicating air to the outside of the housing 21 in accordance with the operation of the magnetic driving unit 22.

[0026] To this end, the loudspeaker device 20 comprises a communication channel 25 which is configured to allow the back chamber 26 of the housing 21 to communicate with the outside space 100 of the vehicle. The communication channel 25 of the loudspeaker device 20 is connected to the air duct 4 between the first terminal 41 and second terminal 42, i.e. between the opening 51 of the partition panel 50 and the fan 3.

[0027] The loudspeaker device 20 can thus be arranged closely to the opening 51 of the air conditioning system 2 to the outside of the vehicle and is connected to the duct system of the air conditioning system. The acoustical impedance of the loudspeaker device 20 from

the port of the air communication channel 25 to the outside is thus quite low because the port may be arranged quite close at the opening 51 to the outside of the vehicle. While the front side 231 of the diaphragm 23 emits sound into the passenger compartment 200 of the vehicle, the acoustical impedance from the front side 231 of the loudspeaker device to the port of the air communication channel 25 at the air duct 4 is quite high, since for the emitted sound waves 5 the extension of the duct system including the fan 3 of the air conditioning system 2 from the passenger compartment 200 back to the port of the air communication channel 25 is quite long. Thus, a high amount of reversed back sound 6 is emitted through the opening 51 in the vehicle partition panel 50 to the outside space 100. As such, there is formed a baffle structure in order to prevent the interference between sound waves 5 radiating from the sound radiating side 231 of the diaphragm 23 to the passenger compartment 200 and opposite-phase sound waves 6 radiating from the opposite side 232 of the diaphragm 23. As a result, this provides good sound quality, especially when the diaphragm 23 vibrates at a frequency in a sub-woofer frequency range (e.g., at a frequency below 200 Hz).

[0028] Fig. 2 shows a vehicle installation structure with an air duct and a recirculating air duct of a vehicle ventilation system and a loudspeaker device according to a further embodiment of the invention. The vehicle installation structure is in most parts similar to the structure according to the embodiment of Fig. 1, so that the same or similar components thereof have the same reference signs and are not described again. In this respect, it is referred to the above description.

[0029] In addition to the structure as described with reference to Fig. 1, the structure according to Fig. 2 comprises a recirculating air duct 7 which is connected to the air duct 4 at a third terminal 43 which is arranged between the first terminal 41 and the second terminal 42 as described above. A first gating device 31 is disposed in the air duct 4 between the first terminal 41 and the third terminal 43 at the port of the recirculating air duct 7, and is provided for regulating an air flow in the air duct 4 between a closed position and an open position. In the closed position, the first gating device 31 prevents air to flow in the air duct 4. In the open position, the first gating device 31 enables air to flow in the air duct 4. There may also be intermediate positions in which the air flow can be reduced continuously and/or in steps. For example, the first gating device is any one of a regulating valve, variable blades, flaps, or throttle as commonly used in such automotive ventilation systems for regulating air flow in an air duct.

[0030] Moreover, there is provided a second gating device 32 disposed in the recirculating air duct 7 for regulating an air flow in the recirculating air duct 7 between a closed position preventing air to flow in the recirculating air duct 7 and an open position enabling air to flow in the recirculating air duct 7. Similarly, there may also be intermediate positions in which the air flow in the recirculating air duct 7 can be reduced continuously and/or in steps. The second gating device may be implemented similarly as the first gating device. The communication channel 25 of the loudspeaker device 20 is connected to the air duct 4 between the first terminal 41 and the first gating device 31.

[0031] With provision of the first and second gating devices, the user and/or the air conditioning system 2 itself may switch between introducing fresh air into the passenger compartment 200 or recirculating of air within the passenger compartment 200, or regulate any states in between, that is partial fresh air and recirculating operation at the same time.

[0032] The structure according to Fig. 2 is shown in a first state of operation in which the first gating device 31 is in open position and the second gating device is in closed position. That is, in this operation state, fresh air 10 is introduced into the passenger compartment 200. In this operation state, from sound perspective the behaviour and sound quality is similar to that according to the embodiment of Fig. 1 since the recirculating air duct 7 is closed for the opposite-phase sound waves 6. For closed gating device 32, the only connection from the front side 231 of the diaphragm 23 to the port of the communication channel 25 is through the long air ducts of the air conditioning system 2. The fan 3 and the long air ducts function as silencer, and noise and reversed back sound are almost vanished.

[0033] The structure according to Fig. 3, which has the same components as the structure according to Fig. 2, is shown in a second state of operation in which the first gating device 31 is in closed position and the second gating device is in open position. That is, in this operation state, fresh air 10 is prevented from being introduced into the passenger compartment 200, and the air in the passenger compartment 200 is recirculated through duct 7. In this operation state, from sound perspective the gating device 31 is in closed position and acts as a shutter preventing the reversed back sound 6 from entering into the passenger compartment 200 through the air duct 4. In addition, since the first gating device 31 is closed, there is no connection for emitted sound waves between the front side 231 of the diaphragm 23 and the port of the air communication channel 25.

[0034] For mixed (fresh air and recircular) ventilation operation (not shown), both gating devices 31, 32 will be partially open. There will be a connection for emitted sound waves between the front side 231 of the diaphragm 23 and the port of the air communication channel 25. The front side 231 of the diaphragm 23 emits sound into the passenger compartment 200 and through the partially open gating devices 31, 32 back to the port of the air communication channel 25. There may potentially be some influence, but it is possible to minimize it with varying the length of at least some of the air ducts of the air conditioning system 2, so that the fan 3 and the length of the air ducts increase the acoustical impedance and function as silencer, and noise and influence of reversed

back sound are reduced.

Claims

1. A vehicle installation structure (1), comprising

   - an air duct (4) configured to form part of a ventilation system (2) of a vehicle for introducing outside air (10) from an outside space (100) of the vehicle to an inside passenger space (200) of the vehicle,
   - the air duct (4) comprising a first terminal (41) for coupling to an opening (51) in a partition panel (50) of the vehicle which separates the outside space (100) from an inner space (300) of the vehicle,
   - the air duct (4) comprising a second terminal (42) for coupling to a fan (3) causing the outside air (10) to flow from the outside space (100) of the vehicle to the inside passenger space (200) of the vehicle,
   - a loudspeaker device (20) comprising a driver (22) and a diaphragm (23), and which is configured to emit sound (5) towards the passenger space (200) of the vehicle from a first side (231) of the diaphragm (23),
   - the loudspeaker device (20) further comprising a housing (21) surrounding a second side (232) of the diaphragm (23) opposite the first side (231) and a communication channel (25) which is configured to allow a back chamber (26) of the housing (21) facing the second side (232) of the diaphragm (23) to communicate with the outside space (100) of the vehicle,
   - wherein the communication channel (25) of the loudspeaker device (20) is connected to the air duct (4) between the first terminal (41) and the second terminal (42).

2. The vehicle installation structure according to claim 1, wherein the air duct (4) is configured to form part of an air conditioning system (2) of the vehicle.

3. The vehicle installation structure according to claim 1 or 2, wherein the air duct (4) is integrally formed with, or forms part of, a box of the ventilation system (2) for accommodating the fan (3).

4. The vehicle installation structure according to one of claims 1 to 3, further comprising,

   - a recirculating air duct (7) connected to the air duct (4) at a third terminal (43) arranged between the first terminal (41) and the second terminal (42),
   - a first gating device (31) for regulating an air flow in the air duct (4) between a closed position preventing air to flow in the air duct (4) and an open position enabling air to flow in the air duct (4), the first gating device (31) disposed in the air duct (4) between the first terminal (41) and the third terminal (43),
   - a second gating device (32) disposed in the recirculating air duct (7) for regulating an air flow in the recirculating air duct (7) between a closed position preventing air to flow in the recirculating air duct (7) and an open position enabling air to flow in the recirculating air duct (7),
   - the communication channel (25) of the loudspeaker device (20) is connected to the air duct (4) between the first terminal (41) and the first gating device (31).

5. The vehicle installation structure according to one of claims 1 to 4, wherein the diaphragm (23) has a cone shape and is supported by an outer circumferential portion of a frame (24), wherein the concave side of the diaphragm (23) forms the first side (231) of the diaphragm.

6. The vehicle installation structure according to one of claims 1 to 5, wherein the loudspeaker device (20) is configured such that the diaphragm (23) vibrates at a frequency in a sub-woofer frequency range.

7. A vehicle structure comprising a vehicle partition panel (50) and a vehicle installation structure (1) according to any of the preceding claims, wherein the air duct (4) is arranged to introduce outside air (10) from the outside space (100) of the vehicle to the inside passenger space (200) of the vehicle through the opening (51) in the vehicle partition panel (50).

8. The vehicle structure according to claim 7, wherein the vehicle partition panel (50) forms an outer skin portion of a vehicle body.

9. The vehicle structure according to one of claims 7 or 8, wherein the air duct (4) is positioned in a vehicle compartment in front of the passenger space (200) of the vehicle, in a part of the vehicle beneath or in front of a dashboard of the vehicle, or in the dashboard of the vehicle.

10. A vehicle comprising a vehicle structure according to one of claims 7 to 9.

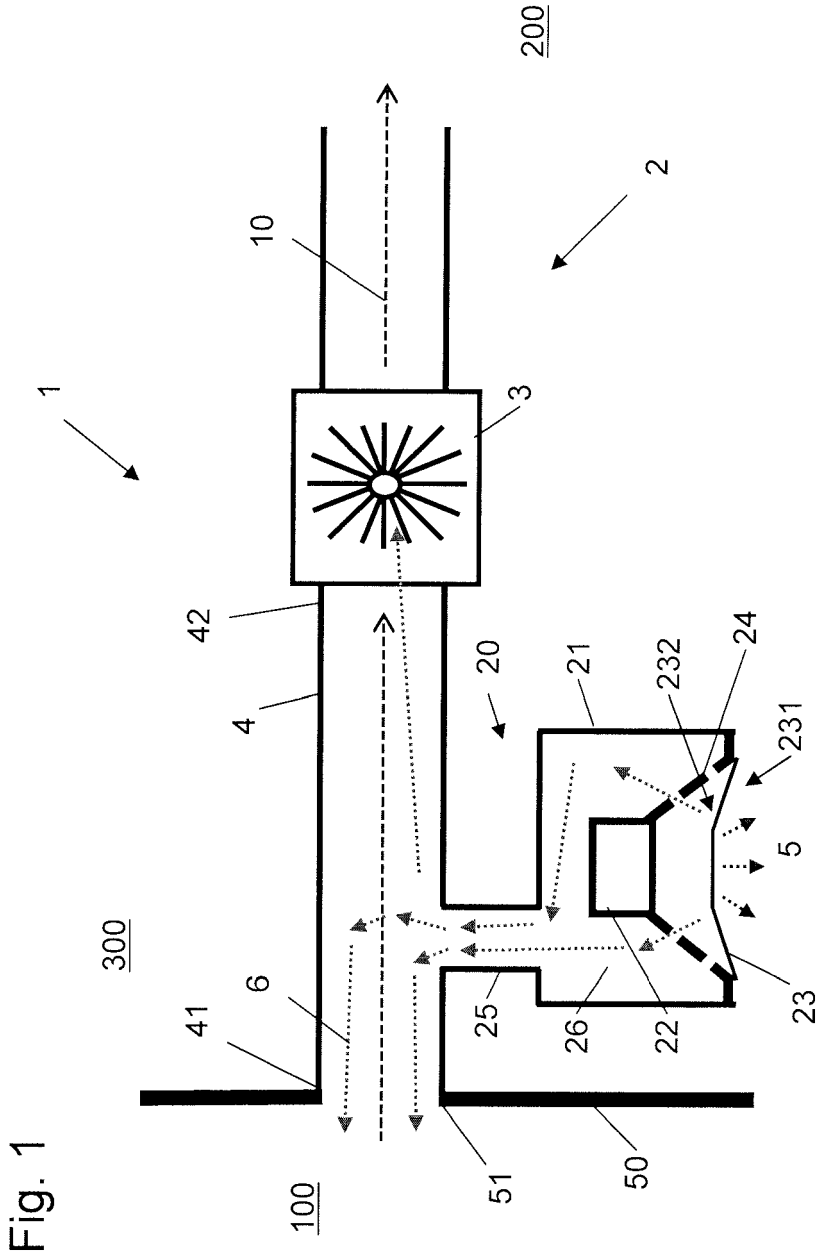
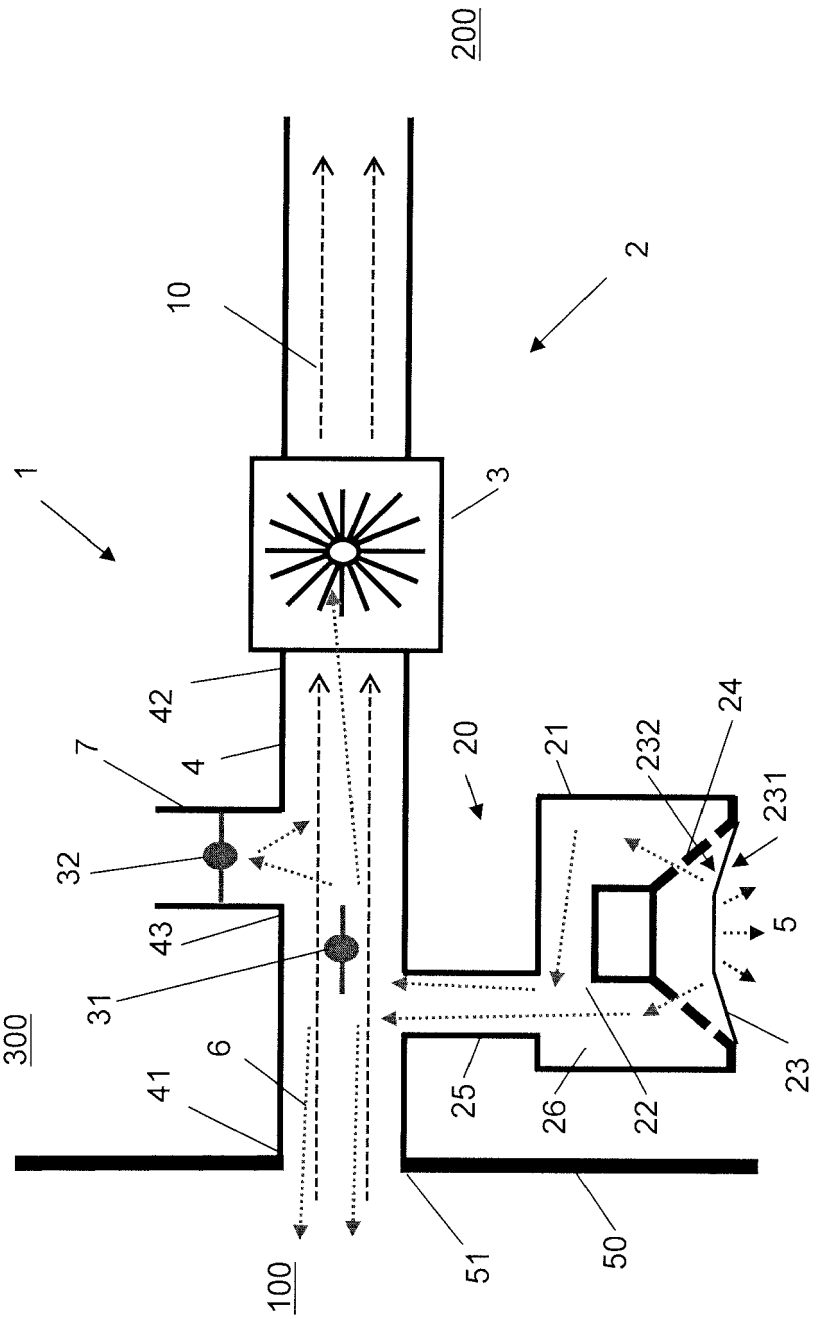


Fig. 1

Fig. 2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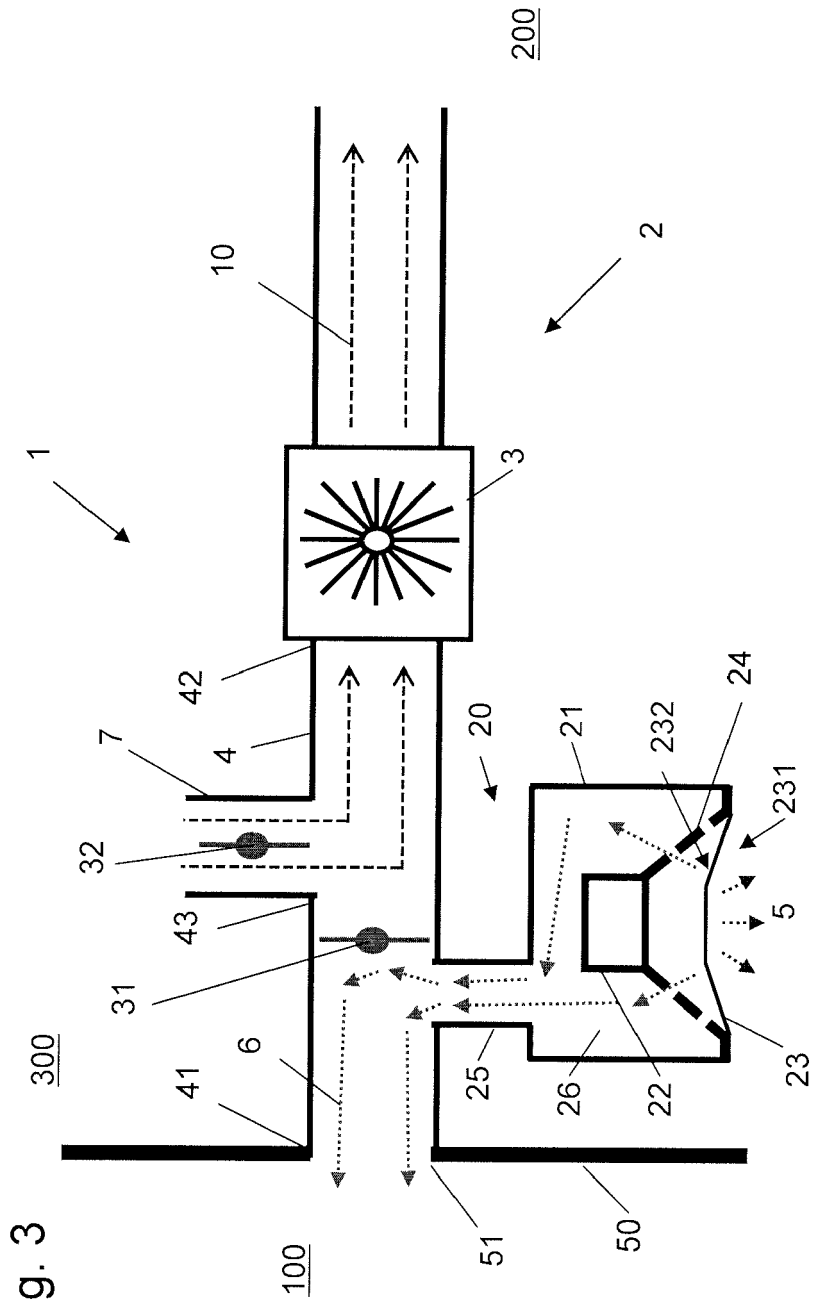
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Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 17 18 8283

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	EP 2 941 011 A1 (ALPINE ELECTRONICS INC [JP]) 4 November 2015 (2015-11-04) * column 5, paragraph 22 - column 8, paragraph 38 * * figure 2 * * claims 1-11 * -----	1-3,5-10 4	INV. H04R1/28
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			TECHNICAL FIELDS SEARCHED (IPC)
			H04R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 February 2018	Meiser, Jürgen

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

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23-02-2018

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- EP 2858377 A1 **[0005]**