An inside air/ outside air switching device that includes: an inside air/ outside air switching case that has an outside air inlet which opens into an engine room, a first inside air inlet and a second inside air inlet which open into a vehicle compartment; an inside air/ outside air switching door that is provided in the inside air/ outside air switching case, and that switches the open intake between the first inside air inlet and the outside air inlet; an inside air introduction support door that opens and closes the second inside air inlet; and a noise insulation member that is provided in such a manner that an operation of the inside air introduction support door is not interfered with, and that blocks out noise which is generated in the engine room and which proceeds from the outside air inlet toward the second inside air inlet when the outside air inlet is open.
INSIDE AIR/OUTSIDE AIR SWITCHING DEVICE

INCORPORATION BY REFERENCE


BACKGROUND OF THE INVENTION

The invention relates generally to an inside air/outside air switching device that has an inside air inlet and a second inside air inlet which opens into a vehicle compartment, and an outside air inlet which opens into an engine room, and more specifically to a technology for minimizing noise that leaks from the engine room into the vehicle compartment through the second inside air inlet.

Description of the Related Art

An inside air/outside air switching device of the above-mentioned type is described in, for example, Japanese Patent Application Publication No. 2002-137621 (JP-A-2002-137621). In the inside air/outside air switching device, a second inside air inlet is formed at a position between an inside air/outside air switching device, which switches an open inlet between a first inside air inlet and an outside air inlet, and an air filter, and an inside air introduction support door that opens and closes the second inside air inlet.

The inside air introduction support door opens the second inside air inlet when the inside air/outside air switching device is in the outside air introduction mode in which the outside air is drawn into the inside air/outside air switching device through the outside air inlet. Thus, the outside air is introduced into the inside air/outside air switching device through the outside air inlet and part of the inside air is introduced into the inside air/outside air switching device through the second inside air inlet.

When the inside air/outside air switching device according to JP-A-2002-137621 is in the outside air introduction mode in which the outside air inlet is open, the second inside air inlet is also open. Therefore, engine noise may enter the inside air/outside air switching device through the outside air inlet and then leak into a vehicle compartment through the second inside air inlet.

SUMMARY OF THE INVENTION

The invention provides an inside air/outside air switching device that has a first inside air inlet, a second inside air inlet, and an outside air inlet, and that is structured in such a manner that noise that leaks into a vehicle compartment through the second inside air inlet is minimized.

An aspect of the invention relates to an inside air/outside air switching device that includes: an inside air/outside air switching case that has an outside air inlet which opens into an engine room, a first inside air inlet which opens into a vehicle compartment, and a second inside air inlet which opens into the vehicle compartment and which is formed in the side wall of the inside air/outside air switching case; an inside air/outside air switching door that is provided in the inside air/outside air switching case, and that switches an open inlet between the first inside air inlet and the outside air inlet; an inside air introduction support door that opens and closes the second inside air inlet; and a noise insulation member that is provided in such a manner that the noise insulation member does not interfere with the operation of the inside air introduction support door, and that blocks out noise which is generated in the engine room and which proceeds from the outside air inlet toward the second inside air inlet when the outside air inlet is open. The inside air/outside air switching device according the aspect of the invention may further include an air blasting unit that is provided at a position which is downstream of the inside air introduction support door in the direction of air flow, and that takes in the air introduced into the inside air/outside air switching case through the inlets. In the inside air/outside air switching device, the inside air introduction support door may be provided at a position that is downstream of the inside air/outside air switching door in the direction of air flow and that is on the inner side of the second inside air inlet, may move inward from the inner wall face of the inside air/outside air switching case when the inside air introduction support door opens the second inside air inlet, and may open and close the second inside air inlet based on a change in the pressure in the inside air/outside air switching case when the outside air inlet is open, and the noise insulation member may be provided at a position outside but near the operation range of the inside air introduction support door.

According to the aspect of the invention described above, the noise that is generated in the engine room and enters the inside air/outside air switching case is blocked out by the noise insulation member. With this structure, even if the second inside air inlet is open, the noise that leaks into the vehicle compartment is minimized.

The inside air/outside air switching device described above may further include an air filter that is provided between the inside air introduction support door and the air blasting unit, and that filters the air introduced into the inside air/outside air switching case through the inlets. The noise insulation member may be formed of two side portions, may have a substantially L-shaped cross section, and may be provided in such a manner that the noise insulation member covers the inside air introduction support door. The inside face of an end of one of the side portions may contact the upper end of the inside air introduction support door. A small space may be left between the lower end of the other side portion and the air filter. In addition, a small space may be left between each of both longitudinal ends of the side portions and the inner wall face of the inside air/outside air switching case.

The noise that is generated in the engine room and enters the inside air/outside air switching case through the outside air inlet proceeds toward the second inside air inlet through the spaces. However, a labyrinth structure is formed because the spaces are small. Therefore, the noise that leaks into the vehicle compartment through the second inside air inlet is minimized.

The inside air/outside air switching device described above may further include an air volume adjustment plate that is provided between the inside air introduction support door and the air blasting unit, and that has a blast resistance which is substantially equal to a blast resistance of an air filter that filters the air introduced into the inside air/outside air switching case through the inlets. The noise insulation member may be formed of two side portions, may have a substantially L-shaped cross section, and may be provided in such a manner that the noise insulation member covers the inside air introduction support door. The inside face of an end
of one of the side portions may contact the upper end of the inside air introduction support door. A small space may be left between the lower end of the other side portion and the air volume adjustment plate. In addition, a small space may be left between each of both longitudinal ends of the side portions and the inner wall face of the inside air/inside air switching case.

[0014] The noise that is generated in the engine room and enters the inside air/inside air switching case through the outside air inlet proceeds to the second inside air inlet through the spaces. However, a labyrinth structure is formed because the spaces are small. Therefore, the noise that leaks into the vehicle compartment through the second inside air inlet is minimized.

[0015] The noise insulation member may be formed of two side portions, may have a substantially L-shaped cross section, and may be provided in such a manner that the noise insulation member covers the inside air introduction support door. The inside face of one end of one of the side portions may contact the upper end of the inside air introduction support door. A space, through which the air that is introduced into the inside air/inside air switching case through the second inside air inlet flows, may be left between the lower end of the other side portion and the upper plate of the air blasting unit.

[0016] With this structure, the noise that is generated in the engine room and enters the inside air/inside air switching device through the outside air inlet is blocked out by the noise insulation member that has the substantially L-shaped cross section. Therefore, the noise that leaks into the vehicle compartment through the second inside air inlet is minimized.

[0017] Side plates may be provided at respective longitudinal ends of the noise insulation member, and each of the side plates may connect one of the side portions to the other side portion. With this structure, the noise that leaks into the vehicle compartment is minimized more reliably because the length of the spaces in the depth direction is increased.

[0018] The pressure in the inside air/inside air switching case when the outside air inlet is open may be determined based on the pressure of the outside air that is introduced into the inside air/inside air switching case through the outside air inlet and the intake negative pressure that is generated when the air blasting unit is driven. When the pressure in the inside air/inside air switching case is lower than the pressure of the inside air, the inside air introduction support door may be drawn inward from the inner wall face to open the second inside air inlet. When the pressure in the inside air/inside air switching case is higher than the pressure of the inside air, the inside air introduction support door may be pushed against the inner wall face of the inside air/inside air switching case to close the second inside air inlet. With this structure, a device that generates power for operating the inside air introduction support door need not be provided, and part of the inside air is introduced into the inside air/inside air switching case through the second inside air inlet.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0019] The features, advantages, and technical and industrial significance of this invention will be described in the following detailed description of example embodiments of the invention with reference to the accompanying drawings, in which the same or corresponding portions will be denoted by the same reference numerals, and wherein:

[0020] FIG. 1 is a view schematically showing the overall structure of an inside air/inside air switching device according to a first embodiment of the invention;

[0021] FIG. 2 is a perspective view showing the appearance of a noise insulation member according to the first embodiment of the invention;

[0022] FIG. 3 is a partially-cutout perspective view showing the inside air/inside air switching device according to the first embodiment of the invention;

[0023] FIG. 4 is a front view showing the state in which an inside air introduction support door is fitted;

[0024] FIG. 5 is a graph showing comparison between the noise level when the noise insulation member according to the first embodiment of the invention is provided and the noise level when no noise insulation member is provided;

[0025] FIG. 6 is a perspective view showing the appearance of a noise insulation member according to a second embodiment of the invention;

[0026] FIG. 7 is a view schematically showing the overall structure of the inside air/inside air switching device according to a third embodiment of the invention; and

[0027] FIG. 8 is a view schematically showing the overall structure of an inside air/inside air switching device according to a fourth embodiment of the invention.

**DETAILED DESCRIPTION OF THE EMBODIMENTS**

[0028] Hereafter, an inside air/inside air switching device according to a first embodiment of the invention will be described with reference to FIGS. 1 to 5. FIG. 1 is a view schematically showing the overall structure of the inside air/inside air switching device. FIG. 2 is a perspective view showing the appearance of a noise insulation member. FIG. 3 is a partially-cutout perspective view showing the inside air/inside air switching device. FIG. 4 is a front view showing the state in which an inside air introduction support door is fitted.

[0029] As shown FIGS. 1 to 3, the inside air/inside air switching device according to the first embodiment of the invention includes an inside air/inside air switching case 10 and an air blasting unit 20. The inside air/inside air switching device is provided at the front portion of a vehicle compartment of a vehicle. The inside air/inside air switching device is arranged below a dashboard and on the side of a front passenger seat. The inside air/inside air switching case 10 is formed of a case made of synthetic resin, and the air blasting unit 20 is connected to the bottom of the inside air/inside air switching case 10. The inner space of the inside air/inside air switching case 10 is communicated with a bell-mouthed inlet 21 of the air blasting unit 20.

[0030] The inside air/inside air switching case 10 has a first inside air inlet 11 and a second inside air inlet 17 (described later in detail) through which the air in the vehicle compartment is introduced into the inside air/inside air switching case 10, and an outside air inlet 12 through which the air outside the vehicle compartment is introduced into the inside air/inside air switching case 10. The first inside air inlet 11 and the second inside air inlet 17 open into the vehicle compartment, and the outside air inlet 12 opens into the engine room. The vehicle compartment and the engine room are separated from each other by a dash panel D.

[0031] A rotary door 13, which is an inside air/inside air switching door that is used to switch the air that is introduced into the inside air/inside air switching case 10 between the
inside air and the outside air, is provided at a position that is downstream of the first inside air inlet 11 and the outside air inlet 12 in the direction of air flow. The rotary door 13 is arranged so as to pivot about right and left pivot shafts 13c. The rotary door 13 is formed of a peripheral wall 13a having an arc-shaped cross section, and fan-shaped side plates 13b that are formed at respective sides of the peripheral wall 13a.

The peripheral wall 13a pivots about the pivot shafts 13c. End portions of the pivot shafts 13c protrude from the right and left side plates 13b, respectively, outward in the axial direction of the pivot shafts 13c. The right and left pivot shafts 13c are rotatably supported by bearing holes 10a formed in the inside air/outside air switching case 10 (see FIG. 3). The pivot shafts 13c are allowed to rotate within a range of approximately 70 degrees.

Flanges 13d are formed on the entire ends of the peripheral wall 13a and flanges 13e are formed on the entire ends of the side plates 13b. The flanges 13d are formed on the peripheral wall 13a at the ends in the circumferential direction of the peripheral wall 13a, and project from the ends outward in the radial direction. The flanges 13e are formed at both ends of each of the right and left side plates 13b, and project from the ends outward in the axial direction of the pivot shafts 13c.

The rotary door 13 may be made of resin, for example, polypropylene, and is easily produced by forming the above-described portions 13a to 13c integrally with each other. Thin gaskets 14 and 15 are fixed all over the respective faces of the flanges 13d and 13e with, for example, an adhesive agent. The gaskets 14 and 15 provide air-tight sealing when the first inside air inlet 11 or the outside air inlet 12 is closed by the rotary door 13.

Thermoplastic elastomer is preferably used as the material for the gaskets 14 and 15. The thermoplastic elastomer is an elastic body that exhibits rubber elasticity at ordinary temperatures and that softens and exhibits liquidity (thermoplasticity) at high temperatures. Therefore, the thermoplastic elastomer is formed into shapes in a manner similar to a manner in which ordinary thermoplastic resin is formed into shapes. Therefore, the gaskets 14 and 15 may be formed integrally with the rotary door 13.

The first inside air inlet 11 has a peripheral portion opening 11a that faces the peripheral wall 13a of the rotary door 13 and side portion openings 11b that extend from the peripheral portion opening 1a toward the pivot shafts 13c. That is, when the rotary door 13 opens the first inside air inlet 11, not only a portion that corresponds to the peripheral wall 13a of the rotary door 13 but also portions that correspond to the side plates 13b of the rotary door 13 are open. In contrast, the outside air inlet 12 is formed only of a peripheral portion opening that faces the peripheral wall 13a of the rotary door 13.

The up-down direction, the right-left direction, and the front-rear direction shown in FIGS. 1 and 3 show the directions of the inside air/outside air switching device when the inside air/outside air switching device is mounted in the vehicle. The pivot shafts 13c for the rotary door 13 are arranged at substantially the center of the inside air/outside air switching case 10 in the front-rear direction and below the inlets 11 and 12. Sealing faces 10h and 10e are formed at positions posterior to the pivot shafts 13c and sealing faces 10f and 10g are formed at positions anterior to the pivot shafts 13c. The sealing faces 10b, 10c, 10d and 10e are inclined downward toward the pivot shafts 13c. Sealing faces 10f and 10g are formed at positions above the pivot shafts 13c.

The sealing faces 10b to 10g are formed in such a manner that flanges 13d and 13e contact the sealing faces 10d, 10c, 10e and 10g when the rotary door 13 is at a position at which the inside air is introduced into the inside air/outside air switching case 10 (position indicated by two-dot chain lines in FIG. 1), and the flanges 13d and 13e contact (are brought into surface contact with) the sealing faces 10b, 10c, 10e and 10g when the rotary door 13 is at a position at which the outside air is introduced into the inside air/outside air switching case 10 (position indicated by solid lines in FIG. 1).

The inside air/outside air switching case 10 having the above-described structure includes at least two cases 10j and 10k that are separately formed. The inside air/outside air switching case 10 is formed by arranging the separate cases 10j and 10k next to each other in the longitudinal direction of the rotary door 13, that is, the right-left direction of the vehicle and then connecting the cases 10j and 10k integrally with each other. The sealing faces 10b to 10g are formed integrally with the inside air/outside air switching case 10.

A switching link member 16 made of resin (see FIG. 3) is connected integrally with one end of the pivot shaft 13c of the rotary door 13. A manual operation force, which is applied to an inside air/outside air switching operation member (e.g., manual operation lever) provided in an air-conditioning operation panel (not shown), is transmitted from the switching link member 16 to the pivot shaft 13c via, for example, a cable to cause the rotary door 13 to pivot about the pivot shafts 13c.

An air filter 30 is provided in the inside air/outside air switching device. In the air filter 30, a filter member formed of, for example, corrugated Japanese paper or a porous urethane foam is supported by a frame made of resin. The air filter 30 has a flat plate shape as shown in FIG. 1, and removes dust in the air. When required, the filter member may be provided with an absorbent, for example, activated charcoal, which absorbs malodorous components. In this way, the filter member offers odorization performance.

In the inside air/outside air switching case 10, the air filter 30 is provided at a position downstream of the pivot shafts 13c of the rotary door 13 in the direction of air flow so that the air filter 30 does not interfere with the pivot motion of the rotary door 13. The air blasting unit 20 includes a blast fan 22 formed of a centrifugal multiblade blower, a drive motor 23, and a casing 24. The casing 24 is made of resin material, and formed in a scroll shape.

The blast fan 22 is driven by the motor 23 so that the air taken in the blast fan 22 through the inlet 21 flows outward in the radial direction of the blast fan 22 as indicated by an arrow A. An air outlet 25 of the casing 24 is connected to an air-conditioning duct (not shown). The blast fan 22 and the motor 23 may be included in an air blasting unit according to the invention.

A heat exchanger for cooling air, a heat exchanger for heating air, etc. are housed in the air-conditioning duct. The air delivered from the air blasting unit 20 is cooled, dehumidified, and re-heated while passing through the air-
conditioning duct. In this way, the temperature of the air is adjusted. Then, the air is introduced into the vehicle compartment.

[0046] The second inside air inlet 17 is formed in the inside air/outside air switching case 10 at a side wall on the vehicle front side. In addition, the second inside air inlet 17 is formed at a position below the outside air inlet 12. That is, the second inside air inlet 17 is formed at a position between the rotary door 13 and the air filter 30. An inside air introduction support door 18, which opens and closes the second inside air inlet 17, is arranged on the inner side of the second inside air inlet 17, that is, at a position closer to the rear of the vehicle than the second inside air inlet 17. The inside air introduction support door 18 is arranged in such a manner that the inside air introduction support door 18 does not interfere with the pivot motion of the rotary door 13.

[0047] As shown in FIGS. 1 and 4, the inside air introduction support door 18 includes a door member 18a, which is formed of a thin rectangular plate, and a pivot shaft 18c. A gasket 18b is fitted on a face of the door member 18a, which faces the second inside air inlet 17. The gasket 18b provides airtight sealing when the inside air introduction support door 18c contacts a sealing face 17a (see FIG. 1) in the side wall, which defines the second inside air inlet 17. Therefore, for example, porous elastic material, for example, a urethane foam or the above-described thermoplastic elastomer may be used as the material for the gasket 18b.

[0048] Both ends of the pivot shaft 18c are rotatably supported by bearing holes 10b that are formed in the inside air/outside air switching case 10, at positions above the second inside air inlet 17. When the operation of the blast fan 22 does not operate, the inside air introduction support door 18 according to the first embodiment of the invention is oriented in the vertical direction (direction of gravitational force) as indicated by solid lines in FIG. 1 so as to close the second inside air inlet 17.

[0049] The inside air introduction support door 18 opens and closes the second inside air inlet 17 in response to changes in the pressure in the inside air/outside air switching case 10. In the outside air mode in which the outside air inlet 12 is opened and the first inside air inlet 11 is closed by the rotary door 13, the pressure in the inside air/outside air switching case 10 is determined based on the pressure of the outside air that is introduced into the inside air/outside air switching case 10 through the outside air inlet 12, that is, the pressure of the outside air, which is influenced by the dynamic pressure that is generated when the vehicle travels, and the intake negative pressure that is generated when the blast fan 22 is driven.

[0050] More specifically, when the blast fan 22 rotates at a high speed, the intake negative pressure increases and the pressure in the inside air/outside air switching case 10 decreases. When the vehicle travels at a high speed, the dynamic pressure increases and the pressure in the inside air/outside air switching case 10 increases. When the vehicle compartment needs to be warmed up rapidly, for example, when a heater is turned on in winter, the voltage that is supplied to the drive motor 23 is maximized to maximize the rotational speed of the blast fan 22 (to maximize the volume of air delivered from the blast fan 22). In this way, the maximum heating capacity is utilized. As a result, the pressure in the inside air/outside air switching case 10 falls below the pressure in the vehicle compartment.

[0051] That is, the intake negative pressure is introduced into the area near the inside air introduction support door 18, which causes a pressure difference between the pressure in the area near the inside air introduction support door 18 and the pressure in the vehicle compartment, that is, the pressure outside the inside air/outside air switching case 10. Namely, a pressure change is caused in the inside air/outside air switching case 10. With the use of this pressure difference, the inside air introduction support door 18 moves inward from the inner wall face of the inside air/outside air switching case 10 as indicated by two dot chains line in FIG. 1. As a result, the second inside air inlet 17 is opened.

[0052] In other words, when the pressure in the inside air/outside air switching case 10 is lower than the pressure of the inside air, the inside air introduction support door 18 moves away from the second inside air inlet 17 and drawn inward from the inner wall face of the inside air/outside air switching case 10. As a result, the second inside air inlet 17 is opened. Thus, part of the inside air is drawn into the inside air/outside air switching case 10 through the second inside air inlet 17. The temperature of the inside air is higher than the low temperature of the outside air in winter. Therefore, if part of the inside air is mixed with the outside air, the temperature of the air at an inlet of the heat exchanger for heating air provided in the air-conditioning duct increases. As a result, the temperature of the air that is warmed while the air passes through the heat exchanger for heating is made higher than that when only the outside air is introduced into the inside air/outside air switching case 10. As a result, the heating efficiency is enhanced.

[0053] On the other hand, when the pressure in the inside air/outside air switching case 10 is higher than the pressure of the inside air, the inside air introduction support door 18 is pushed against the inner wall face of the inside air/outside air switching case 10, more specifically, the inner wall face at a portion around the second inside air inlet 17. As a result, the second inside air inlet 17 is closed. Thus, it is possible to avoid the situation where the low temperature outside air passes through the second inside air inlet 17 and directly flows into the vehicle compartment while the vehicle compartment is heated in the outside air mode.

[0054] The opening amount of the inside air introduction support door 18, in other words, the volume of inside air that is introduced into the inside air/outside air switching case 10 through the second inside air inlet 17 may be adjusted based on the relationship between the weight (gravity) of the inside air introduction support door 18 and the pressure of the air delivered from the blast fan 22. Accordingly, the required volume of inside air that is introduced into the inside air/outside air switching case 10 may be ensured by changing the weight of the inside air introduction support door 18.

[0055] A noise insulation member 19 is provided at a position that is outside but near the operation range of the inside air introduction support door 18. The noise insulation member 19 blocks out the noise generated in the engine room, which proceeds from the outside air inlet 12 toward the second inside air inlet 17 when the outside air inlet 12 is open.

[0056] As shown in FIGS. 1, 2 and 4, the cross section of the noise insulation member 19 is in a substantially L-shape. The noise insulation member 19 is formed of a side portion 19a and another side portion 19b. The inner side of the end portion of the side portion 19a contacts the inside air introduction support door 18 at a portion near the top of the pivot shaft 18c, that is, the upper end of the inside air introduction support
A small space S1 is left between the lower end of the side portion 19b and the upper face of the air filter 30 (see FIG. 1).

The space S1 left between the upper face of the air filter 30 and the noise insulation member 19 is determined in such a manner that the air filter 30 is attached to and detached from the inside air/outside air switching case 10 without hindrance. In addition, a small space S1 is left between each of both ends of the noise insulation member 19, that is, the side portions 19a and 19b, and the inner wall of the inside air/outside air switching case 10 (see FIG. 4). That is, the noise insulation member 19 is formed so as to cover the inside air introduction support door 18. The space S1 left between the inner wall of the inside air/outside air switching case 10 and the noise insulation member 19 may be smaller than the space between the side portion 19b and the upper face of the air filter 30.

With this structure, the noise that is generated in the engine room and that enters the inside air/outside air switching case 10 through the outside air inlet 12 is blocked out by the noise insulation member 19. The noise generated in the engine room leaks toward the second inside air inlet 17 through the small spaces S1. However, the noise that leaks toward the second inside air inlet 17 is minimized because a labyrinth structure is formed due to the small spaces S1.

Next, the operation of the inside air/outside air switching device having the above-described structure will be described. The air that is introduced into the inside air/outside air switching case 10 may be switched between the inside air and the outside air by pivoting the rotary door 13 about the pivot shafts 13c. To select the outside air introduction mode, the rotary door 13 is pivoted to the position indicated by the solid lines in FIG. 1 (FIG. 3 shows the case where the rotary door 13 is at the position at which the outside air is introduced into the inside air/outside air switching case 10).

Thus, the peripheral wall 13a of the rotary door 13 closes the peripheral portion opening 11a of the first inside air inlet 11, and the side plates 13b of the rotary door 13 close the side portion openings 11b of the first inside air inlet 11. At the same time, the peripheral wall 13a of the rotary door 13 moves away from the airflow path on the outside air inlet 12 side. As a result, the outside air inlet 12 is fully open.

The gaskets 14 and 15 fixed to the flanges 13a and 13c of the rotary door 13 are pressed against (brought into surface contact with) the sealing faces 10a, 10c, 10f, and 10g of the inside air/outside air switching case 10. Therefore, surface-sealing is provided between the entire ends of the rotary door 13 and the inside air/outside air switching case 10.

The space on the inner side of the rotary door 13 is entirely communicated with the outside air inlet 12 and a space upstream of the air filter 30 in the direction of air flow. Therefore, the outside air, which is introduced into the inside air/outside air switching case 10 through the outside air inlet 12 when the blast fan 22 is driven, flows through the space on the inner side of the rotary door 13 and uniformly introduced into the air filter 30.

Next, the introduced outside air passes through the air filter 30, and fine dust, malodorous components, etc. are absorbed in the air filter 30 and therefore removed from the air. Then, the introduced outside air from which fine dust, malodorous components, etc. are removed is drawn into the air blasting unit 20 through the inlet 21 and delivered toward the air-conditioning duct under pressure.

The intake negative pressure is introduced into the area near the air filter 30 and the inside air introduction support door 18 when the blast fan 22 is driven, which causes a pressure difference between the pressure in this area and the pressure in the vehicle compartment, that is, the pressure outside the inside air/outside air switching case 10. Due to this pressure difference, the inside air introduction support door 18 opens the second inside air inlet 17. That is, the inside air introduction support door 18 pivots to the position indicated by the two-dot chain lines in FIG. 1. As a result, the outside air is introduced into the inside air/outside air switching case 10 through the outside air inlet 12 and part of the inside air is introduced into the inside air/outside air switching case 10 through the second inside air inlet 17.

To select the inside air introduction mode, the rotary door 13 is pivoted clockwise by approximately 70 degrees from the position indicated by the solid lines in FIG. 1 to the position indicated by the two-dot chain lines in FIG. 1. Thus, the gaskets 14 and 15 fixed to the flanges 13a and 13c of the rotary door 13 are pushed against (brought into surface contact with) the sealing faces 10a, 10c, 10f, and 10g of the inside air/outside air switching case 10. Therefore, surface-sealing is provided between the entire ends of the rotary door 13 and the inside air/outside air switching case 10.

As a result, the outside air inlet 12 is closed and the first inside air inlet 11 is fully open. The inside air, which is introduced into the inside air/outside air switching case 10 through the first inside air inlet 11 when the blast fan 22 is driven, flows through the space on the inner side of the rotary door 13 and is uniformly introduced into the air filter 30.

The introduced inside air passes through the air filter 30, and fine dust, malodorous components, etc. are absorbed in the air filter 30 and therefore removed from the air. Then, the introduced inside air from which fine dust, malodorous components, etc. are removed is drawn into the air blasting unit 20 through the inlet 21 and delivered toward the air-conditioning duct under pressure.

In the inside air introduction mode as well the intake negative pressure is introduced into the area near the air filter 30 and the inside air introduction support door 18 when the blast fan 22 is driven, which causes a pressure difference between the pressure in the area and the pressure in the vehicle compartment, that is, the pressure outside the inside air/outside air switching case 10. Due to this pressure difference, the inside air introduction support door 18 pivots to open the second inside air inlet 17. As a result, the inside air is introduced into the inside air/outside air switching case 10 through the first inside air inlet 11 and part of the inside air is introduced into the inside air/outside air switching case 10 through the second inside air inlet 17.

Next, the noise insulating effect provided by the noise insulation member 19 will be described. FIG. 5 is a graph showing comparison between the noise level when the noise insulation member is provided and the noise level when no noise insulation member is provided. More specifically, FIG. 5 shows the comparison of the above-described noise levels near the ear of an occupant in the front passenger seat in the outside air introduction mode, in the case where the inside air/outside air switching device is mounted in the vehicle. A solid line in FIG. 5 shows the characteristic of the noise level when the noise insulation member 19 is provided at a position that is outside but near the operation range of the inside air introduction support door 18.
A dashed line in FIG. 5 shows the characteristic of the noise level when no noise insulation member 19 is provided. The graph shows that provision of the noise insulation member 19 decreases the noise level in the frequency range from approximately 1200 Hz to approximately 2500 Hz.

When the inside air/inside air switching device having the above-described structure is in the outside air introduction mode, the outside air is introduced into the inside air/inside air switching case 10 through the outside air inlet 12 and part of the inside air is introduced into the inside air/inside air switching case 10 through the second inside air inlet 17. Therefore, the noise generated in the engine room enters the inside air/inside air switching case 10 through the outside air inlet 12 and proceeds toward the second inside air inlet 17. However, the noise generated in the engine room, which enters the inside air/inside air switching case 10 through the outside air inlet 12, is blocked out by the noise insulation member 19.

The noise generated in the engine room leaks toward the second inside air inlet 17 through the small spaces S1. However, the noise that leaks toward the second inside air inlet 17 is minimized because the labyrinth structure is formed due to the small spaces S1. Thus, even if the second inside air inlet 17 is open, the noise that leaks into the vehicle compartment is minimized.

In addition, if the inside air introduction support door 18 is opened with the use of the intake negative pressure that is generated when the blast fan 22 is driven, part of the inside air is introduced into the inside air/inside air switching case 10 through the second inside air inlet 17 not only in the outside air introduction mode but also in the inside air introduction mode. Also, a component used to open and close the inside air introduction support door is, for example, a link member, is no longer necessary, which reduces the component cost.

Next, a second embodiment of the invention will be described. FIG. 6 is a perspective view showing the appearance of a noise insulation member according to the second embodiment of the invention. As shown in FIG. 6, the noise insulation member 19 according to the second embodiment of the invention is provided with side plates 19c that are arranged at respective longitudinal ends of the noise insulation member 19, and that connect the side portion 19a and the side portion 19b to each other. That is, the noise insulation member 19 is provided with side walls formed of the side plates 19c.

With this structure, the length of the space S1 between the upper face of the air filter 30 and the noise insulation member 19 in the depth direction and the length of the space S1 between the noise insulation member 19 and the inner wall of the inside air/inside air switching case 10 in the depth direction are increased. Therefore, the noise that is generated in the engine room that enters the inside air/inside air switching case 10 through the outside air inlet 12 is reduced. Thus, it is possible to reduce the noise that leaks into the vehicle compartment through the second inside air inlet 17.

Next, a third embodiment of the invention will be described. In the embodiments of the invention described above, the air filter 30 is provided between the inside air introduction support door 18 and the air blasting unit 20. Instead of the air filter 30, an air volume adjustment plate 40 may be provided. FIG. 7 is a view schematically showing the overall structure of an inside air/inside air switching device according to the third embodiment of the invention. In the inside air/inside air switching case 10 according to the third embodiment of the invention, the air volume adjustment plate 40 is provided at a position that is downstream of the inside air introduction support door 18 in the direction of air flow, as shown in FIG. 7.

The air volume adjustment plate 40 is used as a substitute for the air filter 30 after the air filter 30 is removed from the inside air/inside air switching case 10. The air volume adjustment plate 40 is a pressure loss adjustment plate that is used to adjust the volume of the intake air that is introduced through the inlets 11, 12, and 17. In the third embodiment of the invention, the air volume adjustment plate 40 has a draft resistance that is substantially equal to the draft resistance of the air filter 30. That is, the air volume adjustment plate 40 is formed in such a manner that the draft resistance thereof is substantially equal to the draft resistance of the air filter 30.

Therefore, the air volume adjustment plate 40 is formed in such a manner that the air volume adjustment plate 40 is easily attached to and detached from the inside air/inside air switching case 10 as in the case of the air filter 30, and is formed of a porous plate 41 that has a large number of draft holes 42. Accordingly, if the air volume adjustment plate 40 is arranged in place of the air filter 30 after the air filter 40 is removed, the volume of the air that passes through the air volume adjustment plate 40 is adjusted in a manner substantially same as that when the air filter 30 is arranged.

As in the embodiments of the invention described above, the noise insulation member 19 is arranged in such a manner that the inner side of the end portion of the side portion 19a contacts the inside air introduction support door 18 at a portion near the top of the pivot shaft 18c, that is, the upper end of the inside air introduction support door 18. A small space S1 is left between the lower end of the side portion 19b and the upper face of the air volume adjustment plate 40 (see FIG. 7).

The amount of space S1 left between the upper face of the air volume adjustment plate 40 and the noise insulation member 19 is determined in such a manner that the air volume adjustment plate 40 is attached to and detached from the inside air/inside air switching case 10 without hindrance. Thus, the noise that is generated in the engine room that enters the inside air/inside air switching case 10 through the outside air inlet 12 is blocked out by the noise insulation member 19. A small space S1 is left between each of the both ends of the noise insulation member 19, that is, the side portions 19a and 19b, and the inner wall of the inside air/inside air switching case 10 (see FIG. 4), as in the above-described embodiments.

A fourth embodiment of the invention will be described. In the embodiments of the invention described above, the air filter 30 or the air volume adjustment plate 40 is arranged between the inside air introduction support door 18 and the air blasting unit 20. However, the inside air/inside air switching case 10 that includes neither the air filter 30 nor the air volume adjustment plate 40 may be used. FIG. 8 is a view schematically showing the overall structure of the inside air/inside air switching device according to the fourth embodiment of the invention.

As shown in FIG. 8, the air blasting unit 20 is provided at a position that is directly downstream of the inside air introduction support door 18 in the direction of air flow. For example, the inside air/inside air switching case 10 accord-
ing to the fourth embodiment of the invention is used when the air filter 30 is provided in the air-conditioning duct (not shown) connected to a downstream-side portion of the air blasting unit 20.

Accordingly, a space S2 is left between the lower end of the side portion 19b of the noise insulation member 19 according to the fourth embodiment of the invention and an upper plate 24a of the casing 24 of the air blasting unit 20. The space S2 is larger than the small space S1.

The space S2 according to the fourth embodiment of the invention is set in such a manner that the intake air introduced into the inside air/outside air switching case 10 through the second inside air inlet 17 flows toward the inlet 21 of the casing 24. Therefore, when the second inside air inlet 17 is opened in response of a change in the pressure in the inside air/outside air switching case 10, the intake air introduced into the inside air/outside air switching case 10 through the second inside air inlet 11 is drawn by the blast fan 22.

With the inside air/outside air switching device having the structure described above, the noise that is generated in the engine room that enters the inside air/outside air switching case 10 through the outside air inlet 12 is blocked out by the noise insulation member 19 that has the substantially L-shaped cross section. Accordingly, it is possible to reduce the noise that leaks into the vehicle compartment through the second inside air inlet 17.

In the embodiments of the invention described above, the noise insulation member 19 is larger than the inside air introduction support door 18 when viewed in the front-rear direction of the vehicle. Alternatively, the noise insulation member 19 may be equal to or smaller than the inside air introduction support door 18 when viewed in the front-rear direction of the vehicle.

In the embodiments of the invention described above, the inside air introduction support door 18 is formed by forming the door member 18a and the pivot shaft 18b integrally with each other and fitting the gasket 18b to the door member 18a. Alternatively, the inside air introduction support door 18 may be formed by forming material, for example, thermoplastic elastomer, in an elastically deformable sheet shaped plate door.

More specifically, a plate door is formed of a single sheet, and only one face of an upper portion of the sheet is fixed to an upper portion of the inner wall face around the second inside air inlet 17. Thus, the second inside air inlet 17 may be opened and closed in response to a change in the pressure in the inside air/outside air switching case 10.

In the embodiments of the invention described above, the inside air introduction support door 18 may be opened and closed based on an intake negative pressure generated by the blast fan 22. Alternatively, the inside air introduction support door 18 may be opened and closed by an actuator, for example, a servo motor.

While the invention has been described with reference to example embodiments thereof, it is to be understood that the invention is not limited to the example embodiments or constructions. To the contrary, the invention is intended to cover various modifications and equivalent arrangements. In addition, while the various elements of the example embodiments are shown in various combinations and configurations, which are example, other combinations and configurations, including more, less or only a single element, are also within the scope of the invention.

What is claimed is:

1. An inside air/outside air switching device, comprising: an inside air/outside air switching case that has an outside air inlet which opens into an engine room, a first inside air inlet which opens into a vehicle compartment, and a second inside air inlet which opens into the vehicle compartment and which is formed in a side wall of the inside air/outside air switching case; an inside air/outside air switching device, that is provided in the inside air/outside air switching case, and that switches an open inlet between the first inside air inlet and the outside air inlet; an inside air introduction support door that opens and closes the second inside air inlet; and a noise insulation member that is provided in such a manner that the noise insulation member does not interfere with an operation of the inside air introduction support door, and that blocks out noise which is generated in the engine room and which proceeds from the outside air inlet toward the second inside air inlet when the outside air inlet is open.

2. The inside air/outside air switching device according to claim 1, further comprising an air blasting unit that is provided at a position which is downstream of the inside air introduction support door in a direction of air flow, and that takes in air introduced into the inside air/outside air switching case through the inlet, wherein:

the inside air introduction support door is provided at a position that is downstream of the inside air/outside air switching door in the direction of air flow and that is on an inner side of the second inside air inlet, moves inward from an inner wall face of the inside air/outside air switching case when the inside air introduction support door opens the second inside air inlet, and opens and closes the second inside air inlet based on a change in a pressure in the inside air/outside air switching case when the outside air inlet is open; and

the noise insulation member is provided at a position outside but near an operation range of the inside air introduction support door.

3. The inside air/outside air switching device according to claim 2, wherein:

the pressure in the inside air/outside air switching case when the outside air inlet is open is determined based on a pressure of outside air that is introduced into the inside air/outside air switching case through the outside air inlet and an intake negative pressure that is generated when the air blasting unit is driven;

when the pressure in the inside air/outside air switching case is lower than a pressure of inside air, the inside air introduction support door is drawn inward from the inner wall face to open the second inside air inlet; and

when the pressure in the inside air/outside air switching case is higher than the pressure of the inside air, the inside air introduction support door is pushed against the inner wall face of the inside air/outside air switching case to close the second inside air inlet.

4. The inside air/outside air switching device according to claim 2, wherein:

the noise insulation member is provided in such a manner that the noise insulation member covers the inside air introduction support door;

a space, through which the air that is introduced into the inside air/outside air switching case through the second
inside air inlet flows, is left between a downstream-side end of the noise insulation member and an upper plate of the air blasting unit; and
an end of the noise insulation member, which is on an opposite side of the downstream-side end, contacts the inner wall face of the inside air/outside air switching case.

5. The inside air/outside air switching device according to claim 4, wherein:
the noise insulation member is formed of two side portions, and has a substantially L-shaped cross section; and
an inside face of an end of one of the side portions, which is the end on the opposite side of the downstream-side end of the noise insulation member, contacts an upper end of the inside air introduction support door.

6. The inside air/outside air switching device according to claim 5, wherein:
side plates are provided at respective longitudinal ends of the noise insulation member; and
each of the side plates connects one of the side portions to the other side portion.

7. The inside air/outside air switching device according to claim 2, further comprising:
an air filter that is provided between the inside air introduction support door and the air blasting unit, and that filters the air introduced into the inside air/outside air switching case through the inlets, wherein:
the noise insulation member is provided in such a manner that the noise insulation member covers the inside air introduction support door;
a small space is left between a downstream-side end of the noise insulation member and the air filter;
an end of the noise insulation member, which is on an opposite side of the downstream-side end, contacts the inner wall face of the inside air/outside air switching case; and
a small space is left between each of both longitudinal ends of the noise insulation member and the inner wall face of the inside air/outside air switching case.

8. The inside air/outside air switching device according to claim 7, wherein:
the noise insulation member is formed of two side portions, and has a substantially L-shaped cross section; and
an inside face of an end of one of the side portions, which is the end on the opposite side of the downstream-side end of the noise insulation member, contacts an upper end of the inside air introduction support door.

9. The inside air/outside air switching device according to claim 8, wherein:
side plates are formed at respective longitudinal ends of the noise insulation member; and
each of the side plates connects one of the side portions to the other side portion.

10. The inside air/outside air switching device according to claim 2, further comprising:
an air volume adjustment plate that is provided at a position which is downstream of the inside air introduction support door in the direction of air flow, and that has a draft resistance which is substantially equal to a draft resistance of an air filter that filters the air introduced into the inside air/outside air switching case through the inlets, wherein:
the noise insulation member is provided in such a manner that the noise insulation member covers the inside air introduction support door;
a small space is left between a downstream-side end of the noise insulation member and the air volume adjustment plate;
an end of the noise insulation member, which is on an opposite side of the downstream-side end, contacts the inner wall face of the inside air/outside air switching case; and
a small space is left between each of both longitudinal ends of the noise insulation member and the inner wall face of the inside air/outside air switching case.

11. The inside air/outside air switching device according to claim 10, wherein:
the noise insulation member is formed of two side portions, and has a substantially L-shaped cross section; and
an end of the noise insulation member, which is on an opposite side of the downstream-side end of the noise insulation member, contacts an upper end of the inside air introduction support door.

12. The inside air/outside air switching device according to claim 11, wherein:
side plates are formed at respective longitudinal ends of the noise insulation member; and
each of the side plates connects one of the side portions to the other side portion.

13. The inside air/outside air switching device according to claim 1, further comprising:
a servo motor that opens and closes the inside air introduction support door.