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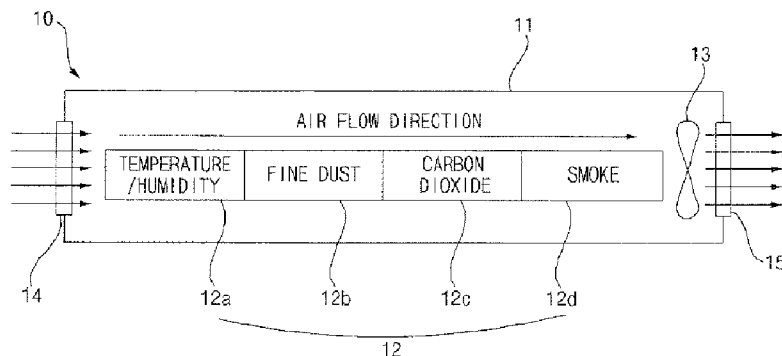
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(54) Title: ACTIVE AIR PURIFIER OF VEHICLE



(57) Abstract: Disclosed is an active air purifier of a vehicle. The disclosed active air purifier provides advantages in that it is possible to accurately detect air contamination sources at the inside and outside of the vehicle, through composite sensor modules, and to actively and rapidly perform air purification for a contamination estimation area associated with contamination of air at the inside of the vehicle, thereby providing a pleasant riding environment to passengers.

Description

Title of Invention: ACTIVE AIR PURIFIER OF VEHICLE

Technical Field

- [1] The present invention relates to an active air purifier of a vehicle, and more particularly to an active air purifier of a vehicle capable of accurately detecting air contamination sources at the inside and outside of the vehicle, through composite sensor modules, and actively and rapidly performing air purification for a contamination estimation area associated with contamination of air at the inside of the vehicle, thereby providing a pleasant riding environment to passengers.

Background Art

- [2] Generally, a vehicle is equipped with a vehicle air conditioning unit for introducing outdoor air present outside of the vehicle into a front machinery chamber, conditioning the introduced air, and then discharging into a passenger compartment, thereby air-conditioning the passenger compartment, or circulating unconditioned air, thereby ventilating the passenger compartment.
- [3] Meanwhile, use of a plurality of sensors to actively sense a contamination degree of indoor air present in a passenger compartment has recently been proposed in order to achieve active purification of indoor air in accordance with the kind of an air contamination source.
- [4] In a conventional vehicle air conditioning unit, however, a plurality of sensors is distributed at various positions in a passenger compartment. For this reason, there is a problem in that, when air contamination occurs in an area corresponding to a portion of the passenger compartment, a corresponding one of the sensors may not sense the air contamination.
- [5] Furthermore, although the plurality of sensors may be arranged in a concentrated manner to take the form of a module, this arrangement is simple collection of sensors. When the plurality of sensors takes the form of a module, the volume thereof is increased. In addition, a configuration of each sensor for power connection and communication of each sensor for transmission of sensing information are complex and, as such, signal transfer may be delayed.

Disclosure of Invention

Technical Problem

- [6] Therefore, the present invention has been made in view of the above problems, and it is an object of the present invention to provide an active air purifier of a vehicle, which is capable of rapidly determining an air contamination source of a passenger compartment, and rapidly recognizing contamination estimation areas corresponding to a

plurality of areas divided from the passenger compartment, using composite sensor modules achieving accurate sensing while having a miniature size, thereby rapidly and actively purifying indoor air, to achieve an enhancement in passenger convenience.

Advantageous Effects of Invention

- [7] In accordance with an exemplary embodiment of the active air purifier of the vehicle according to the present invention may achieve various effects as follows.
- [8] First, a plurality of sensors is arranged in series in a flow direction of sample air, to reduce deviations of the sensors caused by a position combination of the sensors. Accordingly, it may be possible to miniaturize the size of the sensor module, and to achieve an enhancement in accuracy of sensed values.
- [9] Second, air quality improving units are installed at a plurality of areas in a passenger compartment, to rapidly purify air present only in an area determined as a contamination estimation area by a corresponding one of the composite sensor modules. Accordingly, rapid purification may be achieved.
- [10] Third, a flow duct to discharge or introduce indoor air or outdoor air from or into the vehicle is provided, in addition to the existing vehicle air conditioning unit. Accordingly, it may be possible to achieve air purification of the outdoor air and indoor air in a separate manner in accordance with a difference between a contamination degree of the outdoor air and a contamination degree of the indoor air and, as such, it may be possible to establish a pleasant riding environment for passengers during driving of the vehicle.
- [11] Fourth, it may be possible to achieve rapid air purification for contamination estimation areas in various air purification modes.

Brief Description of Drawings

- [12] FIG. 1 is a concept diagram illustrating installation positions of composite sensor modules included in a configuration of an exemplary embodiment of an active air purifier in a vehicle according to the present invention;
- [13] FIG. 2 is a sectional view illustrating a configuration of each composite sensor module included in the configuration of FIG. 1;
- [14] FIG. 3 is a block diagram illustrating an estimation method for estimating a contamination area;
- [15] FIGS. 4a and 4b are block diagrams illustrating different control procedures according to different manufacturing methods;
- [16] FIG. 5 is a concept diagram illustrating an installation position of an air quality improving unit included in the configuration of FIG. 1;
- [17] FIG. 6 is a sectional view illustrating a configuration of the air quality improving unit;

- [18] FIG. 7 is a sectional view illustrating operation of the air quality improving unit of FIG. 1;
- [19] FIG. 8 is a concept diagram illustrating additional ducts of an air conditioning unit;
- [20] FIG. 9 is a plan view illustrating the additional ducts of the air conditioning unit; and
- [21] FIG. 10 is a diagram illustrating various ventilation modes.

Best Mode for Carrying out the Invention

- [22] Reference will now be made in detail to exemplary embodiments associated with an active air purifier of a vehicle, examples of which are illustrated in the accompanying drawings.
- [23] FIG. 1 is a concept diagram illustrating installation positions of composite sensor modules included in a configuration of an exemplary embodiment of an active air purifier in a vehicle according to the present invention. FIG. 2 is a sectional view illustrating a configuration of each composite sensor module included in the configuration of FIG. 1. FIG. 3 is a block diagram illustrating an estimation method for estimating a contamination area. FIGS. 4a and 4b are block diagrams illustrating different control procedures according to different manufacturing methods. FIG. 5 is a concept diagram illustrating an installation position of an air quality improving unit included in the configuration of FIG. 1. FIG. 6 is a sectional view illustrating a configuration of the air quality improving unit. FIG. 7 is a sectional view illustrating operation of the air quality improving unit of FIG. 1. FIG. 8 is a concept diagram illustrating additional ducts of an air conditioning unit. FIG. 9 is a plan view illustrating the additional ducts of the air conditioning unit. FIG. 10 is a diagram illustrating various ventilation modes.
- [24] As illustrated in FIG. 1, the exemplary embodiment of the active air purifier of the vehicle according to the present invention includes composite sensor modules detachably mounted on a vehicle body 1 at a plurality of areas inside and outside the vehicle, to respectively sense degrees of indoor and outdoor air contamination at the plurality of areas.
- [25] In this case, the composite sensor modules 10 may include at least one composite sensor module 10a disposed in a machinery chamber defined at a front part of the vehicle body 1, to accommodate an engine therein, for sensing of a contamination degree of air present outside of the vehicle (hereinafter, referred to as “outdoor air”). In the case of a vehicle different from the above-described vehicle in terms of vehicle kind in that no machinery chamber is provided at the front part of the vehicle body 1, the above-described sensor modules 10 may be disposed at any positions, so long as the positions are upstream of a passenger compartment in an introduction direction of outdoor air into the passenger compartment.

- [26] In addition, the composite sensor modules 10 may include a plurality of composite sensor modules 10b respectively disposed at a plurality of areas in the passenger compartment. When areas of the passenger compartment are defined with respect to seats 50, on which passengers will be seated, such that an area in the passenger compartment where driver and assistant seats 50 are disposed is defined as a “front area”, and an area in the passenger compartment where left and right rear passenger seats 50 are disposed in rear of the driver and assistant seats 50 is defined as a “rear area”, the composite sensor modules 10b may be disposed at left and right sides of the front area and at left and right sides of the rear area, respectively.
- [27] The composite sensor modules 10 may be arranged alone at the above-described positions. Otherwise, the composite sensor modules 10 may be arranged at installation positions of air quality improving units 30, respectively, as respective constituent elements of the air quality improving units 30. Of course, the composite sensor modules 10 are not limited to the above-described arrangements. The composite sensor modules 10 may be disposed at any positions in the passenger compartment, so long as the composite sensor modules 10 can divide the passenger compartment into a plurality of estimated contamination areas, as will be described later.
- [28] As illustrated in FIG. 2, each composite sensor module 10 may include a sensor case 11 defined with an air channel, through which introduction and discharge of air in one direction is carried out, a fan 13 disposed in the sensor case 11, to forcibly flow air, and a plurality of sensors 12 arranged in series in an air flow direction in the sensor case 11, to sense different properties possessed by air, respectively.
- [29] Here, air introduced into and discharged from the sensor case 11 has characteristics as sample air measured by the plurality of sensors 12, for measurement of a contamination degree of indoor air of the vehicle. It should be noted that no substantial purification of the sample air is carried out by the plurality of sensors 12. The configuration for substantially purifying indoor air of the vehicle will be the air quality improving units, which will be described later.
- [30] A sample air inlet 14 is provided at one side of the sensor case 11, for introduction of air. A sample air outlet 15 is provided at the other side of the sensor case 11, for discharge of air measured by the plurality of sensors 12. The sample air inlet 14 and sample air outlet 15 may be arranged to be aligned with each other in an installation direction of the plurality of sensors 12. In this case, it may be possible to reduce position deviations of the plurality of sensors 12 for measurement of a contamination degree of sample air.
- [31] The fan 13, which forces air to flow through the sensor case 11, may be installed near any one of the sample air inlet 14 and sample air outlet 15. However, the fan 13 is preferably installed near the sample air outlet 15, into which sample air is introduced

after passing the plurality of sensors 12, in order to reduce generation of a turbulent flow caused by rotation of the fan 13, for reliable measurement of a contamination degree of sample air by the plurality of sensors 12. In this case, it is unnecessary for the fan 13 to rotate at a strong rotational force because the fan 13 is required only to generate a blowing force capable of discharging sample air through the sample air outlet 15 after sucking the sample air through the sample air inlet 14.

- [32] The plurality of sensors 12 may include a temperature/humidity sensor 12a for sensing the temperature and humidity of air, a fine dust sensor 12b for sensing the concentration of fine dust in air, a carbon dioxide sensor 12c for sensing the amount of carbon dioxide in air, and a smoke sensor 12d for sensing nitric oxide (NO_x), sulfur oxide (SO_x) and VOCs in air.
- [33] The temperature/humidity sensor 12a, fine dust sensor 12b, carbon dioxide sensor 12c and smoke sensor 12b may be arranged in a random order in a flow direction of air flowing in the sensor case 11.
- [34] Although the above-described four sensors are used as examples of the plurality of sensors 12 in the illustrated exemplary embodiment of the present invention, the plurality of sensors 12 is not limited thereto. The four sensors may be partially or completely replaced with other sensors, so long as the replacement sensors can determine a contamination source of contaminated air.
- [35] The composite sensor modules 10 are arranged at a plurality of areas in the passenger compartment, respectively, as described above, and, as such, may accurately detect a contamination source of contaminated air. In addition, even when contamination of air is detected only at a local area of the passenger compartment, it may be possible to operate the air quality improving units, which will be described later, using a value obtained in accordance with the detection (that is, through determination of the position of the composite sensor module 10, which has detected contamination of the associated area), and, as such, rapid air purification may be achieved.
- [36] In addition, the exemplary embodiment of the active air purifier of the vehicle according to the present invention may further include a photographing unit 3 for photographing the outside and inside of the vehicle, as illustrated in FIGS. 1 and 3.
- [37] The photographing unit 3 functions a camera function for photographing figures of the inside and outside of the vehicle according to a current position of the driving vehicle in linkage with a navigation system (not shown) installed in the vehicle.
- [38] Information collected by the above-described photographing unit 3 may be used as a basis for control of operation of the air quality improving unit 30 and opening and closing operations of a window opening/closing device 5, which will be described later.
- [39] The photographing unit 3 may function as an illuminance sensor for measuring il-

luminance around the currently driving vehicle. That is, the illuminance of the currently driving vehicle may be calculated based on brightness of an image processed after being obtained through photographing of the photographing unit 3.

[40] In particular, the photographing unit 3 may photograph the driver present in the vehicle and, as such, may provide an image obtained through the photographing as a basis for determining a current emotional state of the driver. This will be described later in detail.

[41] Meanwhile, the exemplary embodiment of the active air purifier of the vehicle according to the present invention may further include the air quality improving units 30, which are installed at a plurality of areas in the passenger compartment, to selectively operate to improve air qualities of areas determined as contaminated areas (hereinafter, the areas are referred to as “contamination estimation areas”) based on sensed values of indoor or outdoor air contamination sources obtained in accordance with sensing operations of respective composite sensor modules 10, and an air conditioning unit installed to condition indoor air of the vehicle, and to condition air present in contamination estimation areas determined by respective composite sensor modules 10.

[42] Here, the contamination estimation area means an area randomly selected from the passenger compartment. Selection of such an area may be achieved through pattern recognition or Bayesian estimation using application of various conditions associated with determination of an air quality of the passenger compartment. Pattern recognition and Bayesian estimation are well-known statistical theories and, as such, no detailed description thereof will be given.

[43] Various conditions associated with determination of an air quality of the passenger compartment may include installation positions of the composite sensor modules 10 at the inside and outside of the vehicle, OSA/REC values of the composite sensor modules 10, vent opening/closing of the air conditioning unit, blowing rate of the air conditioning unit, opening/closing of vehicle windows, and travel speed of the vehicle.

[44] Values, which can be acquired through pattern recognition or Bayesian estimation, may not only include the above-described contamination estimation areas, but also include concentrations of contamination materials in the contamination estimation areas, and contamination materials, to be preferentially removed, sensed by the composite sensor modules 10.

[45] In particular, in the case of the contamination estimation areas corresponding to areas where passengers seated in the passenger compartment are positioned, these areas are more rapidly sensed by the corresponding composite sensor modules 10, and are then purified by the corresponding air quality improving units 30 and the air conditioning unit, in order to allow the passengers to rapidly escape from air contamination.

- [46] To this end, the exemplary embodiment of the active air purifier of the vehicle according to the present invention may further include a plurality of seating sensors 15 for sensing whether or not passengers have been seated in the seats 50 installed in the passenger compartment, respectively. Contamination estimation areas may be determined while being limited to areas where seating of passengers is sensed by respective seating sensors. In this case, it may be possible to prevent unnecessary operations of the air quality improving units 30 and air conditioning unit and, as such, energy consumption may be reduced.
- [47] Meanwhile, the air quality improving units 30 function to improve air qualities in a plurality of contamination estimation areas. In this regard, the number of air quality improving units 30 may be equal to the number of contamination estimation areas.
- [48] In more detail, the air quality improving units 30 may be arranged at an overhead console assembly 30a installed at a boundary between an indoor roof panel (not designated by any reference numeral) and a front windshield glass (not designated by any reference numeral), a central portion 30B of the indoor roof panel, indoor rear back shelves (rear shelves) 30C, and indoor armrests 30D (including armrests respectively provided at inner lateral surfaces of vehicle doors or armrests respectively provided at the seats 50). Of course, the air quality improving units 30 are not limited to the above-described positions. The air quality improving units 30 may be arranged at any positions, so long as the positions are appropriate positions in contamination estimation areas, respectively.
- [49] As illustrated in FIG. 6, each air quality improving unit 30 may include a housing 33 having an air inlet 39A formed at one side of the housing 33, an air outlet 39B formed at the other side of the housing 33, and an inner space accommodating one composite sensor module 10 therein, a plurality of filters, for example, filters 31A and 31B, sequentially arranged in a direction perpendicular to an air flow direction in an air flow channel, through which air introduced through the air inlet 39A flows, a fan 34 for sucking air into the inner space of the housing 33, and then forcibly discharging the sucked air toward the filters 31A and 31B, and a channel forming damper 35 for establishing specific inlet channels each to guide the air discharged by the fan 34 to flow toward a particular one of the filters 31A and 31B.
- [50] In this case, the composite sensor module 10 may be arranged within the housing 33 of the air quality improving unit 30. Alternatively, the composite sensor module 10 may be provided as a separate constituent element, as described above. In either case, the composite sensor module 10 may sense a contamination degree of indoor air that may require operation of the air quality improving unit 30. When the composite sensor module 10 is arranged within the housing 33 of the air quality improving unit 30, the composite sensor module 10 is preferably disposed at a position where flow resistance

of air caused by the composite sensor module 10 is minimized.

- [51] In this regard, the composite sensor module 10 is preferably arranged in a portion of the inner space upstream of the fan 34 in an air flow direction or is preferably arranged in a portion of the inner space upstream of the filters 31A and 31B in an air flow direction at a position where the composite sensor module 10 has reduced influence on flow of air.
- [52] The air quality improving unit 30 having the above-described configuration may be manufactured in an OEM manner and, as such, may be mounted to the vehicle body 1 by an operator to assemble a complete vehicle. Alternatively, the air quality improving unit 30 may be manufactured in an aftermarket manner and, as such, may be designed to enable selective mounting thereof by a consumer after being sold to the consumer.
- [53] When indoor air contamination in a contamination estimation area is sensed by the composite sensor module 10 in the case in which the air quality improving unit 30 is installed at the vehicle body 1 after being manufactured in an OEM manner, the air conditioning unit 30 provided at the contamination estimation area operates automatically or the air conditioning unit, which will be described in detail later, changes a flow direction of indoor air in the passenger compartment, thereby preferentially rapidly purifying contaminated air present in the contamination estimation area.
- [54] When indoor air contamination in a contamination estimation area is sensed by the composite sensor module 10 in the case in which the air quality improving unit 30 is installed at the vehicle body 1 after being manufactured in an aftermarket manner, the air conditioning unit operates together with an air quality improving unit 30 in the case in which the air quality improving unit 30 is provided at the contamination estimation area, as illustrated in FIG. 4a. On the other hand, when no air quality improving unit 30 is provided at the contamination estimation area, only the air conditioning unit operates. In either case, contaminated air in the contamination estimation area is preferentially rapidly purified.
- [55] On the other hand, when indoor air contamination in a contamination estimation area is sensed by the composite sensor module 10 in the case in which the air quality improving unit 30 is installed at the vehicle body 1 after being manufactured in an aftermarket manner, the air conditioning unit operates together with an air quality improving unit 30 in the case in which the air quality improving unit 30 is provided at the contamination estimation area, as illustrated in FIG. 4b. On the other hand, when no air quality improving unit 30 is provided at the contamination estimation area, only the air conditioning unit operates. In either case, contaminated air in the contamination estimation area is preferentially rapidly purified.
- [56] Meanwhile, the plurality of filters 31A and 31B is sequentially arranged in a direction perpendicular to an air flow direction in the air flow channel of the housing

33. Accordingly, air introduced into the housing 33 naturally passes through one of the plurality of filters 31A and 31B.

[57] In the exemplary embodiment of the present invention, accordingly, it may be possible to efficiently rapidly remove an air contamination source based on a sensed value from the associated composite sensor module 10 in association with the air contamination source.

[58] For best understanding of the present invention, the plurality of filters 31A and 31B is assumed to include two filters 31A and 31B sequentially arranged in the housing 33. In addition, the specific inlet channel is assumed to include two inlet channels.

[59] In more detail, as illustrated in FIG. 6, the air quality improving unit 30 is configured such that air flows through the air quality improving unit 30 from the left to the right by the fan 34. The air inlet 39A, through which indoor air is introduced, is formed at a right side of the housing 33. In addition, the air outlet 39B, through which indoor air is discharged after being purified, is formed at a left side of the housing 33.

[60] The fan 34 is disposed in the inner space of the housing 33 at a position near the air inlet 39A. The two filters 31A and 31B are disposed in the inner space of the housing 33 at a position near the air outlet 39B, to allow indoor air to pass through only one of the filters 31A and 31B. Specific inlet channels 32A and 32B are formed between respective filters 31A and 31B and the fan 34, to form air inlet passages connected to respective filters 31A and 31B. The specific inlet channels 32A and 32B are formed to allow air to flow through one or both of the two filters 31A and 31B by the channel forming damper 35.

[61] Meanwhile, the air quality improving unit 30 may further include a first electrode 37 disposed in the flow channel between the fan 34 and the filters 31A and 31B within the inner space of the housing 33, a second electrode 38 disposed between the filters 31A and 31B and the air outlet 39B within the inner space of the housing 33, and a high voltage generator 36 for applying a high voltage to the first electrode 37.

[62] In this case, one of the two filters 31A and 31B is a high air flow filter (HAF) for collecting charged dust particles. For example, the filter 31A may be an electrostatic filter, whereas the filter 31B may be a deodorizing filter for filtering out odor particles contained in air.

[63] The principle of filtering out fine dust and smell contained in air sucked into the inner space of the housing 33 by the electrostatic filter 31A and deodorizing filter 31B, respectively, will be described hereinafter.

[64] First, the procedure of filtering fine dust by the electrostatic filter 31A will be described. When introduction of fine dust from the outside of the vehicle into the passenger compartment is sensed by one of the sensors 12 of the composite sensor module 10, that is, the fine dust sensor 12b or an air contamination source having a pre-

determined first concentration or above is detected in an area in the passenger compartment regarded as a contamination estimation area, the high voltage generator 36 applies high current to the first electrode 37 and, as such, the first electrode 37 functions as a diffuser charger, to charge dust particles present in air, as illustrated in FIG. 7(a).

[65] The charged dust particles are filtered out by the electrostatic filter 31A while moving toward the second electrode 38 having a polarity different that of the charged dust particles.

[66] Next, a procedure of filtering out odor particles such as smoke by the deodorizing filter 31B will be described. When introduction of smoke from the outside of the vehicle into the passenger compartment is sensed by one of the sensors 12 of the composite sensor module 10, that is, the smoke sensor 12d or an air contamination source having the predetermined first concentration or above is detected in an area in the passenger compartment regarded as a contamination estimation area, the high voltage generator 36 applies high current to the first electrode 37 and, as such, the first electrode 37 functions as an ionizer, to ionize odor particles present in air, as illustrated in FIG. 7(b). The ionized odor particles are filtered out by the deodorizing filter 31B while moving toward the second electrode 38 having a polarity different that of the charged odor particles.

[67] In particular, when indoor air contamination caused by fine dust is sensed by the composite sensor module 10, the channel forming damper 35 closes the specific inlet channel to the deodorizing filter 31B (hereinafter, the channel are referred to as a “second inlet channel 32B”) while opening the specific inlet channel to the electrostatic filter 31A (hereinafter, the channel are referred to as a “first inlet channel 32A”). On the other hand, when indoor air contamination caused by smoke is sensed by the composite sensor module 10, the channel forming damper 35 closes the first inlet channel 32A to the electrostatic filter 31A while opening the second inlet channel 32B to the deodorizing filter 31B.

[68] Of course, it is unnecessary to open one of the first and second inlet channels 32A and 32B or to close one of the first and second inlet channels 32A and 32B by the channel forming damper 35. That is, when the air quality of indoor air is lowered such that the indoor air has predetermined second concentrations of fine dust and smoke respectively lower than predetermined first concentrations of fine dust and smoke, both the first inlet channel 32A and the second inlet channel 32B are opened. When the high voltage generator 36 applies high current to the first electrode 37, the first electrode 37 functions as a diffusion charger for dust particles while functioning as an ionizer for odor particles. Thus, it may be possible to filter out fine dust and smoke present in air in a simultaneous manner.

- [69] Although not shown, the air quality improving unit 30 may include a moisture supplier disposed in the inner space of the housing 33, to spray moisture, and a perfume sprayer disposed in the inner space of the housing 33, to spray perfume.
- [70] When the temperature and humidity of the passenger compartment sensed by the temperature/humidity sensor 12a included in the plurality sensors 12 of the composite sensor module 10 corresponding to the air quality improving unit 30 correspond to pre-determined values, respectively, the air quality improving unit 30 controls the channel forming damper 35 to open both the first inlet channel 32A and the second inlet channel 32B. At the same time, the air quality improving unit 30 controls the high voltage generator 36 to apply high current to the first electrode 37, thereby causing the first electrode 37 to function as a diffusion charger for charging moisture or perfume sprayed around the first electrode 37. Accordingly, the moisture or perfume may be discharged toward the second electrode 38 in an electrostatically sprayed manner and, as such, a pleasant riding environment for passengers may be established.
- [71] In the exemplary embodiment of the active air purifier of the vehicle according to the present invention, it may be possible to simultaneously remove fine dust and smoke through rapid and reliable air purification for a targeted contamination estimation area by the air quality improving unit 30 operating as described above. In addition, since the total flow resistance of air is small, and the flow rate of air is increased by the fan 34, it may be possible to rapidly purify the contamination estimation area to a desired level. Accordingly, there may be an advantage of an enhancement in air purification performance.
- [72] Meanwhile, in the exemplary embodiment of the active air purifier of the vehicle according to the present invention, as illustrated in FIG. 9, the air conditioning unit may include an air conditioner 100 for performing heat exchange of air with refrigerant while circulating the refrigerant through a thermodynamic cycle, and discharging the heat-exchanged air, namely, conditioned air, and a duct unit installed within the vehicle, to discharge, into the passenger compartment, the conditioned air from the air conditioner 100 or air present outside of the vehicle (hereinafter, referred to as “outdoor air”) or to discharge air present in the passenger compartment (hereinafter, referred to as “indoor air”) to the outside.
- [73] Here, it will be appreciated that the duct unit includes existing ducts for guiding conditioned air from the air conditioner 100, and additional ducts provided to actively suck and discharge the indoor air and outdoor air, in addition to the existing ducts, in accordance with the exemplary embodiment of the active air purifier of the vehicle according to the present invention.
- [74] The duct unit may include guide ducts 112A-112B installed within the vehicle such that the guide ducts 112A-112B are connected to the air conditioner 100 while being

hidden from the passenger compartment, to guide conditioned air from the air conditioner 100 to a plurality of areas in the passenger compartment, and a plurality of suction/discharge ducts 117A to 117D branched from the guide ducts 112A-112B, to suck indoor air into the guide ducts 112A-112B or to discharge conditioned air from the guide ducts 112A-112B into the passenger compartment.

- [75] The number of suction/discharge ducts 117A to 117D is preferably equal to the number of predetermined contamination estimation areas in order to rapidly remove air contamination from the contamination estimation areas. More preferably, the suction/discharge ducts 117A to 117D are provided at all contamination estimation areas, respectively.
- [76] The duct unit may further include an outdoor air introduction duct 111A for introducing outdoor air from the outside into the guide ducts 112A-112B, and an indoor air discharge duct 111B for discharging indoor air from the guide ducts 112A-112B to the outside.
- [77] As illustrated in FIG. 9, a first three-way damper V1 may be provided at a connection portion between one of the guide ducts 112A-112B, namely, a duct 112A, and the outdoor air introduction duct 111A. A second three-way damper V2 may be provided at a connection portion between another one of the guide ducts 112A-112B, namely, a duct 112B, and the indoor air discharge duct 111B.
- [78] Meanwhile, the guide ducts 112A-112B may include a supply duct 112A for supplying conditioned air from the air conditioner 100 to the passenger compartment, and a discharge duct 112B for discharging air from the passenger compartment into the air conditioner 100. The guide ducts 112A-112B may further include a first inner duct 113 connected to the supply duct 112A while being connected to a first outer outlet 119A provided at a rear side of the vehicle, and a second inner duct 114 connected to the discharge duct 112B while being connected to a second outer outlet 119B provided at the rear side of the vehicle.
- [79] The first inner duct 113 may be arranged in one of upper and lower spaces defined in the vehicle body 1 at a left side of the vehicle body 1, to extend lengthily in a longitudinal direction of the vehicle body 1. The second inner duct 114 may be arranged in one of the upper and lower spaces defined in the vehicle body 1 at a right side of the vehicle body 1, to extend lengthily in the longitudinal direction of the vehicle body 1.
- [80] Here, the upper space of the vehicle body 1 may mean a space between a roof panel (not shown) and a roof interior material for shielding a lower surface of the roof panel, and the lower space of the vehicle body 1 may mean a space defined in a bottom surface of the vehicle body 1.
- [81] A third three-way valve V3 may be provided at a connection portion between the supply duct 112A and the first inner duct 113. A fourth three-way valve V4 may be

provided at a connection portion between the discharge duct 112B and the second inner duct 114.

[82] The plurality of suction/discharge ducts 117A to 117D may be branched from the first inner duct 113 and second inner duct 114. Suction/discharge three-way dampers Va to Vd may be provided at respective connection portions between corresponding ones of the first and second inner ducts 113 and 114 and the suction/discharge ducts 117A to 117D.

[83] Here, the “three-way damper” is a kind of a valve, and has a configuration in which flow path switching is carried out in such a manner that, among three flow paths branched from a connection portion, one flow path is closed, and the remaining two flow paths are opened. Even when the three-way damper is entitled “three-way valve”, “flow path switching valve” or other names, these elements fall under the scope of the present invention, so long as they have the above-described flow path switching function.

[84] In this case, the supply duct 112A, discharge duct 112B, first inner duct 113 and second inner duct 114 may be sorted as the above-described existing ducts. The outdoor air introduction duct 111A, indoor air discharge duct 111B and suction/discharge ducts 117A to 117D may be sorted as the above-described additional ducts.

[85] The additional ducts provided in the exemplary embodiment of the present invention only have technical characteristics in that the additional ducts contribute to rapid air purification through targeting of contamination estimation areas using the composite sensor modules 10 and air quality improving units 30, in addition to the existing ducts. In practice, the additional ducts may be increased or reduced in accordance with the kind of the vehicle, the size of the vehicle, installation costs and installation purposes.

[86] In addition, an air purification method using an air conditioning unit, which will be described later, is only illustrative. The true right scope of the air purification method should be understood from the accompanying claims.

[87] Hereinafter, operation of the air conditioning unit having the above-described configuration will be briefly described.

[88] First, when it is sensed by the composite sensor modules 10 that the passenger compartment has a higher air contamination degree than outdoor air, the first three-way damper V1 and third three-way damper V3 are controlled to allow introduction of outdoor air from the outdoor air introduction duct 111A into the passenger compartment. In addition, the second three-way damper V2 and fourth three-way damper V4 are controlled to allow discharge of indoor air to the outside. The suction/discharge three-way dampers Va to Vd are also controlled to allow discharge of outdoor air from the first inner duct 113 into the passenger compartment and suction of indoor air into the second inner duct 114.

- [89] That is, when the air contamination degree of the passenger compartment is higher than that of the outside, the air conditioning unit operates to rapidly introduce outdoor air into the passenger compartment through control of the first three-way damper V1 and third three-way damper V3 while discharging outdoor air into the passenger compartment through a selected one of the suction/discharge ducts 117A to 117D corresponding to an area determined as a contamination estimation area by the corresponding composite sensor module 10 in accordance with control of a corresponding one of the suction/discharge three-way dampers Va to Vd.
- [90] On the other hand, when it is sensed by the composite sensor modules 10 that the air contamination degree of the outside is higher than that of the passenger compartment, the first three-way damper V1 is controlled to prevent introduction of outdoor air, and the second three-way damper V2 is controlled to prevent indoor air from being discharged to the outside.
- [91] That is, when the air contamination degree of the outside is higher than that of the passenger compartment, introduction of outdoor air into the passenger compartment is undesirable. In this case, accordingly, the air conditioner 100 of the air conditioning unit is switched to operate in an indoor air mode. In addition, a control operation is preferably executed to rapidly purify air present only in an area determined as a contamination estimation area by the air quality improving unit 30 associated with the determined area.
- [92] FIG. 10 is a diagram briefly illustrating various ventilation modes, which may be implemented in accordance with appropriate arrangements of the suction/discharge ducts 117A to 117D in the passenger compartment.
- [93] As described above, the suction/discharge ducts 117A to 117D may be arranged at various areas in the passenger compartment and, as such, may implement various indoor ventilation modes illustrated in FIG. 10.
- [94] In association with the following description, it is assumed that the first inner duct 113 and second inner duct 114 are arranged at left and right sides of the vehicle body 1, respectively, to extend lengthily in the longitudinal direction of the vehicle body 1, each of the first inner duct 113 and second inner duct 114 is branched along upper and lower sides of the passenger compartment, and the plurality of suction/discharge ducts 117A to 117D are arranged at positions where more effective ventilation and purification for corresponding contamination estimation areas may be achieved by the suction/discharge ducts 117A to 117D.
- [95] Hereinafter, the indoor ventilation modes will be described in more detail with reference to FIG. 10.
- [96] A first ventilation mode is a ventilation method in which outdoor air is introduced through the outdoor air introduction duct 111A, is guided to flow through the first

inner duct 113 and second inner duct 114 arranged at an upper side of the passenger compartment after passing through the supply duct 112A, is then discharged into the passenger compartment, to ventilate the passenger compartment, and is finally discharged through the first outer outlet 119A and second outer outlet 119B. That is, the first ventilation mode is a ventilation mode for rapidly purifying air contamination at an upper side of the passenger compartment.

[97] For ventilation in the first ventilation mode, selected ones of the suction/discharge ducts 117A to 117D, namely, the suction/discharge ducts 117A and 117C arranged at the front upper side of the passenger compartment, are opened by the suction/discharge three-way dampers Va and Vc corresponding thereto, to introduce outdoor air into the passenger compartment. At the same time, selected ones of the suction/discharge ducts 117A to 117D, namely, the suction/discharge ducts 117B and 117D arranged at the rear upper side of the passenger compartment, are opened by the suction/discharge three-way dampers Vb and Vd corresponding thereto, to discharge indoor air to the outside. Thus, the passenger compartment is rapidly ventilated.

[98] A second ventilation mode is a ventilation method in which, similarly to the first ventilation mode, outdoor air is introduced, is guided to flow through the first inner duct 113 and second inner duct 114 arranged at a lower side of the passenger compartment, is then discharged into the passenger compartment through the suction/discharge ducts 117A to 117D arranged at the rear lower side of the passenger compartment, to be circulated toward the front upper side of the passenger compartment, and is finally discharged through the first outer outlet 119A and second outer outlet 119B. That is, the second ventilation mode is a ventilation mode for not only purifying air contamination at the upper side of the passenger compartment, but also achieving air circulation throughout the passenger compartment.

[99] In this case, the suction/discharge three-way valves Va to Vd provided at each of the upper and lower sides of the passenger compartment are preferably appropriately controlled to achieve circulation of outdoor air introduced into the passenger compartment.

[100] A third ventilation mode is a ventilation mode in which the air conditioning unit 100 is switched to the indoor mode, to re-circulate indoor air alone without introduction of outdoor air into the passenger compartment. The third ventilation mode is a ventilation mode applicable when the air contamination degree of the outside is higher than that of the passenger compartment.

[101] In this case, the first three-way damper V1 and second three-way damper V2 are controlled to close the outdoor air introduction duct 111A and indoor air discharge duct 111B. Selected ones of the suction/discharge three-way valves Va to Vd, namely, the suction/discharge three-way valves Vb and Vd, are closed, to prevent indoor air

from being discharged through the first and second outer outlets 119A and 119B.

- [102] A fourth ventilation mode is a ventilation mode similar to the third ventilation mode, except that indoor air is re-circulated through the front and rear suction/discharge ducts 117A to 117D of the first and second inner ducts 113 and 114 arranged at the lower side of the passenger compartment.
- [103] A fifth ventilation mode is a ventilation mode for introducing outdoor air, and discharging the introduced outdoor air into the upper side of the passenger compartment. This ventilation mode is applicable when the air contamination degree of the outside is smaller than that of the passenger compartment. When a large amount of particulate matters (PMs) are present in the passenger compartment, the fifth ventilation mode may be useful in discharging the PMs to the outside while preventing flying of dust present in the passenger compartment.
- [104] A sixth ventilation mode is similar to the fifth ventilation mode. This ventilation mode may be understood as a modified ventilation mode according to position change of contamination estimation areas.
- [105] A seventh ventilation mode is an indoor re-circulation mode. That is, the seventh ventilation mode is a ventilation mode in which air is discharged into the passenger compartment via the suction/discharge ducts 117A to 117d of the first and second inner ducts 113 and 114 arranged at the upper side of the passenger compartment while being sucked from the passenger compartment through the suction/discharge ducts 117A to 117D branched from the first and second inner ducts 113 and 114 arranged at the lower side of the passenger compartment.
- [106] This ventilation mode may be useful when the air contamination degree of the outside is higher than that of the passenger compartment, and a large amount of PMs are present in the passenger compartment. In this case, it may be possible to remove dust particles through filtering while preventing flying of dust present in the passenger compartment, when air is sucked into the lower-side suction/discharge ducts 117A to 117D and, as such, purified air may be again discharged into the passenger compartment.
- [107] An eighth ventilation mode may be understood as a combination of the six and seventh ventilation modes. When the air contamination degree of the outside is higher than that of the passenger compartment, and the carbon dioxide concentration of the passenger compartment is high, a mixture of outdoor air and indoor air is supplied to passengers, and indoor air is partially discharged to the outside through the suction/discharge ducts 117A to 117D of the first and second inner ducts 113 and 114 arranged at the upper side of the passenger compartment. This ventilation mode is useful in efficiently exhausting carbon dioxide because the exhaustion is carried out at positions where respiratory organs of the passengers are positioned, respectively.

- [108] A ninth ventilation mode is a ventilation mode in which outdoor air is introduced to purify the passenger compartment, and the introduced outdoor air passes an electric heater of the air conditioning unit 100 (in particular, an evaporator) to dry the evaporator. In this ventilation mode, indoor air is discharged through the outdoor air introduction duct during parking or if necessary, to dry the evaporator while removing dust and odor accumulated in the outdoor air introduction duct.
- [109] Tenth and eleventh ventilation modes are ventilation modes mainly usable through combination thereof with the above-described ventilation modes. These ventilation modes may be implemented through additional installation of the suction/discharge ducts 117A to 117D and free change of discharge directions of the suction/discharge ducts 117A to 117D.
- [110] The above-described various ventilation modes may be implemented through control of various operations of additional ducts and a plurality of three-way dampers provided at the additional ducts.
- [111] Meanwhile, although not shown, another embodiment of the active air purifier of the vehicle according to the present invention may further include a window state sensor for sensing whether the windows of the vehicle are in an opened state or in a closed state under the condition that the vehicle is driving, and a window opening/closing device for opening or closing the windows.
- [112] It may be possible to control operation of the window opening/closing device in accordance with information as to whether the windows are in an opened state or in a closed state and information as to opening degrees of the windows, which are acquired by the window state sensor, and indoor and outdoor air contamination sources sensed by the above-described composite sensor modules 10.
- [113] Although outdoor air purification or indoor air purification is carried out in a closed state of the passenger compartment through the air quality improving units 30 or air conditioning unit in accordance with indoor and outdoor air contamination sources sensed by the composite sensor modules 10 in the previous exemplary embodiment of the present invention, outdoor air purification or indoor air purification is carried out through active control of operation of the window opening/closing device in this embodiment of the present invention.
- [114] For example, it may be possible to appropriately control the window opening/closing device by linking the vehicle to a navigation system, which senses the current travel position of the vehicle in real time, thereby providing a map around the vehicle, and sensing, during driving of the vehicle, whether the vehicle enters or escapes an area in which degradation of air quality is expected (in particular, a tunnel or the like) under the condition that the windows are in an opened state, by the photographing unit 3 functioning as a illuminance sensor.

- [115] In more detail, when it is sensed, during driving of the vehicle, that the vehicle enters an air quality degradation-expected area such as a tunnel, the window opening/closing device may be controlled to automatically close the windows if the windows are sensed by the window state sensor as being in an opened state under the condition that the air contamination degree of the passenger compartment sensed by the composite sensor modules 10 is equal to or lower than a predetermined contamination degree. On the other hand, the window opening/closing device may be controlled to maintain the windows in an opened state under the condition that the air contamination degree of the passenger compartment sensed by the composite sensor modules 10 exceeds the predetermined contamination degree.
- [116] Conversely, when it is sensed, during driving of the vehicle, that the vehicle escapes the tunnel, the window opening/closing device may be controlled to automatically open the windows if the windows are in an opened state under the condition that the air contamination degree of the outside sensed by the composite sensor modules 10 is equal to or lower than a predetermined contamination degree. On the other hand, the window opening/closing device may be controlled to maintain the windows in a closed state under the condition that the air contamination degree of the outside sensed by the composite sensor modules 10 exceeds the predetermined contamination degree.
- [117] Another embodiment of the active air purifier of the vehicle according to the present invention may further include a vehicle speed sensor for sensing a travel speed of the vehicle during driving of the vehicle, as illustrated in FIG. 3.
- [118] The above-described embodiment of the active air purifier of the vehicle according to the present invention has more advanced technical characteristics than the previous embodiments of the present invention. This embodiment has a gist in that, even under the condition that the windows should be opened or should be maintained in the opened state by the window opening/closing device, the window opening/closing device is controlled to automatically close the opened windows when the travel speed of the vehicle sensed by the vehicle speed sensor during driving of the vehicle is equal to or higher than a predetermined speed.
- [119] This is because, even under the condition that the windows should be maintained in an opened state due to the air contamination degree of the passenger compartment exceeding the predetermined contamination degree, unpleasantness of the passengers caused by wind introduced into the passenger compartment through the opened windows may be higher than advantages obtained through air quality improvement when the current travel speed of the vehicle sensed by the vehicle speed sensor is equal to or higher than a predetermined speed.
- [120] In another embodiment of the active air purifier of the vehicle according to the present invention, an emotional state of the driver currently driving the vehicle is

analyzed based on an image of the driver photographed by the above-described photographing unit 3 when the contamination estimation area associated with carbon dioxide concentration included in air contamination sources sensed by the composite sensor modules 10 is the driver seat, and the windows are opened by the window opening/closing device when it is determined based on analyzed results that the driver drives the vehicle while sleepy, to awake the driver. In this case, accordingly, safety accidents may be prevented.

[121] The above-described embodiments of the active air purifier of the vehicle according to the present invention provide an advantage in that it may be possible to establish a pleasant riding environment during presence of the passengers in the vehicle by accurately sensing indoor air contamination sources by the composite sensor modules 10 while determining contamination estimation areas, and rapidly purifying air present in a targeted contamination estimation area using the air quality improving units 30 and air conditioning unit.

[122] Although exemplary embodiments of the active air purifier of the vehicle according to the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

Claims

- [Claim 1] An active air purifier of a vehicle comprising:
composite sensor modules detachably mounted on a vehicle body at a plurality of areas inside and outside the vehicle, to respectively sense degrees of indoor and outdoor air contamination at the plurality of areas;
air quality improving units installed at a plurality of areas in a passenger compartment, to selectively operate to improve air qualities of areas determined as contaminated areas (hereinafter, the areas are referred to as “contamination estimation areas”) based on sensed values of indoor or outdoor air contamination sources obtained in accordance with respective sensing operations of the composite sensor modules;
and
an air conditioning unit installed to condition indoor air of the vehicle, and to condition air present in the contamination estimation areas determined by the composite sensor modules.
- [Claim 2] The active air purifier according to claim 1, wherein each of the composite sensor modules comprises:
a sensor case defined with an air channel, through which introduction and discharge of air in one direction is carried out;
a fan disposed in the sensor case, to forcibly flow air; and
a plurality of sensors arranged in series in an air flow direction in the sensor case, to sense different properties possessed by air, respectively.
- [Claim 3] The active air purifier according to claim 2, wherein the plurality of sensors comprise:
a temperature/humidity sensor for sensing a temperature of the air and a humidity of the air;
a fine dust sensor for sensing a concentration of fine dust in the air;
a carbon dioxide sensor for sensing an amount of carbon dioxide in the air; and
a smoke sensor for sensing nitric oxide (NO_x), sulfur oxide (SO_x) and volatile organic compounds (VOCs) in the air.
- [Claim 4] The active air purifier according to claim 1, wherein the composite sensor modules comprise at least one composite sensor module disposed in a machinery chamber corresponding to a front part of the vehicle body, and a plurality of composite sensor modules respectively disposed at front, rear, left and right sides of the passenger com-

partment.

[Claim 5] The active air purifier according to claim 1, wherein the contamination estimation areas are determined through pattern recognition or Bayesian estimation using application of sensed values respectively obtained in a plurality of areas divided from the passenger compartment by the composite sensor modules in association with air contamination sources, whether a vent connected to a duct of the air conditioning unit is in an opened state or in a closed state, a blowing rate of outdoor air to the passenger compartment by the air conditioning unit, whether door windows provided at the vehicle are in an opened state or in a closed state, and a travel speed of the vehicle, after the division of the areas.

[Claim 6] The active air purifier according to claim 5, further comprising: a plurality of seating sensors for sensing whether or not passengers have been seated in a plurality of seats provided at the passenger compartment, respectively, wherein the contamination estimation areas are determined while being limited to areas where seating of passengers are sensed by the seating sensors, respectively.

[Claim 7] The active air purifier according to claim 5, wherein the air quality improving units are arranged at an overhead console assembly installed at a boundary between an indoor roof panel and a front windshield glass, a central portion of the indoor roof panel, indoor rear back shelves, and indoor armrests.

[Claim 8] The active air purifier according to claim 7, wherein each of the air quality improving units comprises:
a housing having an air inlet formed at one side of the housing, an air outlet formed at the other side of the housing, and an inner space accommodating a corresponding one of the composite sensor modules therein;
a plurality of filters sequentially arranged in a direction perpendicular to an air flow direction in an air flow channel, through which air introduced through the air inlet flows;
a fan for sucking air into the inner space of the housing, and then forcibly discharging the sucked air toward the filters; and
a channel forming damper for establishing specific inlet channels each to guide the air discharged by the fan to flow toward a particular one of the filters.

- [Claim 9] The active air purifier according to claim 8, wherein the composite sensor module is arranged in a portion of the inner space upstream of the fan in an air flow direction.
- [Claim 10] The active air purifier according to claim 8, wherein the air quality improving unit further comprises:
a first electrode disposed in the flow channel between the fan and the plurality of filters within the inner space of the housing;
a second electrode disposed between the plurality of filters and the air outlet within the inner space of the housing; and
a high voltage generator for applying a high voltage to the first electrode.
- [Claim 11] The active air purifier according to claim 10, wherein:
each of the composite sensor modules comprises a plurality of sensors;
and
the plurality of sensors comprises
a temperature/humidity sensor for sensing a temperature of the air and a humidity of the air,
a fine dust sensor for sensing a concentration of fine dust in the air, a carbon dioxide sensor for sensing an amount of carbon dioxide in the air, and
a smoke sensor for sensing nitric oxide (NO_x), sulfur oxide (SO_x) and volatile organic compounds (VOCs) in the air.
- [Claim 12] The active air purifier according to claim 11, wherein the plurality of filters comprise:
a first filter arranged to allow air to pass through a first inlet channel, which is one of the specific inlet channels; and
a second filter arranged to allow air to pass through a second inlet channel, which is another one of the specific inlet channels.
- [Claim 13] The active air purifier according to claim 11, wherein:
the channel forming damper selectively opens or closes the first inlet channel and the second inlet channel; and
the first filter comprises an electrostatic filter, and the second filter comprises a deodorizing filter.
- [Claim 14] The active air purifier according to claim 13, wherein, when a fine dust concentration sensed by the composite sensor module is equal to or higher than a predetermined concentration,
the channel forming damper of the air quality improving unit opens the first inlet channel while closing the second inlet channel, and

the high voltage generator of the air quality improving unit applies a high current to the first electrode, to charge dust around the first electrode.

[Claim 15] The active air purifier according to claim 13, wherein, when a smoke concentration sensed by the composite sensor module is equal to or higher than a predetermined first concentration, the channel forming damper of the air quality improving unit opens the second inlet channel while closing the first inlet channel, and the high voltage generator of the air quality improving unit applies a high current to the first electrode, to ionize air around the first electrode.

[Claim 16] The active air purifier according to claim 14 or 15, wherein, when the fine dust concentration and the smoke concentration are lowered to predetermined second concentrations, respectively, the channel forming damper of the air quality improving unit simultaneously opens the first inlet channel and the second inlet channel, and the high voltage generator of the air quality improving unit applies a high current to the first electrode, to charge dust around the first electrode and to ionize air around the first electrode.

[Claim 17] The active air purifier according to claim 13, wherein: the air quality improving unit further comprises a moisture supplier disposed in the inner space of the housing, to spray moisture, and a perfume sprayer disposed in the inner space of the housing, to spray perfume the channel forming damper simultaneously opens the first inlet channel and the second inlet channel when a temperature and a humidity, which are sensed by the composite sensor module, correspond to predetermined values, respectively; and the high voltage generator applies a high current to the first electrode, to ionize moisture or perfume sprayed around the first electrode when the sensed temperature and the sensed humidity correspond to the predetermined values, respectively.

[Claim 18] The active air purifier according to claim 1, wherein: the air conditioning unit comprises an air conditioner for performing heat exchange of air with refrigerant while circulating the refrigerant through a thermodynamic cycle, and discharging conditioned air, and

a duct unit installed within the vehicle, to discharge, into the passenger compartment, the conditioned air from the air conditioner or to discharge air present in the passenger compartment to the outside;

the duct unit comprises

a guide duct installed within the vehicle such that the guide duct is connected to the air conditioner while being hidden from the passenger compartment, to guide conditioned air from the air conditioner to a plurality of areas in the passenger compartment, and

a plurality of suction/discharge ducts branched from the guide duct, to suck air present in the passenger compartment into the guide duct or to discharge conditioned air from the guide duct into the passenger compartment; and

the plurality of suction/discharge ducts are arranged such that at least one of the suction/discharge ducts is disposed at each of the contamination estimation areas in the passenger compartment.

[Claim 19]

The active air purifier according to claim 18, wherein:

the duct unit further comprises:

an outdoor air introduction duct for introducing outdoor air from the outside into the guide duct, and

an indoor air discharge duct for discharging air from the guide duct to the outside; and

a first three-way damper is provided at a connection portion between the guide duct and the outdoor air introduction duct, and a second three-way damper is provided at a connection portion between the guide duct and the indoor air discharge duct.

[Claim 20]

The active air purifier according to claim 18, wherein:

the guide duct comprises

a supply duct for supplying conditioned air from the air conditioner to the passenger compartment,

a discharge duct for discharging air from the passenger compartment into the air conditioner,

a first inner duct connected to the supply duct while being connected to a first outer outlet provided at a rear side of the vehicle, and

a second inner duct connected to the discharge duct while being connected to a second outer outlet provided at the rear side of the vehicle;

a third three-way valve is provided at a connection portion between the supply duct and the first inner duct; and

a fourth three-way valve is provided at a connection portion between the discharge duct and the second inner duct.

[Claim 21]

The active air purifier according to claim 20, wherein:

the plurality of suction/discharge ducts are branched from the first inner duct and the second inner duct; and

suction/discharge three-way dampers are provided at respective connection portions between corresponding ones of the first and second inner ducts and the suction/discharge ducts.

[Claim 22]

The active air purifier according to any one of claims 19 to 21, wherein, when an air contamination degree of the passenger compartment sensed by the composite sensor module is higher than an air contamination degree of outdoor air,

the first and third three-way dampers are controlled to introduce outdoor air into the passenger compartment through the outdoor air introduction duct,

the second and fourth three-way dampers are controlled to discharge indoor air present in the passenger compartment to the outside, or

the suction/discharge three-way dampers are controlled to discharge outdoor air into the passenger compartment through the first inner duct and to suck the indoor air into the second inner duct.

[Claim 23]

The active air purifier according to any one of claims 19 to 21, wherein, when an air contamination degree of outdoor air sensed by the composite sensor module is higher than an air contamination degree of the passenger compartment,

the first three-way damper is controlled to prevent introduction of the outdoor air, and the second three-way damper is controlled to prevent indoor air present in the passenger compartment from being discharged to the outside.

[Claim 24]

The active air purifier according to claim 1, further comprising:

a navigation system for sensing a current travel position of the vehicle in real time, thereby providing a map around the vehicle, a photographing unit for photographing an outside of the vehicle and the passenger compartment, and a window opening/closing device for opening or closing windows of the vehicle,

wherein, when it is sensed, during driving of the vehicle, by the navigation system and the photographing unit that the vehicle enters an air quality degradation-expected area, the window opening/closing device is controlled to close the windows under a condition that an air

contamination degree of the passenger compartment sensed by the composite sensor modules is equal to or lower than a predetermined contamination degree, and the window opening/closing device is controlled to open the windows under a condition that the air contamination degree of the passenger compartment sensed by the composite sensor modules exceeds the predetermined contamination degree.

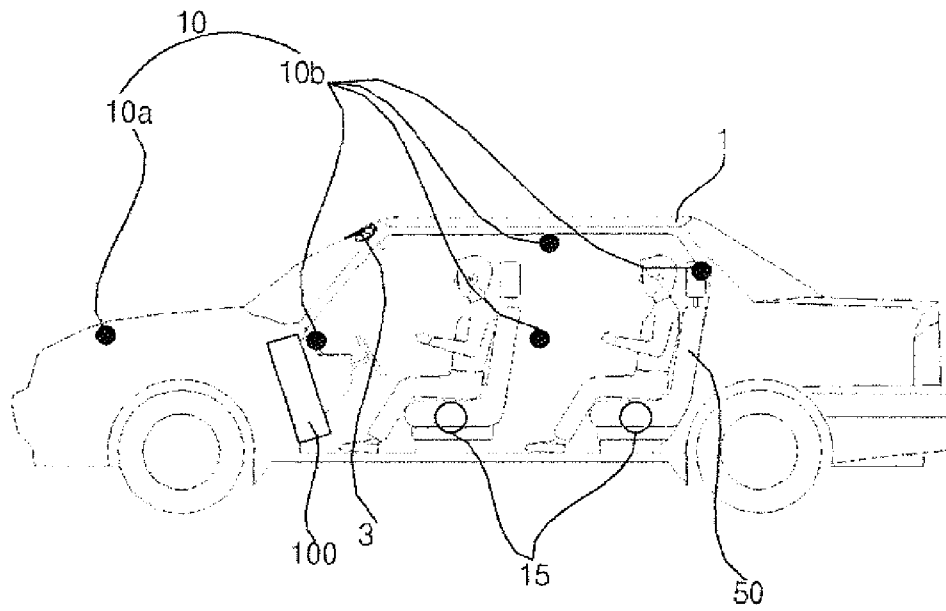
[Claim 25]

The active air purifier according to claim 1, further comprising: a navigation system for sensing a current travel position of the vehicle in real time, thereby providing a map around the vehicle, a photographing unit for photographing an outside of the vehicle and the passenger compartment, and a window opening/closing device for opening or closing windows of the vehicle, wherein, when it is sensed, during driving of the vehicle, by the navigation system and the photographing unit that the vehicle escapes an air quality degradation-expected area, the window opening/closing device is controlled to open the windows under a condition that an air contamination degree of outdoor air sensed by the composite sensor modules is equal to or lower than a predetermined contamination degree, and the window opening/closing device is controlled to close the windows under a condition that the air contamination degree of the outdoor air sensed by the composite sensor modules exceeds the predetermined contamination degree.

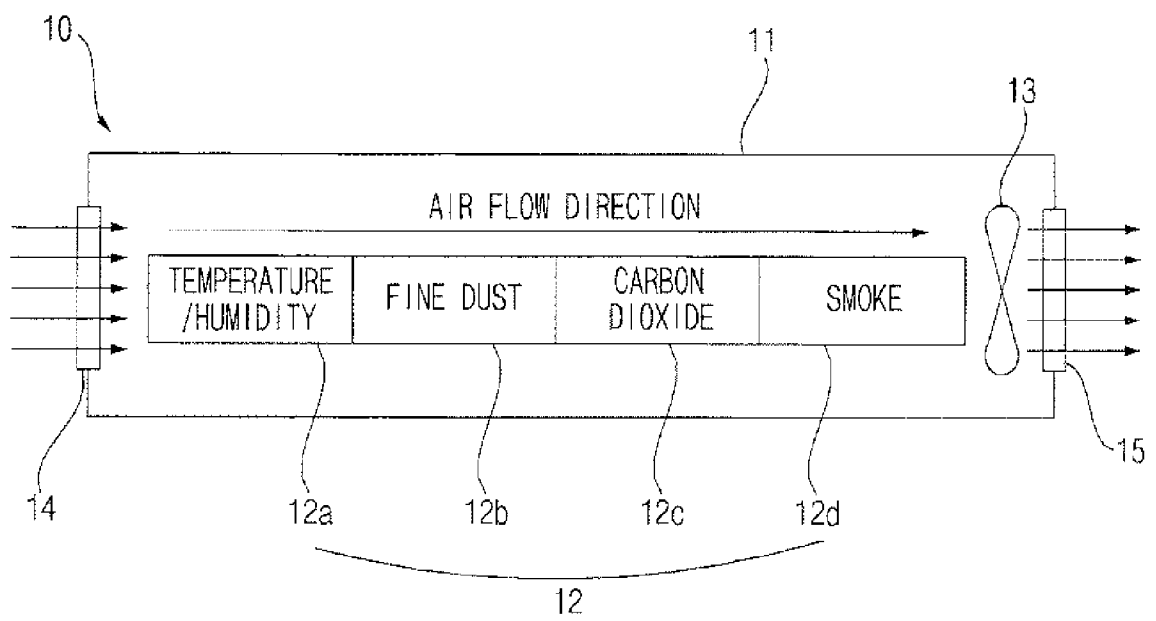
[Claim 26]

The active air purifier according to claim 24 or 25, further comprising: a vehicle speed sensor for sensing a travel speed of the vehicle during driving of the vehicle, wherein, when the travel speed of the vehicle sensed by the vehicle speed sensor during driving of the vehicle is equal to or higher than a predetermined speed, the window opening/closing device is controlled to close the windows, irrespective of the air contamination degree sensed by the composite sensor modules and the air contamination degree of the outdoor air sensed by the composite sensor modules.

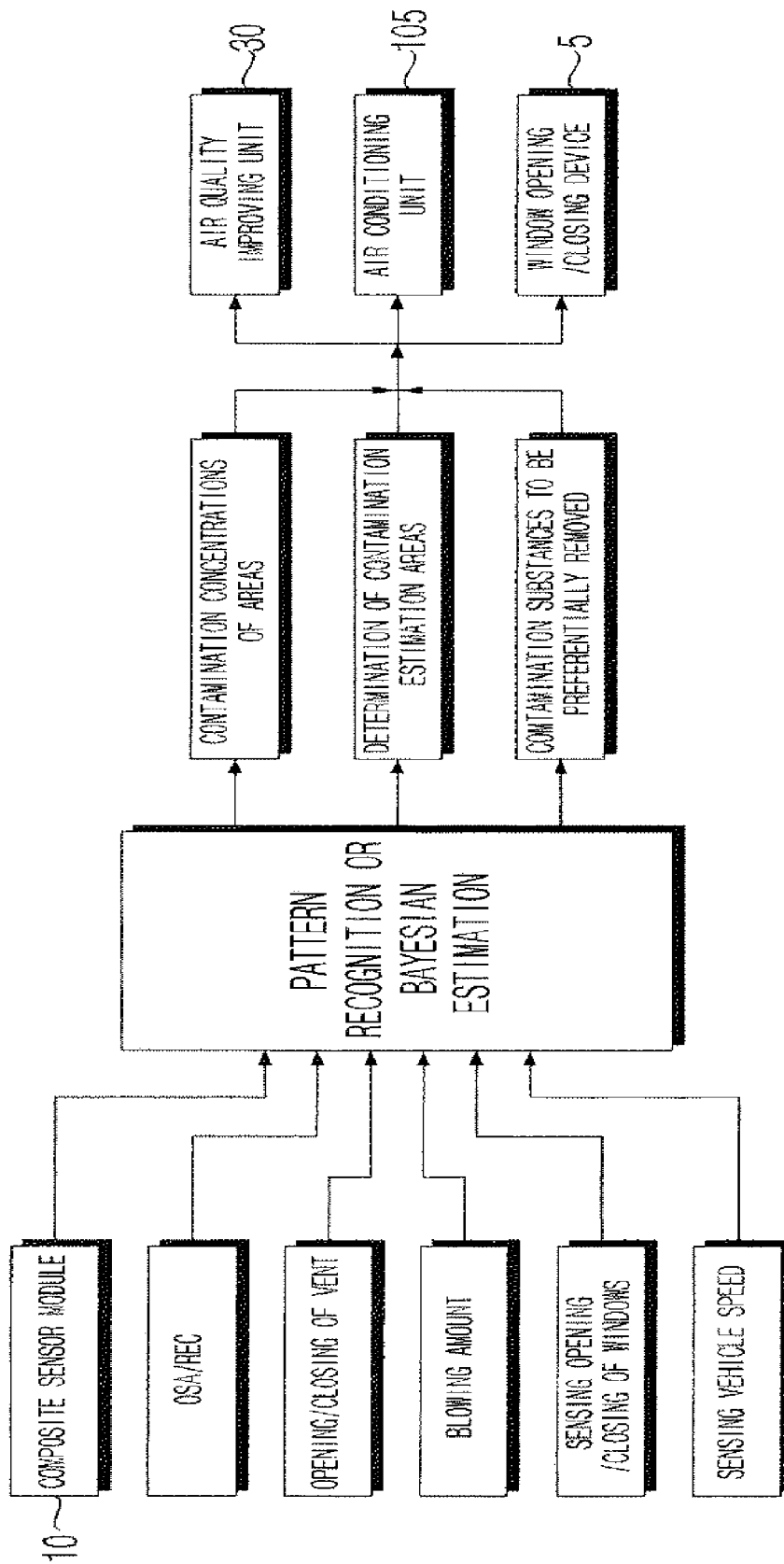
[Fig. 1]



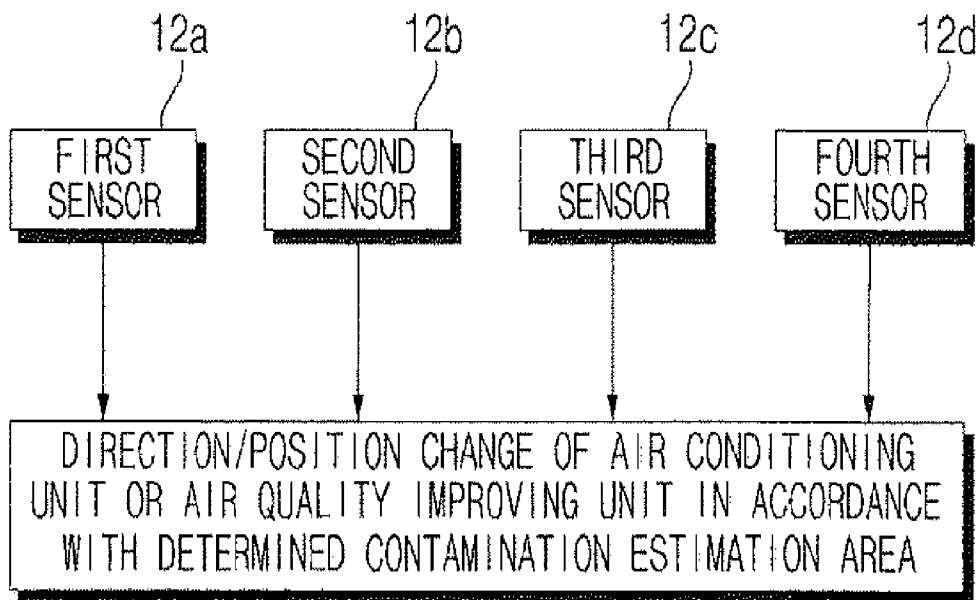
[Fig. 2]



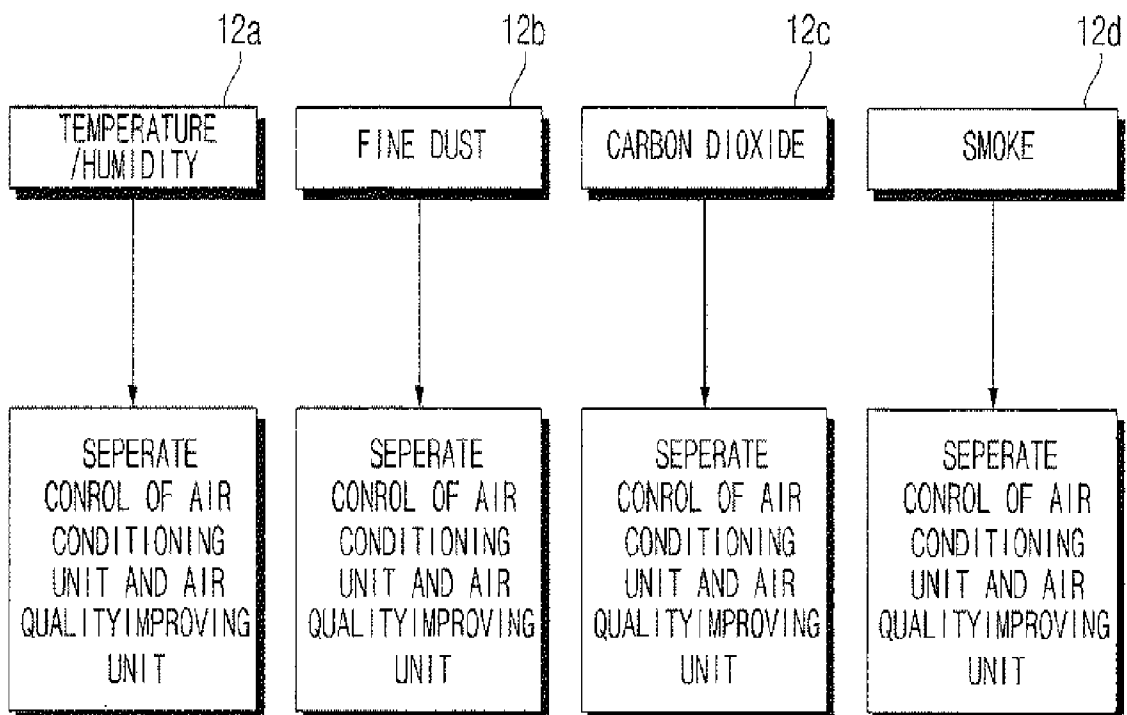
[Fig. 3]



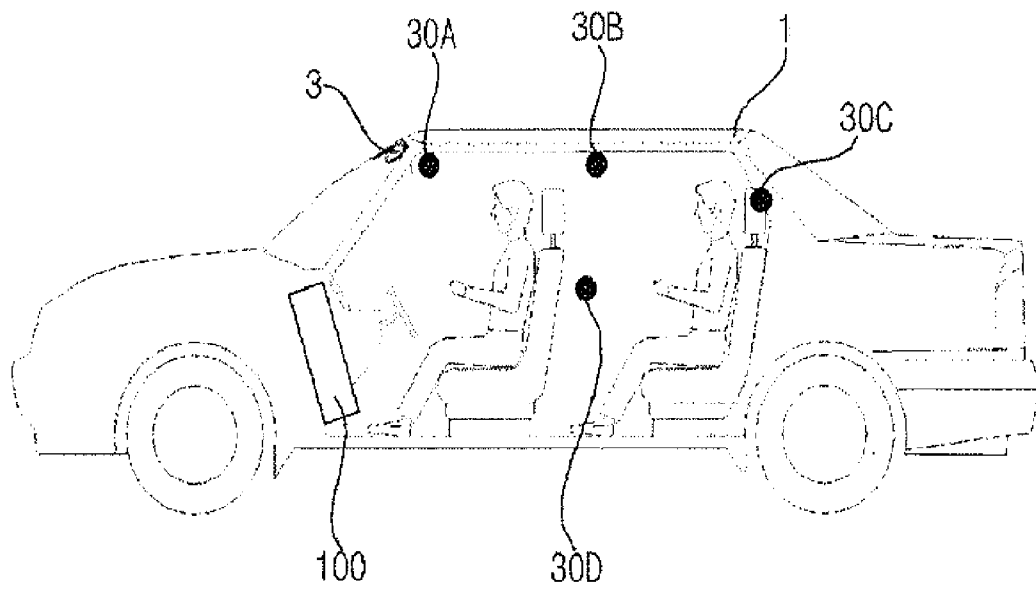
[Fig. 4a]



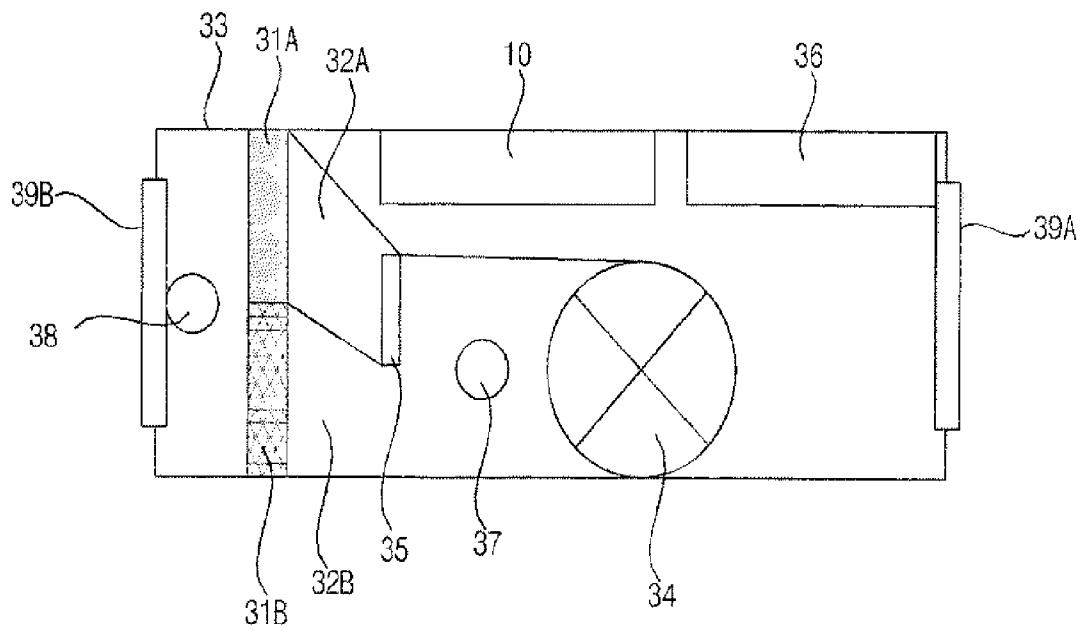
[Fig. 4b]



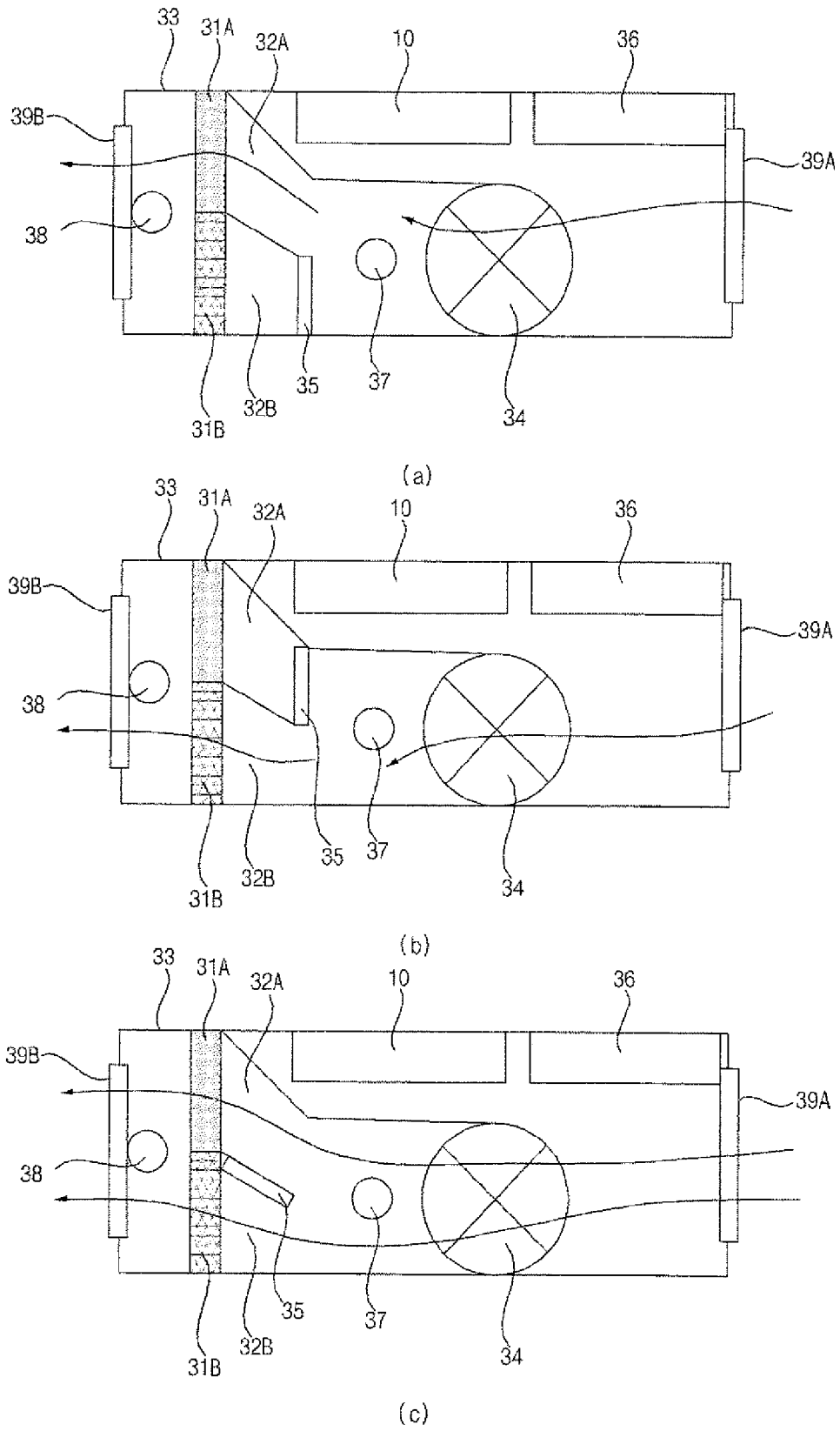
[Fig. 5]



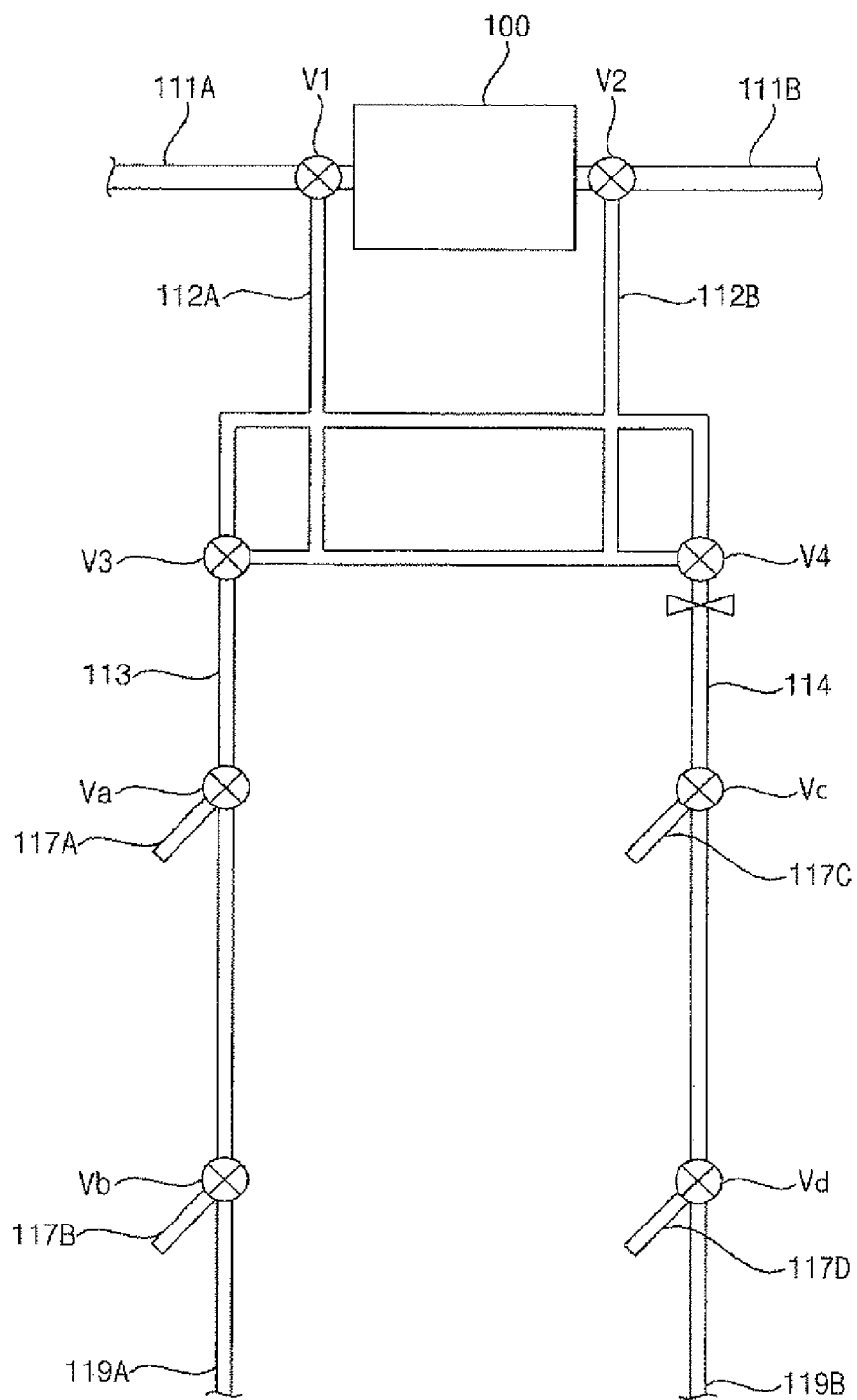
[Fig. 6]



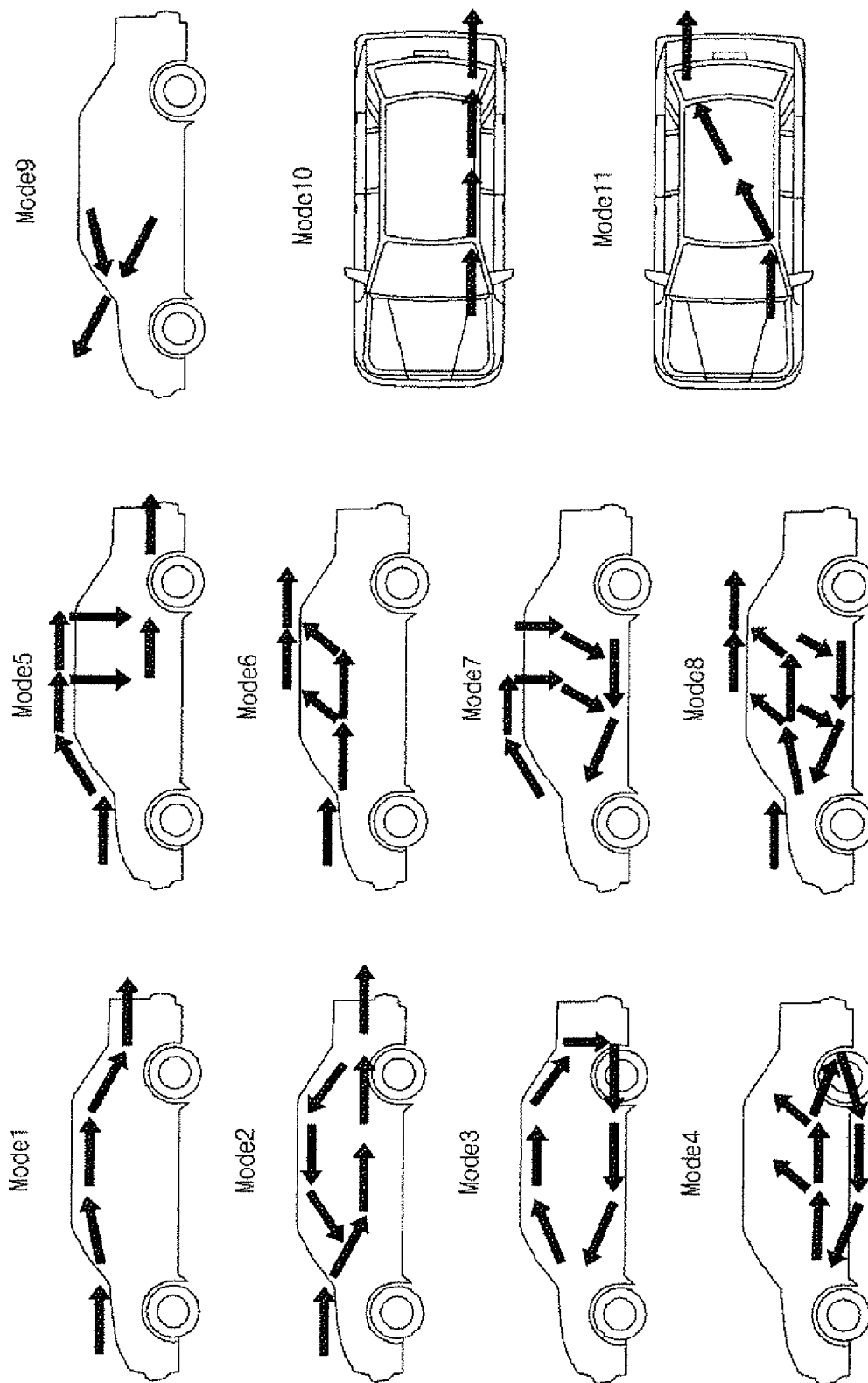
[Fig. 7]



[Fig. 9]



[Fig. 10]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2016/007204**A. CLASSIFICATION OF SUBJECT MATTER****B60H 3/00(2006.01)i, B60H 1/00(2006.01)i, B60H 3/06(2006.01)i, B60H 1/12(2006.01)i**

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 3/00; B60H 3/06; B60H 1/08; B60H 1/00; G06F 3/0488; G05D 23/19; B60H 1/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: air, condition, duct, compartment, sensor, contamination, navigation and filter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2001-260646 A (DENSO CORPORATION) 26 September 2001 See abstract, paragraphs [0008]-[0014], [0025]-[0038] and figures 1-5.	1-26
Y	JP 2013-184703 A (VISTEON GLOBAL TECHNOLOGIES, INC.) 19 September 2013 See paragraphs [0013]-[0026] and figure 1.	1-26
Y	KR 10-2011-0047475 A (DONG-EUI UNIVERSITY INDUSTRY-ACADEMIC COOPERATION FOUNDATION) 09 May 2011 See abstract, claims 1-10 and figures 1-3.	1-26
Y	KR 10-2006-0085992 A (HALLA CLIMATE CONTROL CORPORATION) 31 July 2006 See abstract, claims 1-3 and figure 3.	8-17
Y	US 2015-0094865 A1 (CHOI et al.) 02 April 2015 See abstract, claim 1 and figures 5-126.	24-26



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2016/007204

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