(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 659 346 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
24.05.2006 Bulletin 2006/21

(21) Application number: **05024686.7**

(22) Date of filing: **11.11.2005**

(51) Int Cl.:
F24F 7/08 *(2006.01)* ***F24F 1/00*** *(2006.01)*
F24F 11/00 *(2006.01)*

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL BA HR MK YU

(30) Priority: **17.11.2004 JP 2004332792**

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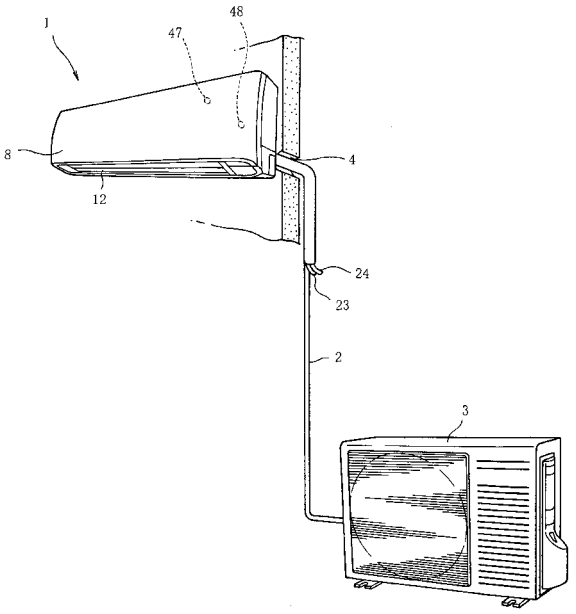
(54) Air conditioner

(57) An air conditioner comprises air pipes (23, 24) inserted through a hole (4) of the building wall; a first fan unit (21) located in an indoor unit (1) and connected to the first air pipe; a second fan unit (22) located in the indoor unit and connected to the second air pipe to exhaust indoor air; a control means (46) ; and an operating unit (49) capable of selecting from among ventilation operation modes including an air-supply/exhaust operation mode of performing both exhaust to discharge indoor air to outdoors and air-supply to take in outdoor air, an air-supply operation mode of performing only air-supply, and an exhaust operation mode of performing only exhaust, and providing the selected ventilation operation mode to the control means.

Fig. 1



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an air conditioner, and more particularly to ventilation of the room associated therewith.

Description of the Related Art

[0002] A general air conditioner such as a domestic appliance has no ventilator. It is therefore required timely to open a window manually to take outdoor air in for ventilation when it is poor in the room air.

[0003] There has been proposed an air conditioner equipped with a ventilator. For example, as disclosed in the patent publication 1 (JP-A 2001/304645), an air conditioner is provided with an air-supply duct (or ventilation pipe) and an outlet duct, and an air-supply fan is located in the air-supply duct and an exhaust fan in the exhaust duct.

[0004] It is often desired to execute powerful exhaust without air-supply, for example, when the room is filled with cigarette smoke and the like. To the contrary, it is also desired to supply fresh outdoor air. The conventional air conditioner is , however, limited to operate only in a single operation mode of ventilation and given no freedom of choice.

[0005] It is therefore the problem to be solved that the operation mode of ventilation can not be selected.

SUMMARY OF THE INVENTION

[0006] The present invention provides an air conditioner with a refrigerant pipe (2) from an indoor unit (1) led out outdoors through a hole (4) of a building wall and connected to an outdoor unit (3). The air conditioner comprises: a first air pipe (23) and a second air pipe (24) inserted through the hole of the building wall; a first fan unit (21) located in the indoor unit and connected to the first air pipe; a second fan unit (22, 60) located in the indoor unit and connected to the second air pipe; a control means (46) for controlling the operation of the first fan unit and the second fan unit; and an operating unit (49) capable of selecting from among ventilation operation modes including an air-supply/exhaust operation mode of performing both exhaust to discharge indoor air to outdoors and air-supply to take in outdoor air, an air-supply operation mode of performing only air-supply to take in outdoor air, and an exhaust operation mode of performing only exhaust to discharge indoor air to outdoors, and providing the selected ventilation operation mode to the control means. The first fan unit has an air-supply function of drawing air outside the building and supplying it indoors through the first air pipe. The second fan unit has an exhaust function of drawing indoor air and exhausting it outside the building through the second air pipe. The control means on receipt of an air-supply/exhaust operation instruction allows an air-supply operation of the first fan unit and an exhaust operation of the second fan unit, on receipt of an air-supply operation instruction allows the air-supply operation of the first fan unit, and on receipt of an exhaust operation instruction allows the exhaust operation of the second fan unit.

[0007] The first fan unit may include a first fan (31) having the number of revolutions variable to adjust the amount of air sent from the first fan unit when the number of revolutions is varied. The second fan unit may include a second fan (41, 61) having the number of revolutions variable to adjust the amount of air sent from the second fan unit when the number of revolutions is varied. The control means may individually control the number of revolutions of the first fan in the first fan unit and the number of revolutions of the second fan in the second fan unit.

[0008] A display unit (15) may be provided at the front of the indoor unit to indicate the ventilation operation-modes including the air-supply/exhaust operation mode of performing both exhaust to discharge indoor air to outdoors and air-supply to take in outdoor air, the air-supply operation mode of performing only air-supply to take in outdoor air, and the exhaust operation mode of performing only exhaust to discharge indoor air to outdoors.

[0009] The display unit may include a pilot display (56) operative to indicate in-ventilation, an air-supply level display (57) located at one side from the centered pilot display and operative to indicate the level of the amount of supplied air, and an exhaust level display (58) located at the other side and operative to indicate the level of the amount of exhausted air.

[0010] In accordance with the present invention, the operating unit selects from among the ventilation operation modes including the air-supply/exhaust operation mode of performing both exhaust to discharge indoor air to outdoors and air-supply to take in outdoor air, the air-supply operation mode of performing only air-supply to take in outdoor air, and the exhaust operation mode of performing only exhaust to discharge indoor air, and provides the selected ventilation operation mode to the control means. In addition, the control means on receipt of the air-supply/exhaust operation instruction allows the air-supply operation of the first fan unit and the exhaust operation of the second fan unit, on receipt of the air-supply operation instruction allows the air-supply operation of the first fan unit, and on receipt of the exhaust operation instruction allows the exhaust operation of the second fan unit. Therefore, the actuation of the operating unit makes it possible to select from among operation modes of ventilation including an air-supply/exhaust operation with simultaneous exhaust and air-supply, an air-supply operation with only air-supply, and an exhaust operation with only exhaust. Accordingly, it is possible to perform ventilation appropriately in a desired ventilation mode depending on the condition of indoor air.

[0011] The control means may individually control the

number of revolutions of the first fan in the first fan unit and the number of revolutions of the second fan in the second fan unit. Thus, the amount of ventilated air can be changed appropriately.

[0012] The display unit may be provided at the front of the indoor unit to indicate the ventilation operation modes including the air-supply/exhaust operation mode, the air-supply operation mode and the exhaust operation mode. Thus, the state of the ventilation operation can be identified at a glance by viewing the display unit.

[0013] The display unit may include the pilot display operative to indicate in-ventilation, the air-supply level display located at one side from the centered pilot display and operative to indicate the level of the amount of supplied air, and the exhaust level display located at the other side and operative to indicate the level of the amount of exhausted air. Thus, the amount of supplied air and the amount of exhausted air can be identified easily. It is therefore possible to adjust ventilation easily.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a perspective view of an indoor unit and an outdoor unit of an air conditioner according to the present invention;

Fig. 2 is a cross-sectional view of the indoor unit;

Fig. 3 is a partly cut-off perspective view of the major part of the indoor unit;

Fig. 4 illustrates a remote in (a) a front view and (b) a front cover-removed front view;

Fig. 5 illustrates control of the air conditioner in (a) an operation pattern table and (b) a controller input/output diagram;

Fig. 6 is a brief illustrative view of an air-supply/exhaust operation;

Fig. 7 is a brief illustrative view of double exhaust;

Fig. 8 is a flowchart on receipt of an instruction for a ventilation operation mode from an operating unit;

Fig. 9 is an operation flowchart of an automatic ventilation based on detection at an air sensor;

Fig. 10 illustrates a ventilation display unit in (a) a front view, (b) a brief diagram of the ventilation halted, (c) a brief diagram of an air-supply/exhaust operation, (d) a brief diagram of the air-supply/exhaust operation with a middle amount of airflow, (e) a brief diagram of the air-supply/exhaust operation with the amount of supplied air different from the amount of exhausted air, (f) a brief diagram of an air-supply operation with a high amount of airflow, (g) a brief diagram of the air-supply operation with a middle amount of airflow, (h) a brief diagram of an exhaust operation with a middle amount of airflow, and (i) a brief diagram of an exhaust operation with a high amount of airflow;

Fig. 11 is an operation pattern table for control of an air conditioner according to a second example; and

Fig. 12 is a brief illustrative view of double air-supply.

DETAILED DESCRIPTION OF THE INVENTION

[0015] The object to allow an air conditioner, which is equipped with a pair of air pipes for executing an air-supply/exhaust operation with simultaneous execution of both air-supply and exhaust, to select an operation mode of ventilation other than the air-supply/exhaust operation can be achieved as follows: an operating unit selects from among ventilation operation modes including an air-supply/exhaust operation mode of performing both exhaust to discharge indoor air to outdoors and air-supply to take in outdoor air, an air-supply operation mode of performing only air-supply to take in outdoor air, and an exhaust operation mode of performing only exhaust to discharge indoor air to outdoors, and provides the selected ventilation operation mode to a control means; and the control means on receipt of an air-supply/exhaust operation instruction allows an air-supply operation of the first fan unit and an exhaust operation of the second fan unit, on receipt of an air-supply operation instruction allows the air-supply operation of the first fan unit, and on receipt of an exhaust operation instruction allows the exhaust operation of the second fan unit.

EXAMPLE 1

[0016] A first example of the air conditioner according to the present invention is described next with reference to Figs . 1-10. Fig. 1 is a perspective view of an indoor unit and an outdoor unit of the air conditioner according to the present invention. Fig. 2 is a cross-sectional view of the indoor unit. Fig. 3 is a partly cut-off perspective view of the major part of the indoor unit. Fig. 4 illustrates a remote in (a) a front view and (b) a front cover-removed front view. Fig. 5 illustrates control of the air conditioner in (a) an operation pattern table and (b) a controller input/output diagram. Fig. 6 is a brief illustrative view of an air-supply/exhaust operation. Fig. 7 is a brief illustrative view of double exhaust. Fig. 8 is a flowchart on receipt of an instruction for a ventilation operation mode from an operating unit. Fig. 9 is an operation flowchart of an automatic ventilation based on detection at an air sensor. Fig. 10 illustrates a ventilation display unit in (a) a front view, (b) a brief diagram of the ventilation halted, (c) a brief diagram of an air-supply/exhaust operation, (d) a brief diagram of the air-supply/exhaust operation with a middle amount of airflow, (e) a brief diagram of the air-supply/exhaust operation with the amount of supplied air different from the amount of exhausted air, (f) a brief diagram of an air-supply operation with a high amount of airflow, (g) a brief diagram of the air-supply operation with a middle amount of airflow, (h) a brief diagram of an exhaust operation with a middle amount of airflow, and (i) a brief diagram of an exhaust operation with a high amount of airflow. In Fig. 5 (b) only ventilation-related primary parts are shown and other parts not shown are also connected

to the controller.

[0017] At first, the whole arrangement of the air conditioner is described.

[0018] In Fig. 1 the air conditioner comprises an indoor unit 1, and an outdoor unit 3 connected to the indoor unit 1 via a pair of refrigerant pipe 2. The indoor unit 1 is located a indoor wall while the outdoor unit 3 is located outdoor. The refrigerant pipe 2 runs through an hole 4 formed through the wall of the house to connect the indoor unit 1 with the outdoor unit 3. The outdoor unit 3 includes equipment such as a compressor (not shown) operative to compress a refrigerant gas, an outdoor side heat exchanger (not shown), a refrigerant circulation path-changing valve (not shown) operative to switch between refrigerant flow direction in circulation paths, and a heat exchanger fan (not shown). In operation of the outdoor unit 3, the refrigerant circulates from the outdoor unit 3 through the refrigerant pipe 2 to the indoor unit 1 for heating/cooling.

[0019] In Fig. 2 the indoor unit 1 includes an indoor side heat exchanger 6, and a circulation fan 7. A movable front panel 8 is provided at the front of the indoor unit 1, and an air inlet 11 is provided behind the front panel 8. On running of the indoor unit 1, the front panel 8 moves forward to allow the air inlet 11 to take room air there through into the indoor unit 1. During halts of the indoor unit 1, the front panel 8 moves rearward or toward the air inlet 11 to enhance the appearance. An air outlet 12 is provided under side of the indoor unit 1. A filter 13 (see Fig. 2) is provided at the front of the air inlet 11. An ultraviolet lamp unit 14 is located above the indoor unit heat exchanger 6. Further, in Figs. 1 and 10, a ventilation display unit 15 (detailed later) is provided in the lower front surface of the indoor unit 1.

[0020] On running of the circulation fan 7 in the indoor unit 1, indoor air is drawn through the air inlet 11, filtrated through the filter 13, heat-exchanged at the indoor unit heat exchanger 6, and blown to the room from the air outlet 12. Thus, during circulation of indoor air by the circulation fan 7, the air is heat-exchanged at the indoor side heat exchanger 6.

[0021] To change the direction of airflow, louvers 16, 17 are provided in the air outlet 12. The lateral louver 16 changes the lateral direction of air blown out. The vertical louver 17 changes the vertical direction of air blown out.

[0022] In Fig. 3 a first fan unit 21 and a second fan unit 22 are provided at a side of the indoor unit 1. In Figs. 1 and 6 the fan units 21, 22 are connected to air pipes 23, 24. The air pipes 23, 24, like the refrigerant pipe 2, are led out outdoors through the hole 4 formed through the wall of the house, and brought into communication with outdoor air.

[0023] In Fig. 6 the first fan unit 21 is the ventilation fan unit for taking in the air from the outside or exhausting the room air, which includes a first fan 31, an inlet side damper 32, and an outlet side damper 33. The first fan 31 is a sirocco fan capable of sending a sufficient amount of air, which, on running, forms airflow in a predetermined direction which is to outlet side from inlet side. As shown in Figs. 6 and 7, the inlet side of the first fan 31 is selectively connected by the inlet damper 32 either to the first air pipe 23 or to the inside of the indoor unit 1. On the other hand, the outlet side of the first fan 31 is selectively connected by the outlet damper 33 either to the first air pipe 23 or to the inside of the indoor unit 1. Thus, the dampers 32, 33 make an air path changing means operative to switch airflow. At taking in the air from outside, the dampers 32, 33 of the first fan unit 21, are changed to taking-in position as shown in Fig. 6. In this case, the inlet damper 32 connects the inlet side of the first fan 31 to the first air pipe 23, and the outlet damper 33 connects the outlet side of the first fan 31 to the inside of the indoor unit 1. This operation is air-supply mode. At exhausting the room air, on the other hand, the dampers 32, 33 of the first fan unit 21 are changed to an exhausting position as shown in Fig. 7. In this case, the inlet damper 32 connects the inlet side of the first fan 31 to the inside of the indoor unit 1, and the outlet damper 33 connects the outlet side of the first fan 31 to the first air pipe 23. This operation is exhaust mode.

[0024] The second fan unit 22 is an exhausting fan unit, which includes a second fan 41, but includes no damper for changing the airflow. The second fan 41 is a sirocco fan, similar to the first fan 31, which, on running, forms airflow in a predetermined direction. As shown in Figs. 6 and 7, the second fan 41 has an inlet side connected to the inside of the indoor unit 1, and an outlet side connected to the second air pipe 24. This operation is exhaust mode.

[0025] As described, the first fan unit 21 has air-supply mode and exhaust mode, the second fan unit 22 has exhaust mode. As shown in Fig. 5(a), the air conditioner of the first example has therefore four types of ventilation patterns: an air-supply/exhaust operation; a single air-supply operation; a single exhaust operation; and a double exhaust operation.

[0026] A controller 46 for controlling the air conditioner having a microcomputer and controls operation of the air conditioner. In particular, with respect to ventilation, as shown in Fig. 5(b), the controller 46 receives a signal from a CO2 sensor 47 located in the vicinity of the indoor unit heat exchanger 6 and operative to detect the density of a CO2 gas. It also receives a signal from a gas sensor 48 located in the vicinity of the indoor unit heat exchanger 6 and operative to detect the density of cigarette smoke, and a signal from a remote controller 49 serving as an operating unit. The CO2 sensor 47 and the gas sensor 48 serve as air pollution sensors operative to detect air pollution. The controller 46 provides drive signals to the first fan 31 and dampers 32, 33 in the first fan unit 21 and the second fan 41 in the second fan unit 31. In addition, the controller provides data indicative of the ventilation condition to the display unit 15. The controller 46 is also connected to various types of other equipment in the indoor unit 1 and the outdoor unit 3, which are allowed to input and output.

[0027] The remote controller 49 having a display section 51 and a detachable front cover 52 as shown in Fig. 4. A plurality of various buttons 53 is provided on the front cover 52 and the body of the remote controller 49. As shown in Fig. 4(b), ventilation-related operational buttons such as a ventilation switching button 53a and a ventilation power button 53b are exposed and made operable when the front cover 52 is opened. As an operational button for use in instruction of ventilation automatically performed depending on the condition of the air pollution, a ventilation and cleaning button 53c is provided on the front cover 52 as shown in Fig. 4(a). When the ventilation switching button 53a is pressed, instructions on an air-supply/exhaust operation with both air-supply mode and exhaust mode, an air-supply operation with only air-supply mode, and an exhaust operation with only exhaust mode are sequentially given to the controller 46 in the body of the indoor unit 1. At the same time, a corresponding ventilation state is shown in the display section 51. When the ventilation power button 53b is pressed, instructions on the power of ventilation are sequentially varied from strong to weak gradually, and the selected instruction is given to the controller 46 in the body of the indoor unit 1.

[0028] The display unit 15 receives a ventilation operation mode associated with the air-supply/exhaust operation, air-supply operation or exhaust operation, and an ability ratio of the amount of ventilated air (a ratio relative to the maximal ability), provided from the controller 46. As shown in Fig. 10, the display unit 15 includes a pilot display 56 operative to indicate in-ventilation, an air-supply level display 57 located at the left side from the centered pilot display and operative to indicate the level of the amount of supplied air in the form of a bar, and an exhaust level display 58 located at the right side and operative to indicate the level of the amount of exhausted air in the form of a bar. The air-supply level display 57 and the exhaust level display 58 are configured to have almost the same length.

[0029] On the basis of the input data from the controller 46, in the ventilation operation, the pilot display 56 turns on, and the air-supply level display 57 and the exhaust level display 58 each indicate the ability ratio of the amount of airflow in the form of a bar. In the air-supply/exhaust operation and the air-supply operation, they indicate the ratio relative to the maximal amount of air sent from the fan unit 21, 22 and, in the case of the maximal amount of airflow, indicate 100 % as shown in Figs. 10 (c) and (f). As the amount of air sent from the fan unit 21, 22 decreases below the maximal amount of airflow, the length of the bar indicated on the level display 57, 58 shortens as shown in Figs. 10(d), (e) and (g). In the air-supply/exhaust operation, the ventilation amount button 53b is employed to make the amount of airflow from the fan unit 21 differ from the amount of airflow from the fan unit 22. In this case, the bar indicated on the level display 57 has a length different from the length of the bar indicated on the level display 58 as shown in Fig. 10(e).

[0030] The exhaust operation includes single exhaust as well as double exhaust and has the maximal exhaust ability on double exhaust. When the first fan unit 21 and the second fan unit 22 are subjected to full running in the state of double exhaust, the ability reaches 100 % as shown in Fig. 10 (i) . When the second fan unit 22 is subjected to full running in the state of single exhaust, the ability lowers down to 50 % as shown with the half length of the bar in Fig. 10(h).

[0031] Thus, in the ventilation display unit 15, the pilot display 56 can be employed to immediately identify if the operation is in ventilation or not. In addition, the air-supply level display 57 and the exhaust level display 58 arranged left and right can be employed to identify at a glance whether the operation is the air-supply/exhaust operation, the air-supply operation or the exhaust operation. In this case, the air-supply level display 57 and the exhaust level display 58 indicate the ratio relative to the maximal amount of airflow in the form of a bar, which makes the ventilation adjustable easily.

[0032] The following description is given based on the flowchart of Fig. 8 to the flow of operation when the ventilation operation mode is instructed.

[0033] In STEP 1, every time when the ventilation switching button 53a is pressed, the instruction is switched among the air-supply/exhaust operation, the air-supply operation and the exhaust operation, and transmitted from the remote controller 49 to the controller 46. In addition, every time when the ventilation amount button 53b is pressed, the instructed amount of airflow to be sent to the room is switched among strong, middle and weak, and the instruction is also transmitted from the remote controller 49 to the controller 46. The amount of airflow can be adjusted by changing the number of revolutions of the fans 31 (fan motor), 41, and the number of the fans 31, 41 to be run (single or double). The controller 46 performs the single exhaust mode when the amount of airflow is middle or weak in the exhaust operation while it performs the double exhaust mode when the amount of airflow is strong in the exhaust operation. In the first example, the air-supply mode can be performed not with the double air-supply mode but with the single air-supply mode only.

[0034] The controller 46 goes to STEP 2 in the air-supply/exhaust operation, STEP 5 in the single air-supply mode, or STEP 8 in the single exhaust mode, and STEP 11 in the double exhaust mode.

[0035] In STEP 2, the controller 46 provides a drive signal to change the dampers 32, 33 for the air- supply mode. If the dampers 32, 33 have already been located at the air-supply mode, the controller 46 maintains the dampers 32, 33 at that state. If the object has been in the instructed state before the controller 46 provides a signal, the controller 46 naturally maintains the state. Accordingly, the associated description will be omitted hereinafter. Then, the controller goes to STEP 3.

[0036] In STEP 3, the controller 46 provides an signal to the first fan 31 for running at the number of revolutions

corresponding to the instructed amount of airflow. In this case, the first fan unit 21 having the air-supply mode and exhaust mode performs the air-supply mode. Then, the controller goes to STEP 4.

[0037] In STEP 4, the controller 46 provides an operation signal to the second fan unit 22 having the exhaust-specified fan unit for running at the number of revolutions corresponding to the instructed amount of airflow, and returns to STEP 1. Then, this condition is maintained until the remote controller 49 is operated again and the ventilation mode is changed.

[0038] If the mode is the single air-supply mode in STEP 1, then the controller goes to STEP 5. In STEPS 5 and 6, similar to STEPS 2 and 3, the controller 46 allows the first fan unit 21 to perform the air-supply mode. Then, the controller goes to STEP 7.

[0039] In STEP 7 the controller 46 halts the second fan unit 22, and returns to STEP 1, remaining the state until the ventilation mode is changed.

[0040] If the mode is the single exhaust mode in STEP 1, then the controller goes to STEP 8. In STEP 8, the controller 46 provides no signal to the dampers 32, 33 and goes to STEP 9.

[0041] In STEP 9, the controller 46 provides a halt signal to the first fan 31 for stopping the first fan 31. Consequently, the first fan unit 21 stops. Then, the controller goes to STEP 10.

[0042] In STEP 10, the controller 46 provides a signal to the second fan unit 22 for running, and returns to STEP 1. Then, the state is maintained until the ventilation mode is changed again.

[0043] If the mode is the double exhaust mode in STEP 1, then the controller goes to STEP 11. In STEP 11, the controller 46 provides a drive signal to change the dampers 32, 33 for the exhaust switched mode. Then, the controller goes to STEP 12.

[0044] In STEP 12, the controller 46 provides a signal to the first fan 31 for running at the number of revolutions corresponding to the instructed amount of airflow. Consequently, the first fan unit 21 performs the exhaust mode. Then, the controller goes to STEP 13.

[0045] In STEP 13, the controller 46 provides a signal to the second fan unit 22 for running at the number of revolutions corresponding to the instructed amount of airflow, and returns to STEP 1. Then, the state is maintained until the remote controller 49 is operated again and the ventilation mode is changed.

[0046] The following description is given based on the flowchart of Fig. 9 to the flow of ventilation operation performed based on the condition of the air pollution detected at the air pollution sensor such as the CO2 sensor 47 and the gas sensor 48.

[0047] In STEP 20, when the ventilation and cleaning button 53c is pressed on the remote controller 49, an instruction signal for a ventilation and cleaning operation (or an automatic ventilation based on the condition of the air pollution in the room) is transmitted to the controller 46, which starts the ventilation and cleaning operation and then goes to STEP 21.

[0048] In STEP 21, the condition of the air pollution detected by the CO2 sensor 47 or the gas sensor 48 is fed to the controller 46, which then goes to STEP 22. In STEP 22, the controller 46 compares the condition of the air pollution with predetermined high and middle settings to determine whether the condition of the air pollution is high state, middle state or low state. The controller goes to STEP 23 if high state, STEP 24 if middle state, and STEP 25 if low state.

[0049] In STEP 23, the controller 46 executes the above STEPS 11-13 to perform the double exhaust mode, and then returns to STEP 21 to maintain the present state until the condition of the air pollution will be under the high state.

[0050] In STEP 24, the controller 46 executes the above STEPS 8-10 to perform the single exhaust mode, and then returns to STEP 21 to maintain the present state until the condition of the air pollution will be under the middle state.

[0051] In STEP 25, the controller 46 provides a halt signal to the fan units 21, 22 to halt the fan units 21, 22 and then returns to STEP 21 to maintain the halt state until the condition of the air pollution will be over the low state.

[0052] Thus, the controller allows the double exhaust mode if the condition of the air pollution is high state, and allows the single exhaust mode if middle state, but halts the exhaust mode if low state.

[0053] As described above, the controller, as the control means, having following controls: 1) when air-supply/exhaust operation signal is made, the first fan unit is changed to air-supply mode, and the exhaust mode of the second fan unit will be started; 2) when the signal of air-supply mode is made, the first fan unit is changed to air-supply mode; and 3) when the signal of exhaust mode is made, the second fan unit is changed to exhaust mode.

[0054] In addition to the above means, the control means further includes means corresponding to each step to be executed, which is operative to execute each step. It is not always required to include all of the above means.

EXAMPLE 2

[0055] A second example of the air conditioner according to the present invention is described next. Fig. 11 is an operation pattern table for control of the air conditioner according to the second example. Fig. 12 is a brief illustrative view of double air- supply mode. In the description of the second example those corresponding to the components of the preceding first example are denoted with the same reference numerals and omitted from the following detailed description.

[0056] In the preceding first example the second fan unit 22 is the exhausting fan unit while in the second example a second fan unit 60 is provided instead of the second fan unit 22. The second fan unit 60 the ventilation

fan unit for taking in the air from the outside or exhausting the room air similar to the first fan unit 21 and includes a second fan 61, an inlet side damper 62, and an outlet side damper 63. The second fan 61, the inlet side damper 62 and the outlet side damper 63 have the same structures and functions as those of the second fan 31, the inlet side damper 32 and the outlet side damper 33 in the first fan unit 21. The second fan unit 60 is possible to perform both air-supply mode and exhaust mode. In the second example, therefore, a double air-supply mode can be performed as shown in Fig. 11.

[0057] The following description is given to the flow of operation in the air conditioner of the second example when the ventilation is instructed. Only steps added and modified are described. In STEP 1 of Fig. 8, in the air-supply mode, the controller 46 performs the single air-supply mode if the power of airflow to be sent is middle or weak while it performs the double air-supply mode if the power of airflow is strong. In the double air-supply mode, the following STEPS 14-16 (not shown in the figure) are added to the flow shown in Fig. 8 such that the first fan unit 21 is subjected to the air-supply mode (STEP 14) , and the dampers 62, 63 are changed to the air-supply mode (STEP 15) and the second fan 61 is run (STEP 16). Consequently, both the first fan unit 21 and the second fan unit 60 are subjected to the air-supply mode as shown in Fig. 12.

[0058] As the second fan unit 60 is the air-supply/exhaust double-functioned fan unit, in STEPS 4, 7, 10, 13 the indication "EXHAUST-SPECIFIED UNIT" should be replaced by "AIR-SUPPLY/EXHAUST DOUBLE-FUNCTIONED UNIT" and the indication "RUN" by "ALLOW EXHAUST OPERATION OF". The flow of the exhaust operation of the second fan unit 60 is same as the flow (STEPS 11, 12) of the exhaust operation of the first fan unit 21, which switches the dampers 62, 63 to the exhaust switched position and runs the second fun 61.

[0059] The examples of the invention have been described in detail though the present invention is not limited to the above examples but rather can be modified variously within the scope of the invention as recited in the appended claims. Modifications of the present invention may be exemplified as below.

(1) The fan is preferably a sirocco fan though it may also be a fan in another form. For example, it may be such a fan that can reverse the direction of rotation. In this case, the dampers 32, 33 can be omitted. Nevertheless, a fan that rotates in a certain direction, such as a sirocco fan, is preferable to ensure a large amount of airflow.

(2) The sequence of the steps in each flowchart may be modified appropriately.

(3) The control means comprises a microcomputer though it may have another configuration.

(4) The refrigerant pipe 2 and the air pipes 23, 24 may be inserted either through the same hole of the wall of the house or through different holes separately. The hole of the wall for the air conditioner may be employed to insert a drain pipe, power wires and communications wires therethrough, in addition to the refrigerant pipe 2 and the air pipes 23, 24.

(5) In the automatic ventilation based on the condition of the air pollution, the single exhaust mode or the double exhaust mode is performed though the single air-supply mode or the double air-supply mode may also be performed.

(6) The air pollution sensors may select appropriate sensors other than the CO2 sensor and the gas sensor if they can detect indoor air pollution.

(7) In the automatic ventilation operation based on the condition of the air pollution, the amount of airflow is switched with the use of the single exhaust operation or the double exhaust operation. It is also possible to adjust the amount of airflow based on the condition of the air pollution by changing the number of revolutions of the fan unit. For example, in the air-supply/exhaust operation, the single exhaust operation and the double exhaust operation, the controller can change the number of revolutions of the fan unit based on the condition of the air pollution.

(8) The first fan unit 21 is the air-supply/exhaust double-functioned fan unit though it may be an exhaust-specified fan unit.

(9) The double operation is not always required though it is preferable to perform the double operation to ensure a large amount of airflow.

(10) The locations of the air-supply level display 57 and the exhaust level display 58 to be arranged thereon can be altered appropriately. For example, they may be arranged at left/right-reversed locations. The pilot display 56 may be omitted.

(11) The operating unit comprises the remote controller 49 though the location and structure thereof may be varied appropriately if it can instruct the ventilation operation modes and so forth. For example, it may be arranged in the body of the indoor unit 1.

INDUSTRIAL AVAILABILITY

[0060] In the air conditioner equipped with a pair of air pipes capable of executing the air-supply/exhaust operation with simultaneous execution of both air-supply and exhaust, the actuation of the operating unit makes it possible to select from among the operation modes of ventilation including the air-supply/exhaust operation with simultaneous execution of both air-supply and exhaust, the air-supply operation with only air-supply and the exhaust operation with only exhaust. Therefore, the present invention is optimally applicable to air conditioners operative to ventilate while air conditioning.

Claims

1. An air conditioner with a refrigerant pipe from an in-

door unit led out outdoors through a hole of a building wall and connected to an outdoor unit, comprising:

a first air pipe and a second air pipe inserted through the hole of the building wall;
a first fan unit located in the indoor unit and connected to the first air pipe;
a second fan unit located in the indoor unit and connected to the second air pipe;
a control means for controlling the operation of the first fan unit and the second fan unit; and
an operating unit capable of selecting from among ventilation operation modes including an air-supply/exhaust operation mode of performing both exhaust to discharge indoor air to outdoors and air-supply to take in outdoor air, an air-supply operation mode of performing only air-supply to take in outdoor air, and an exhaust operation mode of performing only exhaust to discharge indoor air to outdoors, and providing the selected ventilation operation mode to the control means,
wherein the first fan unit has an air-supply function of drawing air outside the building and supplying it indoors through the first air pipe,
wherein the second fan unit has an exhaust function of drawing indoor air and exhausting it outside the building through the second air pipe,
wherein the control means on receipt of an air-supply/exhaust operation instruction allows an air-supply operation of the first fan unit and an exhaust operation of the second fan unit, on receipt of an air-supply operation instruction allows the air-supply operation of the first fan unit, and on receipt of an exhaust operation instruction allows the exhaust operation of the second fan unit.

2. The air conditioner according to claim 1, wherein the first fan unit includes a first fan having the number of revolutions variable to adjust the amount of air sent from the first fan unit when the number of revolutions is varied,
wherein the second fan unit includes a second fan having the number of revolutions variable to adjust the amount of air sent from the second fan unit when the number of revolutions is varied,
wherein the control means is possible to individually control the number of revolutions of the first fan in the first fan unit and the number of revolutions of the second fan in the second fan unit.

3. The air conditioner according to claim 1 or 2,
wherein a display unit is further provided at the front of the indoor unit to indicate the ventilation operation modes including the air-supply/exhaust operation mode of performing both exhaust to discharge indoor air to outdoors and air-supply to take in outdoor air, the air-supply operation mode of performing only air-supply to take in outdoor air, and the exhaust operation mode of performing only exhaust to discharge indoor air to outdoors.

4. The air conditioner according to claim 3, wherein the display unit includes a pilot display operative to indicate in-ventilation, an air-supply level display located at one side from the centered pilot display and operative to indicate the level of the amount of supplied air, and an exhaust level display located at the other side and operative to indicate the level of the amount of exhausted air.

Fig. 1

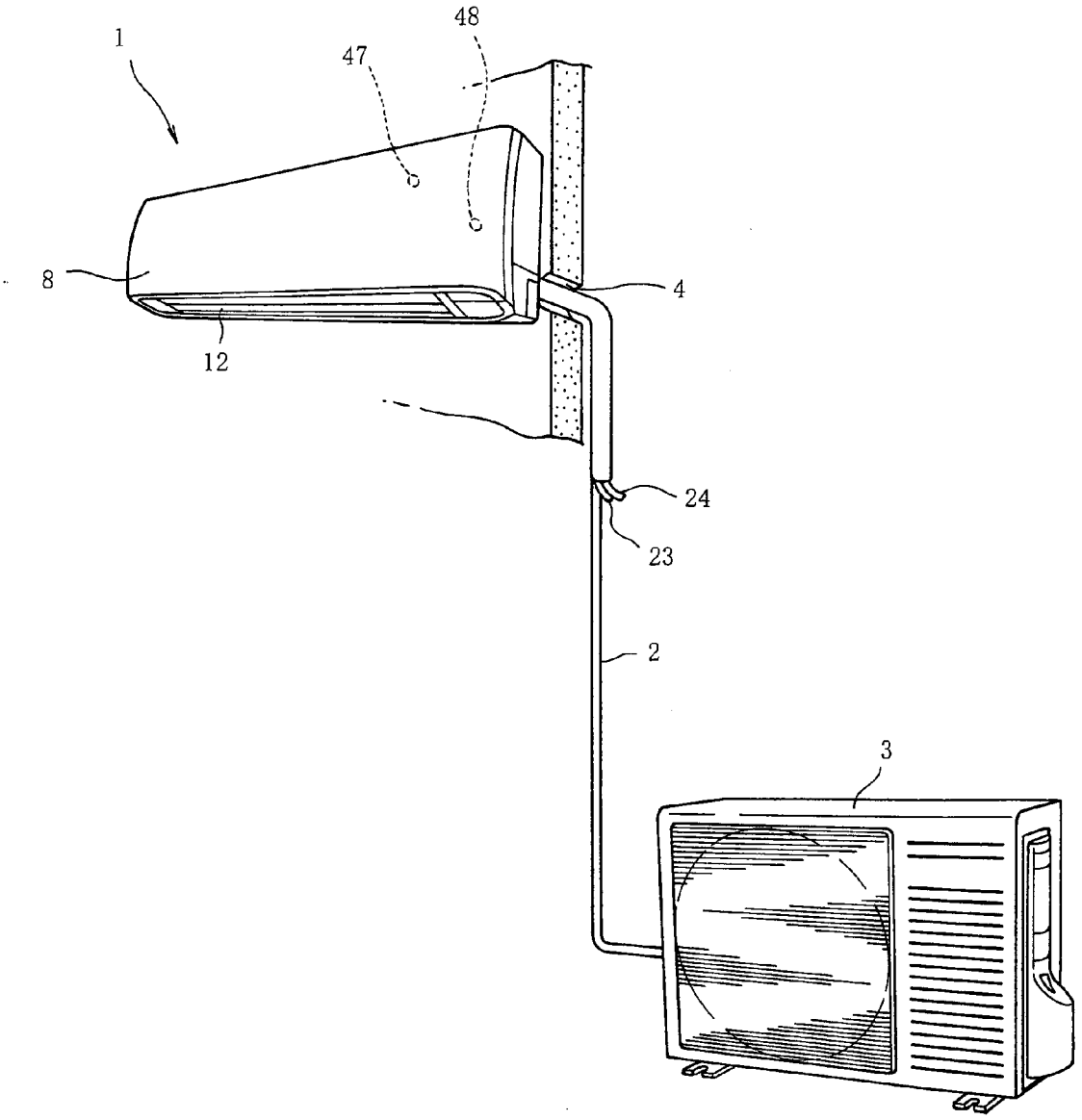

Fig. 2

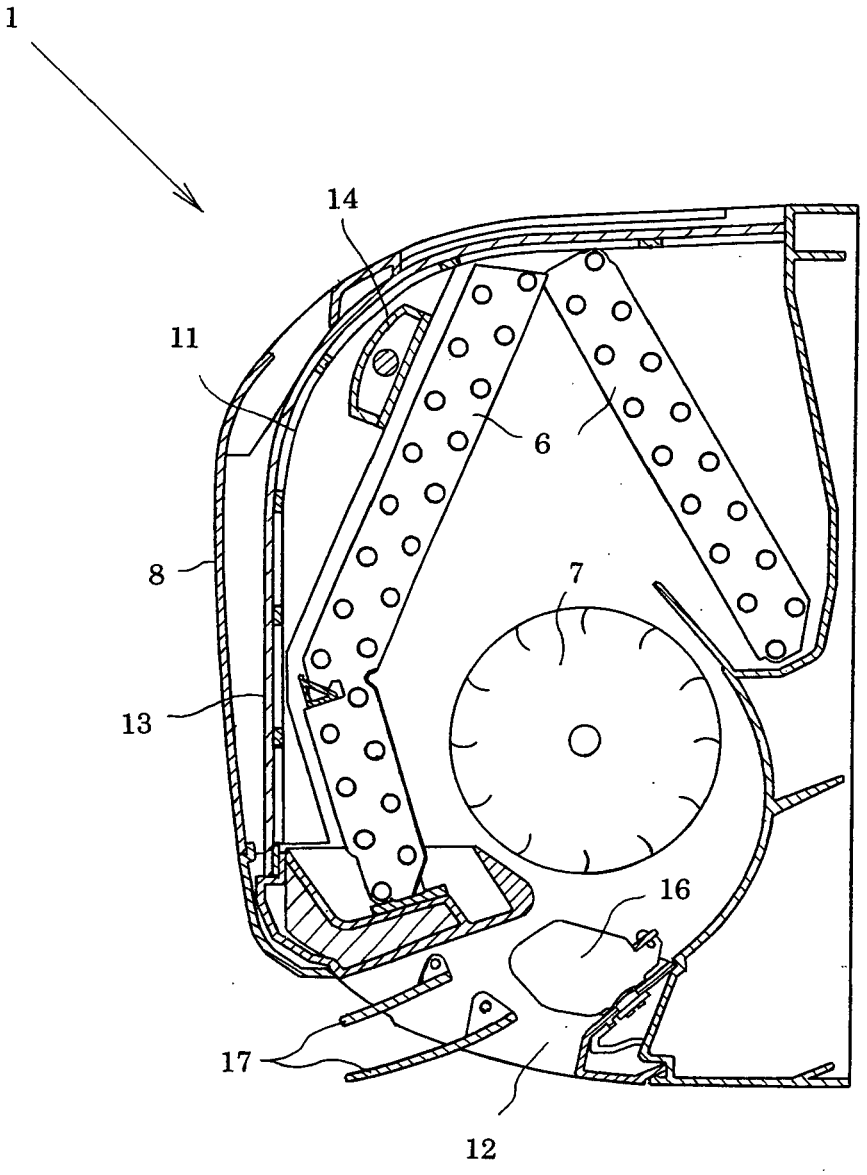

Fig. 3

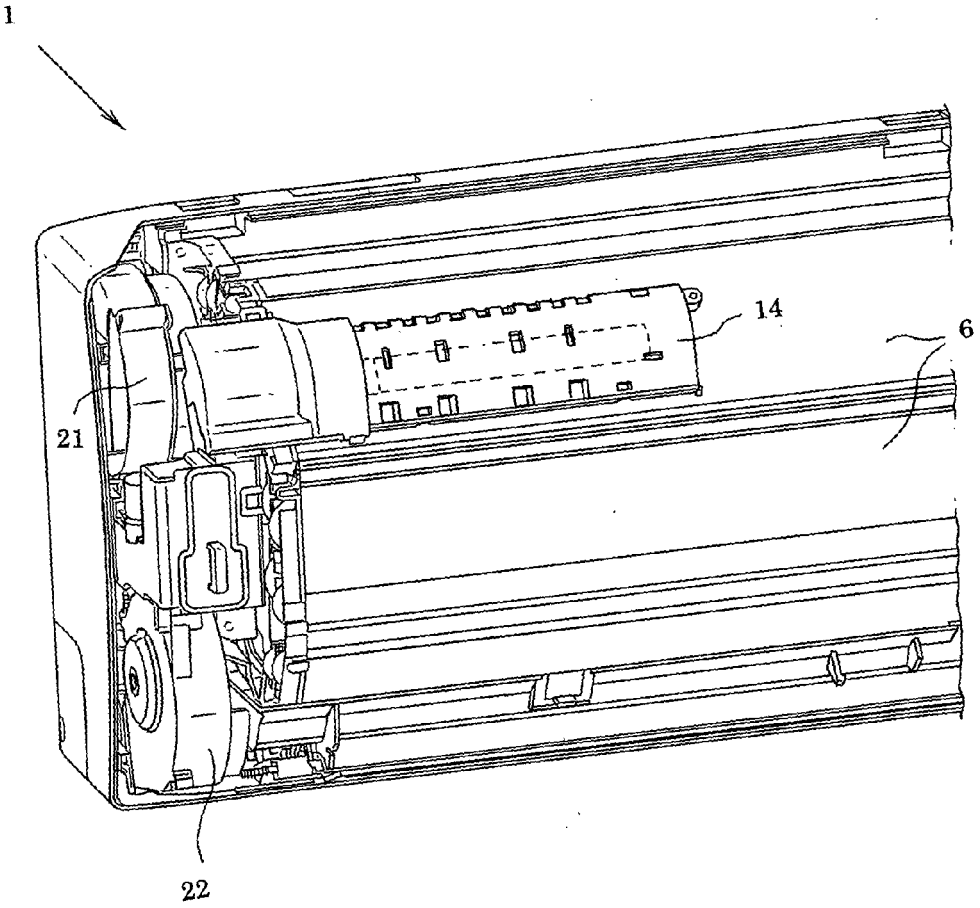

Fig. 4(a)

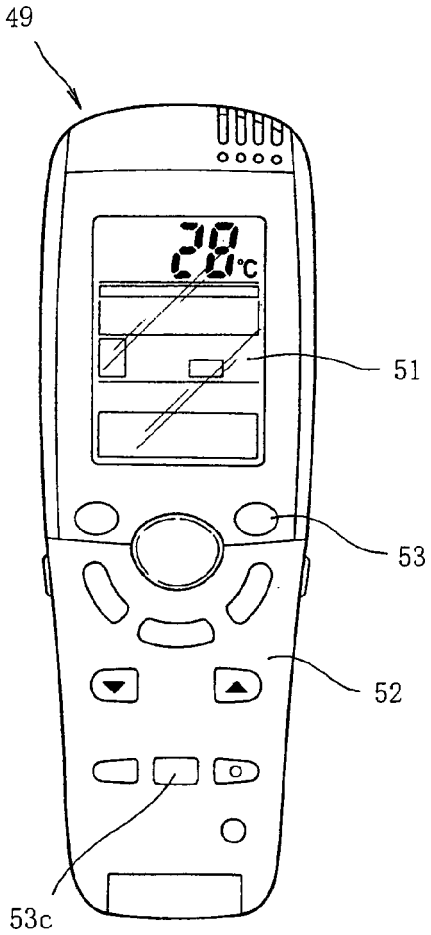

Fig. 4(b)

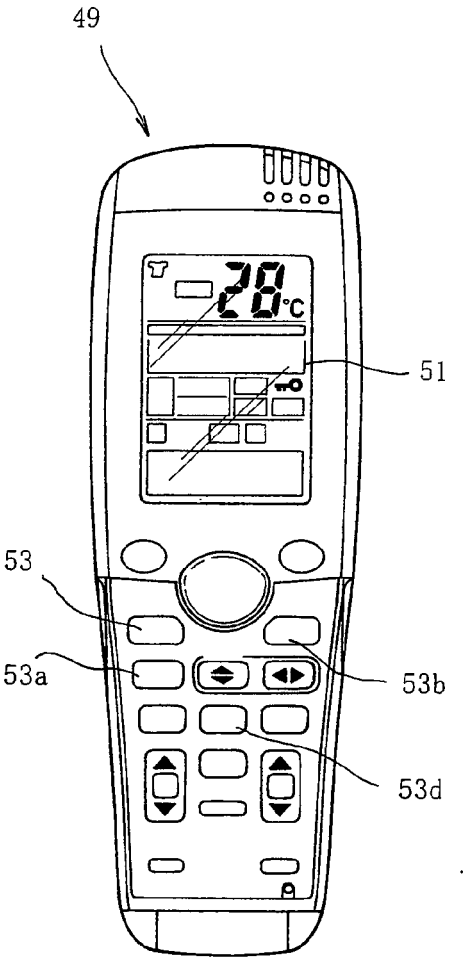

Fig. 5(a)

	AIR-SUPPLY/ EXHAUST OPERATION	SINGLE AIR-SUPPLY	SINGLE EXHAUST	DOUBLE EXHAUST
FIRST FAN UNIT (AIR-SUPPLY/EXHAUST DOUBLE -FUNCTIONED FAN UNIT)	AIR-SUPPLY OPERATION	AIR-SUPPLY OPERATION	HALT	EXHAUST OPERATION
SECOND FAN UNIT (EXHAUST-SPECIFIED FAN UNIT)	EXHAUST OPERATION	HALT	EXHAUST OPERATION	EXHAUST OPERATION

Fig. 5(b)

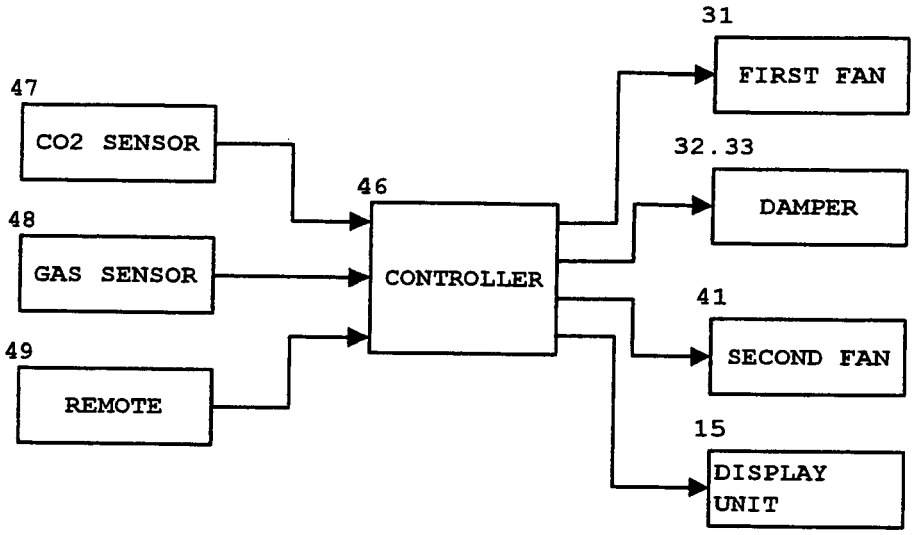
31
FIRST FAN
47
CO2 SENSOR
32.33
DAMPER
46
48
GAS SENSOR
CONTROLLER
41
SECOND FAN
49
REMOTE
15
DISPLAY UNIT

Fig. 6

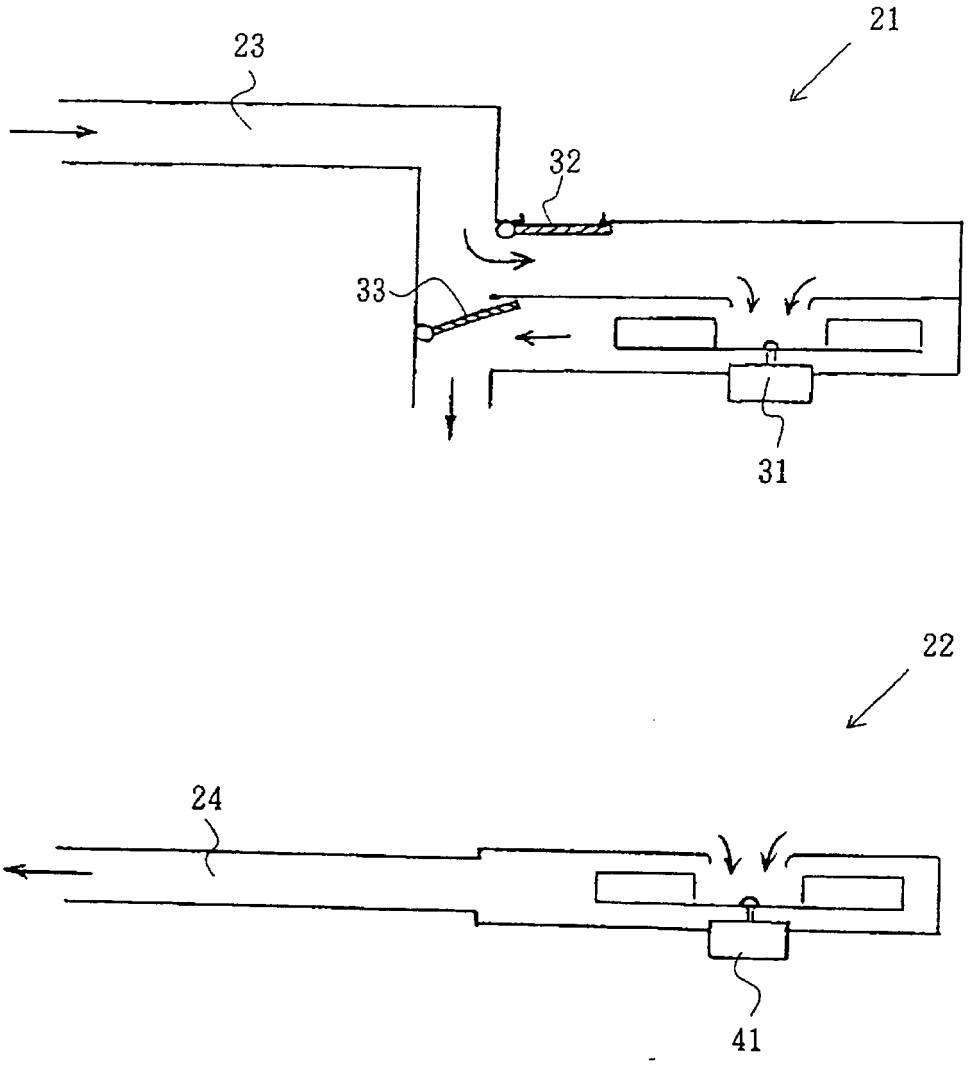

Fig. 7

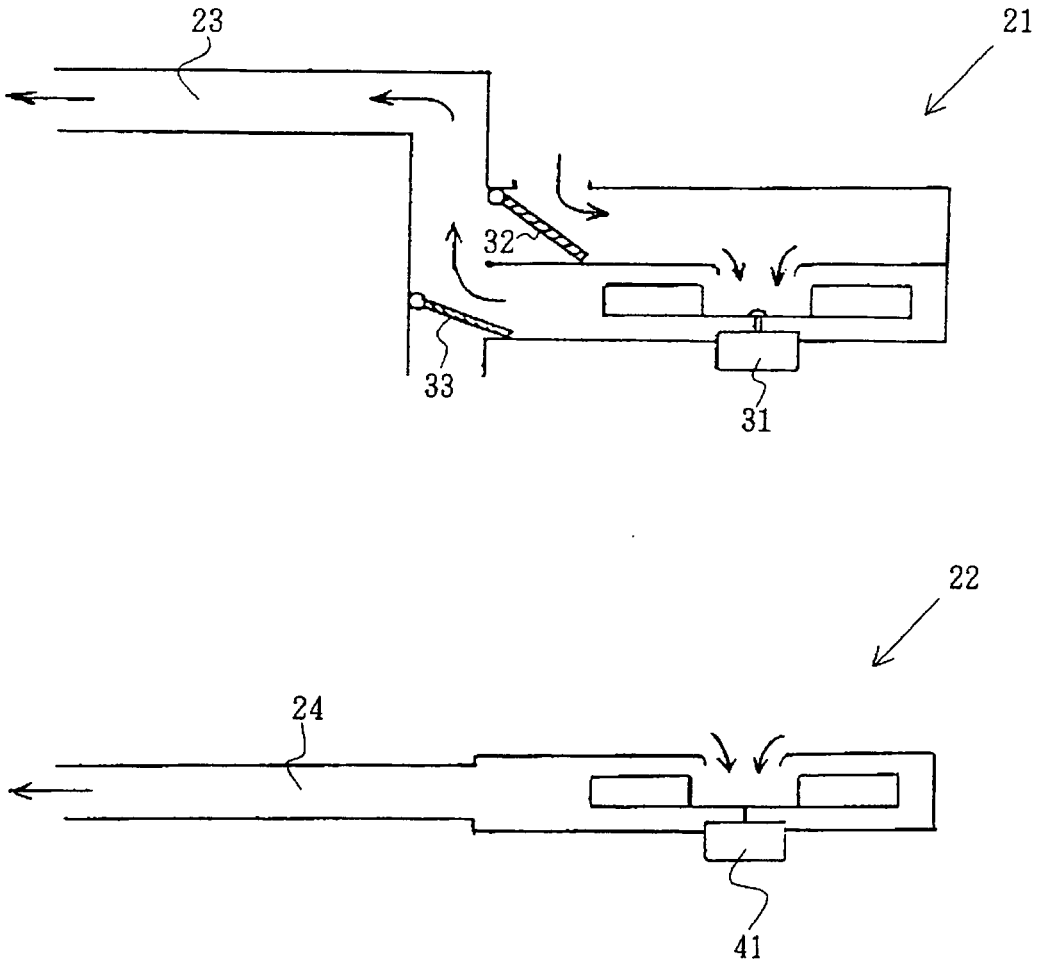

Fig. 8

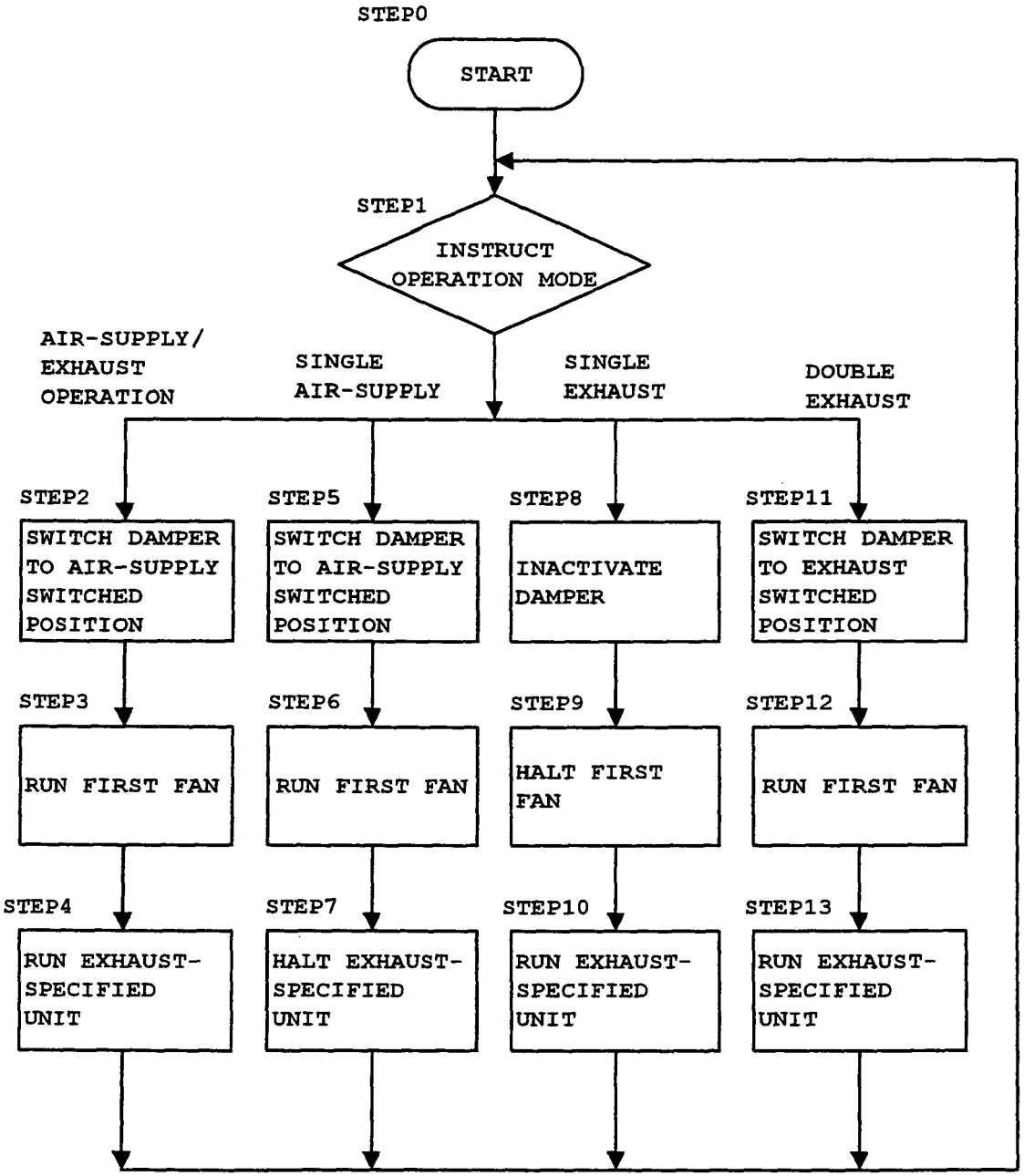
STEP0
START
STEP1
INSTRUCT OPERATION MODE
AIR-SUPPLY/ EXHAUST OPERATION
SINGLE AIR-SUPPLY
SINGLE EXHAUST
DOUBLE EXHAUST
STEP2
SWITCH DAMPER TO AIR-SUPPLY SWITCHED POSITION
STEP5
SWITCH DAMPER TO AIR-SUPPLY SWITCHED POSITION
STEP8
INACTIVATE DAMPER
STEP11
SWITCH DAMPER TO EXHAUST SWITCHED POSITION
STEP3
RUN FIRST FAN
STEP6
RUN FIRST FAN
STEP9
HALT FIRST FAN
STEP12
RUN FIRST FAN
STEP4
RUN EXHAUST-SPECIFIED UNIT
STEP7
HALT EXHAUST-SPECIFIED UNIT
STEP10
RUN EXHAUST-SPECIFIED UNIT
STEP13
RUN EXHAUST-SPECIFIED UNIT

Fig. 9

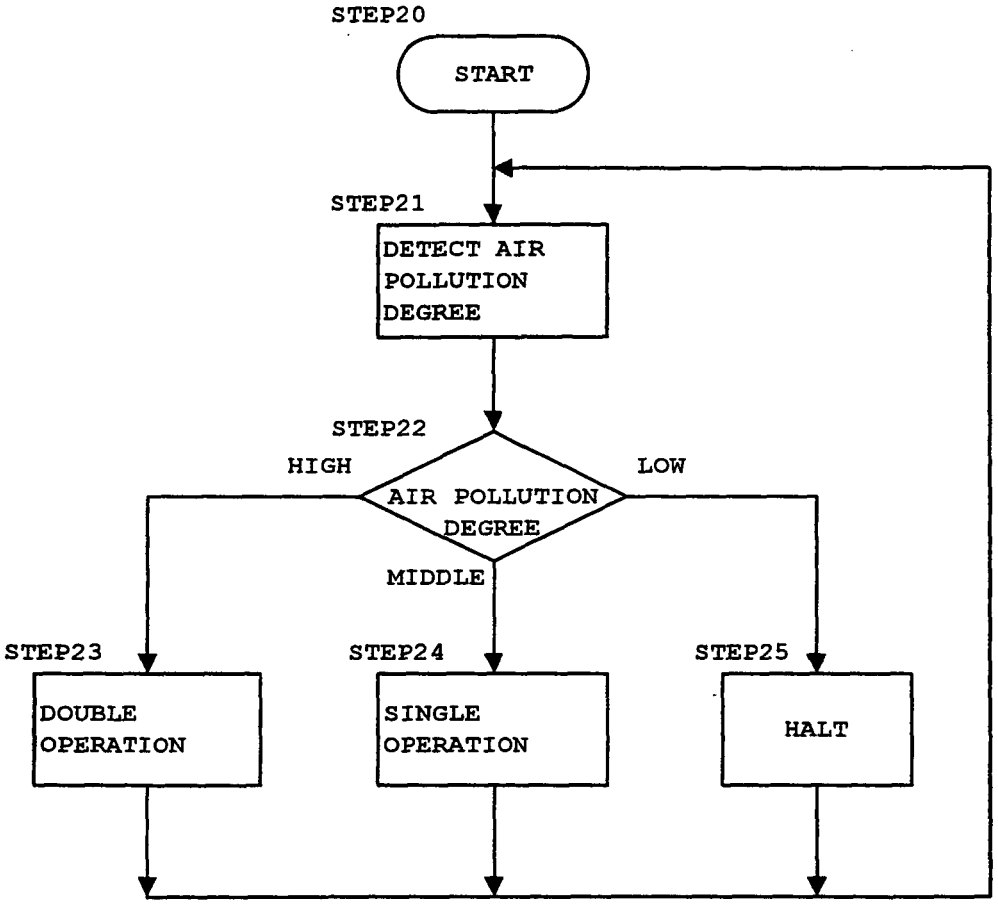
STEP20
START
STEP21
DETECT AIR POLLUTION DEGREE
STEP22
HIGH
AIR POLLUTION DEGREE
LOW
MIDDLE
STEP23
DOUBLE OPERATION
STEP24
SINGLE OPERATION
STEP25
HALT

Fig. 10
(a)

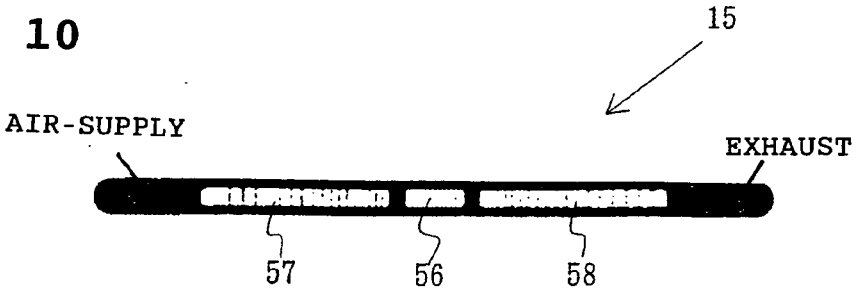

Fig. 10
(b)

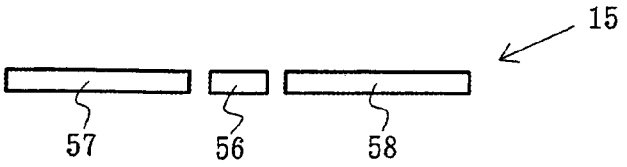

Fig. 10
(c)

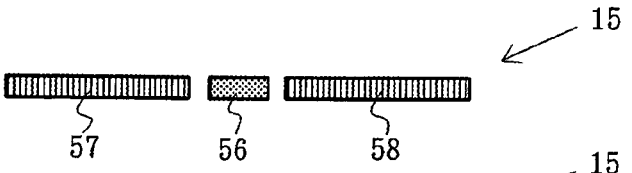

Fig. 10
(d)

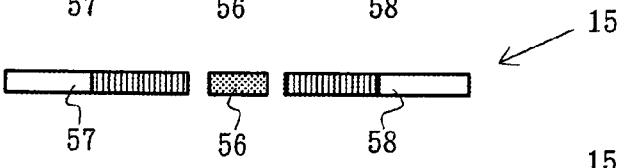

Fig. 10
(e)

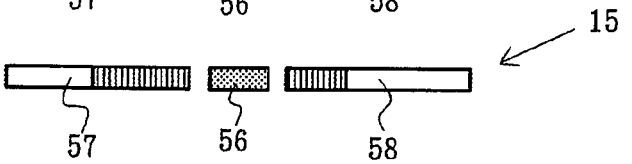

Fig. 10
(f)

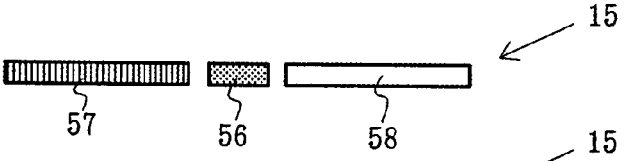

Fig. 10
(g)

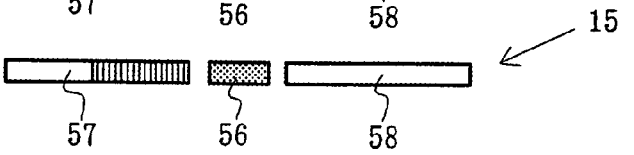

Fig. 10
(h)

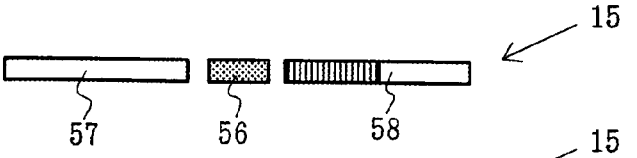

Fig. 10
(i)

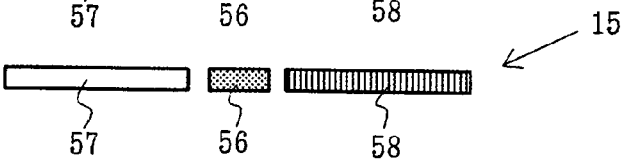

Fig. 11

	AIR-SUPPLY / EXHAUST OPERATION	SINGLE AIR-SUPPLY	SINGLE EXHAUST	DOUBLE EXHAUST	DOUBLE AIR-SUPPLY
FIRST FAN UNIT (AIR-SUPPLY/EXHAUST DOUBLE-FUNCTIONED FAN UNIT)	AIR-SUPPLY OPERATION	AIR-SUPPLY OPERATION	HALT	EXHAUST OPERATION	AIR-SUPPLY OPERATION
SECOND FAN UNIT (AIR-SUPPLY/EXHAUST DOUBLE-FUNCTIONED FAN UNIT)	EXHAUST OPERATION	HALT	EXHAUST OPERATION	EXHAUST OPERATION	AIR-SUPPLY OPERATION

Fig. 12