



(11) **EP 4 261 466 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
18.10.2023 Bulletin 2023/42

(51) International Patent Classification (IPC):
F24F 7/007 ^(2006.01) **F24F 11/52** ^(2018.01)
F24F 11/64 ^(2018.01) **F24F 110/30** ^(2018.01)

(21) Application number: **20965045.6**

(52) Cooperative Patent Classification (CPC):
F24F 7/007; F24F 11/52; F24F 11/64;
F24F 2110/30

(22) Date of filing: **08.12.2020**

(86) International application number:
PCT/JP2020/045731

(87) International publication number:
WO 2022/123661 (16.06.2022 Gazette 2022/24)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(71) Applicant: **MITSUBISHI ELECTRIC CORPORATION**
Chiyoda-ku
Tokyo 100-8310 (JP)

(72) Inventor: **HASHIKAWA, Takahiro**
Tokyo 100-8310 (JP)

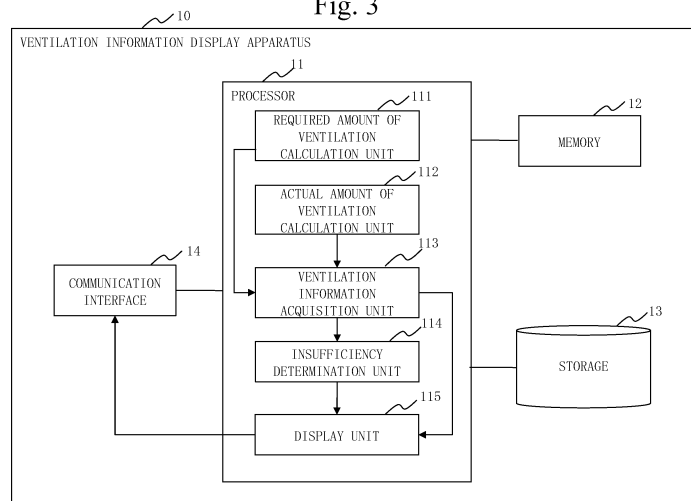
(74) Representative: **Studio Torta S.p.A.**
Via Viotti, 9
10121 Torino (IT)

(54) **VENTILATION INFORMATION DISPLAY DEVICE**

(57) A ventilation information display apparatus (10) includes functions of a ventilation information acquisition unit (113) and a display unit (115). The ventilation information acquisition unit (113) acquires required ventilation information indicating a required amount of ventilation, which is an amount of ventilation required in a target space and actual ventilation information indicating an ac-

tual amount of ventilation, which is an amount of ventilation of a ventilator installed in the target space. The display unit (115) displays the required amount of ventilation indicated in the required ventilation information and the actual amount of ventilation indicated in the actual ventilation information that are acquired by the ventilation information acquisition unit (113).

Fig. 3



EP 4 261 466 A1

Description**Technical Field**

[0001] The present disclosure relates to a technique to display information relating to ventilation.

Background Art

[0002] When designing a facility, a required amount of ventilation which is an amount of ventilation required in a target space is estimated from a floor area and an occupancy area per person, and a capacity of a ventilator is selected. On the other hand, the required amount of ventilation varies under an actual usage environment since the number of occupants in the target space changes from moment to moment.

[0003] Patent Literature 1 describes that the number of occupants in a target space is detected, a required amount of ventilation is calculated based on the detected number of occupants, and an amount of ventilation is controlled depending on the calculated required amount of ventilation.

Citation List**Patent Literature**

[0004] Patent Literature 1: JP 2020-038052 A

Summary of Invention**Technical Problem**

[0005] When a required amount of ventilation exceeds a maximum available amount of ventilation of a ventilator, that is, when an amount of ventilation is insufficient, a user can respond to the insufficiency in the amount of ventilation by taking an action such as opening a window for ventilation or reducing the number of occupants. However, it is difficult for the user to know the required amount of ventilation and an actual amount of ventilation of the ventilator during operation and to determine whether or not the amount of ventilation is insufficient.

[0006] The present disclosure aims to enable the user to easily grasp the required amount of ventilation and the actual amount of ventilation of the ventilator during operation.

Solution to Problem

[0007] A ventilation information display apparatus according to the present disclosure includes:

a ventilation information acquisition unit to acquire required ventilation information indicating a required amount of ventilation, which is a target value of an amount of ventilation in a target space, and actual

ventilation information indicating an actual amount of ventilation, which is an amount of ventilation of a ventilator installed in the target space; and a display unit to display the required amount of ventilation indicated in the required ventilation information and the actual amount of ventilation indicated in the actual ventilation information that are acquired by the ventilation information acquisition unit.

Advantageous Effects of Invention

[0008] In the preset disclosures, required ventilation information and actual ventilation information are displayed. By checking the displayed information, a user can easily grasp a required amount of ventilation and an actual amount of ventilation. As a result, it is possible to specify that the amount of ventilation is insufficient and take an action such as opening a window for ventilation or reducing the number of occupants.

Brief Description of Drawings**[0009]**

Fig. 1 is a configuration diagram of a ventilation system 1 according to Embodiment 1.

Fig. 2 is a diagram illustrating a configuration example of a ventilator 2 according to Embodiment 1.

Fig. 3 is a configuration example of a ventilation information display apparatus 10 according to Embodiment 1.

Fig. 4 is a flowchart of a process of the ventilation information display apparatus 10 according to Embodiment 1.

Fig. 5 is an explanatory diagram of a calculation method of calculating an actual amount of ventilation according to Embodiment 1 and is the diagram illustrating a correlation between a torque current and a motor frequency that realizes a target air volume.

Fig. 6 is an explanatory diagram of the calculation method of calculating the actual amount of ventilation according to Embodiment 1 and is the diagram illustrating a relationship between an air volume and a static pressure.

Fig. 7 is an explanatory diagram of a display process according to Embodiment 1.

Fig. 8 is an explanatory diagram of a timing of maintenance or replacement according to Modification 1.

Fig. 9 is a configuration diagram of the ventilation information display apparatus 10 according to Embodiment 2.

Fig. 10 is a flowchart of a record process according to Embodiment 2.

Fig. 11 is a flowchart of an output process according to Embodiment 2.

Fig. 12 is a configuration diagram of the ventilation information display apparatus 10 according to Embodiment 3.

Fig. 13 is a flowchart of a process of the ventilation information display apparatus 10 according to Embodiment 3.

Description of Embodiments

Embodiment 1.

*** Description of Configuration ***

[0010] A configuration of a ventilation system 1 according to Embodiment 1 will be described with referring to Fig. 1.

[0011] The ventilation system 1 includes a ventilator 2, a number of occupants detection device 3, a display device 4, and a ventilation information display apparatus 10. The ventilation information display apparatus 10 is connected to the number of occupants detection device 3 and the display device 4 via a transmission path 5.

[0012] The ventilator 2 is a device that ventilates a target space 6. As a specific example, the ventilator 2 is a ventilator in which an air supply mechanism and an air exhaust mechanism are integrated, as illustrated in Fig. 2. In Fig. 2, the ventilator 2 includes an air supply fan 21, an air exhaust fan 22, a total heat exchanger 23, and air filters 24a and 24b.

[0013] By operating the air supply fan 21, outside air is taken in and supplied to the target space 6 through the total heat exchanger 23. By operating the air exhaust fan 22, air is taken in from the target space 6 and exhausted outside through the total heat exchanger 23. The total heat exchanger 23 performs total heat exchange between supplied air and exhausted air.

[0014] The number of occupants detection device 3 is a device that detects the number of occupants in the target space 6. In Embodiment 1, the number of occupants detection device 3 is an infrared sensor installed within the target space 6 as a detection range. However, the number of occupants detection device 3 is not limited to the infrared sensor as long as it is a device that is able to detect the number of occupants. For example, the number of occupants detection device 3 may be an entry/exit management device that manages entering/exiting to the target space 6 by means of a card reader installed at an entrance/exit of the target space 6.

[0015] The display device 4 is a device that displays information. In Fig. 1, the display device 4 is a remote controller for controlling the ventilator 2. However, the display device 4 is not limited to the remote controller as long as it is a device that is able to display information. For example, the display device 4 may be a device such as a Personal Computer (PC) installed in the target space 6 or the like, or a device such as a smartphone or a tablet of an occupant in the target space 6.

[0016] A configuration of the ventilation information display apparatus 10 according to Embodiment 1 will be described with referring to Fig. 3.

[0017] The ventilation information display apparatus

10 is a computer.

[0018] The ventilation information display apparatus 10 includes hardware of a processor 11, a memory 12, a storage 13, and a communication interface 14. The processor 11 is connected with other hardware devices via a signal line and controls the other hardware devices.

[0019] The processor 11 is an Integrated Circuit (IC) that performs processing. Specific examples of the processor 11 are a Central Processing Unit (CPU), a Digital Signal Processor (DSP), and a Graphics Processing Unit (GPU).

[0020] The memory 12 is a storage device that stores data temporarily. Specific examples of the memory 12 are a Static Random Access Memory (SRAM), and a Dynamic Random Access Memory (DRAM).

[0021] The storage 13 is a storage device that stores data. A specific example of the storage 13 is a Hard Disk Drive (HDD). Further, the storage 13 may be a portable recording medium such as a Secure Digital (SD, registered trademark) memory card, a CompactFlash (CF, registered trademark), a NAND flash, a flexible disk, an optical disc, a compact disc, a Blu-ray (registered trademark) disc, or a Digital Versatile Disk (DVD).

[0022] The communication interface 14 is an interface for communicating with an external device. Specific examples of the communication interface 14 are an Ethernet (registered trademark) port, a Universal Serial Bus (USB) port, and a High-Definition Multimedia Interface (HDMI, registered trademark) port.

[0023] The ventilation information display apparatus 10 includes a required amount of ventilation calculation unit 111, an actual amount of ventilation calculation unit 112, a ventilation information acquisition unit 113, an insufficiency determination unit 114, and a display unit 115, as functional components. Functions of the individual functional components of the ventilation information display apparatus 10 are implemented by software.

[0024] A program that implements the functions of the individual functional components of the ventilation information display apparatus 10 is stored in the storage 13. This program is read into the memory 12 by the processor 11 and run by the processor 11. Hence, the functions of the individual functional components of the ventilation information display apparatus 10 are implemented.

[0025] Fig. 3 illustrates only one processor as the processor 11. However, there may be a plurality of processors 11. The plurality of processors 11 may cooperate with each other to run the program that implements the individual functions.

*** Description of Operation ***

[0026] Operation of the ventilation information display apparatus 10 according to Embodiment 1 will be described with referring to Figs. 4 through 7.

[0027] An operation procedure of the ventilation information display apparatus 10 according to Embodiment 1 is equivalent to a ventilation information display method

according to Embodiment 1. Further, a program that implements the operation of the ventilation information display apparatus 10 according to Embodiment 1 is equivalent to a ventilation information display program according to Embodiment 1.

[0028] A flow of a process of the ventilation information display apparatus 10 according to Embodiment 1 will be described with referring to Fig. 4.

[0029] The process illustrated in Fig. 4 is repeatedly executed at predetermined intervals.

(Step S11 of Fig. 4: Required amount of ventilation calculation process)

[0030] The required amount of ventilation calculation unit 111 calculates a required amount of ventilation, which is an amount of ventilation required in the target space 6 and writes the required amount of ventilation to the memory 12 with a calculated time. In other words, the required amount of ventilation is a target value of the amount of ventilation in the target space 6.

[0031] Specifically, the required amount of ventilation calculation unit 111 specifies the number of occupants in the target space 6 with using the number of occupants detection device 3. In Embodiment 1, the number of occupants detection device 3 is an infrared sensor so that the required amount of ventilation calculation unit 111 specifies the number of occupants in the target space 6, from sensor data acquired by the infrared sensor. The required amount of ventilation calculation unit 111 calculates the required amount of ventilation for the target space 6 by multiplying the specified number of occupants by the required amount of ventilation per occupant, which has been set in advance.

[0032] The required amount of ventilation per occupant may be varied based on an indicator such as a condition of an occupant and a prevalence situation of an infectious disease. For example, if the occupant is coughing or sneezing, the required amount of ventilation per occupant may be increased. Further, the more the infectious disease such as influenza prevails, the greater the required amount of ventilation per occupant may be.

[0033] The calculation method of calculating the required amount of ventilation is not limited to the above method. For example, the required amount of ventilation calculation unit 111 may calculate the required amount of ventilation for the target space 6, based on information acquired by a device such as a CO₂ sensor or a dust sensor, that is able to measure a degree of contamination for the target space 6.

(Step S12 of Fig. 4: Actual amount of ventilation calculation process)

[0034] The actual amount of ventilation calculation unit 112 calculates an actual amount of ventilation, which is an actual amount of ventilation of the ventilator 2 installed in the target space 6 and writes the actual amount of

ventilation to the memory 12 with a calculated time.

[0035] Specifically, based on the number of revolutions or a current value of a fan motor of the ventilator 2, the actual amount of ventilation calculation unit 112 calculates an air volume of the ventilator 2 as the actual amount of ventilation. At this time, it is preferable that the actual amount of ventilation calculation unit 112 does not calculate the actual amount of ventilation with using performance values shown immediately after installing the ventilator 2, such as catalog values, but calculates the actual amount of ventilation with taking into account reduction in air volumes due to deterioration over time such as dust clogging or dirtiness of the air filters 24a and 24b.

[0036] When a plurality of ventilators 2 is installed in the target space 6, the actual amount of ventilation as a whole of plurality of ventilators 2 is calculated by summing up the actual amount of ventilation of each ventilator 2.

[0037] An example of the calculation method of calculating the actual amount of ventilation will be described with referring to Figs. 5 and 6.

[0038] In Figs. 5 and 6, it is assumed that the ventilator 2 performs a constant air volume control to control the fan motor to keep the amount of ventilation constant.

[0039] As illustrated in Fig. 5, a correlation between a torque current and a motor frequency that realizes a target air volume is set in the constant air volume control. The ventilator 2 controls the air volume to realize the target air volume by controlling the motor frequency depending on the set correlation. That is, when a pressure loss of an air path increases due to dust clogging or the like of the air filters 24a and 24b, the ventilator 2 raises the motor frequency to maintain the target air volume. In Figs. 5 and 6, the motor is controlled at the motor frequency of a point 1 at an initial state. As the pressure loss increases, the motor is controlled to increase the motor frequency in the order of a point 2, a point 3, and a point 4. However, when the pressure loss is so large that the target air volume is not maintained at an upper value of the motor frequency, the air volume gradually decreases as illustrated in Fig. 6.

[0040] Therefore, while the target air volume can be maintained, the actual amount of ventilation calculation unit 112 may treat the target air volume as the actual amount of ventilation. When the pressure loss is so large that the target air volume is not maintained, the actual amount of ventilation calculation unit 112 gradually reduces the actual amount of ventilation depending on the pressure loss.

[0041] The actual amount of ventilation calculation unit 112 may treat an air volume measured by a measuring instrument that measures an air volume of the ventilator 2, as the actual amount of ventilation.

(Step S13 of Fig. 4: Ventilation information acquisition process)

[0042] The ventilation information acquisition unit 113 acquires required ventilation information indicating the

required amount of ventilation for a past reference period calculated in step S 11 and acquires actual ventilation information indicating the actual amount of ventilation for the past reference period calculated in step S12.

[0043] Specifically, the ventilation information acquisition unit 113 reads from the memory 12, the required amount of ventilation calculated in the past reference period, as the required ventilation information, and reads from the memory 12, the actual amount of ventilation calculated in the past reference period, as the actual ventilation information.

(Step S14 of Fig. 4: Insufficiency determination process)

[0044] The insufficiency determination unit 114 determines whether or not the required amount of ventilation indicated in the required ventilation information acquired in step S13 is greater than the actual amount of ventilation indicated in the actual ventilation information acquired in step S13. When the required amount of ventilation is greater than the actual amount of ventilation, the insufficiency determination unit 114 determines that the amount of ventilation is insufficient.

(Step S15 of Fig. 4: Display process)

[0045] The display unit 115 displays on the display device 4, a temporal change in the required amount of ventilation indicated in the required ventilation information acquired in step S13 and a temporal change in the actual amount of ventilation indicated in the actual ventilation information in step S13. Further, when it is determined that the amount of ventilation is insufficient in step S14, the display unit 115 displays on the display device 4, insufficiency information indicating the insufficiency in the amount of ventilation.

[0046] As a specific example as illustrated in Fig. 7, the display unit 115 displays a graph illustrating the temporal change in the required amount of ventilation and the temporal change in the actual amount of ventilation, and also displays as the insufficiency information, the words "amount of ventilation is insufficient" and the current required amount of ventilation as well as the current actual amount of ventilation. Further, the display unit 115 displays in emphasis on a part in the graph where the required amount of ventilation is greater than the actual amount of ventilation, by changing the color of the part or by other means.

[0047] When it is determined that the amount of ventilation is insufficient, the display unit 115 may inform a user of the situation by turning on a lamp, making an audible sound, or the like.

*** Effect of Embodiment 1 ***

[0048] As described above, the ventilation information display apparatus 10 according to Embodiment 1 displays the required ventilation information and the actual

ventilation information. By checking the displayed information, the user can easily grasp the required amount of ventilation and the accrual amount of ventilation. As a result, it is possible to specify that the amount of ventilation is insufficient and possible to take an action such as opening a window for ventilation or reducing the number of occupants.

[0049] Further, the ventilation information display apparatus 10 according to Embodiment 1 displays the graph representing the temporal change in the required amount of ventilation and the temporal change in the actual amount of ventilation. By checking this graph, it is easily for an administrator of the ventilation system 1 to determine whether or not maintenance or replacement for the ventilator 2 is necessary.

*** Other Configurations ***

<Modification 1>

[0050] In step S15, the display unit 115 may indicate a timing of the maintenance or the replacement for the ventilator 2.

[0051] Specifically, as illustrated in Fig. 8, the actual amount of ventilation gradually decreases due to the dust clogging or the like of the air filters 24a and 24b. As a result, the actual amount of ventilation gradually approaches a reference value of the required amount of ventilation, such as a mean value or a median value of the required amount of ventilation. The display unit 115 estimates from the slope or the like of the actual amount of ventilation, a time point where the actual amount of ventilation falls below the reference value of the required amount of ventilation. Then, the display unit 115 displays the estimated time point as the timing of the maintenance or the replacement.

[0052] This makes it possible for the administrator of the ventilation system 1 to grasp by checking the graph, the timing at which the maintenance or the replacement for the ventilator 2 is necessary.

[0053] In step S15, when the situation where the amount of ventilation is insufficient has continued for more than a certain period of time, the display unit 115 may indicate that the maintenance or the replacement for the ventilator 2 is necessary at an early stage.

<Modification 2>

[0054] In step S12, the actual amount of ventilation calculation unit 112 may calculate in addition to the actual amount of ventilation, an estimated amount of ventilation, which is an amount of ventilation of the ventilator 2 to be estimated in a case where the ventilator is maintained, and may write the calculated estimated amount of ventilation to the memory 12. As a specific example, the actual amount of ventilation calculation unit 112 calculates the estimated amount of ventilation in a case where the dust clogging is eliminated by cleaning or replacing the

air filters 24a and 24b.

[0055] In this case, in step S13, the ventilation information acquisition unit 113 acquires in addition to the required ventilation information and the actual ventilation information, estimated ventilation information indicating a current estimated amount of ventilation. In step S15, the display unit 115 displays in addition to the temporal change in the required amount of ventilation and the temporal change in the actual amount of ventilation, the estimated amount of ventilation which is indicated in the estimated ventilation information.

[0056] When the estimated amount of ventilation is greater than or equal to the required amount of ventilation, the insufficiency in the amount of ventilation can be solved by maintaining the ventilator 2. Therefore, by checking the displayed information, the administrator of the ventilation system 1 can easily determine whether or not the insufficiency in the amount of ventilation can be solved if the ventilator 2 is maintained.

[0057] In step S14, the insufficiency determination unit 114 may determine whether or not the estimated amount of ventilation is greater than or equal to the required amount of ventilation. Then, in step S15, when it is determined that the amount of ventilation is insufficient and the estimated amount of ventilation is greater than or equal to the required amount of ventilation, the display unit 115 may display a message recommending the maintenance for the ventilator 2. When it is determined that the amount of ventilation is insufficient and the estimated amount of ventilation is less than the required amount of ventilation, the display unit 115 may display a message recommending the replacement for the ventilator 2.

<Modification 3>

[0058] In Embodiment 1, the required amount of ventilation calculation unit 111 calculates the required amount of ventilation and the actual amount of ventilation calculation unit 112 calculates the actual amount of ventilation. However, the required amount of ventilation and the actual amount of ventilation may be calculated by an external device. Then, the ventilation information acquisition unit 113 may acquire the required amount of ventilation and the actual amount of ventilation calculated by the external device.

<Modification 4>

[0059] In Embodiment 1, the individual functional components are implemented by software. However, Modification 4 may be possible in which the individual functional components are implemented by hardware. A point in Modification 4 which differs from Embodiment 1 will be described.

[0060] When the individual functional components are implemented by hardware, the ventilation information display apparatus 10 includes an electronic circuit in

place of the processor 11, the memory 12, and the storage 13. The electronic circuit is a dedicated circuit that implements the functions of the individual functional components, a function of the memory 12, and a function of the storage 13.

[0061] The electronic circuit is assumed to be a single circuit, a composite circuit, a programmed processor, a parallel-programmed processor, a logic IC, a Gate Array (GA), an Application Specific Integrated Circuit (ASIC), or a Field-Programmable Gate Array (FPGA).

[0062] The individual functional components may be implemented by one electronic circuit. The individual functional components may be decentralized into a plurality of electronic circuits and implemented by the plurality of electronic circuits.

<Modification 5>

[0063] Modification 5 may be possible in which some of the individual functional components are implemented by hardware and the remaining individual functional components are implemented by software.

[0064] The processor 11, the memory 12, the storage 13, and the electronic circuit are referred to as processing circuitry. That is, the functions of the individual functional components are implemented by the processing circuitry.

[0065] Further, "unit" in the above description may be read as "circuit", "step", "procedure", "process", or "processing circuitry".

Embodiment 2.

[0066] Embodiment 2 differs from Embodiment 1 in that instead of displaying information on the display device 4, the information is output to a terminal or the like of the administrator of the ventilation system 1. In Embodiment 2, this difference will be described and a description of the same point will be omitted.

*** Description of Configuration ***

[0067] A configuration of the ventilation information display apparatus 10 according to Embodiment 2 will be described with referring to Fig. 9.

[0068] The ventilation information display apparatus 10 differs from the ventilation information display apparatus 10 illustrated in Fig. 3 in that the ventilation information display apparatus 10 includes a record unit 116 and an output unit 117 as functional components. The record unit 116 and the output unit 117 are implemented by software or hardware just as other functional components.

55 *** Description of Operation ***

[0069] Operation of the ventilation information display apparatus 10 according to Embodiment 2 will be de-

scribed with referring to Fig. 10 and Fig. 11.

[0070] An operation procedure of the ventilation information display apparatus 10 according to Embodiment 2 is equivalent to a ventilation information display method according to Embodiment 2. Further, a program that implements the operation of the ventilation information display apparatus 10 according to Embodiment 2 is equivalent to a ventilation information display program according to Embodiment 2.

[0071] A process of the ventilation information display apparatus 10 according to Embodiment 2 includes a record process and an output process.

[0072] The record process according to Embodiment 2 will be described with referring to Fig. 10.

[0073] When it is determined that the amount of ventilation is insufficient in step S14 of Fig. 4, the record process is executed.

(Step S21 of Fig. 10: Ventilation determination process)

[0074] The record unit 116 determines whether or not a ventilation measure has been executed.

[0075] Specifically, the record unit 116 determines whether or not the number of occupants in the target space 6 has decreased. That is, the record unit 116 specifies with using the number of occupants detection device 3, the number of occupants in the target space 6 and determines whether or not the number of occupants has decreased below the number of occupants specified in step S 11.

[0076] Further, the record unit 116 determines whether or not a fitting that separates the target space 6 has been opened. The fitting that separates the target space 6 is a window or a door installed in the target space 6. For example, the record unit 116 determines with using a sensor that detects opening/closing the fitting, whether or not it has been detected that the fitting is opened.

[0077] In at least one of the cases where it is determined that the number of occupants in the target space 6 has decreased and where it is determined that the fitting that separates the target space 6 has been opened, the record unit 116 determines that the ventilation measure has been executed. When it is determined that the ventilation measure has been executed, the record unit 116 proceeds the process to step S22. On the other hand, when it is determined that the ventilation measure has not been executed, the record unit 116 proceeds the process to step S23.

(Step S22 of Fig. 10: Measure record process)

[0078] The record unit 116 writes to the memory 12 that the ventilation measure has been executed.

[0079] Specifically, when it is determined in step S21 that the number of occupants has decreased, the record unit 116 writes to the memory 12 that the measure of reducing the number of occupants has been executed. Further, when it is determined in step S21 that the fitting

has been opened, the record unit 116 writes to the memory 12 that the measure of manually ventilating has been executed. When it is determined in step S21 that the number of occupants has decreased and the fitting has been opened, the record unit 116 writes to the memory 12 that the measure of reducing the number of occupants and of manually ventilating has been executed.

(Step S23 of Fig. 10: Elapsed time determination process)

[0080] The record unit 116 determines whether or not a specified time has elapsed since it was determined in step S14 that the amount of ventilation was insufficient. The specified time is a time set in advance.

[0081] When the specified time has elapsed since it was determined that the amount of ventilation was insufficient, the record unit 116 ends the process. On the other hand, when the specified time has not elapsed since it was determined that the amount of ventilation was insufficient, the record unit 116 returns the process to step S21.

[0082] An output process according to Embodiment 2 will be described with referring to Fig. 11.

[0083] The output process is executed at a timing specified by the administrator of the ventilation system 1 or at a regular timing.

(Step S31 of Fig. 11: Past record output process)

[0084] The output unit 117 outputs to a terminal or the like of the administrator of the ventilation system 1, the required amount of ventilation indicated in the required ventilation information acquired in step S13 and the actual amount of ventilation indicated in the actual ventilation information acquired in step S13 together with past record information indicating an execution history of the ventilation measure written in step S22 to the memory 12.

[0085] The output unit 117 may output as a graph as illustrated in Fig. 7, the required amount of ventilation indicated in the required ventilation information and the actual amount of ventilation indicated in the actual ventilation information. Further, as described in Modification 2, the output unit 117 may indicate the timing of the maintenance or the replacement on the graph or the like.

*** Effect of Embodiment 2 ***

[0086] As described above, the ventilation information display apparatus 10 according to Embodiment 2 outputs the required amount of ventilation and the actual amount of ventilation to a terminal or the like of the administrator of the ventilation system 1. This makes the administrator to easily grasp a state of excess or insufficiency in the amount of ventilation.

[0087] Further, the ventilation information display apparatus 10 according to Embodiment 2 outputs to a terminal or the like of the administrator of the ventilation

system 1, the past record information indicating a record of the ventilation measure executed in a case where the amount of ventilation is insufficient. This makes the administrator to easily grasp whether or not an appropriate measure has been executed in the case where the amount of ventilation is insufficient. As a result, the administrator can take an action such as reminding the user to execute the ventilation measure.

*** Other Configurations ***

<Modification 6>

[0088] In Embodiment 2, it is determined in step S21 whether or not the number of occupants in the target space 6 has decreased. However, there is a case where the insufficiency in the amount of ventilation is not solved even if the number of occupants has slightly decreased. **[0089]** Therefore, when the number of occupants has decreased, the record unit 116 may determine in step S21 whether or not the required amount of ventilation is less than or equal to the actual amount of ventilation, by letting the required amount of ventilation calculation unit 111 calculate the required amount of ventilation and letting the actual amount of ventilation calculation unit 112 calculate the actual amount of ventilation. In this case, the record unit 116 determines that the ventilation measure has been executed not in the case where the number of occupants has decreased, but in the case where the number of occupants has decreased and the required amount of ventilation has been less than or equal to the actual amount of ventilation.

Embodiment 3.

[0090] Embodiment 3 differs from Embodiments 1 and 2 in that the number of people available to enter the room is specified based on the required amount of ventilation per person and the actual amount of ventilation. In Embodiment 3, this difference will be described and a description of the same point will be omitted.

[0091] In Embodiment 3, a case where a function is added to Embodiment 1 will be described. However, it is possible to add the function to Embodiment 2. Further, it is also possible to realize only the function of Embodiment 3 separately from Embodiments 1 and 2.

*** Description of Configuration ***

[0092] A configuration of the ventilation information display apparatus 10 according to Embodiment 3 will be described with referring to Fig. 12.

[0093] The ventilation information display apparatus 10 differs from the ventilation information display apparatus 10 illustrated in Fig. 3 in that the ventilation information display apparatus 10 includes a number of people calculation unit 118 as a functional component. The number of people calculation unit 118 is implemented by

software or hardware just as other functional components.

*** Description of Operation ***

[0094] An operation of the ventilation information display apparatus 10 according to Embodiment 3 will be described with referring to Fig. 13.

[0095] An operation procedure of the ventilation information display apparatus 10 according to Embodiment 3 is equivalent to a ventilation information display method according to Embodiment 3. Further, a program that implements the operation of the ventilation information display apparatus 10 according to Embodiment 3 is equivalent to a ventilation information display program according to Embodiment 3.

The process indicated in Fig. 13 is executed at a timing instructed by the user to execute the process or at a regular timing.

[0096] In Embodiment 3, the number of occupants in the target space 6 is assumed to be zero.

(Step S41 of Fig. 13: Actual amount of ventilation calculation process)

[0097] The actual amount of ventilation calculation unit 112 calculates the actual amount of ventilation, which is an actual amount of ventilation of the ventilator 2 installed in the target space 6 and writes the actual amount of ventilation to the memory 12. A specific method of calculating the actual amount of ventilation is the same as step S12 of Fig. 4.

(Step S42 of Fig. 13: Number of people calculation process)

[0098] Based on the required amount of ventilation per occupant and the actual amount of ventilation calculated in step S41, the number of people calculation unit 118 calculates the number of people available to enter the target space 6.

[0099] Specifically, the number of people calculation unit 118 calculates as the number of people available to enter the target space 6, a value acquired by dividing the actual amount of ventilation calculated in step S41 by the required amount of ventilation per occupant and rounding down fractions.

(Step S43 of Fig. 13: Display process)

[0100] The display unit 115 displays on the display device 4, the number of people available to enter the room calculated in step S42.

*** Effect of Embodiment 3 ***

[0101] As described above, the ventilation information display apparatus 10 according to Embodiment 3 displays the number of people available to enter the target space 6. This makes the user of the target space 6 to know in advance, the number of people available to enter the target space 6.

[0102] For example, if the target space 6 is a conference room, the user can know the number of people available to enter the conference room at a time of making a reservation or the like for the conference room. Therefore, the number of participants for a conference is adjusted depending on the number of people available to enter the room. Alternatively, it is possible to make an adjustment such as changing the conference room to be used to another conference room. In this example, it is desirable that the display device 4 is not a remote controller of the ventilator 2, but a terminal of the user such as a PC, a smartphone, or a tablet.

[0103] Further, with using the required amount of ventilation per occupant depending on an indicator such as an epidemic state of infectious diseases, it is possible to specify the appropriate number of people depending on a situation.

*** Other Configurations ***

<Modification 7>

[0104] In Embodiment 3, the number of occupants in the target space 6 is assumed to be zero. However, the number of occupants in the target space 6 may be more than or equal to one. In this case, the number of people calculation unit 118 may calculate in step S42, the number of people available to enter the target space 6 by subtracting the number of occupants, from a value acquired by dividing the actual amount of ventilation by the required amount of ventilation per occupant and rounding down fractions.

[0105] For example, if the target space 6 is a shared office or the like, a usage way is considered such as displaying how many more people is available to enter the room, on the display device 4 installed at an entrance of the target space 6.

[0106] The embodiments and modifications of the present disclosure have been described above. Two or more of these embodiments and modifications may be implemented in combination. Alternatively, one or more of them may be partially implemented. The present disclosure is not limited to the above embodiments and modifications, and various modifications can be made as needed.

Reference Signs List

[0107] 1: ventilation system; 2: ventilator; 3: number of occupants detection device; 4: display device; 5: trans-

mission path; 6: target space; 10: ventilation information display apparatus; 11: processor; 12: memory; 13: storage; 14: communication interface; 111: required amount of ventilation calculation unit; 112: actual amount of ventilation calculation unit; 113: ventilation information acquisition unit; 114: insufficiency determination unit; 115: display unit; 116: record unit; 117: output unit; 118: number of people calculation unit; 21: air supply fan; 22: air exhaust fan; 23: total heat exchanger; 24a: air filter; 24b: air filter

Claims

1. A ventilation information display apparatus comprising:
 - a ventilation information acquisition unit to acquire required ventilation information indicating a required amount of ventilation, which is a target value of an amount of ventilation in a target space, and actual ventilation information indicating an actual amount of ventilation, which is an amount of ventilation of a ventilator installed in the target space; and
 - a display unit to display the required amount of ventilation indicated in the required ventilation information and the actual amount of ventilation indicated in the actual ventilation information that are acquired by the ventilation information acquisition unit.
2. The ventilation information display apparatus according to claim 1, wherein when the required amount of ventilation is greater than the actual amount of ventilation, the display unit displays insufficiency information indicating insufficiency in an amount of ventilation.
3. The ventilation information display apparatus according to claim 1 or claim 2, wherein
 - the required ventilation information indicates the required amount of ventilation for a past reference period,
 - the actual ventilation information indicates the actual amount of ventilation for the past reference period, and
 - the display unit displays the required amount of ventilation and the actual amount of ventilation for the past reference period.
4. The ventilation information display apparatus according to any one of claims 1 to 3, wherein
 - the ventilation information acquisition unit acquires estimated ventilation information indicating an estimated amount of ventilation, which is

an amount of ventilation of the ventilator to be estimated in a case where the ventilator is maintained, and the display unit displays the estimated amount of ventilation indicated in the estimated ventilation information. 5

5. The ventilation information display apparatus according to claim 2 further comprises: 10

in at least one of cases where the number of occupants in the target space has decreased after the insufficiency information has been displayed and where a fitting that separates the target space has been opened after the insufficiency information has been displayed, a measure record unit to record in past record information, that a ventilation measure has been executed; and a past record output unit to output the past record information recorded by the measure record unit. 15 20

6. The ventilation information display apparatus according to claim 5, wherein 25

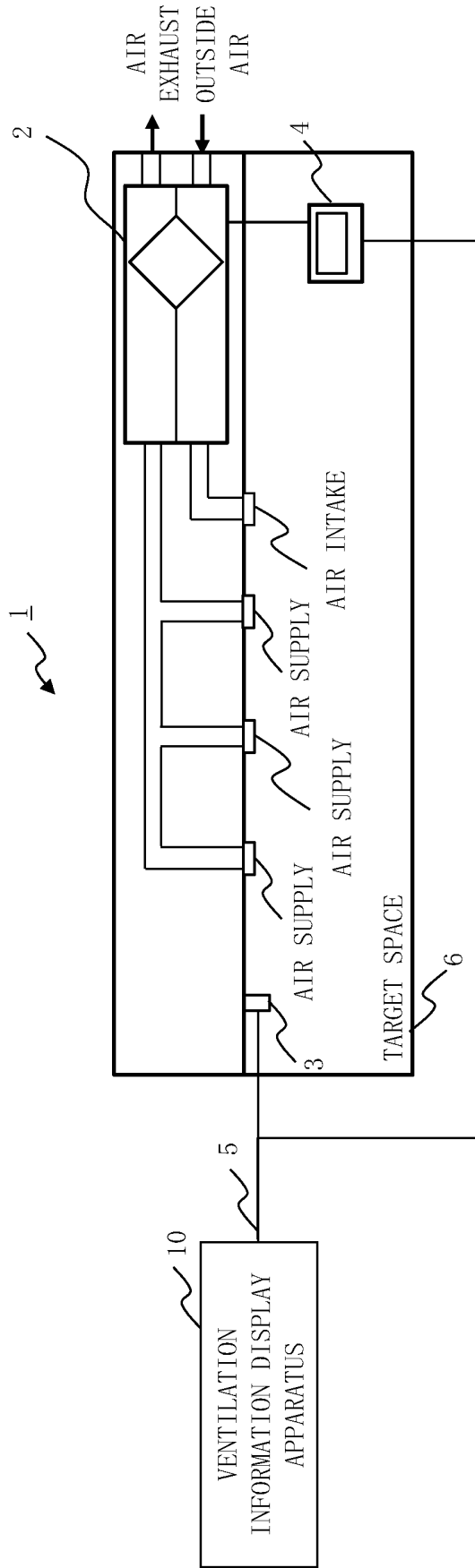
the required ventilation information indicates the required amount of ventilation for a past reference period, the actual ventilation information indicates the actual amount of ventilation for the past reference period, and the past record output unit outputs the required ventilation information, the actual ventilation information, and the past record information 30 35

7. The ventilation information display apparatus according to any one of claim 5 or claim 6, wherein the past record output unit outputs timing information indicating a recommendation timing for maintenance or replacement for the ventilator, specified from a temporal change in the required amount of ventilation and a temporal change in the actual amount of ventilation. 40 45

8. The ventilation information display apparatus according to any one of claims 1 to 7, wherein the display unit displays the number of people available to enter the target space, specified from a required amount of ventilation per person and the actual amount of ventilation. 50

55

Fig. 1



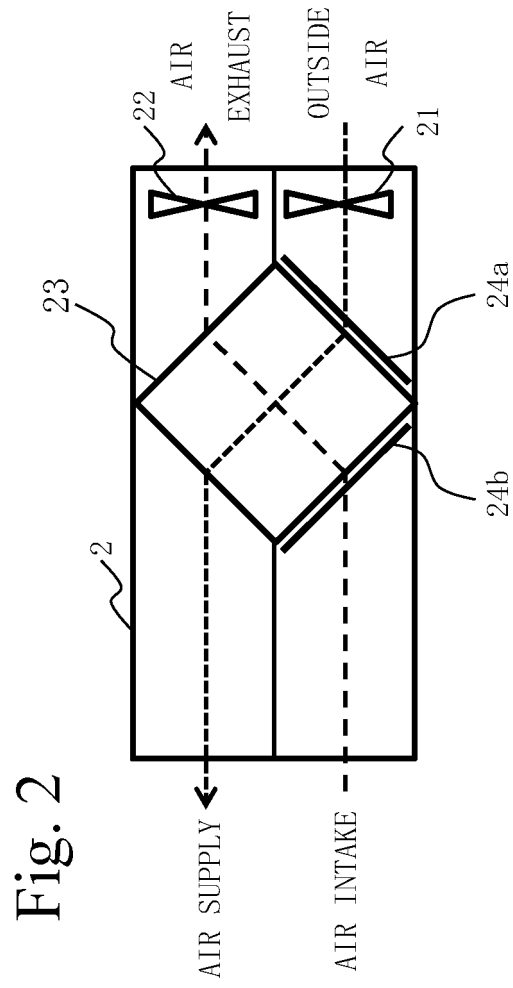


Fig. 2

Fig. 3

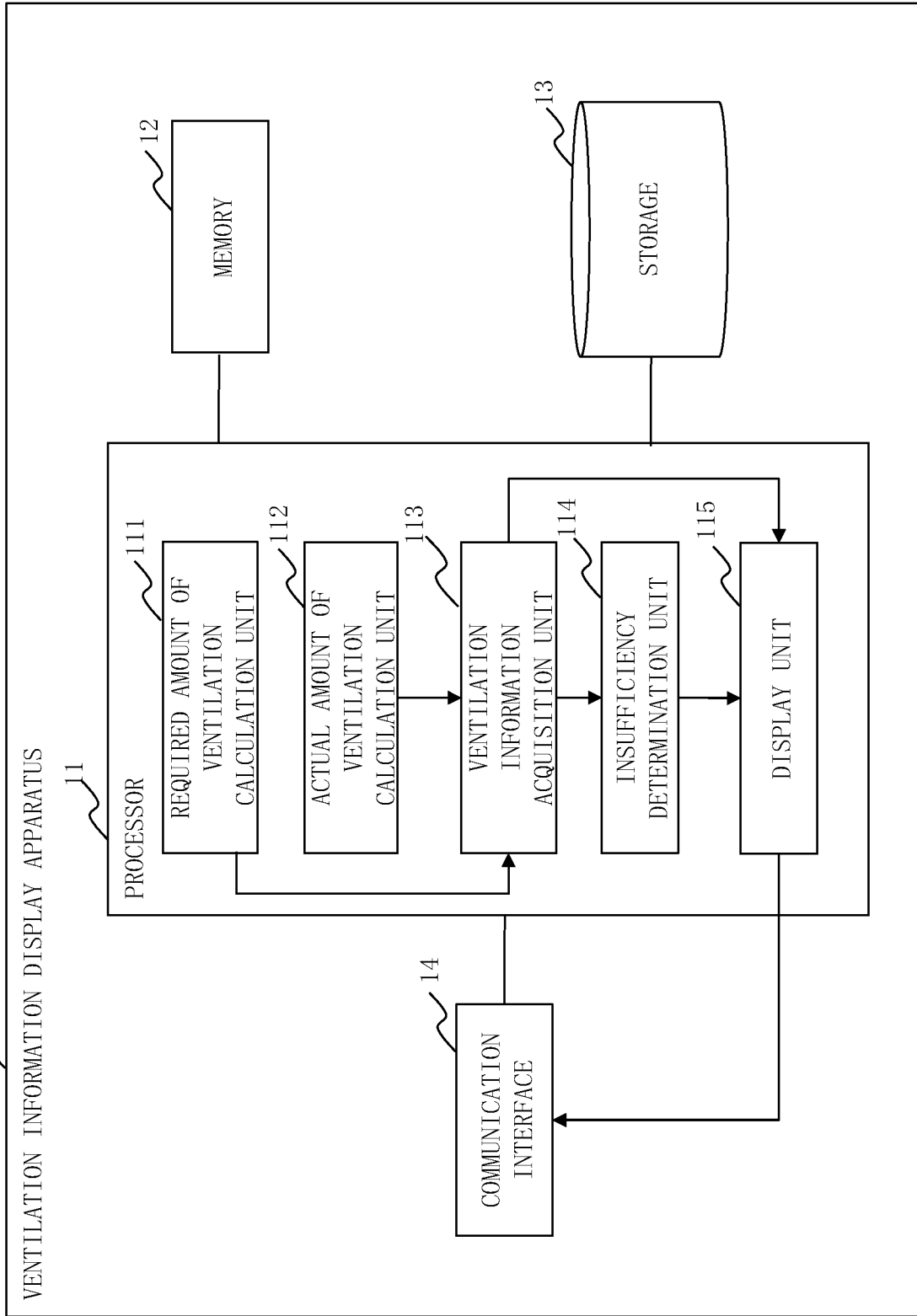
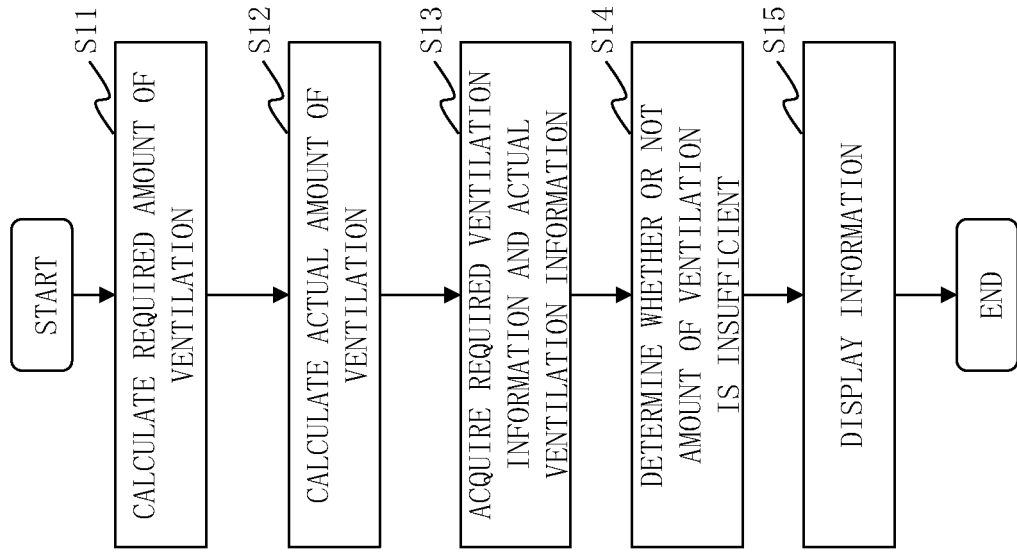


Fig. 4



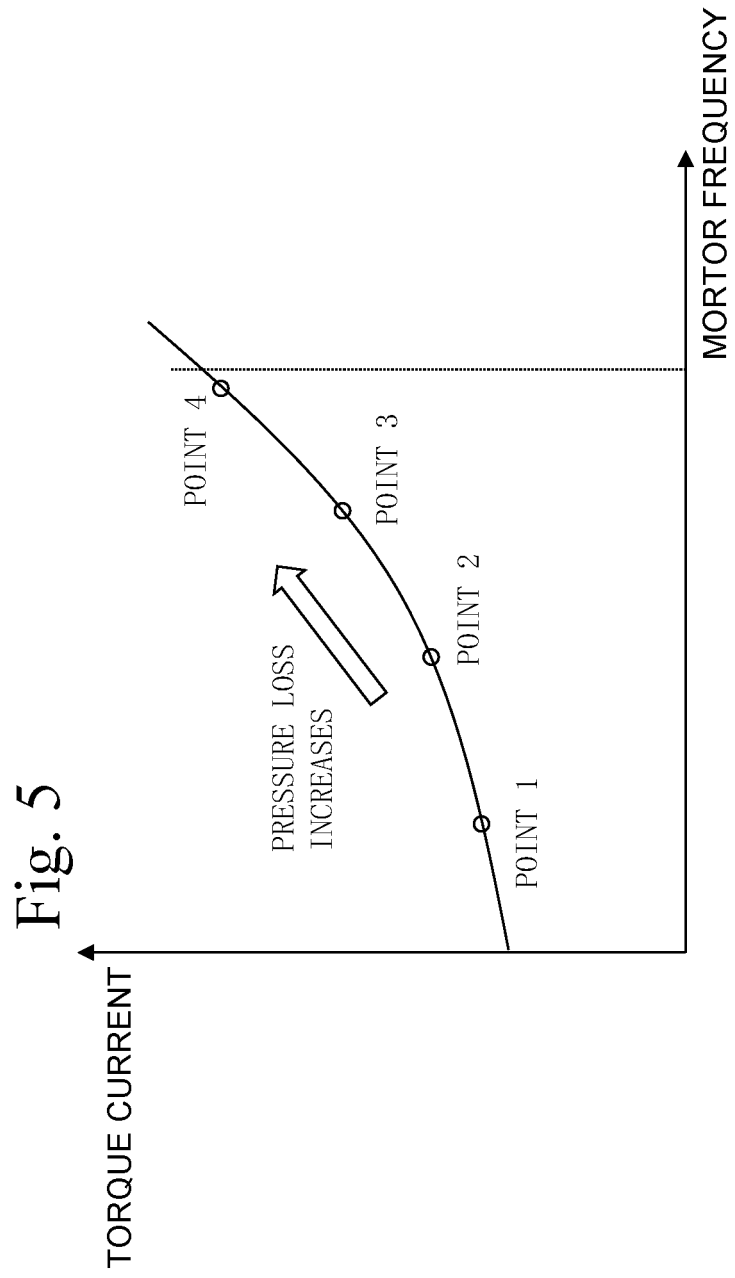


Fig. 6

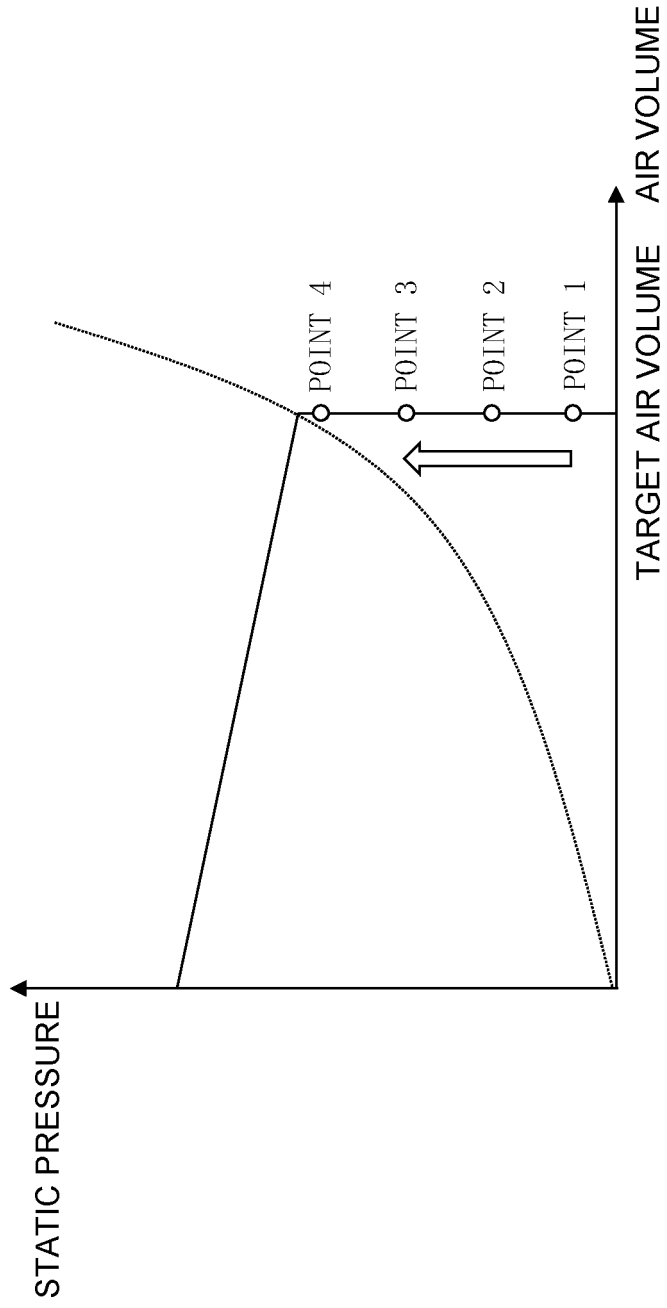
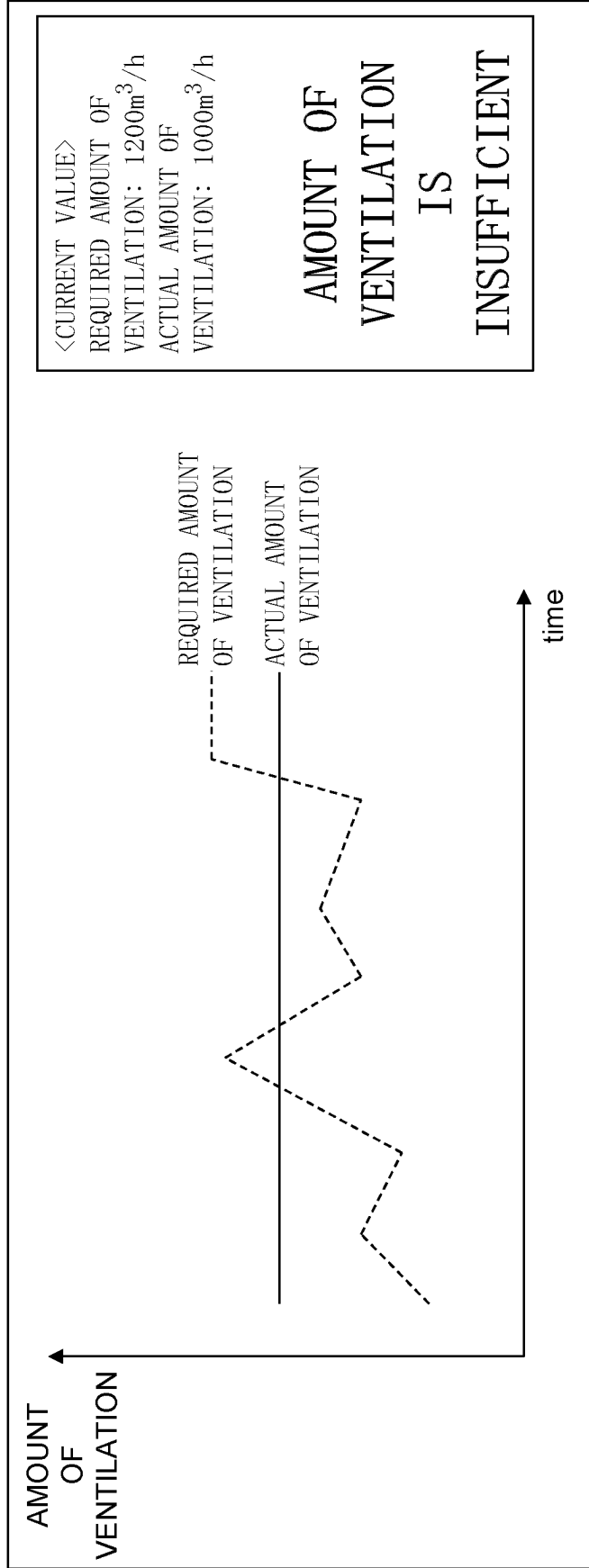


Fig. 7



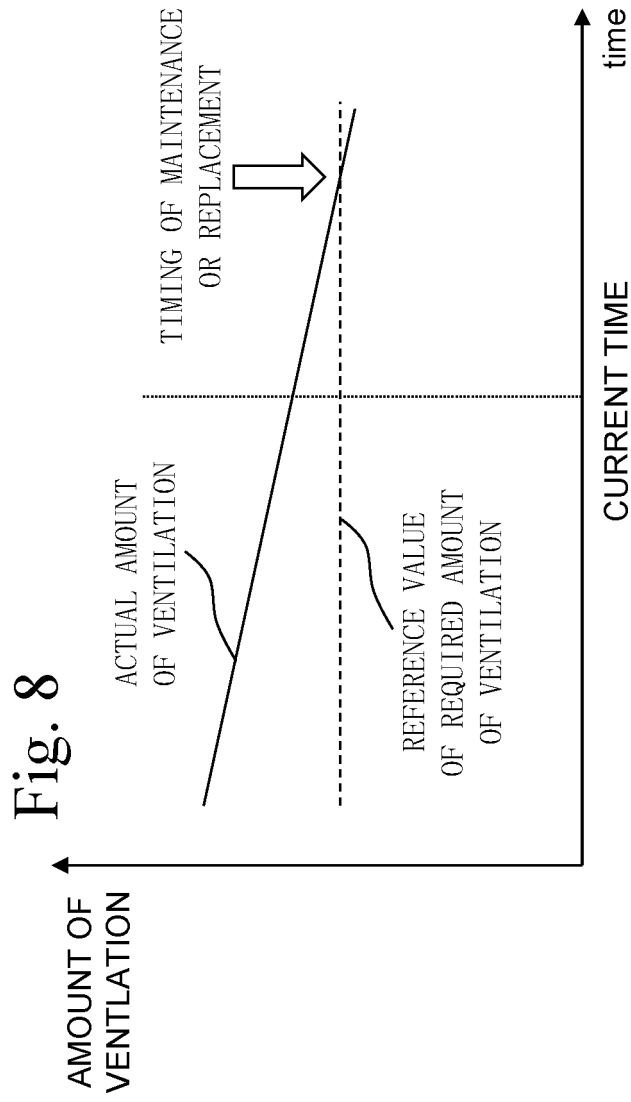


Fig. 9

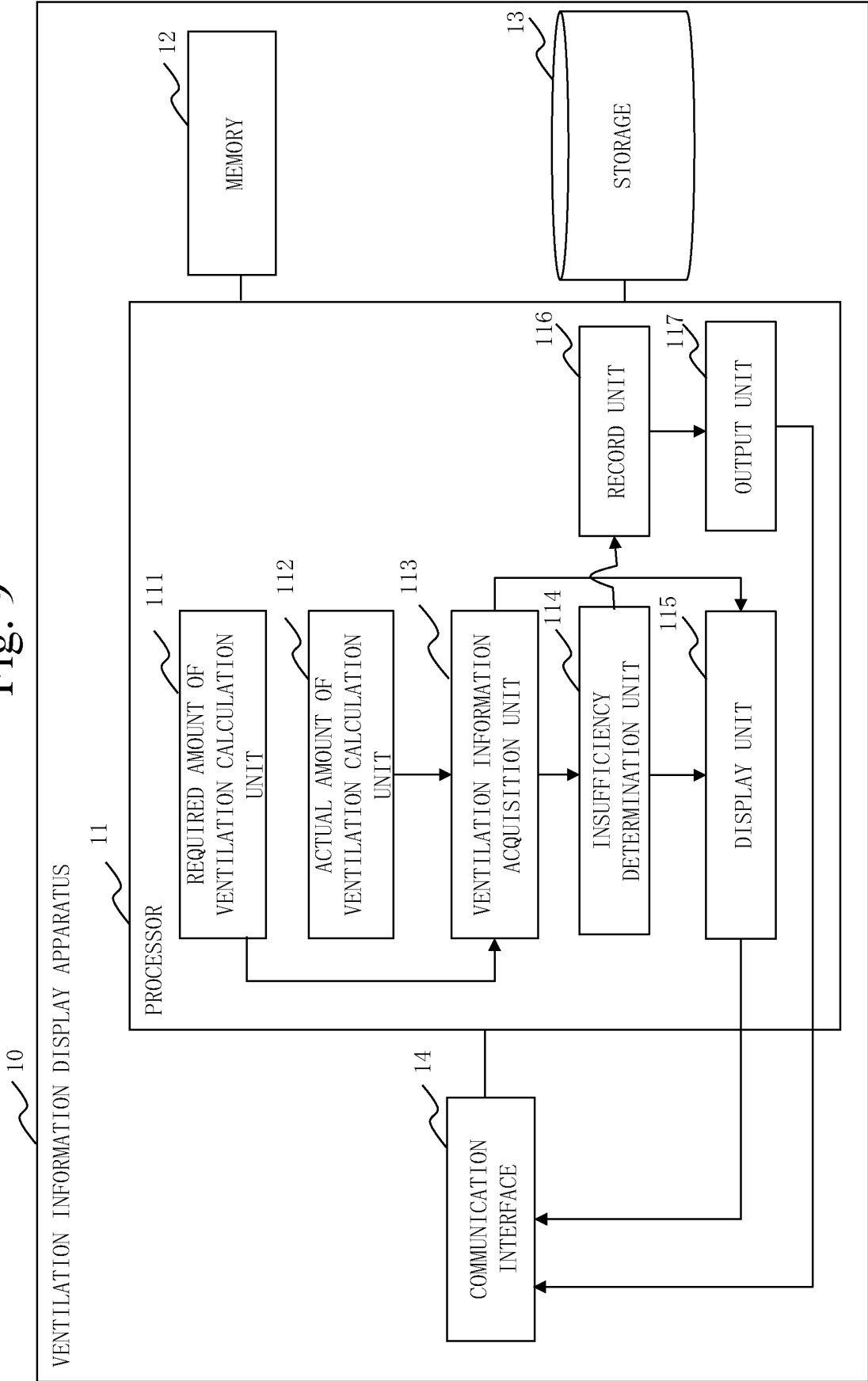


Fig. 10

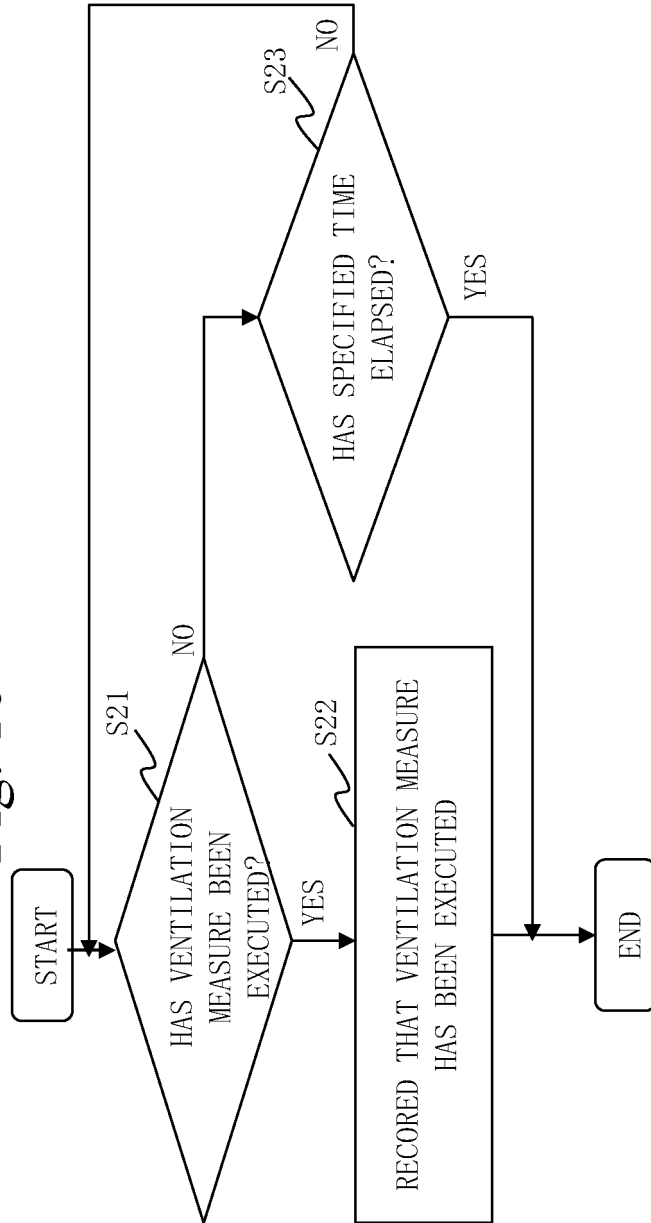


Fig. 11

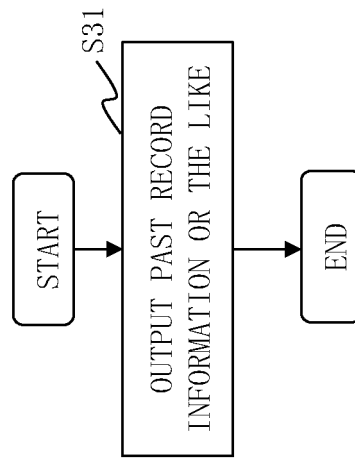
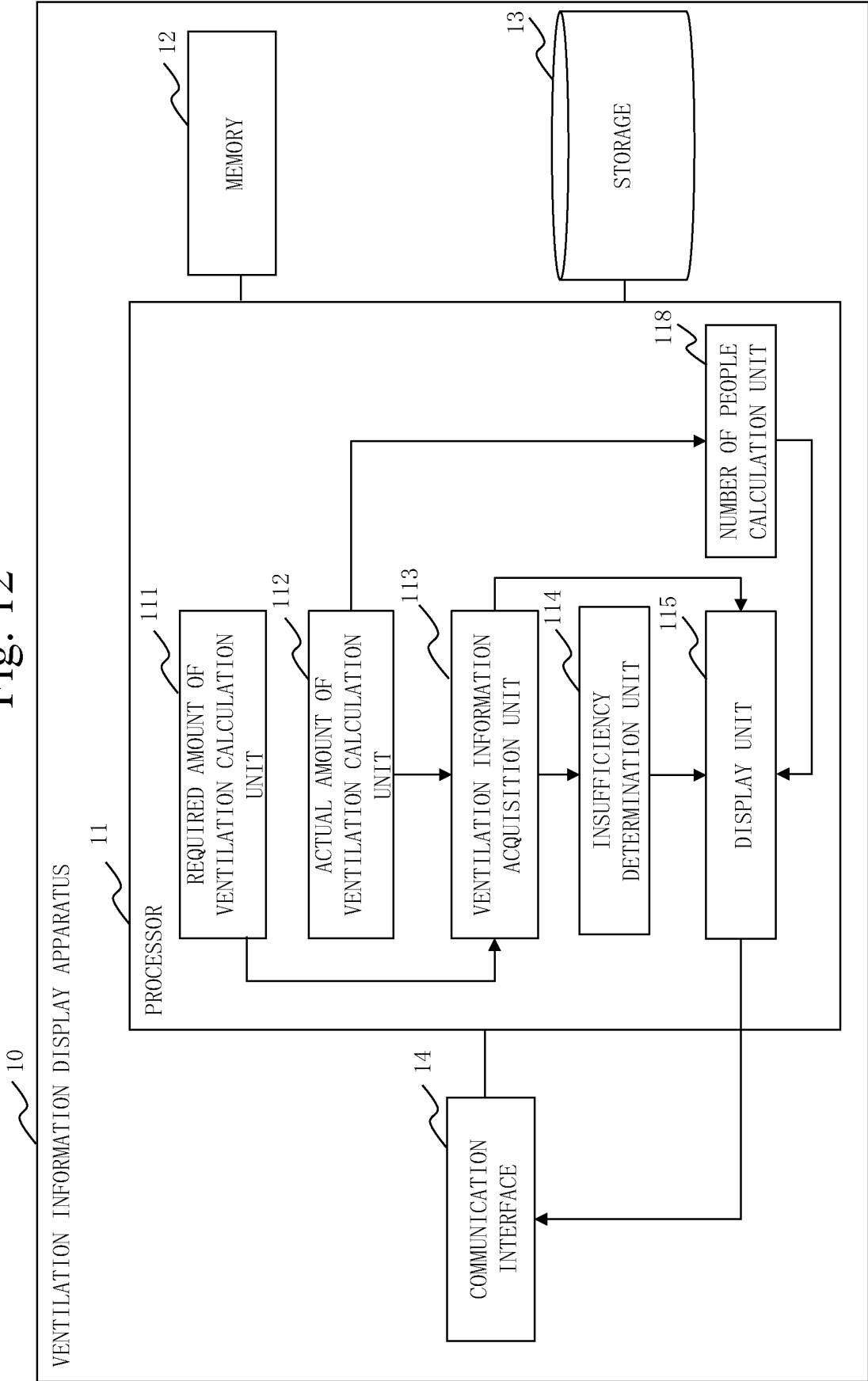


Fig. 12



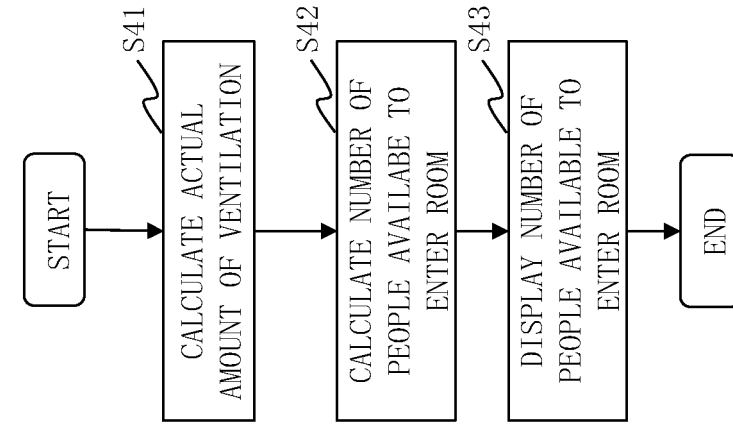


Fig. 13

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/045731

5	A. CLASSIFICATION OF SUBJECT MATTER Int. Cl. F24F7/007(2006.01) i, F24F11/52(2018.01) i, F24F11/64(2018.01) i, F24F110/30(2018.01) n FI: F24F7/007 B, F24F11/52, F24F11/64, F24F110:30 According to International Patent Classification (IPC) or to both national classification and IPC																
10	B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int. Cl. F24F7/007, F24F11/52, F24F11/64, F24F110/30																
15	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Published examined utility model applications of Japan 1922-1996 Published unexamined utility model applications of Japan 1971-2021 Registered utility model specifications of Japan 1996-2021 Published registered utility model applications of Japan 1994-2021																
20	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)																
25	C. DOCUMENTS CONSIDERED TO BE RELEVANT																
30	<table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>Y</td> <td>JP 2005-106322 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 21 April 2005 (2005-04-21), paragraphs [0008]-[0014], [0081]-[0103], fig. 6-10</td> <td>1-8</td> </tr> <tr> <td>Y</td> <td>JP 2005-98571 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 14 April 2005 (2005-04-14), paragraphs [0133]-[0158]</td> <td>1-8</td> </tr> <tr> <td>Y</td> <td>JP 2019-168194 A (MITSUBISHI ELECTRIC CORP.) 03 October 2019 (2019-10-03), paragraph [0058]</td> <td>1-8</td> </tr> <tr> <td>Y</td> <td>JP 9-229463 A (TOSHIBA CORP.) 05 September 1997 (1997-09-05), paragraph [0004], fig. 5</td> <td>1-8</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	Y	JP 2005-106322 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 21 April 2005 (2005-04-21), paragraphs [0008]-[0014], [0081]-[0103], fig. 6-10	1-8	Y	JP 2005-98571 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 14 April 2005 (2005-04-14), paragraphs [0133]-[0158]	1-8	Y	JP 2019-168194 A (MITSUBISHI ELECTRIC CORP.) 03 October 2019 (2019-10-03), paragraph [0058]	1-8	Y	JP 9-229463 A (TOSHIBA CORP.) 05 September 1997 (1997-09-05), paragraph [0004], fig. 5	1-8	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.															
Y	JP 2005-106322 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 21 April 2005 (2005-04-21), paragraphs [0008]-[0014], [0081]-[0103], fig. 6-10	1-8															
Y	JP 2005-98571 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 14 April 2005 (2005-04-14), paragraphs [0133]-[0158]	1-8															
Y	JP 2019-168194 A (MITSUBISHI ELECTRIC CORP.) 03 October 2019 (2019-10-03), paragraph [0058]	1-8															
Y	JP 9-229463 A (TOSHIBA CORP.) 05 September 1997 (1997-09-05), paragraph [0004], fig. 5	1-8															
35																	
40	<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.																
45	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family																
50	Date of the actual completion of the international search 20.01.2021	Date of mailing of the international search report 02.02.2021															
55	Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.															

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2020/045731

5
10
15
20
25
30
35
40
45
50
55

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2005-106323 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 21 April 2005 (2005-04-21), paragraph [0098]	5-8

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2020038052 A [0004]