Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2596151 A1 2009/02/03

(21) **2 596 151**

(12) DEMANDE DE BREVET CANADIEN CANADIAN PATENT APPLICATION

(13) **A1**

(22) **Date de dépôt/Filing Date:** 2007/08/03

(41) **Mise à la disp. pub./Open to Public Insp.:** 2009/02/03

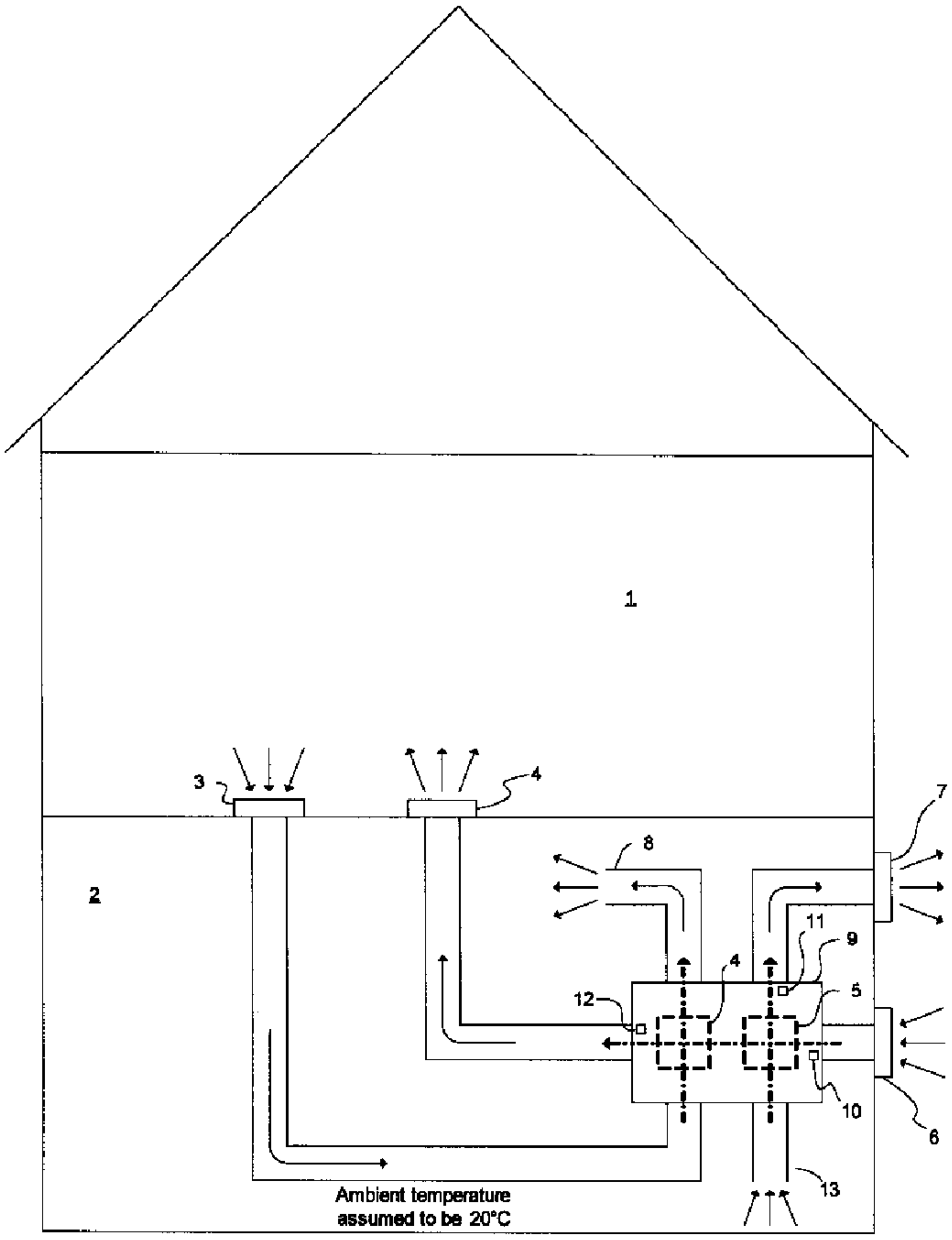
(51) **Cl.Int./Int.Cl.** *F24F 11/02* (2006.01), *F24F 12/00* (2006.01), *F24F 7/08* (2006.01)

(71) **Demandeur/Applicant:**
AIR TECH EQUIPMENT LTD., CA

(72) **Inventeurs/Inventors:**
BOUDREAU, PATRICK PAUL, CA;
BOULAY, MICHAEL, CA

(74) **Agent:** GOWLING LAFLEUR HENDERSON LLP

(54) Titre : METHODE ET APPAREILLAGE DE COMMANDE DE SYSTEME DE VENTILATION
(54) Title: METHOD AND APPARATUS FOR CONTROLLING VENTILATION SYSTEM



(57) **Abrégé/Abstract:**
An energy recovery ventilation system is described which allows for continuous fan speed control through pulse width modulation of direct current fans. The device described is capable of fine motor speed control without the disadvantages of high noise, low

(57) Abrégé(suite)/Abstract(continued):

efficiency and a fixed number of speeds present in commonly-used speed-varying techniques used with alternating current (AC) fans. This is accomplished through the use of direct current (DC) fans and pulse width modulation. A controller is used to optimize the ventilation and energy efficiency of the system through the use of several temperature sensors. The device also provides a control process for the self-optimization of the system, should it be detected that the supply and exhaust airflows are unequal. An unbalance is detected by calculating the thermal efficiencies of the exhaust and supply airflows.

Abstract

An energy recovery ventilation system is described which allows for continuous fan speed control through pulse width modulation of direct current fans. The device described is capable of fine motor speed control without the disadvantages of high noise, low efficiency and a fixed number of speeds present in commonly-used speed-varying techniques used with alternating current (AC) fans. This is accomplished through the use of direct current (DC) fans and pulse width modulation. A controller is used to optimize the ventilation and energy efficiency of the system through the use of several temperature sensors. The device also provides a control process for the self-optimization of the system, should it be detected that the supply and exhaust airflows are unequal. An unbalance is detected by calculating the thermal efficiencies of the exhaust and supply airflows.

Method and Apparatus for Controlling Ventilation System

Technical Field

The present invention relates to the control of an energy recovery ventilation system by means of direct current (DC) control and to a control process for the optimization of a ventilation system.

Background of the Invention

Current energy recovery ventilators rely on alternating current (AC) fans. Speed control of AC motors is generally accomplished using tapped transformers, triacs, capacitors or induction coils. These existing solutions present several inconveniences including a limited number of speeds, excessive noise and vibration due to harmonics and reduced energy efficiency. In addition, these techniques also allow for a low number of fan speeds, typically three, which can result in lower ventilation efficiency.

Furthermore, installed ventilation systems often exhibit lower ventilation efficiency than was measured during product testing, resulting in a suboptimal amount of sensible and latent energy being transferred between the exhaust and supply airflows. This is due in part to unbalanced supply and exhaust airflows. A number of factors can lead to this unbalance, including the length and type of the air ducts leading to and from the ventilator and dirty air filters blocking the flow of air. Current ventilation systems do not provide a means for detecting and automatically correcting unbalanced airflows.

Another issue affecting the performance of ventilation systems is the lack of real-time data concerning indoor and outdoor atmospheric conditions to be used in control algorithms. Current systems do not incorporate the means (i.e. sensors) necessary for the automated, optimized control of a ventilation system, based on outdoor and indoor environmental conditions.

As a result of these concerns, a device allowing fine control of fan speeds and runtime optimization of the airflows entering and exiting a building is necessary.

Objects and Summary

The disclosed device improves the energy efficiency of a ventilation system in terms of electricity consumption as well as improved ventilation effectiveness. It also allows for a potential reduction in the cost to heat and air condition a house.

One reason for the improved electrical efficiency of the described device is the use of DC fans in the place of AC fans. DC fans exhibit higher efficiency than AC fans, especially when used at variable speeds. An additional advantage is that a ventilation system using DC fans can be used much more easily in different regions. A ventilation system meant to be powered by a North American 115V/60Hz supply cannot be easily adapted to a European 230V/50Hz network. Adapting a DC-based system to a different mains voltage often involves simply toggling a switch on the DC power supply. In addition, the ventilation system can be used much more easily and efficiently when it is not connected to the power distribution grid. For example, the ventilation system can be used with alternative sources of energy, including solar panels, windmills or batteries.

The improved energy efficiency is also due to the fine control of fan speeds. With conventional ventilation systems, fan speeds are generally limited to “low”, “medium” and “high” settings. In a given situation where an airflow greater than that provided by the “medium” settings is required, the airflow provided by the high setting may be excessive. In this situation, the higher fan speed must be used to ensure an acceptable air quality. This results in increased energy consumption and therefore, reduced energy efficiency. Fine speed control allows for the lowest energy consumption while attaining the required ventilation rate.

Fine speed control is accomplished with DC fans, using pulse width modulation (PWM). It is especially useful when establishing balanced exhaust and supply airflows. In systems with a limited number of discrete speed settings, it is unlikely that the fans can be adjusted in such a way as to equalize the airflows.

The disclosed device allows the ventilation system to minimize ventilation rates without compromising air quality. This minimizes its consumption of electricity. In addition, the system is able to optimize the transfer of sensible energy, based on input from sensors located in the supply airflow. The transfer of latent energy is also optimized based on the detected humidity levels. The disclosed device also provides automatic, controlled balancing of the exhaust and supply airflows.

A control circuit receives input from temperature and humidity sensors located in the incoming supply air stream, to measure the properties of the outdoors air, and in the outgoing supply air stream, to measure the properties of the treated air. This data is used to determine the flow rates necessary to maximize the effectiveness of the ventilation system, and the duty cycles of the PWM signals for each fan.

The automatic balancing of the supply and exhaust airflows by the controller prevents the creation of a negative or positive pressure in the structure. In the winter especially, a positive pressure is undesirable since it leads to increased electricity usage for heating. Therefore, a mechanism for ensuring balanced airflows increases not only the ventilation effectiveness of the system, but may also lower the operating costs of a building's heating system.

Likewise, in the summer, a negative pressure is undesirable because it can cause infiltration of hot air and moisture. This causes an increased utilization of air conditioning or dehumidification systems, resulting in increased electricity costs. Balanced airflows may therefore result in lower electricity usage and lower operating costs of a building's heating, ventilation and air condition systems during the entire year.

There is also a sensor to measure the temperature of the exhaust airflow. This sensor is used in conjunction with the two sensors described above to determine whether the exhaust and supply airflows are balanced. If they are not, the fan speeds are adjusted in order to equalize the two air flows. If three fans are present, in the case of a recirculation fan for example, the third fan should be either temporarily deactivated or taken into account during efficiency calculations in order to obtain accurate results.

One method of determining whether the supply and exhaust airflows are balanced, is to calculate the thermal efficiency of the system. The thermal efficiencies when calculated from the supply outlet and when calculated from the exhaust outlet are equal to the efficiencies determined during product testing when the two airflows are balanced.

Brief Description of the Drawings

The present invention, in terms of preferred embodiments, is illustrated in the attached drawings, wherein:

Figure 1 shows the positioning of the fans and the temperature sensors within the support structure of one possible embodiment of the invention: a ventilation system with two energy exchange cores, using 3 temperature sensors;

Figure 2 shows the positioning of fans and temperature sensors within the structure of a second embodiment of the invention, a ventilation system with a single energy exchange core, such as a heat recovery ventilator, with 3 temperature sensors;

Figure 3 shows the positioning of the fans and temperature sensors inside the structure of a two-core ventilation system, using 4 temperature sensors for increased accuracy;

Figure 4 shows the positioning of fans and temperature sensors in the structure of a simple air-mixing ventilation system;

Figure 5 shows a layout of a two level house with a possible embodiment of a two-core device with three temperature sensors in place;

Figure 6 shows another layout of a two level house with another embodiment of a two-core device using four temperature sensors; and

Figure 7A-7F are flow chart showing an exemplary embodiment of a controlling method of the present invention.

Description of Preferred Embodiments of the Invention

Figure 1 shows an example of an embodiment of the invention. It should be evident to a person skilled in the art that the invention may assume other forms. As an example, the embodiment presented in figure 1 indicates a cross-flow. Parallel flow or counter-flow, for instance, could be substituted without changing the nature of the invention.

The device should include an electronic control board with a controller 1, to receive and process input signals. There are also at least two direct current (DC) fans: a fan 2 to draw fresh air from the outside into the building, and another fan 3 to draw stale air from the building to the outside. There is a temperature sensor 4 and a humidity sensor 5 at the inlet of the outside supply duct 9. Another temperature sensor 6 and a second humidity sensor 7 are located at the outlet of the building supply duct 10. A third temperature sensor 8 is positioned in the exhaust air stream 11. Optionally, an additional temperature sensor could be placed into the air stream coming from inside the building 12 if increased precision is required.

The control of the DC fan speed can be accomplished through the use of field effect transistors (FETs) for example, although another type of switch could be substituted. The supply voltage to the fan is controlled by pulse width modulation, through signals sent to the switch (e.g. the FET) from a microcontroller, for example. Obviously, the utilization of pulse width modulation in this case allows for an extremely large range of fan speeds.

Based on the temperature data received from the sensors, one is able to determine whether the supply and exhaust airflows are balanced, by calculating the thermal efficiencies of the two streams. When the two airflows are balanced, the thermal efficiencies of the ventilation system will be equal to their predetermined values when calculated using the temperature of the supply stream and the temperature of the exhaust stream. If it is found that the two airflows are unbalanced, the duty cycles of the two (or more) fans can be adjusted accordingly, increasing or decreasing the fan speed and thus the air flow in order to balance the supply and exhaust airflows.

As shown in figure 1, an optional, third recirculation fan 13 can be present. While the controller is balancing the ventilation system, by calculating the thermal efficiency of the ventilation system, this third fan is halted or taken into consideration in the efficiency calculations, so as to allow an accurate calculation of the efficiency.

The illustration presented in figure 1 also shows two energy transfer cores 14 and 15. The precise type of core or its construction does not affect the present invention. They are included in the figure for illustrative purposes only.

Figure 2 presents another possible embodiment of the invention, containing a single core 10. In this particular figure, three temperature sensors 4, 5 and 6 are present, though a fourth sensor could be used to measure the temperature of the exhaust airflow entering through duct 9 before passing through the device. Temperature sensor 4 is measuring the temperature of the air passing through the fresh air duct 7, while temperature sensor 5 measures the temperature of the treated air entering the structure through the supply duct 8, and temperature sensor 6 measures the temperature of the air passing through the exhaust duct 11. The information from these sensors is used by the control board 1 to optimize the performance of the ventilation system. The air entering the ventilation system to be exhausted is assumed to be at 20°C.

Figure 3 shows another embodiment of the invention, using four temperature sensors 4, 6, 8 and 12. The embodiment shown comprises two cores 14 and 15, though the fourth temperature sensor can also be used with a single-core ventilation system. Sensor 4 measures the temperature of the fresh air entering the device. Sensor 6 measures the temperature of the treated air entering the building. Sensor 8 measures the temperature of the exhaust air to be expelled from the house. The additional sensor 12 measures the temperature of the air entering the system.

Figure 4 is an illustration of a ventilation system that mixes the outside and exhaust airflows. Temperature sensor 4 measures the temperature of the fresh air entering the system. Temperature sensor 6 measures the temperature of the treated air to be circulated inside the building. Temperature sensor 8 measures the temperature of the air to be exhausted to the outside. In this case, the temperature of the air entering through duct 11 is assumed to be approximately 20°C.

Figure 5 illustrates one installation of the ventilation system 9 in a two level house. Fresh air is drawn from the outside, through duct 6, while stale air is exhausted through duct 7. Inside the ventilation system 9, there are two energy exchange cores 4 and 5. Stale air is drawn into the ventilation system through duct 13, and heat and/or moisture is exchanged with the fresh air drawn through duct 6. The temperature of the stale air is assumed to be 20°C in this case, while the temperature of the fresh air is measured by sensor 10. There may be a second core 4, which exchanges heat and/or moisture between the treated air leaving the core 5 and stale air drawn through duct 3 to be recirculated to the basement area 2 through duct 8. The treated air is then circulated to the upper level 1 through duct 4. The temperature of the air to be exhausted outside through duct 7 is measured by sensor 11. This data is fed to the controller and is used to optimize the performance of the ventilation system. During the balancing process, the airflow drawn through duct 3 and expelled through duct 8 is reduced to zero, to allow for accurate readings.

Figure 6 shows a second possible installation of the ventilation system 9 in a two level house. In this installation, fresh air is once again drawn through duct 6, and heat and/or moisture is exchanged with stale air drawn through ducts 3 and 13, by means of two energy exchange cores 4 and 5. The treated air is circulated to the upper level 1 through duct 4, while the stale air is exhausted through duct 7, and recirculation air is sent to the basement 2 through duct 8. Temperature sensor 10 measures the temperature of the fresh air entering through duct 6, while temperature sensor 12 measures the temperature of the treated air to be circulated to the upper level 1 through duct 4. In this case, the temperature of the stale air drawn into the ventilation system 9 through duct 13 is measured by sensor 14, and the temperature of the air to be exhausted through duct 7 is measured by sensor 11. The temperature data is once again used by the controller to optimize the ventilation efficiency of the system and no air is drawn through ducts 3 and 8 during the balancing process. A single-core ventilation system could also be used, without changing the nature of the invention.

Figure 7 shows an example process for controlling one possible embodiment of the present invention. A desired humidity level 100 is set, and one of three operating settings 101 is selected depending on the floor area of the dwelling and the number of bedrooms. The fans are run 102 at the chosen speed and the recirculation fan is activated. A timer, used to determine when to perform a self-balancing test, is checked 103. If the time has elapsed, then the self-balancing process begins at 138. If the measured humidity level is below the desired level 104, then the process will continue at point 126. If not, the temperature and humidity levels are read and the dewpoint is calculated 105. If the measured temperature is less than -10°C 106, then the device will enter into a defrost cycle.

During the defrost cycle, the recirculation fan is deactivated 107 and the supply and exhaust fans are run in a minimum air quality maintenance mode 108. When the temperature rises above -10°C 111, the recirculation fan is reactivated 110.

After the end of this defrost cycle, or if entering into the defrost cycle was not necessary, then the temperature/humidity sensors are read and the dewpoint is calculated 109. If the temperature is below is 10°C 112, but above -10°C 113, then the process continues at point 120. However, if the temperature is below -10°C, then the defrost cycle will commence at 107. If the dewpoint is below 11°C 114, then the exhaust fan speed will be reduced by 10% 116 if the supply and exhaust fans are already running at their maximum speeds 115, or the supply and exhaust fan speeds will be increased by 5% 118 if they are not. In this case, the process continues at 102. On the other hand, if the dewpoint was below 11°C, then the supply and exhaust fan speeds will be lowered by 5% 119, and the process will continue at 102 if they are both currently at least 15% below their nominal speeds 117, or if the fan speeds are not 15% below their nominal speeds, the process will continue at 102 without a change in speed.

The process in case of an outside temperature between -10°C and 10°C is shown in Figure 7C. If the dewpoint of the outgoing, treated air is below 8°C 120 and the temperature of the outgoing air is above 14°C, then the process will continue at 103, after increasing the speed of the exhaust and supply fans by 5% if they were not already at their maximum speeds. However, if the dewpoint of the outgoing air was above 80°C 120 or if the temperature was below 14°C, then the exhaust and supply fan speeds will be decreased by 5% if they were not already 15% below their nominal values, before the process continues at 103.

When the relative humidity measured is below the desired level and the temperature is below 10°C 126, then the process continues at 132. If not, then if the dewpoint is above 11°C 127 or if the temperature is above 29°C 128, then the supply and exhaust fans are run at maintenance speeds 130 and the process continues at 103. If, however, the dewpoint is below 11°C 127 and the temperature is below 29°C 128, then the process will continue at point 103 without change in fan speed if the supply and exhaust fans are not running at nominal speeds 129, or with an increase in speed of 5% 131 if they are not.

In the case of an outside relative humidity below the desired level and an outside temperature below 10°C, a process is followed starting at 132. If it happens that the temperature is below -10°C 132, then a defrost cycle is initiated at 107. If the dewpoint of the outgoing, treated air is above 8°C 133 or if the temperature of the treated air is below 14°C 134 then the supply and exhaust fans are run in a maintenance mode 136 and the process continues at 103. However, if the dewpoint of the outgoing air is below 8°C and if the temperature of the outgoing air is above 14°C, then the process will continue at 103, with an increase of 5% in the speed of the exhaust and supply fans, if they are not currently at their nominal speeds.

Point H marks the beginning of the self-balancing process. The recirculation fan, if present, is deactivated 138 and the supply and exhaust fans are set to run at a medium speed 139. All temperature sensors are read 140 and the thermal efficiencies of the device, seen from the supply and exhaust airflows, are calculated based on these readings 141. If the supply efficiency is found to be greater than the exhaust efficiency 142, then the supply fan speed may be increased and/or the exhaust fan speed may be decreased 143 and the self-balance test continues at 140. On the other hand, if the exhaust efficiency is found to be higher than the supply efficiency 144, then the exhaust fan speed may be increased and/or the supply fan speed may be decreased 145 and the self-balance test continues at 140. Finally, if the efficiency calculated using the exhaust outlet temperature is found to be equal to the efficiency calculated based on the supply outlet temperature within a certain tolerance, the recirculation fan is reactivated 146, the timer used to trigger the next self-balance test is set 147, and the process returns to point A 101.

The process described and the temperatures are used only as examples. They may be changed or adjusted without affecting the nature of the invention. In addition, other inputs may be considered in the described process, such as a manual switch to force the device to operate at high speed.

Figure 7 shows an example process for controlling one possible embodiment of the present invention. A desired humidity level 100 is set, and one of three operating settings 101 is selected depending on the floor area of the dwelling and the number of bedrooms. The fans are run 102 at the chosen speed and the recirculation fan is activated. A timer, used to determine when to perform a self-balancing test, is checked 103. If the time has elapsed, then the self-balancing process begins at 138. If the measured humidity level is below the desired level 104, then the process will continue at point 126. If not, the temperature and humidity levels are read and the dewpoint is calculated 105. If the measured temperature is less than -10°C 106, then the device will enter into a defrost cycle.

During the defrost cycle, the recirculation fan is deactivated 107 and the supply and exhaust fans are run in a minimum air quality maintenance mode 108. When the temperature rises above -10°C 111, the recirculation fan is reactivated 110.

After the end of this defrost cycle, or if entering into the defrost cycle was not necessary, then the temperature/humidity sensors are read and the dewpoint is calculated 109. If the temperature is below is 10°C 112, but above -10°C 113, then the process continues at point 120. However, if the temperature is below -10°C, then the defrost cycle will commence at 107. If the dewpoint is below 11°C 114, then the exhaust fan speed will be reduced by 10% 116 if the supply and exhaust fans are already running at their maximum speeds 115, or the supply and exhaust fan speeds will be increased by 5% 118 if they are not. In this case, the process continues at 102. On the other hand, if the dewpoint was below 11°C, then the supply and exhaust fan speeds will be lowered by 5% 119, and the process will continue at 102 if they are both currently at least 15% below their nominal speeds 117, or if the fan speeds are not 15% below their nominal speeds, the process will continue at 102 without a change in speed.

The process in case of an outside temperature between -10°C and 10°C is shown in Figure 7C. If the dewpoint of the outgoing, treated air is below 8°C 120 and the temperature of the outgoing air is above 14°C, then the process will continue at 103, after increasing the speed of the exhaust and supply fans by 5% if they were not already at their maximum speeds. However, if the dewpoint of the outgoing air was above 80°C 120 or if the temperature was below 14°C, then the exhaust and supply fan speeds will be decreased by 5% if they were not already 15% below their nominal values, before the process continues at 103.

When the relative humidity measured is below the desired level and the temperature is below 10°C 126, then the process continues at 132. If not, then if the dewpoint is above 11°C 127 or if the temperature is above 29°C 128, then the supply and exhaust fans are run at maintenance speeds 130 and the process continues at 103. If, however, the dewpoint is below 11°C 127 and the temperature is below 29°C 128, then the process will continue at point 103 without change in fan speed if the supply and exhaust fans are not running at nominal speeds 129, or with an increase in speed of 5% 131 if they are not.

In the case of an outside relative humidity below the desired level and an outside temperature below 10°C, a process is followed starting at 132. If it happens that the temperature is below -10°C 132, then a defrost cycle is initiated at 107. If the dewpoint of the outgoing, treated air is above 8°C 133 or if the temperature of the treated air is below 14°C 134 then the supply and exhaust fans are run in a maintenance mode 136 and the process continues at 103. However, if the dewpoint of the outgoing air is below 8°C and if the temperature of the outgoing air is above 14°C, then the process will continue at 103, with an increase of 5% in the speed of the exhaust and supply fans, if they are not currently at their nominal speeds.

Point H marks the beginning of the self-balancing process. The recirculation fan, if present, is deactivated 138 and the supply and exhaust fans are set to run at a medium speed 139. All temperature sensors are read 140 and the thermal efficiencies of the device, seen from the supply and exhaust airflows, are calculated based on these readings 141. If the supply efficiency is found to be greater than the exhaust efficiency 142, then the supply fan speed may be increased and/or the exhaust fan speed may be decreased 143 and the self-balance test continues at 140. On the other hand, if the exhaust efficiency is found to be higher than the supply efficiency 144, then the exhaust fan speed may be increased and/or the supply fan speed may be decreased 145 and the self-balance test continues at 140. Finally, if the efficiency calculated using the exhaust outlet temperature is found to be equal to the efficiency calculated based on the supply outlet temperature within a certain tolerance, the recirculation fan is reactivated 146, the timer used to trigger the next self-balance test is set 147, and the process returns to point A 101.

The process described and the temperatures are used only as examples. They may be changed or adjusted without affecting the nature of the invention. In addition, other inputs may be considered in the described process, such as a manual switch to force the device to operate at high speed.

WHAT IS CLAIMED IS:

1.An apparatus for controlling ventilation system as described.

2. A method for controlling ventilation system as described.

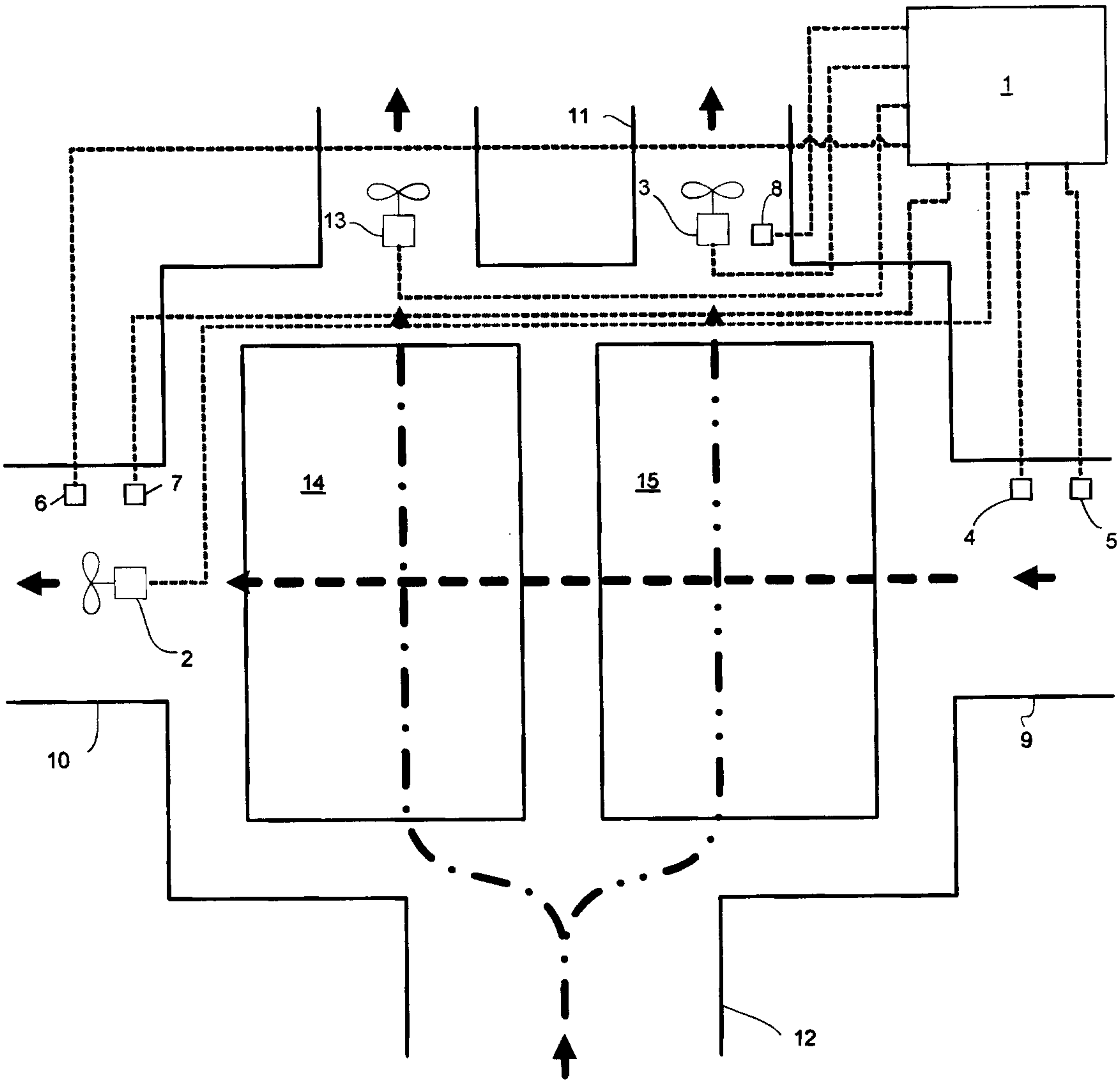


Figure 1

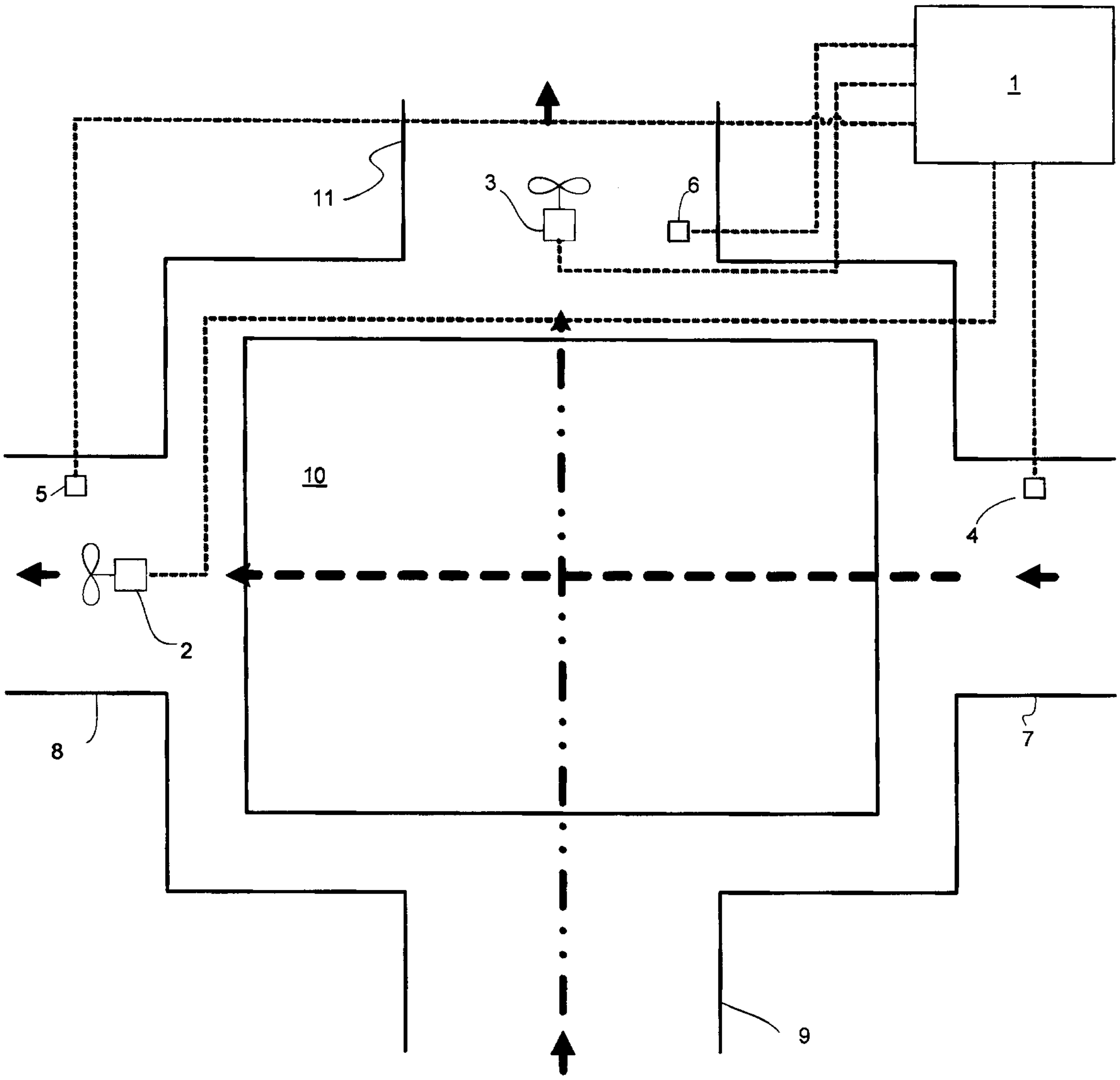


Figure 2

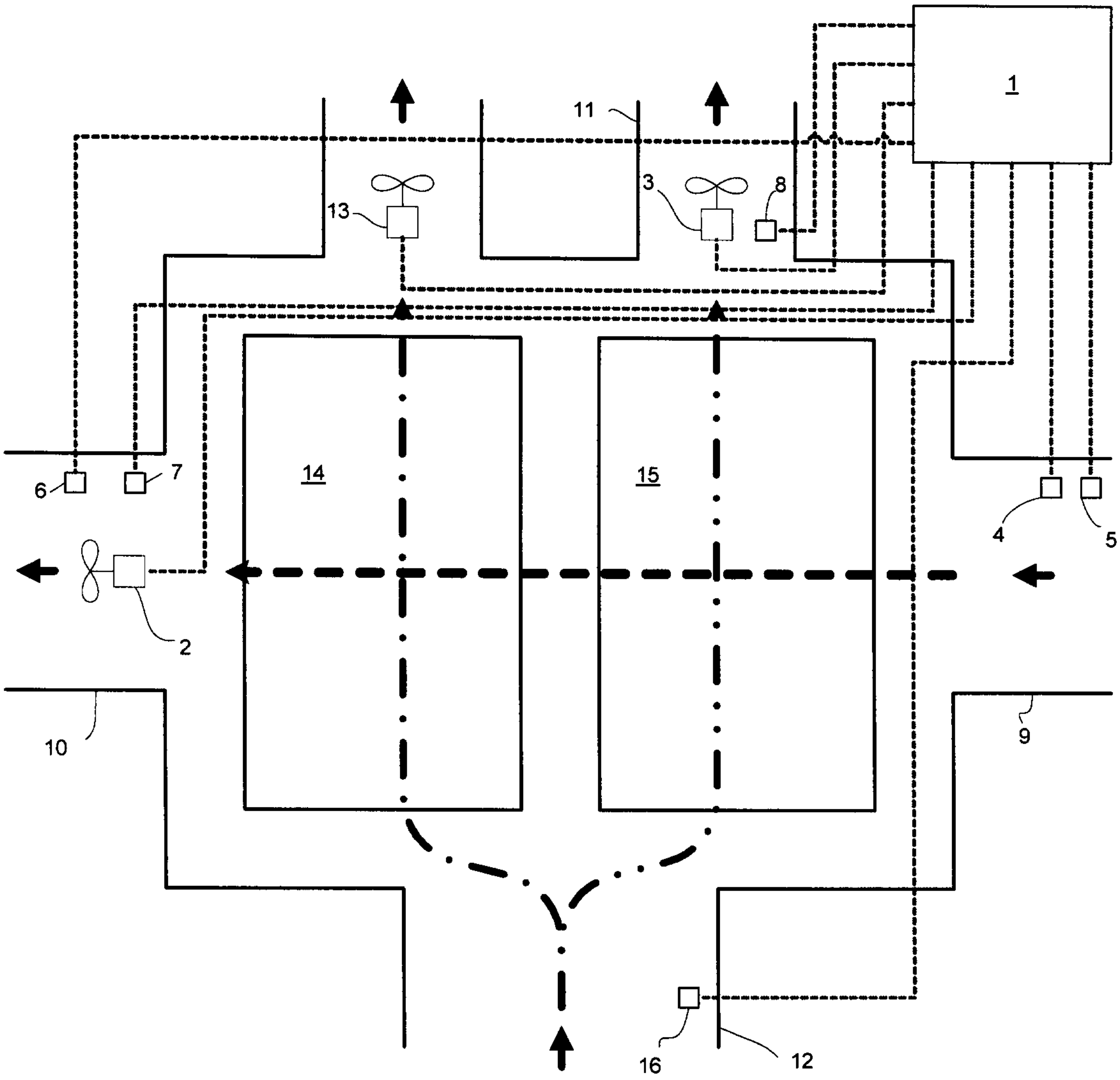


Figure 3

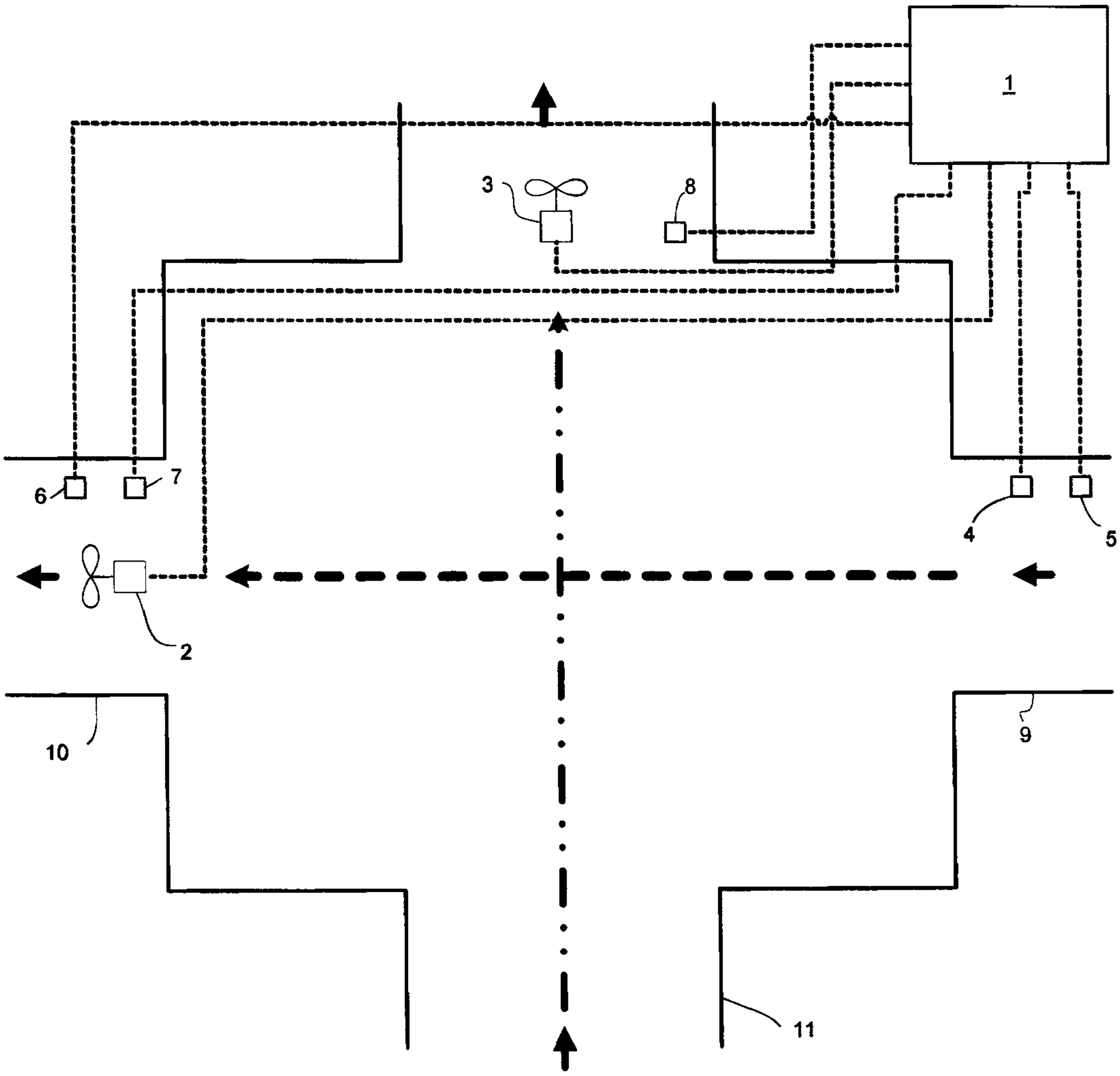


Figure 4

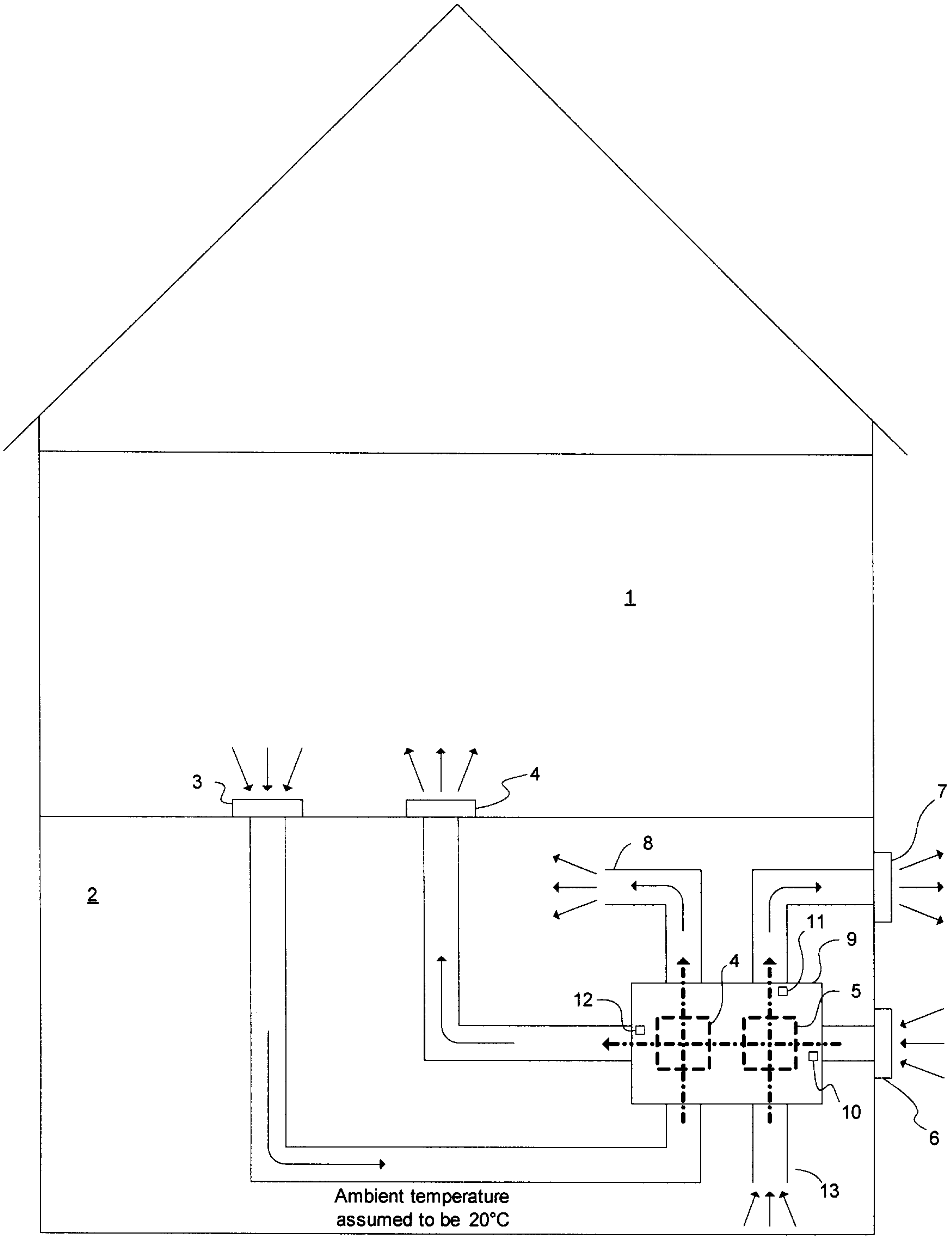

1
2
3
4
7
8
4
11
9
5
12
10
6
13
Ambient temperature assumed to be 20°C

Figure 5

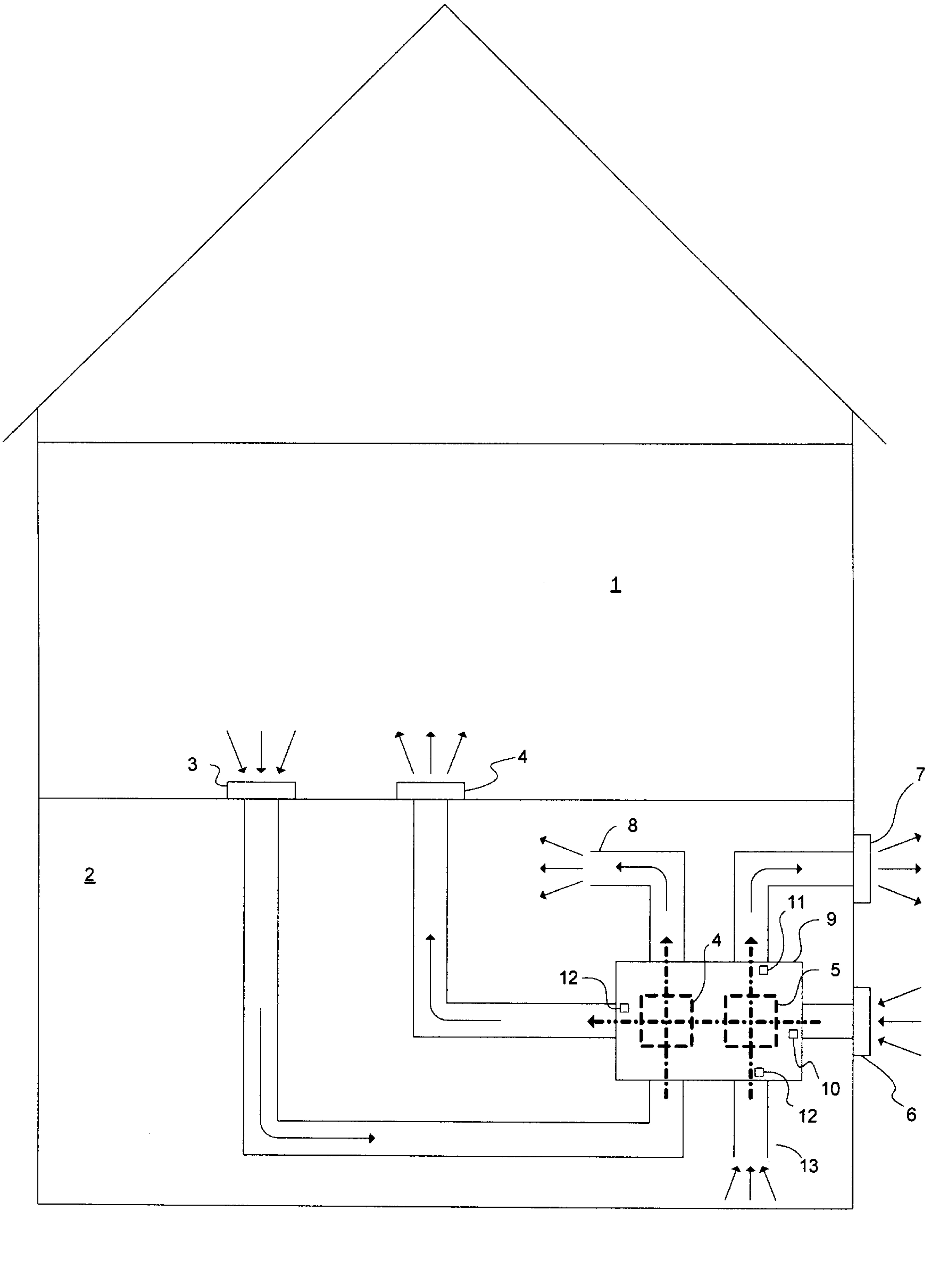
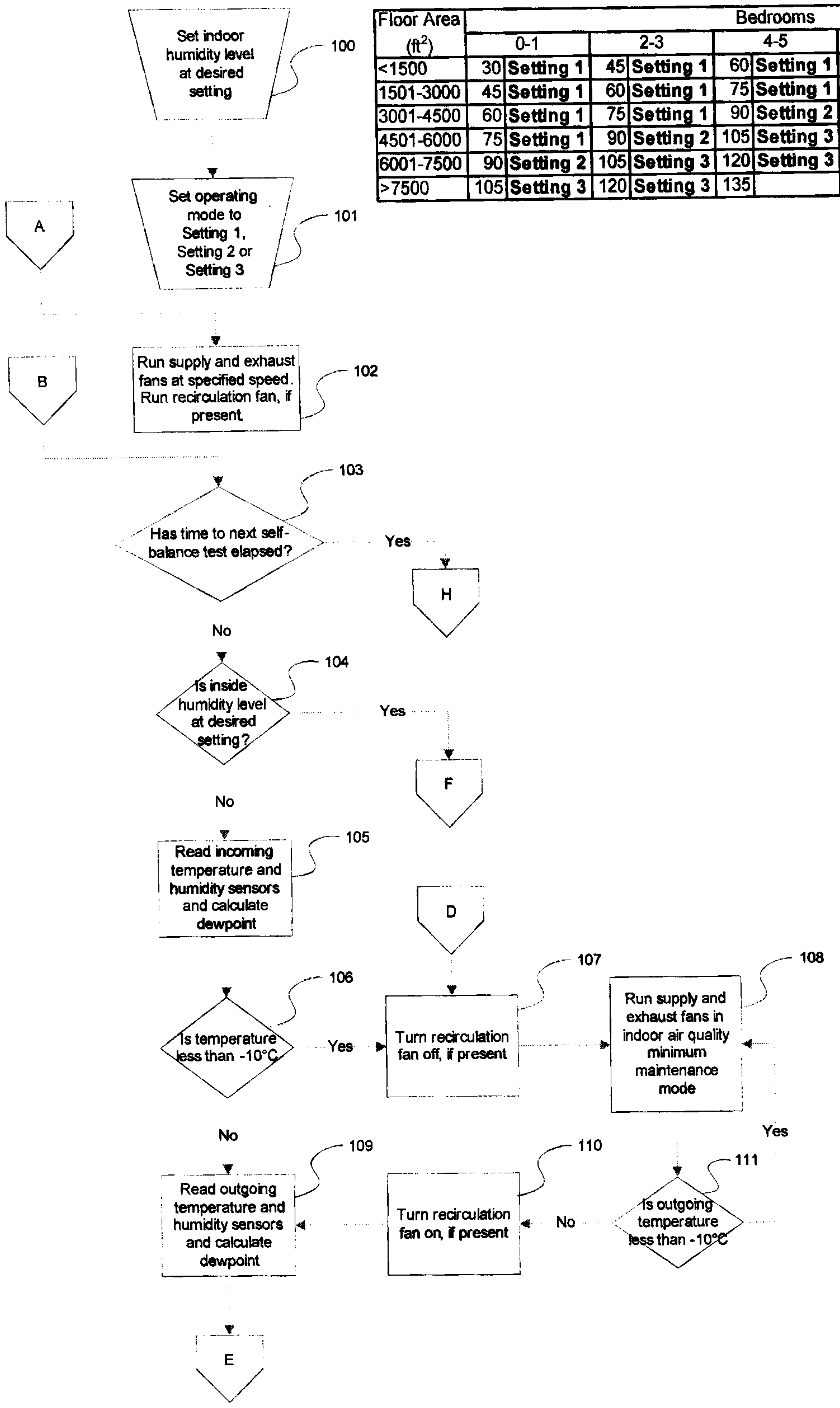


Figure 6



Floor Area (ft^2)	Bedrooms									
	0-1		2-3		4-5		6-7		>7	
<1500	30	**Setting 1**	45	**Setting 1**	60	**Setting 1**	75	**Setting 1**	90	**Setting 2**
1501-3000	45	**Setting 1**	60	**Setting 1**	75	**Setting 1**	90	**Setting 2**	105	**Setting 3**
3001-4500	60	**Setting 1**	75	**Setting 1**	90	**Setting 2**	105	**Setting 3**	120	**Setting 3**
4501-6000	75	**Setting 1**	90	**Setting 2**	105	**Setting 3**	120	**Setting 3**	135	
6001-7500	90	**Setting 2**	105	**Setting 3**	120	**Setting 3**	135		150	
>7500	105	**Setting 3**	120	**Setting 3**	135		150		165	

Figure 7A

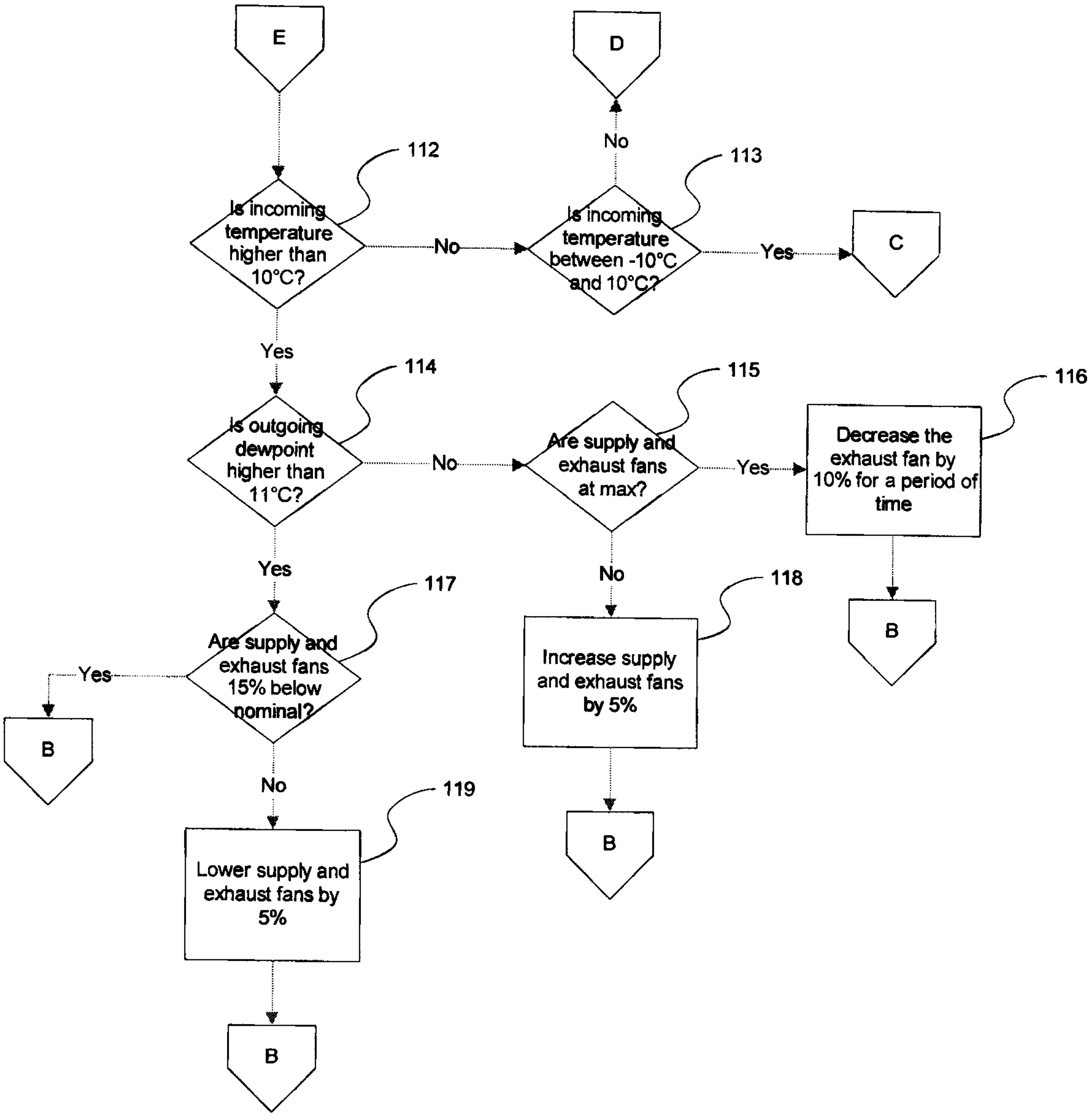

E
D
C
B
B
B
B
112
113
114
115
116
117
118
119
Is incoming temperature higher than 10°C?
No
Is incoming temperature between -10°C and 10°C?
Yes
No
Yes
Is outgoing dewpoint higher than 11°C?
No
Are supply and exhaust fans at max?
Yes
Decrease the exhaust fan by 10% for a period of time
Yes
No
Are supply and exhaust fans 15% below nominal?
Yes
No
Increase supply and exhaust fans by 5%
Lower supply and exhaust fans by 5%

Figure 7B

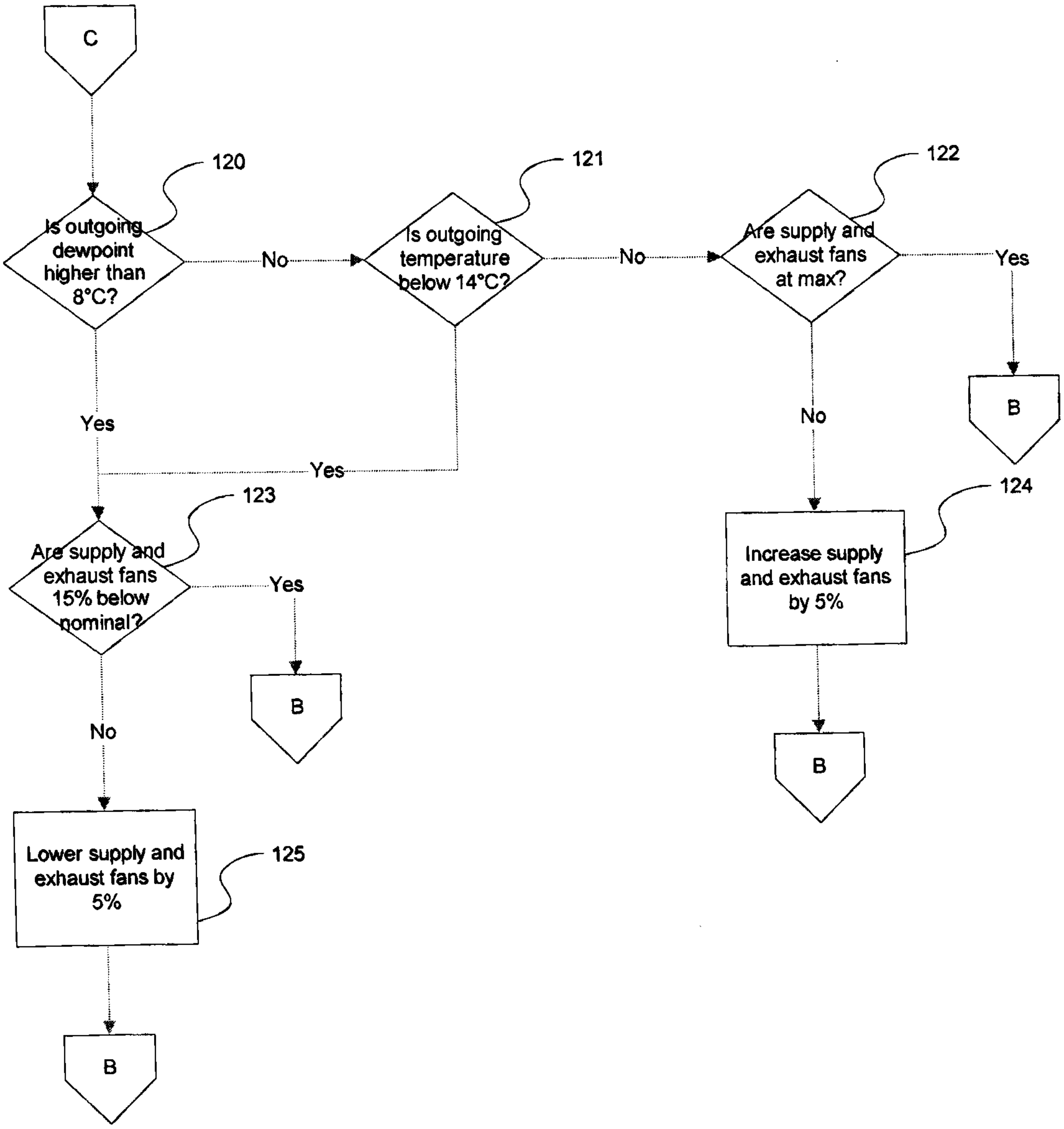

C
120
Is outgoing dewpoint higher than 8°C?
No
121
Is outgoing temperature below 14°C?
No
122
Are supply and exhaust fans at max?
Yes
B
Yes
Yes
No
123
Are supply and exhaust fans 15% below nominal?
Yes
B
124
Increase supply and exhaust fans by 5%
B
No
Lower supply and exhaust fans by 5%
125
B

Figure 7C

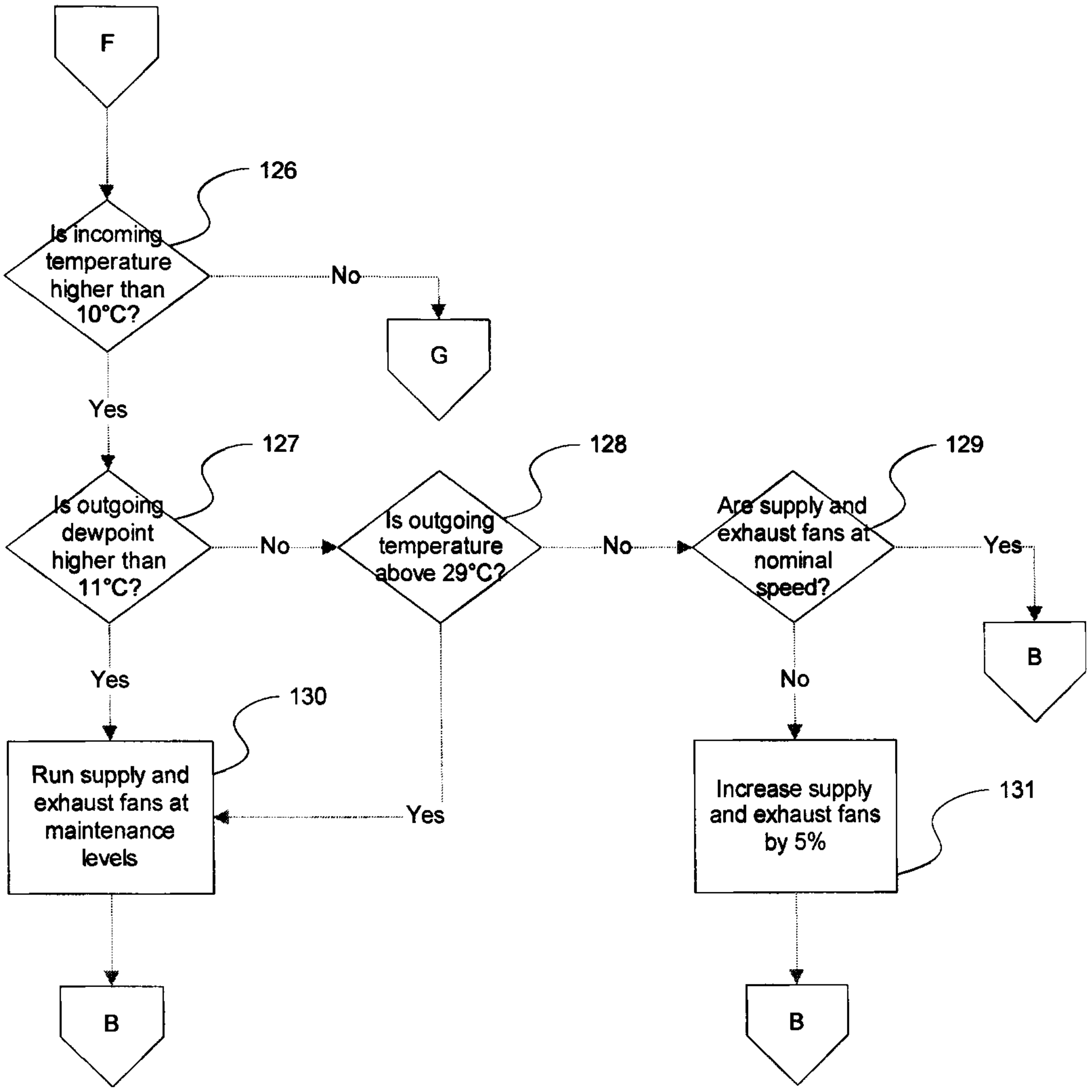

F
126
Is incoming temperature higher than 10°C?
No
G
Yes
127
Is outgoing dewpoint higher than 11°C?
No
128
Is outgoing temperature above 29°C?
No
129
Are supply and exhaust fans at nominal speed?
Yes
B
Yes
130
Run supply and exhaust fans at maintenance levels
Yes
No
Increase supply and exhaust fans by 5%
131
B
B

Figure 7D

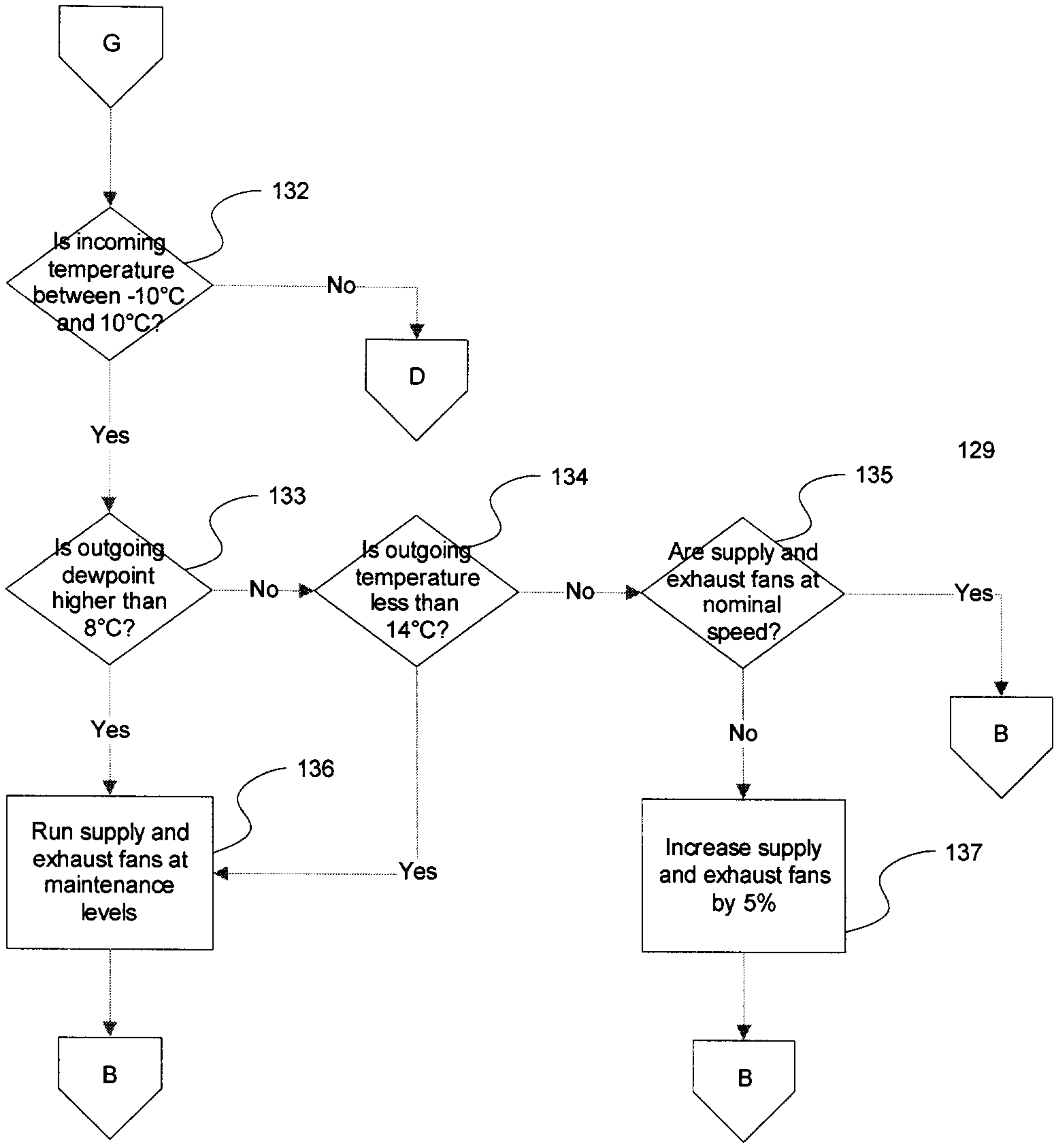

G
132
Is incoming temperature between -10°C and 10°C?
No
D
Yes
129
133
Is outgoing dewpoint higher than 8°C?
No
134
Is outgoing temperature less than 14°C?
No
135
Are supply and exhaust fans at nominal speed?
Yes
B
Yes
136
Run supply and exhaust fans at maintenance levels
Yes
No
Increase supply and exhaust fans by 5%
137
B
B

Figure 7E

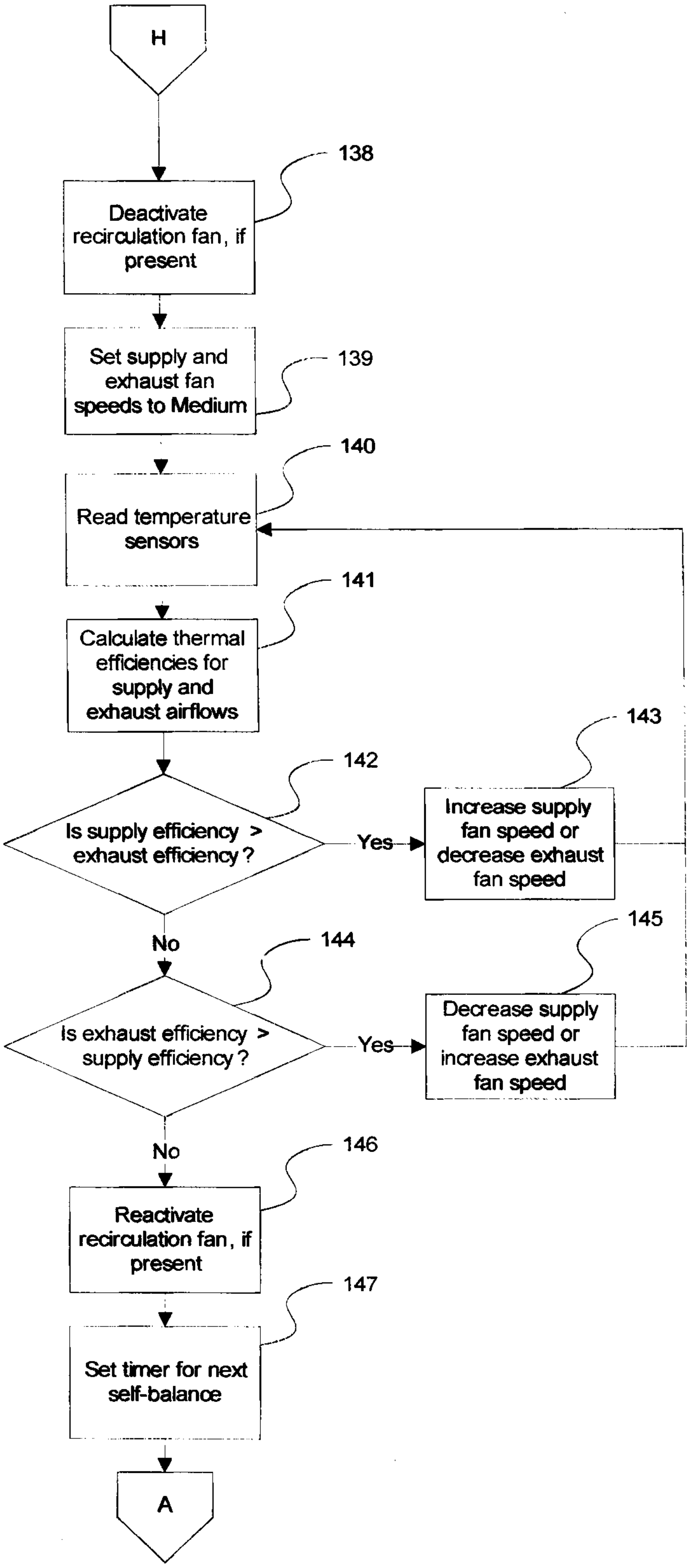
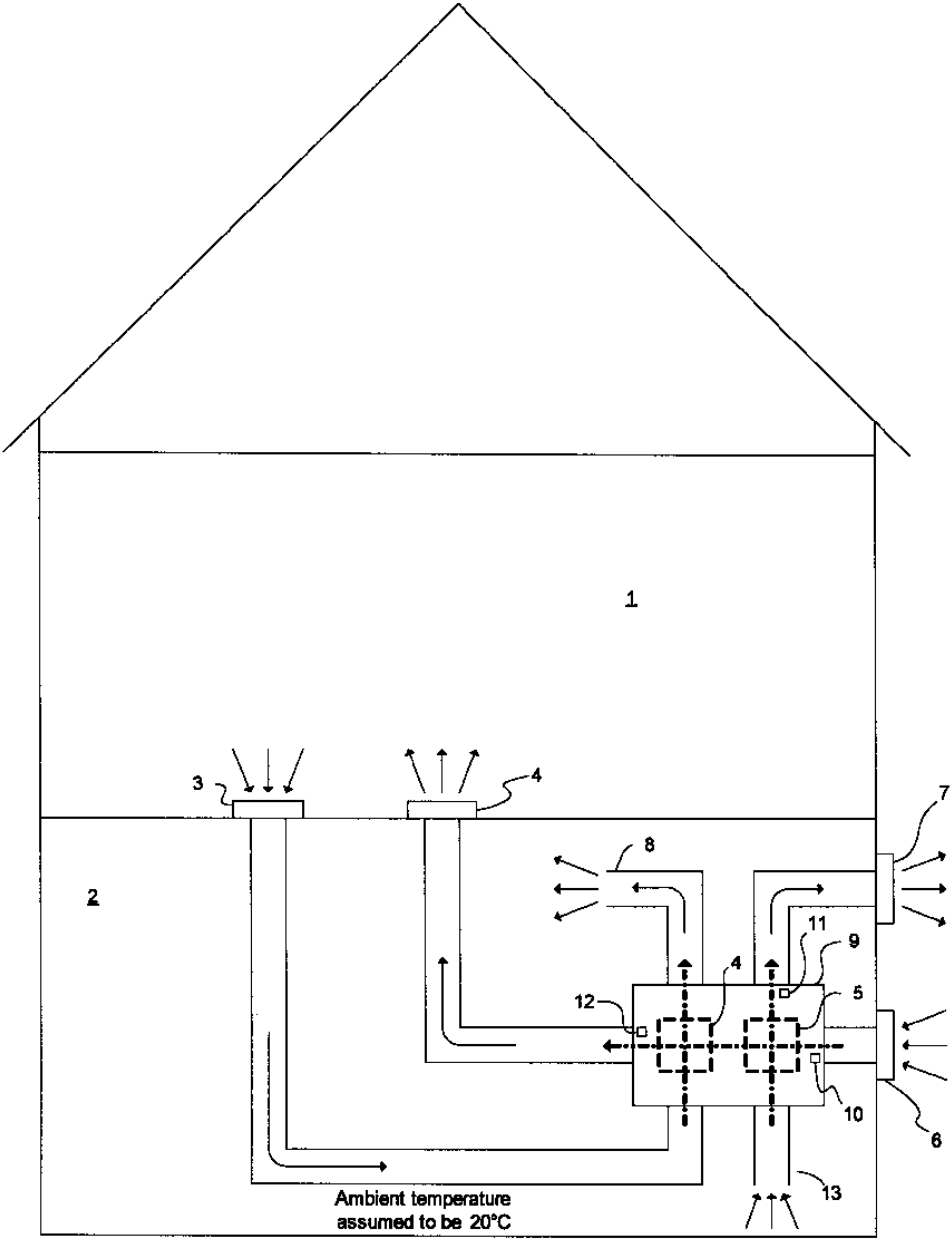

H
138
Deactivate recirculation fan, if present
139
Set supply and exhaust fan speeds to Medium
140
Read temperature sensors
141
Calculate thermal efficiencies for supply and exhaust airflows
142
Is supply efficiency > exhaust efficiency?
Yes
143
Increase supply fan speed or decrease exhaust fan speed
No
144
Is exhaust efficiency > supply efficiency?
Yes
145
Decrease supply fan speed or increase exhaust fan speed
No
146
Reactivate recirculation fan, if present
147
Set timer for next self-balance
A

Figure 7F


1
2
3
4
7
8
4
11
9
12
5
10
6
13
Ambient temperature
assumed to be 20°C