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<p>(54) Title: METHOD FOR REGULATION OF VENTILATION AS WELL AS AN AIR-CONDITIONING DEVICE USED IN THE METHOD</p>		
<p>(57) Abstract</p> <p>The invention concerns a method for regulation of ventilation, wherein air is removed out of a room space (H) or equivalent through an air-conditioning device (10) as outlet air (L₁) and in which said air-conditioning device (10) part of the outlet air is recirculated as return air (L₂) back into the room space, whereby return air (L₂) is mixed with outdoor air to be passed into the room space. Before the outlet air (L₁) is made to flow via the return-air damper (15) to the point of mixing (C) of return air (L₂) and outdoor air, the outlet air is fitted to flow first via the outlet-air damper (14) placed in the outlet-air duct (11a) and, thereupon, via the return-air damper (15). The portion (L₃) of the outlet air (L₁) that is not recirculated via the return-air damper (15) or equivalent is removed as waste air (L₃), without throttling, out of the air-conditioning device. The invention also concerns an air-conditioning device.</p>		

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Method for regulation of ventilation as well as an air-conditioning device used in the method

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The invention concerns a method for regulation of ventilation as well as an air-conditioning device used in the method.

A method for regulation of ventilation is known wherein the indoor
10 air is circulated so that at least a portion of the indoor air, a so-called return-air portion, is mixed with the outdoor air passed into the room. The proportion of outdoor air can be regulated within the range of 0 to 100 per cent, i.e., in extreme cases, either all the air passed into the room consists of outdoor air or of recircu-
15 lated return air.

In the prior-art, traditional mixing-regulation methods, as a rule, three dampers are used so that at least two dampers are interconnected mechanically or electrically so that, when the return-air
20 damper is opened, the outdoor-air damper and the waste-air damper are closed to a corresponding extent. The possible changes in the turning angles of the dampers are within the range of 0...90°.

A problem in the prior-art mixing ventilation methods and in the
25 devices used in said methods has been the poor controllability of the inlet and outlet air flows. The control of the mixing ratio and of the mixing degree has not been adequate. The inlet and outlet air flows have been changed even by 30 per cent while the mixing ratio of outdoor air and return air has been changed within the
30 range of 0...100 per cent. Moreover, in the prior-art methods and solutions of equipment, it has not been possible to define or, thus, to control the mixing ratio of outdoor air to return air. For example, if it has been desired that the ratio of outdoor air to return air is 1/3, in reality this ratio has been 2/1. In such a
35 case, the amount of outdoor air has been multiple as compared with the desired amount of outdoor air. Moreover, the overall inlet air quantity has still been 20 to 30 per cent larger than the desired overall air quantity. A situation of the sort described above causes

a considerable variation in the pressure ratios in an air-conditioning plant as well as a significant increase in the requirement of energy.

The mixing of outdoor air and return air, i.e. their mixing degree,
5 has also been problematic in the prior-art air-conditioning methods and devices. When attempts have been made to mix warm return air and cold outdoor air, the mixed air, however, remains in layers so that the warm air flows in the upper portion of the duct and the cold air in its lower portion. This causes problems in particular
10 in a heating radiator, because in such a case the bottom portion of the radiator tends to be frozen.

In traditional solutions of mixing units, it has become a further problem that, with higher proportions of return air, the inlet and
15 outlet air blowers become connected in series from the point of view of air flow. This causes an increase in the amounts of air both in the inlet-air ducts and in the outlet-air ducts. An increase in the amounts of air causes an increase in the speed of rotation of the blower and, consequently, of its motor, and thereby an increase in
20 the amount of electric current taken by the blower. When certain limit values of electric current are exceeded, the over-current protection switches are activated and the whole system stops.

The object of the invention is to overcome the drawbacks mentioned
25 above and to provide such a ventilation method and such an air-conditioning device used in the ventilation method by means of which the inlet-air and outlet-air flows, the mixing ratio, and the mixing degree are controlled.

The object of the invention has been achieved by means of a ventila-
30 tion method which is mainly characterized in that, before the outlet air is made to flow via the return-air damper to the point of mixing of return air and outdoor air, the outlet air is fitted to flow first via the outlet-air damper placed in the outlet-air duct and, there-
35 upon, via the return-air damper, and the portion of the outlet air that is not recirculated via the return-air damper or equivalent is removed as waste air, without throttling, out of the air-conditioning device.

The air-conditioning device in accordance with the invention is mainly characterized in that the equipment comprises an outlet-air damper placed in the outlet-air duct, which said outlet-air damper is fitted to be placed before the return-air damper, in relation to
5 the air flow, whereby the portion of the outlet air that does not flow as return air into the inlet-air duct is removed out of the device as waste air.

By means of the ventilation method in accordance with the invention,
10 constant flows of inlet air and outlet air have been achieved irrespective of the mixing ratios. By means of the method and the solution of equipment in accordance with the invention, a controlled degree of mixing of fresh air and return air has been obtained. No formation of temperature layers can be noticed. Moreover, according
15 to the invention, such a ventilation method has been obtained by means of which the mixing ratio is changed in a linear way in accordance with a control message given as a set value.

According to the invention, such a method for regulation of ventila-
20 tion and such an air-conditioning device used in said regulation method have been accomplished wherein the outlet-air damper is fitted to be located before the point of branching of the waste-air flow and the return-air flow. The waste-air flow is fitted to be removed out of the device into the open air so that said flow is not choked.
25 True enough, the waste-air duct may comprise a separate damper that closes and opens the duct, but the function of said damper is only to act as a closing member in said duct portion, operating by the on-off principle. Thus, in the closed position, free flow from open air through said waste-air duct is prevented. The return air
30 is fitted to enter into the mixing point in the device, i.e. into the so-called mixing unit, at a very high speed. Said high velocity is accomplished so that the cross-sectional flow area of the return-air duct or duct opening is made smaller than that of the outdoor-air duct. Under these circumstances, the area of the return-air
35 damper is optimally about 1/3, i.e. about 30 %, of the area of the outdoor-air damper, and advantageously also about 30 % of the area of the outlet-air damper. In stead of the areas of said dampers, it is also possible to speak of the cross-sectional flow areas of the

duct portions placed facing said dampers, i.e. the cross-sectional flow area of the duct placed facing the return-air damper is optimally about 30 % of the cross-sectional flow area of the duct placed facing the outdoor-air damper and advantageously also about 30 % of the cross-sectional flow area of the duct placed facing the outlet-air damper. Thus, even with low circulation pressures a sufficiently rapid flow is obtained at the mixing point. Thus, the mixing degree, i.e. the mixing of the return air and the outdoor air becomes adequate. Under these circumstances, there are no temperature layers, which is the case in the prior-art solutions of equipment. The device in accordance with the invention is also given such a control quantity as a set value as indicates directly the desired percentage proportion of fresh air in the inlet air to be passed into the room. The control unit, in which the functions that accomplish a linear control have been preset, regulates the desired opening positions of the dampers in particular for the return-air damper and for the outdoor-air damper and for the outlet-air damper. In the present application, when dampers are spoken of, what is meant is generally valves that regulate flow of air.

In the following, the invention will be described with reference to some preferred embodiments of the invention illustrated in the figures in the accompanying drawings, the invention being, however, not supposed to be confined to said embodiments alone.

Figure 1 illustrates a prior-art ventilation method and an air-conditioning machine used in the method. The illustration is schematical.

Figure 2 is a partly schematical illustration of the ventilation method in accordance with the present invention and of an air-conditioning device used in the ventilation method.

Figure 3 illustrates a second preferred embodiment of the invention.

Figure 4A is a block diagram illustration of a preferred embodiment of the control unit.

Figure 4B shows a second embodiment of the control unit.

Fig. 1 illustrates a method and a device in accordance with the prior art. The blower P_1 makes the outlet air flow in the way shown by the arrow L_1 . Part of the air quantity L_1 is branched as return air L_2 via the return-air damper D_3 to the mixing point C. Part L_3 of the outlet air is removed as waste air to the open air. The blower P_2 makes outdoor air L_4 flow via the outdoor-air damper D_1 to the mixing point C, and in this way the return air L_2 and the outdoor air L_4 are mixed and carried further as a combined air flow L_5 into the room space as inlet air.

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The waste-air damper D_2 is fitted to be placed after the return-air damper D_3 , in relation to the direction of air flow. When return air is circulated as of maximum amount while the outdoor-air damper D_1 is closed, while the return-air damper D_3 is fully open, and while the waste-air damper is closed, the blowers P_1 and P_2 are in series. In such a case, loading is produced in the blower P_1 as the suction effect of the blower P_2 attempts to rotate the blower P_1 . When the outlet-air flow is far larger than the inlet-air flow, the flow attempts to rotate the blower P_2 . In an extreme case, the blower P_1 or P_2 is loaded, and the overload relays switch off the main electricity circuit and stop the system.

In the prior-art systems, the damper D_1 and D_3 is, as a rule, controlled mechanically. The dampers D_1 and D_3 are interconnected in such a way that, when the return-air damper D_3 is opened to a certain extent, the outdoor-air damper D_1 and the waste-air damper D_2 are closed to the corresponding extent. By means of the prior-art regulation of said type, no controlled mixing ratio is, however, obtained. Whereas it has been desirable to obtain a mixing ratio of outdoor air to return air equal to, e.g., 1:3, in reality this ratio may have been 2:1. In this way, the amount of outdoor air has been multiple as compared with the desired amount of outdoor air. Moreover, in the prior-art solutions, the overall inlet-air quantity has been 20 to 30 % higher than the desired amount. This circumstance has caused a considerable variation in the pressure ratios in an air-conditioning installation as well as a significant increase in the requirement of energy.

In the prior-art solutions of equipment, the mixing of outdoor air and return air, i.e. their mixing degree, has not been at the desired level either. When attempts have been made to mix warm return air and cold outdoor air, the mixed air has, however, remained in layers.

5 In such a case, the warm air flows in the upper portion of the duct and the cold air in the lower portion.

Fig. 2 shows the ventilation method in accordance with the invention as well as illustrates the principle of the air-conditioning device

10 10 in accordance with the invention. The air-conditioning device 10 comprises an outlet-air duct 11a and an inlet-air duct 12a. Between said ducts, a connection duct 13 is provided for return air. At the end of the outlet-air duct 11a there is a waste-air duct 11b, and at the end of the inlet-air duct there is an outdoor-air duct 12b.

15 According to the invention, an outlet-air damper 14 is fitted in the outlet-air duct 11a. The outlet-air damper 14 is fitted to be placed, in the direction of the outlet-air flow L_1 , before the return-air damper 15 placed in the duct portion or duct opening 13 between the ducts 11a and 12a.

20 The outdoor-air damper 16 placed in the outdoor-air duct 12b is fitted to be located before the return-air damper 15, in the direction of the outdoor-air flow L_4 . The device further comprises a first blower 17 placed in the outlet-air duct 11a before the outlet-air

25 damper 14. In a corresponding way, a second blower 18 is placed in the inlet-air duct 12a. The blower 18 is fitted to be located after the return-air damper 15. Between the return-air damper 15 and the second blower 18, for example, a filter 19 and a heat exchanger 20 may be fitted, which said heat exchanger may be an air heater.

30 The equipment illustrated in Fig. 2 operates as follows. The first blower 17 is fitted to make the air flow, in the way denoted with the arrow L_1 , out of the room space H or equivalent, and said outlet air is made to flow in the outlet-air duct 11a via the outlet-air

35 damper 14 that restricts the flow. After the outlet-air damper 14 the air enters into the duct space E at the front side of the return-air damper 15. The difference in pressure between the ducts 11a and 12a and the effect of the blower 17 that pushes the air flow and the

effect of the blower 18 that sucks the air flow make the air flow in the way denoted with the arrow L_2 back into the room space H through the inlet-air duct 12a. The portion of the outlet air L_1 that is not made to flow as recirculation through the return-air damper 15 and the duct opening 13 into the inlet-air duct 12a is removed as waste air L_3 out of the ventilation device and preferably into the open air. The proportion of outdoor air in the inlet air L_5 that is made to flow in the duct 12a is regulated by means of the outdoor-air damper 16 placed in the outdoor-air duct.

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It is characteristic of the device of the invention that the waste air is not throttled. It is an essential feature of the invention that the portion of the outlet air L_1 that is not circulated via the return-air damper 15 is removed without separate control as waste air in the way illustrated by the arrow L_3 . Thus, the waste air does not have to be regulated separately, and the waste-air flow does not have to be throttled separately.

According to the invention, such a ventilation method and such an air-conditioning device are provided wherein, when the return-air damper 15 is being opened or closed, the outdoor-air damper 16 is opened or closed so that, when the amount of air that passes through the duct portion 13 is reduced by adjusting the return-air damper 15, the amount of outdoor air that passes via the outdoor-air damper 16 in the way indicated by the arrow 4 is increased by the corresponding amount. In a corresponding way, when the amount of return air that is made to flow through the duct 13 is increased by opening the return-air damper 15, the amount of outdoor air coming via the outdoor-air damper 16 is reduced by the corresponding amount by closing the outdoor-air damper 16. According to the invention, the control unit 22 carries out said regulation for the return-air damper 13 and for the outdoor-air damper 16 separately.

An effective characteristic curve is formed both for the return-air damper 15, for the outdoor-air damper 16, and for the outlet-air damper 14, and said effective characteristic curve is non-linearized inversely proportionally to the desired effective characteristic curve. In the ventilation method of the invention, the air-condition-

ing device is given the desired percentage amount of outdoor air, calculated from the amount of inlet air L_5 , as the initial setting. The controller 22 that carries out the linearization gives the dampers 16, 15 and 14 the desired opening positions, which are essentially
5 dependent on the effective characteristic curves of the dampers. An embodiment is also possible wherein a set value S is given as an initial setting which indicates the percentage of return air L_2 in the inlet air L_5 . The rest of the inlet air L_5 consists of outdoor air L_4 . The controller in accordance with the invention regulates the
10 outdoor-air damper 16 and the return-air damper 15 so that, when the air flow via the outdoor-air damper 16 is reduced by a certain amount, the air flow via the return-air damper 15 is increased by the corresponding amount. In a corresponding way, when the air flow via the outdoor-air damper 16 is increased, the air flow via the return-air
15 damper 15 is reduced by the corresponding amount. Said linear regulation of the mixing ratio is also accomplished so that the outlet-air flow L_1 and the inlet-air flow L_5 remain within pre-adjusted desired constant values. The outdoor-air damper 16 is fitted to be located before the mixing point C of the return-air flow L_2 and the
20 outdoor-air flow L_4 , in relation to the outdoor-air flow L_4 .

For example, when a control quantity of 70 % is given as the initial setting, the control unit 22 in accordance with the invention carries out the regulation so that it sets the return-air damper 15 and the
25 outdoor-air damper 16 in such positions that the proportion of outdoor air in the inlet air L_5 becomes 70 % of the inlet air L_5 , whereas the proportion of the return air is 30 % of the inlet air L_5 . Thus, to the control unit, one control quantity S is fed, which indicates the percentage proportion of outdoor air in the inlet air L_5 , and
30 the control unit 22 in accordance with the invention adjusts the correct positions, determined on the basis of said control quantity, for the return-air damper 15, for the outdoor-air damper 16, and for the outlet-air damper 14.

35 The regulation of the outlet-air damper 14 takes place as follows. When the proportion of outdoor air starts being reduced from 100 % downwards, thereby the proportion of return air is increased from 0 % upwards. At the initial stage of the regulation the outlet-air

damper 14 is fully open, and during the regulation the outlet-air damper 14 starts being closed in order that the amount of outlet air (L_1) should remain invariable in spite of the fact that the blower 17 placed in the outlet-air duct and the blower 18 placed in the inlet-air duct become connected ever increasingly in series as the flow of return air is increased. The outlet-air damper 14 prevents reduction of the pressure at the pressure side of the blower 17 and increase in the pressure at the suction side of the blower 18 in particular cases in which the return-air circulation is at the maximum. In this way, an overloading of the motors of the blowers 17 and 18 is prevented when the blowers 17 and 18 are connected in series in relation to the air flow.

The control of the device in accordance with the invention takes into account the requirement of outdoor air in cases in which the amounts of outlet air and inlet air are different, for example the amount of outlet air is lower than the amount of inlet air. For example, when the amount of outlet air is 20 % lower than the amount of inlet air, the minimum proportion of outdoor air becomes 20 % of inlet air. In other words, the whole of the outlet air is run as return air, but additionally a proportion of 20 % of outdoor air is required in order that 100 % of the inlet-air amount could be reached.

In a situation contrary to the above, when the flow of outlet air is higher than the flow of inlet air, the outlet-air damper 14, the return-air damper 15, and the outdoor-air damper 16 are controlled so that the maximum of the return air is equal to the amount of inlet air, and the excess air is passed out of the device as waste air.

In a so-called situation of forcible control, e.g. in night-time heating operation, it is also possible to use 100 % of return air, in which case the amounts of outdoor air and waste air are 0 %. In such a case, the return-air damper 15 and the outlet-air damper 14 are controlled so that the amount of air circulated in the device is regulated as equal to the amount of inlet-air flow if the latter amount is smaller than the amount of outlet-air flow, or as equal to the amount of outlet-air flow if the latter amount is smaller than the amount of inlet-air flow.

In each installation, the control unit comprises system-specific parameters, by means of which the control unit defines the control curves important for it in view of the operation of the mixing part C as well as said control curves separately for each damper. Said control curves are defined so that an effective characteristic curve is non-linearized inversely proportionally to the desired effective characteristic curve. The control unit 22 is aware of the opening position of each damper at each particular time. According to the invention, it is also possible to use a control unit of its own for each damper. In such a case, the control units are in data communication with each other and give the dampers 14,15 and 16 the operating positions determined by the percentage proportion of outdoor-air quantity in the inlet air L_5 , given as the set value.

The outdoor-air damper 16 and the return-air damper 15 are substantially perpendicular to each other. In a corresponding way, the return-air damper 15 and the outlet-air damper 14 are substantially perpendicular to each other. That means that the air flows that pass through the dampers 15 and 16 and the central axes of the ducts in which the dampers 15 and 16 are placed are perpendicular to each other. In a corresponding way, the return-air damper 15 is perpendicular to the outlet-air damper 14, i.e. the central axis of the duct 13 is substantially perpendicular to the central axis of the duct 11a. It is also essential that the return-air damper 15 is placed at the proximity of the outdoor-air damper 16. In a case in which the duct 13 does not consist of a through opening only, but of a longer duct portion, the return-air damper 15 is placed at the end next to the outdoor-air damper 16. The area of the return-air damper 15 is substantially smaller than the areas of the outdoor-air damper 16 and of the outlet-air damper 14. An optimal ratio of the areas of the return-air damper 15 and the outdoor-air damper 16 is 1:3, i.e. the area of the return-air damper 15 is about 30 % of the area of the outdoor-air damper 16. In a corresponding way, an optimal ratio of the areas of the return-air damper 15 and the outlet-air damper 14 is about 1:3, i.e. the area of the return-air damper 15 is about 30 % of the area of the outlet-air damper 14. The ratios of areas may, in this connection, also refer to the cross-sectional flow areas of the ducts placed facing said dampers. Maximum ranges

of variation of the above ratios or areas are 10 % to 75 %. As the cross-sectional flow area at the return-air damper 15 is essentially smaller than at the other dampers, and in particular at the outdoor-air damper 16, the flow in the duct 13 always has an adequate velocity even with low differences in pressure, and at the mixing point an adequate degree of mixing of outdoor air and return air is always obtained, and, thus, no formation of layers of temperature occurs. Thus, the locations and the ratios of areas of the dampers have a substantial effect on the mixing degree. Thus, the mixing degree can be made good. With the device in accordance with the invention, no formation of temperature layers can be noticed. $\Delta T = 0...2^{\circ}\text{C}$ across the entire flow cross-section after the mixing point C of the return-air flow L_2 and the outdoor-air flow L_4 .

Fig. 3 illustrates a second preferred embodiment of the invention, wherein the equipment comprises a fourth damper 21, which is fitted to regulate the waste-air flow L_3 by the on-off principle. The function of said damper is not to throttle the waste-air flow L_3 , but its function is just to close the waste-air duct 11b in particular in cases in which all the outlet air is recirculated as return air into the duct 12a. Thus, the damper 21 is either closed or open. During said maximum return-air circulation, it is preferable to keep the damper 21 closed expressly in order that outdoor air could not be mixed with the return air L_2 through the waste-air duct. Also, in cases in which the ventilation device is out of operation, the connection to the outdoor air is closed by means of the dampers 21 and 16, and free flow through the dampers 21 and 16 is excluded.

Fig. 4A is a block-diagram illustration of the principle of the ventilation method in accordance with the invention and of the related control unit. A control quantity S is set in the control unit 22 as a set value. The control quantity S indicates the desired percentage proportions of the amount of outdoor air or of the amount of return air in the inlet air L_5 . The control unit 22 adjusts each damper 14,15,16 and/or 21 separately. There are no mechanical couplings, levers, rods, or electric slave action between said dampers. Thus, each damper is regulated independently.

By means of the control unit 22 in accordance with the invention it is achieved that the flows of inlet air and outlet air remain constant irrespective of the mixing ratio. The mixing ratio (amount of outdoor air to amount of return air) is altered in a linear way in accordance with the message S that controls the mixing ratio. The control unit 22 regulates the outdoor-air damper and the return-air damper so that, when the amount of air flowing via the outdoor-air damper is increased, the amount of air flowing via the return-air damper is reduced by the corresponding amount and, in a corresponding way, when the amount of air flowing via the outdoor-air damper is reduced, the amount of air flowing via the return-air damper is increased by the corresponding amount. In addition to the linear regulation of said mixing ratio, the control unit 22 also accomplishes regulation of the device so that the outlet-air flow L_1 and the inlet-air flow L_5 always remain at the desired preset and pre-adjusted value.

Fig. 4B illustrates a second embodiment of the control of the dampers. For each damper 14,15,16 and 21 there is a control unit 23,24,25 and 26 of its own. The control units are interconnected by means of data buses 27. The set value S, which indicates the desired percentage proportion of outdoor-air flow in the entire inlet air L_5 to be passed into the room space H, is given to one or, alternatively, to several control units 23,24,25 and 26, which thus give the actuators that regulate the positions of the dampers 14,15,16 and 21 the positions that accomplish the desired flow of inlet air L_5 .

WHAT IS CLAIMED IS:

1. Method for regulation of ventilation, wherein air is removed out
5 of a room space (H) or equivalent through an air-conditioning device
(10) as outlet air (L_1) and in which said air-conditioning device
(10) part of the outlet air is recirculated as return air (L_2) back
into the room space, whereby return air (L_2) is mixed with outdoor
10 air to be passed into the room space, c h a r a c t e r i z e d in
that, before the outlet air (L_1) is made to flow via the return-air
damper (15) to the point of mixing (C) of return air (L_2) and outdoor
air, the outlet air is fitted to flow first via the outlet-air damper
(14) placed in the outlet-air duct (11a) and, thereupon, via the
15 return-air damper (15), and the portion (L_3) of the outlet air (L_1)
that is not recirculated via the return-air damper (15) or equivalent
is removed as waste air (L_3), without throttling, out of the air-
conditioning device.
2. Method as claimed in claim 1, c h a r a c t e r i z e d in
20 that in the method such a damper (14,15,16) control unit (22) is
used as is given a control quantity (S) which indicates the desired
proportion of outdoor air (L_4) or of return air (L_2) in the inlet
air (L_5) to be passed into the room (H) or equivalent, and which
said control unit adjusts, for the dampers, positions that accomplish
25 said given set value, and that the control unit (22) is fitted to
regulate each damper (14,15,16 and/or 21) separately.
3. Method as claimed in claim 1, c h a r a c t e r i z e d in
that in the method each damper is regulated separately by means of a
30 separate control unit (23,24,25,26) of each damper, which said control
units (23,24,25 and 26) are in data communication with each other.
4. Regulation method as claimed in any of the preceding claims 1 to
3, c h a r a c t e r i z e d in that such a control unit (22;23...
35 26) is used as controls the dampers so that, when the amount of
outdoor air that flows via the outdoor-air damper (16) is increased,
the amount of air that flows via the return-air damper is reduced by
the corresponding amount and, when the amount of air that flows via

the outdoor-air damper (16) is reduced, the amount of air that flows via the return-air damper (14) is increased by the corresponding amount, and that in said regulation the amounts of inlet-air flow and outlet-air flow are kept at the desired preset values.

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5. Air-conditioning device which comprises an outlet-air duct (11a) and therein a first blower (17), and an inlet-air duct (12a) and therein a second blower (18), and a connecting duct or duct opening (13) which interconnects said duct portions and through which return air is recirculated from the outlet-air duct (11a) into the inlet-air duct (12a), and in which said air-conditioning device the outlet-air duct (11a) is connected with a waste-air duct (11b) and the inlet-air duct (12a) is connected with an outdoor-air duct (12b), and which said equipment comprises a return-air damper (15) in the return-air duct or duct opening (13) and an outdoor-air damper (16) in the outdoor-air duct (12b), c h a r a c t e r i z e d in that the equipment comprises an outlet-air damper (14) placed in the outlet-air duct (11a), which said outlet-air damper (14) is fitted to be placed before the return-air damper (15), in relation to the air flow (L_1), whereby the portion of the outlet air (L_1) that does not flow as return air (L_2) into the inlet-air duct (12a) is removed out of the device (10) as waste air (L_3) without throttling, whereas the return air (L_2) is mixed with the outdoor-air flow (L_4) introduced along the outdoor-air duct (12b).

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6. Air-conditioning device as claimed in claim 5, c h a r a c t e r i z e d in that the outdoor-air damper (16) is fitted to be placed before the point of mixing (C) of the return-air flow (L_2) and the outdoor-air flow (L_4), relative the outdoor-air flow (L_4).

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7. Air-conditioning device as claimed in claim 5 or 6, c h a r a c t e r i z e d in that the device comprises a fourth damper (21), which operates by the open/close principle, whereby in the open position a free unthrottled flow is permitted via the damper, and in the closed position the duct is closed by means of the damper (21), and which said damper is placed in the waste-air duct (11b) after the point of branching (E) of the waste-air flow (L_3) and the return-air flow (L_2).

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8. Air-conditioning device as claimed in any of the preceding claims 5 to 7, characterized in that, at the return-air damper (15), the cross-sectional flow area of the duct is 10 % to 75 %, preferably about 30 %, of the cross-sectional flow area of the duct placed facing the damper (16 and/or 14).
9. Air-conditioning device as claimed in any of the preceding claims 5 to 8, characterized in that the return-air duct or duct opening (13) and the outdoor-air duct (12b) are placed so that their central axes are substantially perpendicular to each other, and that the return-air damper (15) fitted in the duct opening (13) is fitted to be placed substantially at the proximity of the outdoor-air damper (16).
10. Air-conditioning device as claimed in any of the preceding claims 5 to 9, characterized in that the air-conditioning device comprises a control unit (22), to which a control quantity (S) which indicates the desired proportion of outdoor air in the inlet air (L_5) is fed as a set value, and which said control unit (22) regulates each damper (14,15,16 and/or 21) separately, and that there is such a control unit (22) as regulates the dampers so that, when the flow of air flowing through the outdoor-air damper (16) is increased, the flow of air flowing through the return-air damper (15) is reduced by the corresponding amount, and, in a corresponding way, when the flow of air flowing through the outdoor-air damper (16) is reduced, the flow of air flowing through the return-air damper (15) is increased by the corresponding amount, and that, when said air flows are being regulated, the outlet-air flow and the inlet-air flow (L_1, L_5) are kept at their pre-adjusted desired flow-quantity values.

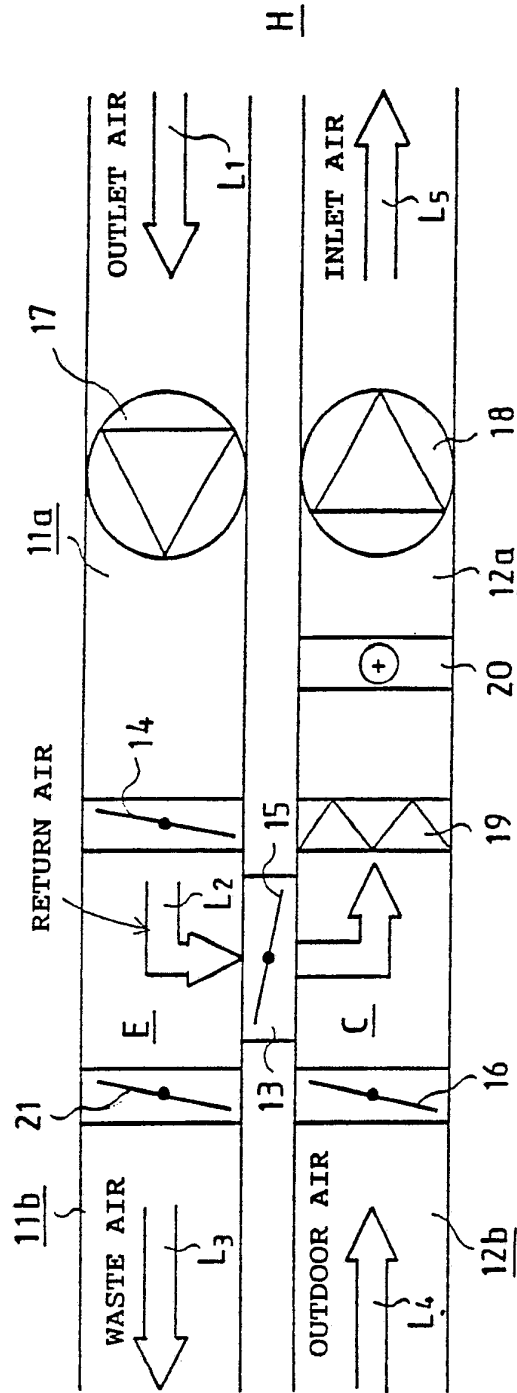


FIG. 3

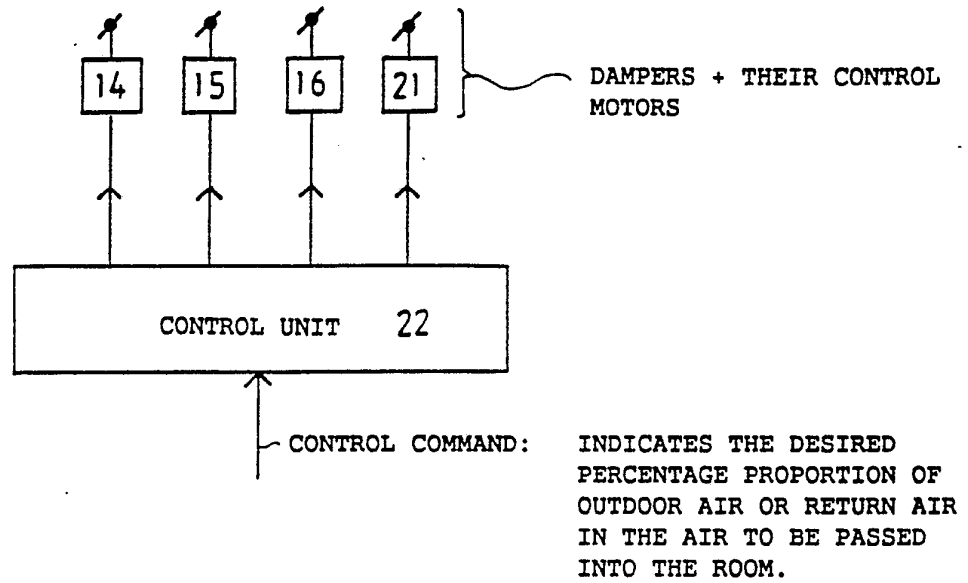


FIG. 4A

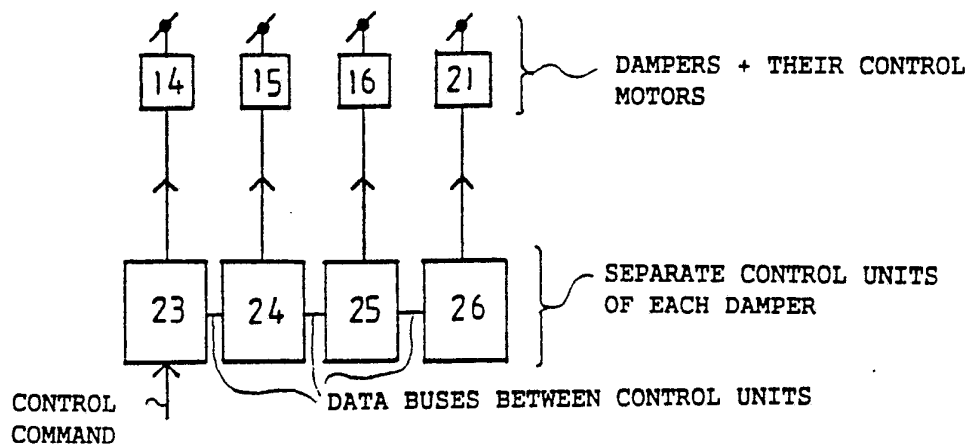



FIG. 4B

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI89/00010

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC ⁴		
F 24 F 3/044		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System ¹	Classification Symbols	
IPC 4	F 24 F 1/00, /02, 3/00, /044, 5/00, 7/00, /04, /06, /08, 11/06-/047, /08	
US C1	98:33; 236:49	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched ⁸		
SE, NO, DK, FI classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
Y	FLÄKT TEKNIK AB, published May 1984, Stenstorp, Enhetsaggregat VKAG, VKUG, See page 19, figure 2	1-10
Y	EP, A2, 0 146 488 (CARRIER CORPORATION) 26 June 1985 See especially figure 5 and abstract & US, 4549601 US, 4630670	1-10
<p>¹⁰ Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"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)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"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</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"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.</p> <p>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
1989-04-13	1989-04-13	
International Searching Authority	Signature of Authorized Officer	
Swedish Patent Office	 Peter de Bellmond	