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

(11) EP 0 694 150 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
24.03.1999 Bulletin 1999/12

(21) Application number: **94912565.2**

(22) Date of filing: **22.04.1994**

(51) Int Cl.[6]: **F24F 11/04**, F24F 3/044

(86) International application number:
PCT/FI94/00154

(87) International publication number:
WO 94/25804 (10.11.1994 Gazette 1994/25)

(54) AN AIR-CONDITIONING APPARATUS AND A METHOD OF CONTROLLING ITS OPERATION

KLIMAANLAGE UND VERFAHREN ZUR BETRIEBSSTEUERUNG

APPAREIL POUR LE CONDITIONNEMENT DE L'AIR ET PROCEDE POUR CONTROLER SON FONCTIONNEMENT

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **23.04.1993 FI 931848**

(43) Date of publication of application:
31.01.1996 Bulletin 1996/05

(73) Proprietor: **ABB FLÄKT OY**
SF-00620 Helsinki (FI)

(72) Inventors:
- **KANNINEN, Seppo, Kalevi**
  FIN-02230 Espoo (FI)
- **LESKINEN, Seppo, Juhani**
  FIN-01120 Västerskog (FI)
- **ROLIN, Ingmar, Erik**
  FIN-02730 Espoo (FI)

(74) Representative: **Füchsle, Klaus, Dipl.-Ing. et al**
Hoffmann Eitle,
Patent- und Rechtsanwälte,
Arabellastrasse 4
81925 München (DE)

(56) References cited:
WO-A-89/07738
DE-A- 2 027 803
US-A- 2 224 407
US-A- 4 199 101

EP 0 694 150 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] This invention relates to a method of controlling the operation of an air-conditioning apparatus comprising

- a device for supplying outdoor air into a room;
- a device for removing indoor air from the room;
- a return device for returning the removed indoor air as return air into the room; and
- adjusting means for adjusting the amounts of outdoor air, indoor air removed from the room, and indoor air to be returned into the room, said means being adjustable between a closed position preventing the passage of air and an open position allowing the passage of air;
- the adjusting means being adjustable for controlling the mixing ratios between said amounts of air according to desired conditions to be achieved in the room.

[0002] The need for air-conditioning in buildings depends on the number of people staying in the building at a specific time, the amount of impurities entering the air, the heat load, etc. The air-conditioning system, especially the flow of air, has to be designed according to the maximum load. As the heat load is very often the factor determining the design values, the air-conditioning system often has to be operated at an unnecessarily high power, especially in winter, if the power cannot be adjusted. This would require a very high amount of energy, especially thermal energy, as whatever the way cold outdoor air is introduced into the building, the air has to be heated.

[0003] To avoid unnecessary consumption of energy, different ways of adjusting the power of the air-conditioning apparatus have been developed. The most natural way is to decrease the supply and exhaust air flows of the air-conditioning system simultaneously when full power is not needed. This may take place e.g. by adjusting the rotation speed of the blowers, by varying the performance curves of the blowers by adjusting the blade angle, or by bringing the air entering the blower into a rotation movement by so-called leading-blade adjusters or simply by increasing the air resistance of the system by dampers.

[0004] However, reduction in the air flow causes problems in the distribution of air into rooms. The properties of conventional air distribution means, especially the throw length, change as the air flow is reduced so that the air flow emerging from the air distribution means will not reach everywhere in the room, and so the air will not change at all in some part of the room. The situation is critical especially when the temperature of supply air differs from the temperature of indoor air. If supply air is colder than indoor air, it easily "drops" to the floor level and causes draught, in addition to which air will not change efficiently at the breathing level. If supply air is warmer than indoor air, it remains in (or rises to) the top portion of the room and is usually removed through an exhaust valve directly into the outdoor air, and so air will not change at all at the level where people are staying (so-called short-circuit flow).

[0005] In addition to this common problem, all of the above-mentioned ways of adjustment have their own special problems. The otherwise unproblematic adjustment of the rotation speed is very expensive as well as the adjustment of the blade angle. With small air flows, the adjustment of the blade angle results in operation within the unstable portion of the specific curve of the blower, which at worst may bring about a so-called pumping (hunting) phenomenon: the air flow from the blower changes several times per second, as a result of which forceful pressure impacts and noises may occur. The risk of pumping is great especially when the resistance curve of the air-conditioning system is not a square parabola. Though considerably smaller, the same risk is present in the adjustment utilizing a leading-blade adjuster and dampers; for instance, the air flow from axial blowers can be adjusted by a damper only within a very small air flow range.

[0006] So-called return air operation has been developed mainly to avoid air distribution problems. In the return air operation the flow of outdoor air into the building and the flow of so-called exhaust air from the building are reduced by dampers while passing a portion of the exhaust air flow after the exhaust blower to the suction side of the supply air blower, where it is mixed with outdoor air sucked by the blowers. The exhaust air portion to be passed back into the building is to be kept equal to the reduction of the outdoor and/or exhaust air flow caused by the dampers. The supply and exhaust air blowers and the air distribution means thereby operate all the time at the designed air flow rate, and the above-described operational problems will not occur.

[0007] In principle, the return air system seems to be simple, but once the return air damper is opened to admit exhaust air into the supply air blower, the fully separate exhaust and supply air systems become a single extremely complicated system difficult to control; experiences from apparatus implementations show that air flows in particular are impossible to control. As the problems associated with return air operation are so complex that a comprehensive description of great complexity would be required to explain them thoroughly, the problems encountered and the consequences of uncontrollable situations will be dealt with below only in broad outline.

[0008] In practice, one of the most severe problems is that the flow of outdoor air critical to health is not achieved. The widely used devices for ensuring the minimum flow of outdoor air, based on the limitations of the position of the outdoor air damper, do not even guarantee that any outdoor air at all enters the system, to say nothing about ensuring the minimum flow of outdoor air. The situation is further complicated by the fact that the air flows vary in different portions of the system according to the required adjustment range, and the air flows should be controllable everywhere in the flow area.

[0009] The situation could perhaps be controlled to some extent if the relationship between the air flow and the position of the damper were fixed or at least could be expressed as a mathematical equation. Unfortunately, this is not the case, but the damper adjustment curves depend on the shape of the damper blade, the front surface velocity, and the position of the damper blade in quite a complicated way. The adjustment curves always have to be determined experimentally.

[0010] The manufacturers of air-conditioning apparatuses supply standardized mixing sections, the properties of which cannot be modified, and no performance data are usually given for the sections as a whole. Performance data are usually given for separate dampers to be installed in ducts, whereas the validity of the data when the dampers have been installed in the mixing section has not been assured in any way, and no limit values have been given for the properties of adjustable systems.

[0011] It has happened frequently that blower motors have been switched off by themselves during return air operation due to the increased air flow and the resulting increase in the electric power. Several measurements have shown that the minimum flow of outdoor air cannot be achieved in spite of the adjustment of the position of the damper. In certain cases, the pressure ratios within the building have been disturbed so badly during return air operation that the front doors have been difficult to open. As a result, many researchers and building officials, among others, have suggested that the return air operation should be abandoned. Problems associated with the mixing process itself, especially cases where the exhaust air is moist either due to moisture evaporated into the air within the building or due to the humidification of supply air, have further justified such demands. In practice, condensate and frost formation has occurred in the mixing sections; in the worst case, the mixing sections have frozen when cold outdoor air and moist return air have come into contact with each other. The poor controllability of the air flows has obviously further aggravated the situation. The mixing section, which operates flawlessly in laboratory tests, when "appropriate" air flows are mixed at "appropriate" speeds, may cause great difficulties when the poor controllability of air flows results in the mixing of "inappropriate" air flows at "inappropriate" speeds.

[0012] The poor operation of the mixing section also endangers the operation of air-conditioning apparatus sections positioned after the mixing section. Due to the uneven speed and/or temperature distribution, the heating element will not reach its designed performance values or its resistance increases. It has even happened that the heating element has frozen due to the inefficient operation of the mixing section. The resistance of the filter section increases and its service life decreases, droplets are entrained in the air flow from the humidifying parts or cooling elements, causing moisture and hygiene problems, their resistance increases, and the performance values deteriorate, etc. The poor controllability of the mixing section thus simply deteriorates the operation of all subsequent sections of the air-conditioning apparatus.

[0013] A method and an apparatus respectively according to claim 1 and claim 4 are known from US-A-41 99 101, which concerns the restriction of the outdoor air flow by utilising return air.

[0014] US-A-22 24 407 describes a system in which a minimum outside air flow is obtained when, due to to high or to low an outside air temperature, the heating power is not enough to heat or the cooling power is not enough to cool the outside air to a suitable temperature. Thus, it is suggested to change to a return air use with a minimum outside air flow by regulating the position of air shutters when the temperature of the outside air lies outside a defined temperature range. The operation is continued in this way until the outside air temperature has returned to a temperature within the defined range.

[0015] An object of the present invention is to provide a method which avoids the above draw backs and allows the operation of an air-conditioning apparatus to be controlled.

[0016] This object is solved according to the present invention by a method comprising the features of claim 1. Detailed embodiments are described in the dependent method claims.

[0017] An essential feature of the invention is that the supply device and the return device can be used alternately and periodically for periods such that a desired mixing ratio between outdoor air and return air is achieved in the room.

[0018] Another object of the invention is to provide a controllable air-conditioning apparatus in which desired air flows and mixing ratios are achieved with a high accuracy; the minimum flow of outdoor air is achieved under all circumstances; the pressure ratios of the building remain undisturbed at all operating points in all rooms to be air-conditioned; the mixing process will not cause problems in the mixing section itself nor does it disturb the operation of subsequent sections; and the apparatus required for adjustment is substantially simpler than previously.

[0019] This object is solved according to the present invention by an apparatus comprising the features of claim 4. Detailed embodiments are defined in the dependent apparatus claims.

[0020] An essential feature of the invention is that the operation of the mixing section (return device) is designed so as to be controllable according to the properties of the system only at two operating points of the mixing section, or at a limited number of operating points, and the mixing section is operated by ON/OFF adjustment only at these operating points. A desired mixing ratio is achieved by varying the duration of operation at each operating point.

[0021] At its simplest, the system operates through ON/OFF adjustment so that the outdoor air device and the return air device are used alternately, i.e., only outdoor air or only return air is introduced into the room. A desired mixing ratio, i.e. the ratio between the outdoor air flow and the return air flow, is achieved by varying the duration of the different operating periods. Accordingly, if the total air flow to be passed into the room should contain one half of return air, the dampers of the return device are open for one half of the total operating time and closed for the other half. If the minimum requirement of outdoor air flow is e.g. 30% of the total air flow, the outdoor air damper is open for 30% of the total time.

[0022] As time measurements can be easily made with a very high accuracy, the desired mixing ratio will also be achieved with a very high accuracy: in practice, the deviation is less than 0.5%. In the same way as in the present-day systems, the adjustment is based on the degree of use of the building, the purity or temperature of air, the outdoor temperature, etc. On the contrary, the adjusting motors are simple ON/OFF motors, which are considerably cheaper and more reliable in operation than relatively adjusting motors in use today. Also, the adjustment logic is somewhat simpler.

[0023] In addition to ensuring the minimum flow of outdoor air, problems associated with the mixing process itself, such as condensation, freezing, uneven temperature distribution, etc., will be avoided, as two air flows of different temperatures need not be mixed. The fact that the operation of sections positioned after the mixing section will not be disturbed is easy to prove in a laboratory test at the two operating points, at which the effect of uneven temperature distribution need not be taken into account.

[0024] In the following the invention will be described in greater detail with reference to the attached drawings, in which

Figures 1 and 2 are schematic views of one preferred embodiment of an air-conditioning apparatus according to the invention in outdoor air flow operation and in return air flow operation, respectively; and

Figures 3 and 4 show alternative embodiments of the air-conditioning apparatus.

[0025] The air-conditioning apparatus shown in Figure 1 of the drawings comprises a supply device 1, an exhaust device 2, and a return device 3.

[0026] The supply device 1 comprises a supply air duct 5 extending from outdoor air to a room 4. A damper 6, a filter 7, a heat recovery means 8, a damper 9, heating and cooling elements 10, 11, and a blower 12 are installed inside the duct 5. The blower creates an outdoor air flow A in the duct.

[0027] The exhaust device 2 comprises an exhaust air duct 13 extending from the room to outdoor air. A filter 14, a blower 15, dampers 16, a heat recovery means 17 and a damper 18 are installed inside the duct. The blower creates an exhaust air flow B in the duct.

[0028] The return device 3 comprises a return air duct 19, within which a damper 20 is installed. A return air flow C consisting of exhaust air passes through the duct.

[0029] The dampers 9, 16 and 20 are connected to operating means 21 which adjust the dampers into different operating positions, in this specific example between a closed position and an open position. The operating means are controlled by adjustable time switches 22, by means of which the durations of the open periods can be adjusted.

[0030] The operation of the return device 3 is designed to be controlled according to the properties of the system only at two operating points of the return device. The air-conditioning apparatus shown herein operates through ON/OFF adjustment so that only outdoor air A or only return air C is passed alternately into the room during the different operating periods. In the former case, the dampers 6 and 9 of the supply device and the dampers 16 and 18 of the exhaust device are fully open, while the damper 20 of the return device is fully closed. In the latter case, the dampers 6 and 9 of the supply device and the dampers 16 and 18 of the exhaust device are fully closed while the damper 20 of the return device is fully open. A desired mixing ratio, i.e. the ratio between the amount of outdoor air and the amount of return air in the room is achieved by adjusting the duration of the different operating periods, i.e. the time during which the dampers are open. If the desired proportion of outdoor air A in the total air flow introduced into the room is 50% and the proportion of return air C is 50%, the dampers are open for one half of the total time and closed for the other half. On the other hand, if the desired minimum amount of outdoor air in the total amount of air is 30%, the dampers 6 and 9 of the supply duct should be kept open for 30% of the total time while the damper 20 of the return duct is closed.

[0031] As the operating modes of the dampers can be controlled easily and accurately by the timers 22, the desired mixing ratio is achieved with a very high accuracy. The operating means 21 are preferably ON-OFF servomotors.

[0032] It is noted that no mixing of an outdoor air flow and return air flow takes place inside the air-conditioning apparatus itself, but the mixing takes place in the room as the different air flows are passed alternately into the room in operating periods of a desired duration.

[0033] As already mentioned above, the total air flow tends to increase during return air operation, as the resistance of the damper 20 is considerably smaller than the combined resistance of the elements 16, 17, 18 and 6, 7, 8, 9. This may result in overloading of the blower motors, noise and draught problems in the rooms to be air-conditioned, etc.

[0034] These problems can be avoided and the total air flow can be kept constant by making the damper 20 so small that its resistance is sufficient in the open position, or by restricting its open position so that a desired resistance is achieved. However, it is preferable to position a part 23 causing a single resistance in conjunction with the damper 20, preferably after it, which part evens out the air flow. The part may be a perforated plate or a nozzle plate, the free area of the openings of which is selectable or adjustable in a desired way; or it may be a series of plates having mutual spacings adjustable by varying the position of the plates with respect to each other, or any other similar device.

[0035] In this way, an important improvement is achieved over the prior art: the operation of the mixing section can be controlled and the desired performance values can be predesigned in accordance with the requirements of each particular apparatus, in addition to which the apparatus can be prefabricated also in this respect. The required additional parts are considerably cheaper than e.g. the savings that could be obtained in the price of electric motors.

[0036] In some cases, however, it is not possible to operate the apparatus with a 100% outdoor air flow e.g. because the power of the heat element 10 is not sufficient at extreme subzero temperatures or because temperature variations would occur in the building due to the low temperature efficiency and heat capacity of the heat recovery elements 8, 17 and the slowness and poor air distribution of the heating system.

[0037] The operation of the system can be ensured even in such cases by providing the servomotors of the dampers with a limiter, beginning from a certain outdoor temperature or mixing ratio. In the "outdoor" position the limiter allows the outdoor and exhaust air dampers 6, 9, 16, 18 to open to a position corresponding e.g. to a 70% outdoor air flow, and the return air damper 20 to be closed to a position corresponding to a 30% return air flow (= controlled operating point). The duration of the open period has to be increased correspondingly by dividing the time corresponding to the 100% air flow by 0.7.

[0038] The air flow ratios are maintained unchanged and can be adjusted even in this case, whereas there are three flow resistances to be adjusted in place of one resistance (the dampers 6, 9, 16, 18 only for one operating point, and the damper 20 for two operating points corresponding to 100% and 30% air flows). The adjustment is more complicated, although it is still easy as compared with the systems presently in use.

[0039] In this case it is necessary to mix cold and warm, possibly also moist, air. As compared with the present-day systems, the technique is, however, substantially easier as the operation has to be checked only at two operating points, where the air flows are controllable, and so the number of laboratory tests is limited, and it can be taken for granted that a device operating appropriately in laboratory conditions will also operate in practice. Moreover, by a reasonable number of tests, it is possible to determine the moisture, temperature and mixing ratio ranges within which the humidifying part operates flawlessly.

[0040] Excellent results will be achieved if the conventional heat transfer technique is replaced with the system according to claim 3, where all thermic operations are performed by a single heat exchanger. Its operation is described more fully in Finnish Patent Application 915 511.

[0041] When the switching arrangement shown in Figure 3 is used, the system is self-balancing to some extent: for instance, on transition from outdoor air operation to return air operation, the liquid circulation system operates in a manner resembling heat recovery for some time due to the large liquid volumes and heat surfaces. In other words, it first cools the air in a heat exchanger 17' on the exhaust air side and then again heats it up in a heating element 8' on the supply air side. As there is no risk of freezing, the adjustment can be made to act in advance so that a valve 24 closes the heat supply at the same time as or slightly before the return air damper 20 starts to open. As a consequence, the temperature of the supply air first drops slightly on transition to return air operation, then rises slightly, and finally returns to room temperature. As the maximum temperature difference between the supply air and the heating liquid flowing in the heat exchanger circuit is clearly less than 10°C, the temperature variation of the supply air remains small, especially as compared with conventional heat exchanger systems, in which the temperature difference is between 40 and 50°C.

[0042] As the temperature of the return air is decreased before the mixing, the mixing of return air with outdoor air is substantially easier than in conventional systems; temperature layers will not occur equally easily, the risk of freezing and condensing is smaller, etc.

[0043] This arrangement provides another major advantage. As the return air damper 20 is positioned "outside" the heat exchanger means, the air resistances of the elements 16, 17, 18 and 6, 7, 8, 9, shown in Figure 2, decrease by an amount corresponding to the resistance of the elements 8 and 17, that is, at least by 150 Pa. First, this means that the resistance of the system changes on transition to return air operation considerably less than in conventional systems, that is, the air flow changes less. The difference is at least 300 Pa, which is really significant. Second, the proportion of the dampers 18 and 7 of the above-mentioned resistances increases substantially, that is, the system becomes considerably easier to adjust. This affects the operation of the damper 20 especially drastically. The principle can, of course, also be applied in the conventional system shown in Figure 1.

[0044] One embodiment of the system is to realize the return air operation merely by the use of the supply air blower, as shown in Figure 4. In this case, the return air is taken directly from the exhaust duct 13 or from the return duct 19 specially provided for the purpose directly to the suction side of the supply air blower 12. The exhaust air blower 15 is stopped entirely during the return air period. In this way the electric power consumed by the exhaust air blower will be saved, which may be significant. However, the proportion of return air of the total air flow can be adjusted continuously between 0 and 100% by varying the duration of the operating periods. The use of return air is also possible in apparatuses where the exhaust and supply air blowers are remote from each other.

Claims

1. Method of controlling the operation of an air-conditioning apparatus comprising

   - a device (1) for supplying outdoor air (A) into a room (4);
   - a device (2) for removing indoor air (B) from the room;
   - a return device (3) for returning removed indoor air as return air (C) into the room; and
   - adjusting means (9, 16, 20) for adjusting the amounts of outdoor air, indoor air removed from the room, and indoor air to be returned into the room, said means being adjustable from a closed position preventing the passage of air to an open position allowing the passage of air;
   - the adjusting means being adjustable to control the mixing ratios between said amounts of air according to desired conditions to be achieved in the room;

   characterized in that, on the one hand, the outdoor air (A) or a mix of outdoor air (A), predominantly, and return air (C) and, on the other hand, the return air (C) or a mix of return air (C), predominantly, and outdoor air (A) are passed into the room (4) alternately, and that the durations of the open periods of the adjusting means (9, 16, 20) are varied to correspond with a desired mixing ratio between the amounts of outdoor air (A) and return air (C) in the room.

2. Method according to claim 1, **characterized in that** the operation of the return device (3) is controllable in a few, preferably two, operating positions of the adjusting means (9, 16, 20), and that the adjusting means are adjusted to these operating positions only.

3. Method according to claim 1 or 2, **characterized in that** the adjusting means (9, 16, 20) are adjusted in such a way that the adjusting means (9) for outdoor air (A) and the adjusting means (20) for return air (C) are positioned alternately in the open position and in the closed position, the duration of the open periods being such that a desired ratio is achieved between the outdoor air and the return air.

4. Air-conditioning apparatus for a room, comprising

   - a supply device (1) supplying outdoor air (A) into a room (4) and comprising a supply duct (5) between outdoor air and the room, a means (12) for creating an outdoor air flow in the supply duct and means (9) for adjusting the outdoor air flow;
   - an exhaust device (2) passing exhaust air (B) from the room and comprising an exhaust duct (13) from the room, a means (15) creating an exhaust air flow in the exhaust duct, and means (16) for adjusting the exhaust air flow;
   - a return device (3) for returning exhaust air into the room as return air (C) and comprising a return duct (19) between the exhaust duct and the supply duct, and means (20) for adjusting the exhaust air flow in the return duct; and
   - operating means (21) for adjusting the open periods of the respective adjusting means;

   characterized in that the operating means (21) are arranged to open the adjusting means (9, 20) of the supply duct (5) and the return duct (13) such that, on the one hand, the outdoor air (A) or a mix of outdoor air (A), predominantly, and return air (C) and, on the other hand, the return air (C) or a mix of return air (C), predominantly, and outdoor air (A) are passed into the room (4) alternately for the duration of open periods, which correspond to a desired mixing ratio between outdoor air (A) and return air (C) in the room (4).

5. Air-conditioning apparatus according to claim 4, **characterized in that** the operation of the return device (3) is controllable in to at least two operating positions of the adjusting means (9, 16, 20), preferably in a closed position and an open position, and that the operating means (22) are arranged to set the adjusting means (9, 20) of the supply duct (5) and the return duct (19) in these operating positions only alternately for time periods such that a desired ratio between amounts of outdoor air (A) and return air (C) to be passed into the room (4) one after the other is achieved.

6. Air-conditioning apparatus according to claim 4 or 5, **characterized in that** the return duct (19) is provided, in addition to the adjusting means (20), with resistance means (23) for adjusting flow resistance acting on the return air flow (C) passing through the return duct (19).

7. Air-conditioning apparatus according to claim 5, **characterized in that** operating positions of the ad-

justing means (9, 20) of the supply duct (5) and the return duct (19) deviate from their fully closed position and/or fully open position.

8. Air-conditioning apparatus according to claim 4 or 5, **characterized in that** the return duct (19) is connected to the exhaust duct (13) prior to the operating means (14, 15, 17', 18) of the exhaust duct and to the supply duct (5) on the suction side of a blower (12) in the supply duct.

Patentansprüche

1. Verfahren zum Kontrollieren der Arbeitsweise einer Klimatisierungsvorrichtung, die Klimatisierungsvorrichtung umfassend:

   - eine Vorrichtung (1) zum Versorgen eines Raums (4) mit Außenluft (A) ;
   - eine Vorrichtung (2) zum Entfernen von Innenluft (B) aus dem Raum;
   - eine Rückführungsvorrichtung (3) zum Zurückführen von entfernter Innenluft als Umluft (C) in den Raum; und
   - Einstellmittel (9, 16, 20) zum Einstellen der Menge der Außenluft, der aus dem Raum entfernten Innenluft und Innenluft, die in den Raum zurückgeführt werden muß, wobei die Mittel von einer geschlossenen Position, die den Durchtritt von Luft verhindert, zu einer offenen Position, die den Durchtritt der Luft erlaubt, einstellbar sind;
   - und wobei die Einstellmittel einstellbar sind, um die Mischverhältnisse zwischen den Luftmengen entsprechend den gewünschten Bedingungen, die in dem Raum erreicht werden sollen, zu kontrollieren;

   dadurch gekennzeichnet, daß

   - einderseits die Außenluft (A), oder vorherrschend eine Mischung von Außenluft (A), und Umluft (C), und anderseits die Umluft (C) oder vorherrschend eine Mischung von Umluft (C), und Außenluft (A) abwechselnd in den Raum (4) geleitet werden, und daß die Dauer der Öffnungszeiten der Einstellmittel (9, 16, 20) verändert werden, um mit einem gewünschten Mischverhältnis zwischen den Mengen der Außenluft (A) und der Umluft (C) in dem Raum zu korrespondieren.

2. Ein Verfahren gemäß Patentanspruch 1, dadurch gekennzeichnet, daß die Arbeitsweise der Rückführungsvorrichtung (3) in einigen wenigen, vorzugsweise zwei, Betätigungspositionen der Einstellmittel (9, 16, 20) kontrollierbar ist, und daß die Einstellmittel nur auf diese Betätigungspositionen eingestellt werden.

3. Ein Verfahren gemäß Patentanspruch 1 oder 2, dadurch gekennzeichnet, daß die Einstellmittel (9, 16, 20) in einer derartigen Weise eingestellt werden, daß die Einstellmittel (9) für Außenluft (A) und die Einstellmittel (20) für Umluft (C) abwechselnd in der offenen Position und in der geschlossenen Position positioniert werden, wobei die Dauer der Öffnungszeiten so gewählt wird, daß ein gewünschtes Verhältnis zwischen der Außenluft und der Umluft erreicht wird.

4. Eine Klimatisierungsvorrichtung für einen Raum, umfassend

   - eine Versorgungsvorrichtung (1), die einen Raum (4) mit Außenluft (A) versorgt, und die einen Versorgungskanal (5) zwischen der Außenluft und dem Raum, ein Mittel (12) zum Erzeugen einer Außenluftströmung in dem Versorgungskanal, und Mittel (9) zum Einstellung der Außenluftströmung umfaßt;
   - eine Abluftvorrichtung (2), die Abluft (B) aus dem Raum leitet und einen Abluftkanal (13) von dem Raum, ein Mittel (15) zum Erzeugen einer Abluftströmung in dem Abluftkanal, und Mittel (16) zum Einstellung der Abluftströmung umfaßt;
   - eine Rückführungsvorrichtung (3) zum Zurückführen der Abluft in den Raum als Umluft (C), wobei die Rückführungsvorrichtung einen Rückführungskanal (19) zwischen dem Abluftkanal und dem Versorgungskanal und Mittel (20) zum Einstellen der Abluftströmung in dem Rückführungskanal umfaßt; und
   - Betätigungsmittel (21) zum Einstellen der Öffnungszeiten der betreffenden Einstellmittel;

   dadurch gekennzeichnet, daß

   - die Betätigungsmittel (21) angeordnet sind, um die Einstellmittel (9, 20) des Versorgungskanals (5) und des Rückführungskanals (13) derart zu öffnen, daß einerseits die Außenluft (A), oder eine Mischung von vorherrschend Außenluft (A) und Umluft (C), und anderseits die Umluft (C), oder eine Mischung von vorherrschend Umluft (C) und Außenluft (A), für die Dauer der Öffnungszeiträume, die mit einem gewünschten Mischverhältnis zwischen Außenluft (A) und Umluft (C) in dem Raum (4) korrespondieren, abwechselnd in den Raum (4) geleitet wird.

5. Eine Klimatisierungsvorrichtung gemäß Patentanspruch 4, dadurch gekennzeichnet, daß die Arbeitsweise der Rückführungsvorrichtung (3) in wenig-

stens zwei Betätigungspositionen der Einstellmittel (9, 16, 20) kontrollierbar ist, vorzugsweise in einer geschlossenen Position und in einer offenen Position, und daß die Betätigungsmittel (22) angeordnet sind, um die Einstellmittel (9, 20) des Versorgungskanals (5) und des Rückführungskanals (19) in diesen Betätigungspositionen lediglich abwechselnd für Zeiträume einzustellen, so daß ein gewünschtes Verhältnis zwischen den Mengen der Außenluft (A) und der Umluft (C), die nacheinander in den Raum (4) zu leiten sind, erreicht wird.

6. Eine Klimatisierungsvorrichtung gemäß Patentanspruch 4 oder 5, dadurch gekennzeichnet, daß der Rückführungskanal (19) zusätzlich zu den Einstellmitteln (20) vorgesehen ist, und Widerstandsmittel (23) aufweist zum Einstellen des Strömungswiderstandes, der auf die Umluftströmung (C) wirkt, die durch den Rückführungskanal (19) hindurchtritt.

7. Eine Klimatisierungsvorrichtung gemäß Patentanspruch 5, dadurch gekennzeichnet, daß Betätigungspositionen der Einstellmittel (9, 20) des Versorgungskanals (5) und des Rückführungskanals (19) von ihrer vollständig verschlossenen Position und/oder vollständig offenen Position abweichen.

8. Eine Klimatisierungsvorrichtung gemäß Patentanspruch 4 oder 5, dadurch gekennzeichnet, daß der Rückführungskanal (19) vor den Betätigungsmitteln (14, 15, 17', 18) des Abluftkanals mit dem Abluftkanal (13) und mit dem Versorgungskanal (5) auf der Saugseite eines Gebläses (12) in dem Versorgungskanal verbunden ist.

Revendications

1. Procédé de commande du fonctionnement d'un appareil de conditionnement d'air comportant

- un dispositif (1) destiné à amener de l'air extérieur (A) dans une pièce (4);
- un dispositif (2) destiné à évacuer l'air intérieur (B) de la pièce;
- un dispositif de retour (3) destiné à ramener l'air intérieur évacué sous forme d'air de retour (C) dans la pièce; et
- des moyens de réglage (9, 16, 20) destinés à ajuster les quantités d'air extérieur, d'air intérieur évacué de la pièce, et d'air intérieur devant être ramené dans la pièce, lesdits moyens étant réglables depuis une position fermée empêchant le passage d'air jusqu'à une position ouverte permettant le passage d'air;
- les moyens de réglage étant réglables afin de commander les rapports de mélange entre lesdites quantités d'air en fonction des conditions que l'on souhaite obtenir dans la pièce;

caractérisé en ce que, d'une part, l'air extérieur (A) ou un mélange d'air extérieur (A), principalement, et d'air de retour (C) et, d'autre part, l'air de retour (C) ou un mélange d'air de retour (C), principalement, et d'air extérieur (A) passent dans la pièce (4) de manière alternée, et en ce que les durées des périodes ouvertes des moyens de réglage (9, 16, 20) sont modifiées afin de correspondre à un rapport de mélange souhaité entre les quantités d'air extérieur (A) et d'air de retour (C) dans la pièce.

2. Procédé selon la revendication 1, caractérisé en ce que le fonctionnement du dispositif de retour (3) peut être commandé dans seulement quelques, de préférence deux, positions de fonctionnement des moyens de réglage (9, 16, 20), et en ce que les moyens de réglage sont ajustés sur ces positions de fonctionnement seulement.

3. Procédé selon la revendication 1 ou 2, caractérisé en ce que les moyens de réglage (9, 16, 20) sont ajustés d'une manière telle que les moyens de réglage (9) pour l'air extérieur (A) et les moyens de réglage (20) pour l'air de retour (C) sont placés alternativement dans la position ouverte et dans la position fermée, la durée des périodes ouvertes étant telle qu'un rapport souhaité est obtenu entre l'air extérieur et l'air de retour.

4. Appareil de conditionnement d'air pour une pièce, comportant

- un dispositif d'alimentation (1) destiné à amener de l'air extérieur (A) dans une pièce (4) et comportant une conduite d'alimentation (5) entre l'air extérieur et la pièce, des moyens (12) destinés à créer un écoulement d'air extérieur dans la conduite d'alimentation et des moyens (9) destinés à ajuster l'écoulement d'air extérieur;
- un dispositif d'évacuation (2) laissant passer de l'air d'évacuation (b) de la pièce et comportant une conduite d'évacuation (13) de la pièce, des moyens (15) créant un écoulement d'air d'évacuation dans la conduite d'évacuation, et des moyens (16) destinés à ajuster l'écoulement d'air d'évacuation;
- un dispositif de retour (3) destiné à ramener l'air d'évacuation dans la pièce sous forme d'air de retour (C) et comportant une conduite de retour (19) entre la conduite d'évacuation et la conduite d'alimentation, et des moyens (20) destinés à ajuster l'écoulement d'air d'évacuation dans la conduite de retour; et
- des moyens d'actionnement (21) destinés à ajuster les périodes ouvertes des moyens de

réglage respectifs; caractérisé en ce que les moyens d'actionnement (21) sont prévus pour ouvrir les moyens de réglage (9, 20) de la conduite d'alimentation (5) et de la conduite de retour (13) de telle sorte que, d'une part, de l'air extérieur (A) ou un mélange d'air extérieur (A), principalement, et d'air de retour (C) et, d'autre part, de l'air de retour (C) ou un mélange d'air de retour (C), principalement, et d'air extérieur (A) passent de manière alternée dans la pièce (4) pendant la durée des périodes ouvertes, qui correspondent à un rapport de mélange souhaité entre l'air extérieur (A) et l'air de retour (C) dans la pièce (4).

5. Appareil de conditionnement d'air selon la revendication 4, caractérisé en ce que le fonctionnement du dispositif de retour (3) peut être commandé dans au moins deux positions de fonctionnement des moyens de réglage (9, 16, 20), de préférence dans une position fermée et une position ouverte, et en ce que les moyens d'actionnement (22) sont prévus pour placer les moyens de réglage (9, 20) de la conduite d'alimentation (5) et de la conduite de retour (19) dans ces positions de fonctionnement seulement de manière alternée pendant des périodes telles qu'un rapport souhaité entre les quantités d'air extérieur (A) et d'air de retour (C) devant passer dans la pièce (4) l'un après l'autre est obtenu.

6. Appareil de conditionnement d'air selon la revendication 4 ou 5, caractérisé en ce que la conduite de retour (19) est pourvue, en plus des moyens de réglage (20), de moyens de résistance (23) destinés à ajuster la résistance d'écoulement agissant sur l'écoulement d'air de retour (C) passant à travers la conduite de retour (19).

7. Appareil de conditionnement d'air selon la revendication 5, caractérisé en ce que des positions de fonctionnement des moyens de réglage (9, 20) de la conduite d'alimentation (5) et de la conduite de retour (19) s'écartent de leur position totalement fermée et/ou de leur position totalement ouverte.

8. Appareil de conditionnement d'air selon la revendication 4 ou 5, caractérisé en ce que la conduite de retour (19) est reliée à la conduite d'évacuation (13) avant les moyens d'actionnement (14, 15, 17', 18) de la conduite d'évacuation et à la conduite d'alimentation (5) du côté d'aspiration d'un ventilateur (12) dans la conduite d'alimentation.

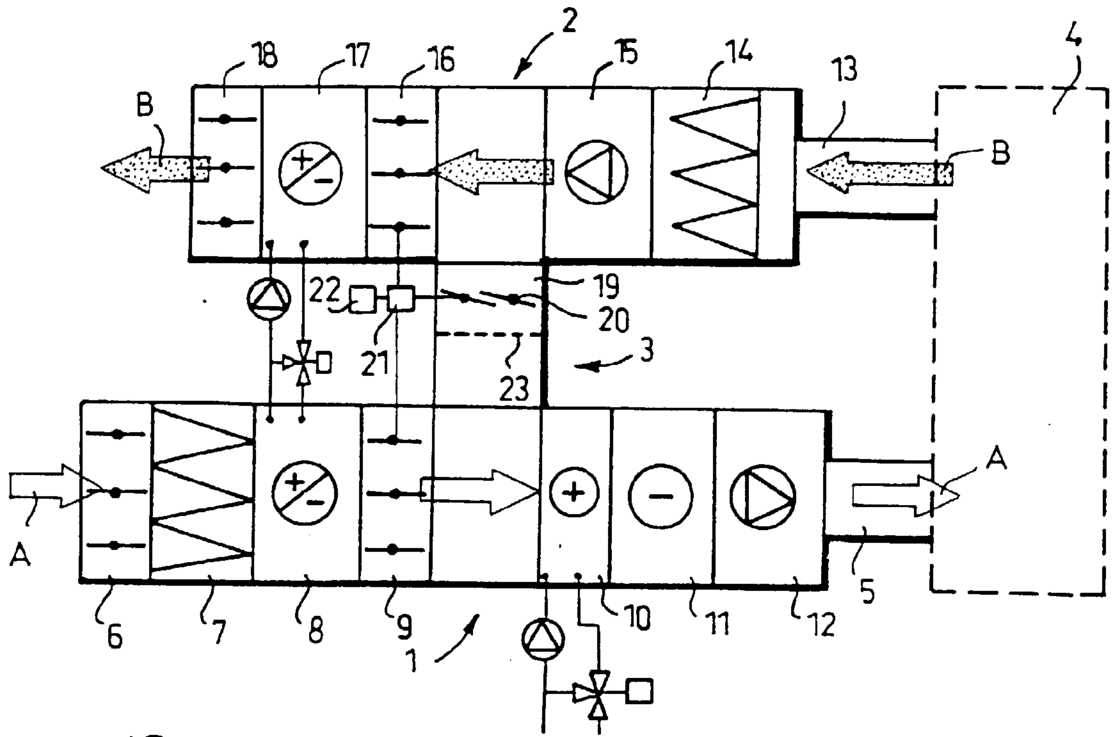
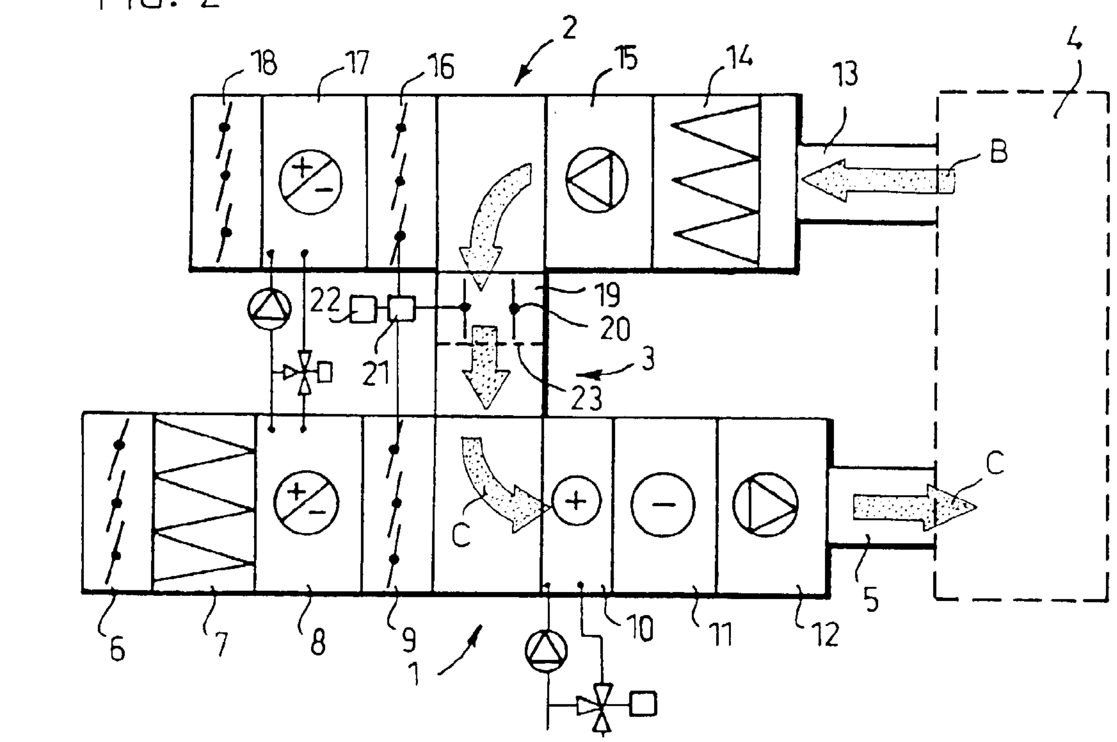

2
18
17
16
15
14
13
4
B
B
22
19
20
21
3
23
A
A
6
7
8
9
1
10
11
12
5

FIG. 1

FIG. 2


2
18
17
16
15
14
13
4
B
22
19
20
21
3
23
C
C
6
7
8
9
1
10
11
12
5

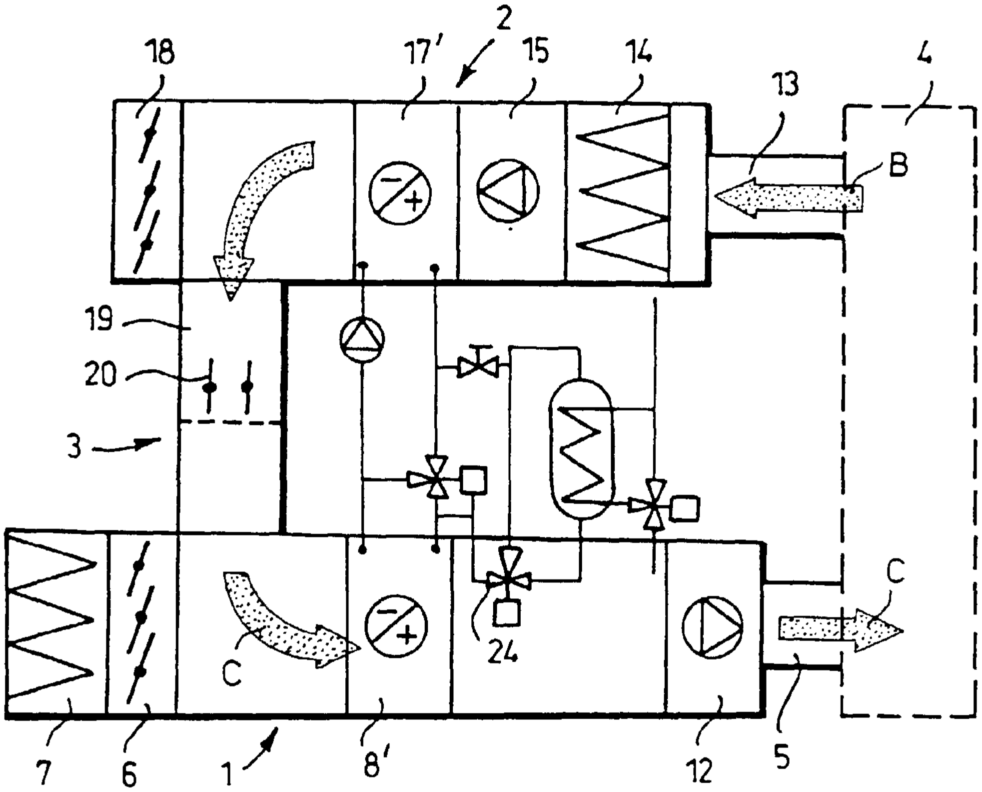

2
18
17'
15
14
4
13
B
19
20
3
C
24
C
7
6
1
8'
12
5

FIG. 3

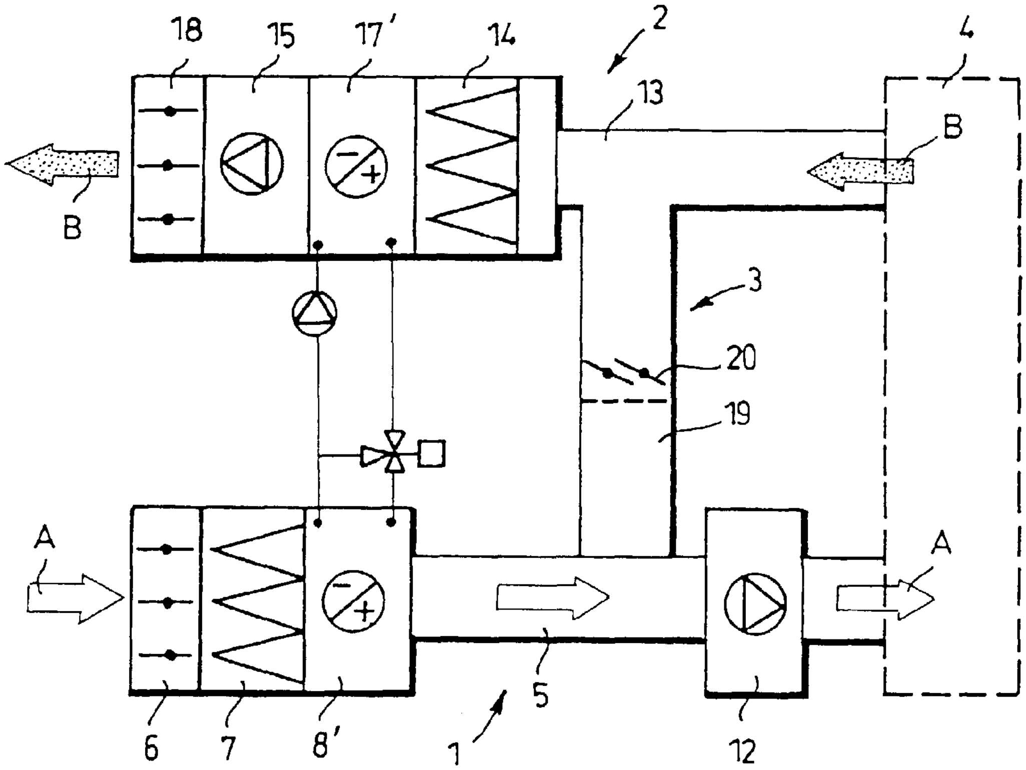

18
15
17'
14
2
4
13
B
B
3
20
19
A
A
6
7
8'
1
5
12

FIG. 4