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(54) METHOD AND SYSTEM FOR VENTILATING A BUILDING

VERFAHREN UND SYSTEM ZUR BELÜFTUNG EINES GEBÄUDES

PROCÉDÉ ET SYSTÈME DE VENTILATION D'UN BÂTIMENT

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Description

[0001] The invention refers to a method and system for ventilating a building, which building is provided with a ventilation unit which is arranged for exchanging the air inside and outside the building. Such a configuration is generally known. The ventilation unit may be constituted by a heat recovery ventilation unit comprising means for forced air movement from the outside to the inside and means for forced air movement from the inside of the building to the outside. Ducts are provided, leading to the various individual rooms in the building, for guiding fresh and exhaust air between the ventilation unit and the individual rooms. An example of such prior art system has been shown in figure 1.

[0002] One problem with the known configurations is that the air transportation ducts are susceptible for pollution, but will not be cleaned in practice. The invention contemplates providing an improved method for ventilating a building to at least overcome said problem.

[0003] Thereto a method for ventilating a building according to the features of claim 1 is provided.

[0004] The invention is based on the understanding that stairwells, halls etc., besides their conventional function for offering, as a central room, access to other rooms at the same floor or at different floors, can additionally be used -as a multipurpose room- for the transportation of fresh air, fed to that central room by the central ventilation unit. In particular when the central room extends throughout the building from the ground floor to about the roof or the attic, there is no need for a fresh air supply duct, as the function of fresh supply duct is taken over by the central room, extending between the ventilation unit in the roof area and the other rooms, connected to the central room, via inner doors. By doing so, contamination or pollution of the fresh air ducts -which is a serious problem in the known ventilation systems- cannot occur. Contamination of the central room, acting as a fresh air supply duct, will be prevented by normal house cleaning activities.

[0005] To be able to supply the fresh air from the central room to the various other rooms in a well controllable way, at least part of the inner doors are provided with a ventilator, e.g. small fans or a combination of small fans and ventilation openings to force air to flow into or out of the relevant room from or to the central room, and extract the surplus of the return air through a fan or through a passive opening in the door. The result is a controlled simultaneous two-way ventilation flow rate over the inner doors and/or inner walls. Preferably, the ventilation means comprise a fan that is adapted to be mechanically and/or electrically driven. More in particular, the ventilation means may comprise a mixing fan that is adapted to mix air from the central room and the respective rooms that can be entered via the inner doors provided with said mixing fans. A further advantage of the use of said mixing fans is that air pressure differences inside the building can be minimized. Consequently, leakage of air through

apertures in the building envelope remains as small as possible. It is noted that the term "building envelope" throughout this application is construed as the separation between the interior and the exterior environments of a building. It serves as the outer shell to protect the indoor environment as well as to facilitate its climate control.

[0006] It is noted that GB 518,215 discloses a system for ventilating buildings, wherein air is supplied to a central room provided in the building via a ventilation unit that sucks air from outside the building. The air can enter the rooms adjacent the central room via apertures provided in the walls. The air may be heated or cooled. The air may leave the rooms through spaces between the closed windows and the frames or alternatively via small ventilating discs or the like.

[0007] The inner door comprises next to the ventilator such as a fan, a further ventilation means, for instance a further fan or a passive opening. For instance in inner doors that separate a bedroom from the central room, a fan and a passive opening may be provided. Such a passive opening may for instance be a slit between the inner door and the floor below said inner door. Because in bedrooms the air flows are relatively small, a passive opening may suffice.

[0008] In inner doors between the central room and adjacent rooms between which rooms the air flows are relatively large, two fans may be provided to actively force the first and second air flows in the predetermined directions. Thus, the first air flow from the central room to the other room and the second air flow, the return flow, from the other room back into the central room.

[0009] According to a further aspect of the invention, the first air flow and the second air flow may pass the inner door at different locations. For example, the first air may enter the other room via an upper passage provided in the inner door and the second air flow leaving the other room may enter the central room via a lower passage provided in the inner door. Due to the fan provided in the inner door, for instance at an upper side thereof, the air entering the other room may be blown into said room over a larger distance than the distance over which air is extracted out of said room via the further fan or the passive opening, for instance provided at a lower side of the door. Consequently, air that enters the room will not leave the room directly. The air is able to mix with air already available in said room before the surplus will leave the room again.

[0010] According to another aspect of the invention, the location of passage of the respective first and second air flows may be exchanged. For instance, by providing the ventilation means in the inner door with valves, the flow direction may be reversed. Due the possibility to actively determine the flow directions and the locations of passage of said first and second air flows, the system may help to control the temperature inside the other room.

[0011] For instance, if the room is slightly warm, the warm air may leave the other room at the upper passage

and fresh air may enter the room at the lower passage. On the other hand, when the other room is slightly cold, during warming said room fresh air may enter the other room via the upper passage and thus relatively cold air may leave the other room via the lower passage.

[0012] It may be preferred to provide means for setting indoor climate parameters, for measuring climate variables and for controlling the speed and/or direction of the inner door ventilators, for instance of the fans. Besides, it may be preferred to provide that the inner door fans are energized only at mainly closed inner doors and/or only for occupied and/or used rooms on demand. Such means may comprise a control that is adapted to control at least one ventilation means provided in the inner doors. The control may further be arranged to control the ventilation unit in the top area of the building such that the air flow entering the building may be adapted to the demanded air flows over the inner doors.

[0013] Finally, the ventilation means in the inner doors - or the inner doors themselves - may include filter means for filtering the air moved from the central room to the relevant other rooms and/or vice versa. In this way aerosol dust, fibres and small particles etc. can be filtered out throughout the whole building, by which the indoor environment is further improved.

[0014] To explain the invention, exemplary embodiments thereof will hereinafter be described with reference to the accompanying drawings, wherein:

Figure 1 shows an example of a prior art ventilation system;

Figure 2 shows a first configuration of a building ventilation system according to the invention; and

Figure 2b shows a second configuration of a building ventilation system according to the invention.

[0015] Figure 1 shows an example of a prior art ventilation system, comprising an air to air heat recovery ventilation unit 1, which is connected to two duct systems, viz. a duct system 2 for collecting and transporting exhaust air from more or less temporarily damp rooms like the kitchen, toilet and bathroom, via the unit 1 to the outside, as well a duct system 3 arranged for distributing fresh air in living rooms and bedrooms etc. As stated before, such a duct system 3 may cause (health) problems due to contamination at the inside of the duct, which can hardly be removed effectively. The described prior art system is a so-called balanced mechanical ventilation system. Other prior art systems (not shown) comprise a system with natural air supply and mechanical air extraction, a system with mechanical air supply and natural air extraction and an entirely natural ventilation system without mechanical intervention.

[0016] Figure 2 schematically shows a first configuration of building ventilation system according to the invention, including a ventilation unit 4 mainly in the top area of the building, arranged for exchanging the air inside and outside the building. The unit 4 may be similar to the

unit 1 in the prior art configuration shown in figure 1. A duct system 5 is provided for exhausting air from the kitchen, toilet and bathroom. The duct system may be similar to the duct system 2 in figure 1.

[0017] Instead of a second duct system, like the duct system 3 in figure 1, a central room 6, e.g. an (existing or adapted) stairwell or hall, is used to transport fresh air, supplied via the ventilation unit 4 towards other rooms surrounding (or connected to) the central room 6, in particular living rooms and bedrooms, which can be entered via inner doors 7 between those rooms and the central room 6. In the example the doors of several rooms open onto the stairwell 6, which runs from the ground floor to the attic. Ventilation means, formed by small low power and quiet fans 8 in the inner doors 7 are provided to enable air to move from the central room 6 to the relevant other room or vice versa. The surplus return flow may need a fan or a passive ventilation opening 9 in the door and/or the separation wall in dependence of the kind of other room to be ventilated.

[0018] The fan 8 may be provided adjacent an upper side of the inner door 7 and a further fan (not shown) or the passive ventilation opening may be provided at a lower side of the inner door. As is clearly visible in figure 2, a first air flow from the central room 6 may be forced into the other room (indicated with arrows) by means of the fan 8 provided in the inner door 7. A second air flow, the surplus return flow (also indicated with arrows) may leave the room via a further fan 8 or via the passive ventilation opening 9. As can be seen in Figure 2, the door 7 between the central room 6 and the living room (lower room at the right side of the building) comprises two fans 8, one arranged near the upper side of the inner door 7 and adapted to supply air to the living room and one arranged near the lower side of the inner door 7 provided to actively force the return flow back into the central room 6. The door 7 between the central room 6 and the bedroom (room above the living room) comprises a fan 8 adjacent the upper side of the inner door 7 to supply air to the bedroom and a ventilation opening 9 adjacent the lower side of the door such that the surplus flow may leave the bedroom and return to the central room 6. The configuration of the ventilation system that is shown in Figure 2 is particularly suitable to ventilate the building when the outer temperature is relatively low, for instance during the winter. Relatively cold air is supplied to the other room via the upper fan 8 such that relatively warm air available in said other room will not leave the room upon supply of fresh air. Relatively cold air will leave the other room via the second fan 8, in case of the living room, or via the passive opening 9, in case of the bedroom. During summertime, the configuration of the system according to the invention may be slightly different, as shown in Figure 28. The flow direction of the respective fans 8 (indicated with arrows) is opposite of the flow direction of the respective fans 8 as shown in Figure 2. This configuration may be desired in case the outer temperature may be relatively high, for instance during summer. When sup-

plying fresh air from the central room to the other rooms, such as the living room or the bedroom, the air enters the other room adjacent the lower side of the inner door 7 and the surplus return flow leaves the other room via upper side of the inner door 7. Consequently, relatively warm air will leave the other room and the air inside the room will be of a relatively low temperature.

[0019] Due to the method according to the invention, the concentration of contamination inside the rooms adjacent the central room will be lower in comparison to the prior art system as described earlier and considerably lower compared to so called "leeward bedrooms" for ventilation systems with mechanical extract ventilation and ventilation systems with natural ventilation. Due to the ventilation via the inner doors, no apertures in the building envelope are necessary compared to ventilation systems with mechanical extract ventilation and ventilation systems with natural ventilation. This contributes to an increased thermal and sound insulation of the building. Furthermore, no ventilation grids have to be provided in the window frame, maximizing the view and indoor lighting through said windows.

[0020] A control module 10 may be provided for setting indoor climate parameters, measuring climate variables and controlling the speed and/or direction of the inner door fans 8. The connections between the control module 10 and the fans 8 and the unit 4 may be wired or wireless.

[0021] The inner doors 7 and/or fans 8 may be provided with sensors, providing that the individual fans only are energized at mainly closed inner doors and only at occupied and/or used rooms. In case the inner doors 7 are open, the ventilation between the central room and the other room is ensured. Consequently, no need to actively force air from the central room to the other room is necessary when the inner door is in an open position.

[0022] In the embodiment as described numerous adaptations and modifications are possible. For instance, depending on the kind of building and the kind of room to be ventilated, a certain configuration of fans and passive openings may be provided in the inner door between said room and the central room. Furthermore, different kinds of fans may be used in the system, dependent on the flow rate necessary. Furthermore, the control unit may be adapted to control the ventilation means and/or the ventilation unit based on predetermined parameters. These parameters may for instance be determined in dependence of the kind of building, the outside air conditions etc.

[0023] These and other adaptations and modifications are possible without departing from the scope of the invention as defined in the claims.

Claims

1. Method for ventilating a building, comprising steps of:

- providing a ventilation unit (4) mainly in the top area of the building, arranged for exchanging the air inside and outside the building;
- providing a central room (6), e.g. a stairwell or hall, via which several other rooms can be entered via inner doors (7), wherein the ventilation unit is arranged to feed fresh air to the central room;

characterized in that the method furthermore comprises the steps of:

- providing at least part of said inner doors and /or separation wall with at least one ventilator (8) arranged to force air to move from the central room (6) to the relevant other room and/or vice versa, wherein the inner door (7) and/or the separation wall further is provided with at least one of a further ventilation means and a passive opening (9) for the surplus of a return flow of air to create a two-way flow rate over the inner doors (7).

2. Method according to claim 1, wherein the ventilator (8) comprises a fan such as a mixing fan that is mechanically and/or electrically driven.
3. Method according to any one of the preceding claims, wherein the ventilator simultaneously provide a first air flow between the central room (6) and the at least one other room and a second air flow between said at least one other room and the central room (6), such that in an inner side of the at least one other room the first air flow mixes with air present in said room and air from said room leaves the room with the second air flow.
4. Method according to claim 3, wherein the first air flow and the second air flow pass the inner door (7) at different locations, for example the first air flow entering the other room via an upper passage and the second air flow leaving the other room via a lower passage provided in said inner door.
5. Method according to claim 4, wherein the location of passage of the respective first and second air flows is exchanged.
6. Method according to any one of the preceding claims, comprising setting indoor climate parameters, measuring climate variables and controlling the speed and/or direction of the ventilators.
7. Method according to any one of claims 2-6, comprising that the inner door fans (8) only are energized at mainly closed inner doors (7).
8. Method according to any one of claims 2-7, wherein

the fans (8) are only energized at occupied and/or used rooms on demand.

9. Building ventilation system, comprising a ventilation unit (4) mainly in the top area of the building, arranged for exchanging the air inside and outside the building, a central room (6), e.g. a stairwell or hall, via which several other rooms can be entered via inner doors (7), wherein the ventilation unit is arranged to supply fresh air to the central room; **characterized in that** the system furthermore comprises: at least one ventilator (8) in at least part of said inner doors and /or separation wall arranged to force air to move from the central room to the relevant other room or vice versa, wherein the inner doors and/or separation wall further are provided with one of a further fan or a passive opening (9) such that a two-way flow rate over the inner doors and/or inner walls is created
10. System according to claim 9, wherein the at least one ventilator comprises a fan, for instance a mixing fan that is mechanically and/or electrically drivable to actively force an air stream in a predetermined direction.
11. System according to any one of claims 9-10, comprising means (10) arranged for setting climate parameters, measuring climate variables and controlling the speed and/or direction of the inner door ventilators.
12. System according to any one of claims 9-11, comprising means (10) providing that the inner door ventilators only are energized at mainly closed inner doors.
13. System according to any one of claims 11-12, wherein the means for setting parameters and/or the means for energizing the ventilators comprise a control unit (10) that is adapted to control the respective ventilation means (9).
14. System according to any of claims 9-13, wherein said ventilator include filter means for filtering the air moved from the central room to the relevant other rooms and/or vice versa.

Patentansprüche

1. Verfahren zur Belüftung eines Gebäudes, umfassend folgende Schritte:
 - Bereitstellung einer Belüftungseinheit (4), hauptsächlich im oberen Bereich des Gebäudes, angeordnet zum Austauschen von Luft innerhalb und außerhalb des Gebäudes;

- Bereitstellung eines zentralen Raumes (6), z. B. eines Treppenhauses oder einer Halle, über den mehrere andere Räume durch Innentüren (7) betreten werden können, wobei die Belüftungseinheit angeordnet ist, um Frischluft dem zentralen Raum zuzuführen;

dadurch gekennzeichnet, dass das Verfahren ferner folgende Schritte umfasst:

- Ausrüstung von mindestens einem Teil der Innentüren und/oder einer Trennwand mit mindestens einem Ventilator (8), angeordnet um Luft zu zwingen, sich von dem zentralen Raum (6) zu dem entsprechenden anderen Raum und/oder umgekehrt zu bewegen, wobei die Innentür (7) und/oder die Trennwand ferner mindestens mit einem weiteren Ventilationsmittel oder einer passiven Öffnung (9) für den Überschuss eines Rückstroms von Luft versehen ist, um eine Zweiwege-Strömungsrate über die Innentüren (7) zu schaffen.

2. Verfahren nach Anspruch 1, wobei der Ventilator (8) einen Lüfter, wie beispielsweise einen Umwälzlüfter umfasst, der mechanisch und/oder elektrisch angetrieben wird.
3. Verfahren nach einem der vorhergehenden Ansprüche, wobei der Ventilator gleichzeitig für einen ersten Luftstrom zwischen dem zentralen Raum (6) und dem mindestens einen anderen Raum und einen zweiten Luftstrom zwischen dem mindestens einen anderen Raum und dem zentralen Raum (6) sorgt, sodass in einer Innenseite des mindestens einen anderen Raumes der erste Luftstrom sich mit der in dem Raum anwesenden Luft vermischt und Luft aus dem Raum den Raum mit dem zweiten Luftstrom verlässt.
4. Verfahren nach Anspruch 3, wobei der erste Luftstrom und der zweite Luftstrom die Innentür (7) an verschiedenen Stellen passieren, zum Beispiel dass der erste Luftstrom über einen oberen Durchgang in den anderen Raum eintritt und der zweite Luftstrom über einen unteren Durchgang, der in der Innentür bereitgestellt ist, den anderen Raum verlässt.
5. Verfahren nach Anspruch 4, wobei die Durchgangsstelle des jeweiligen ersten und zweiten Luftstroms ausgetauscht wird.
6. Verfahren nach einem der vorhergehenden Ansprüche, umfassend das Einstellen von Innenraum-Klimaparametern, das Messen von Klimavariablen und das Steuern der Geschwindigkeit und/oder Richtung der Ventilatoren.

7. Verfahren nach einem der Ansprüche 2-6, umfassend, dass die Innentürlüfter (8) nur bei vorwiegend geschlossenen Innentüren (7) mit Strom versorgt werden.
8. Verfahren nach einem der Ansprüche 2-7, wobei die Lüfter (8) nur bei besetzten und/oder verwendeten Räumen auf Anfrage mit Strom versorgt werden.
9. System zur Belüftung eines Gebäudes, umfassend eine Ventilationseinheit (4), hauptsächlich im oberen Bereich des Gebäudes, angeordnet zum Austauschen der Luft innerhalb und außerhalb des Gebäudes, einen zentralen Raum (6), z. B. ein Treppenhaus oder eine Halle, über den mehrere andere Räume durch Innentüren (7) betreten werden können, wobei die Ventilationseinheit angeordnet ist, um Frischluft dem zentralen Raum zuzuführen;
dadurch gekennzeichnet, dass das System ferner Folgendes umfasst:

mindestens einen Ventilator (8) in mindestens einem Teil der Innentüren und/oder einer Trennwand, angeordnet, um Luft von dem zentralen Raum zu dem entsprechenden anderen Raum zu bewegen oder umgekehrt, wobei die Innentüren und/oder die Trennwand ferner mit einem weiteren Lüfter oder einer passiven Öffnung (9) versehen ist, sodass eine Zweizeige-Strömungsrate über die Innentüren und/oder Innenwände geschaffen wird.
10. System nach Anspruch 9, wobei der mindestens eine Ventilator einen Lüfter umfasst, beispielsweise einen Umwälzlüfter, der mechanisch und/oder elektrisch angetrieben werden kann, um einen Luftstrom aktiv in eine vorbestimmte Richtung zu zwingen.
11. System nach einem der Ansprüche 9-10, umfassend Mittel (10), angeordnet zum Einstellen von Klimaparametern, Messen von Klimavariablen und Steuern der Geschwindigkeit und/oder Richtung der Innentürventilatoren.
12. System nach einem der Ansprüche 9-11, umfassend Mittel (10), die dafür sorgen, dass die Innentürventilatoren nur bei vorwiegend geschlossenen Innentüren mit Strom versorgt werden.
13. System nach einem der Ansprüche 11-12, wobei die Mittel zum Einstellen von Parametern und/oder die Mittel, um die Ventilatoren mit Strom zu versorgen, eine Steuereinheit (10) umfassen, die geeignet ist, die jeweiligen Ventilationsmittel (9) zu steuern.
14. System nach einem der Ansprüche 9-13, wobei der Ventilator Filtermittel zum Filtern von Luft, die von dem zentralen Raum zu den entsprechenden ande-

ren Räumen und/oder umgekehrt bewegt wird, umfasst.

5 Revendications

1. Méthode d'aération d'une construction, comprenant les étapes consistant à :

- fournir une unité d'aération (4) principalement dans la zone supérieure de la construction, agencée pour échanger l'air intérieur et extérieur de la construction ;
- fournir une salle centrale (6), par exemple un escalier ou un hall, par l'intermédiaire duquel on peut entrer dans plusieurs autres salles par l'intermédiaire de portes intérieures (7), dans laquelle l'unité d'aération est agencée pour acheminer de l'air neuf vers la salle centrale ;

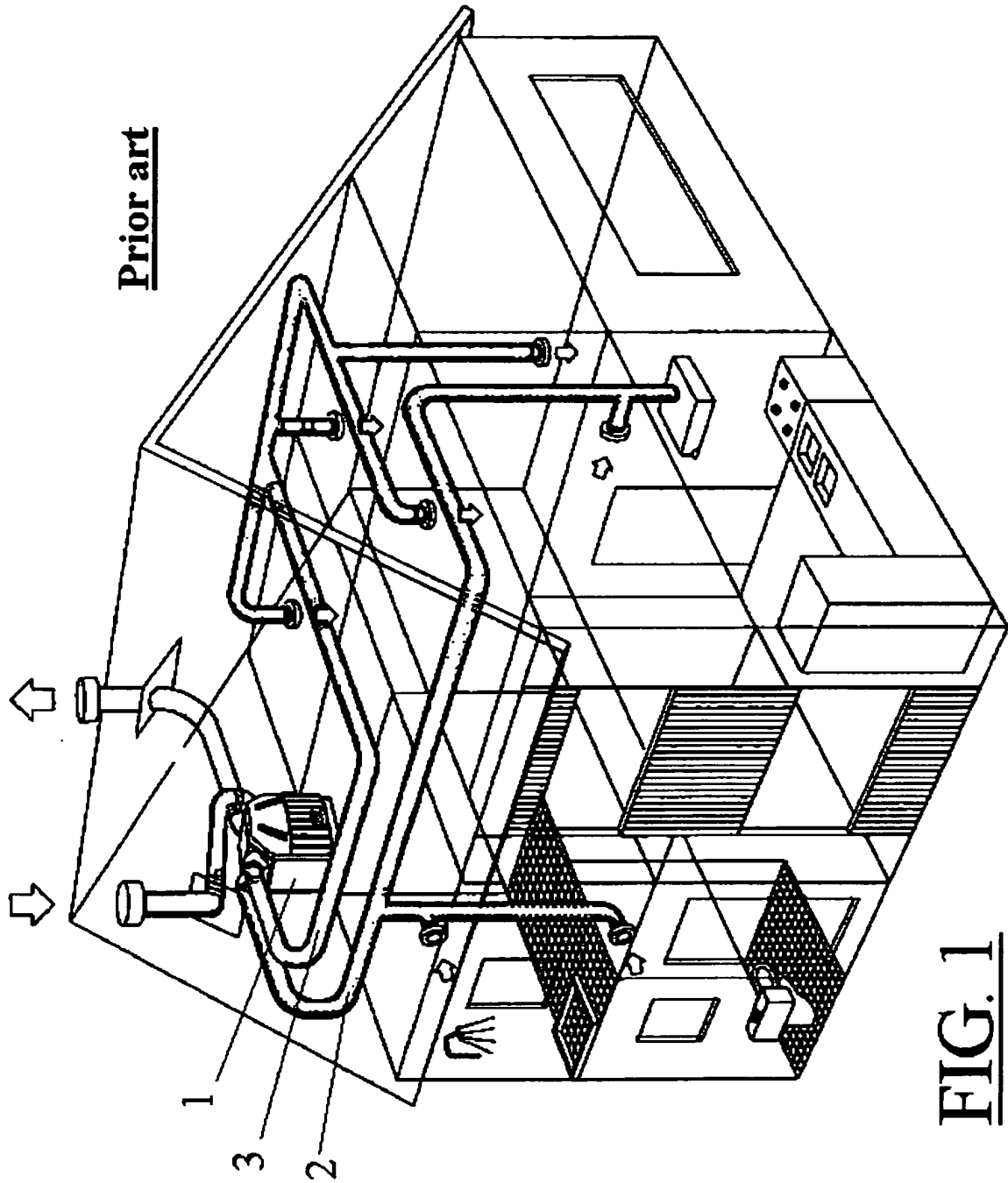
caractérisée en ce que la méthode comporte en outre les étapes consistant à :

- munir au moins une partie des portes intérieures et/ou d'une paroi de séparation d'au moins un aérateur (8) agencé pour forcer l'air à se déplacer depuis la salle centrale (6) vers l'autre salle concernée et/ou vice versa, dans laquelle la porte intérieure (7) et/ou la paroi de séparation est en outre munie d'au moins un parmi un autre moyen d'aération et une ouverture passive (9) pour le surplus d'écoulement d'air en retour pour créer un débit bidirectionnel sur les portes intérieures (7).

2. Méthode selon la revendication 1, dans laquelle l'aérateur (8) comprend un ventilateur tel qu'un ventilateur de mélange qui est entraîné mécaniquement et/ou électriquement.
3. Méthode selon l'une quelconque des revendications précédentes, dans laquelle l'aérateur fournit simultanément un premier écoulement d'air entre la salle centrale (6) et la au moins une autre salle et un second écoulement d'air entre la au moins une autre salle et la salle centrale (6), de telle sorte que dans un côté intérieur de la au moins une autre salle le premier écoulement d'air se mélange avec l'air présent dans la salle et l'air provenant de la salle quitte la salle avec le second écoulement d'air.
4. Méthode selon la revendication 3, dans laquelle le premier écoulement d'air et le second écoulement d'air traversent la porte intérieure (7) à des emplacements différents, par exemple le premier écoulement d'air pénètre dans l'autre salle par l'intermédiaire d'un passage supérieur et le second écoulement d'air quitte l'autre salle par l'intermédiaire d'un

- passage inférieur agencé dans la porte intérieure.
5. Méthode selon la revendication 4, dans laquelle l'emplacement de passage des premier et second écoulements d'air respectifs est échangé. 5
 6. Méthode selon l'une quelconque des revendications précédentes, comprenant la fixation de paramètres du climat intérieur, la mesure de variables du climat et la commande de la vitesse et/ou la direction des aérateurs. 10
 7. Méthode selon l'une quelconque des revendications 2 à 6, consistant en ce que les ventilateurs de porte intérieure (8) sont uniquement mis sous tension au niveau de portes intérieures principalement fermées (7). 15
 8. Méthode selon l'une quelconque des revendications 2 à 7, dans laquelle les ventilateurs (8) sont uniquement mis sous tension à la demande au niveau de salles occupées et/ou utilisées. 20
 9. Système d'aération de construction, comprenant une unité d'aération (4) principalement dans la zone supérieure de la construction, agencée pour changer l'air intérieur et extérieur de la construction, une salle centrale (6), par exemple un escalier ou un hall, par l'intermédiaire de laquelle on peut entrer dans plusieurs autres salles par l'intermédiaire de portes intérieures (7), dans lequel l'unité d'aération est agencée pour fournir de l'air neuf à la salle centrale ; **caractérisé en ce que** le système comprend de plus : 25

au moins un aérateur (8) dans au moins une partie des portes intérieures et/ou d'une paroi de séparation agencé pour pousser l'air à se déplacer depuis la salle centrale vers l'autre salle concernée ou vice versa, dans lequel les portes intérieures et/ou la paroi de séparation sont de plus munies d'un parmi un autre ventilateur ou une ouverture passive (9) de telle sorte qu'un débit bidirectionnel sur les portes intérieures et/ou les parois intérieures est créé. 30 35 40 45
 10. Système selon la revendication 9, dans lequel le au moins un aérateur est constitué d'un ventilateur, par exemple un ventilateur de mélange qui peut être entraîné mécaniquement et/ou électriquement pour pousser de manière active un flux d'air dans une direction prédéterminée. 50
 11. Système selon l'une quelconque des revendications 9 à 10, comprenant des moyens (10) agencés pour régler des paramètres de climat, mesurer des variables de climat et commander la vitesse et/ou la direction des aérateurs de porte intérieure. 55
 12. Système selon l'une quelconque des revendications 9 à 11, comprenant des moyens (10) assurant que les aérateurs de porte intérieure sont uniquement mis sous tension au niveau de portes intérieures principalement fermées.
 13. Système selon l'une quelconque des revendications 11 à 12, dans lequel les moyens pour fixer des paramètres et/ou les moyens pour mettre sous tension les aérateurs comprennent une unité de commande (10) qui est adaptée pour commander les moyens d'aération respectifs (9).
 14. Système selon l'une quelconque des revendications 9 à 13, dans lequel l'aérateur comprend des moyens de filtration pour filtrer l'air déplacé depuis la salle centrale vers les autres salles concernées et/ou vice versa.



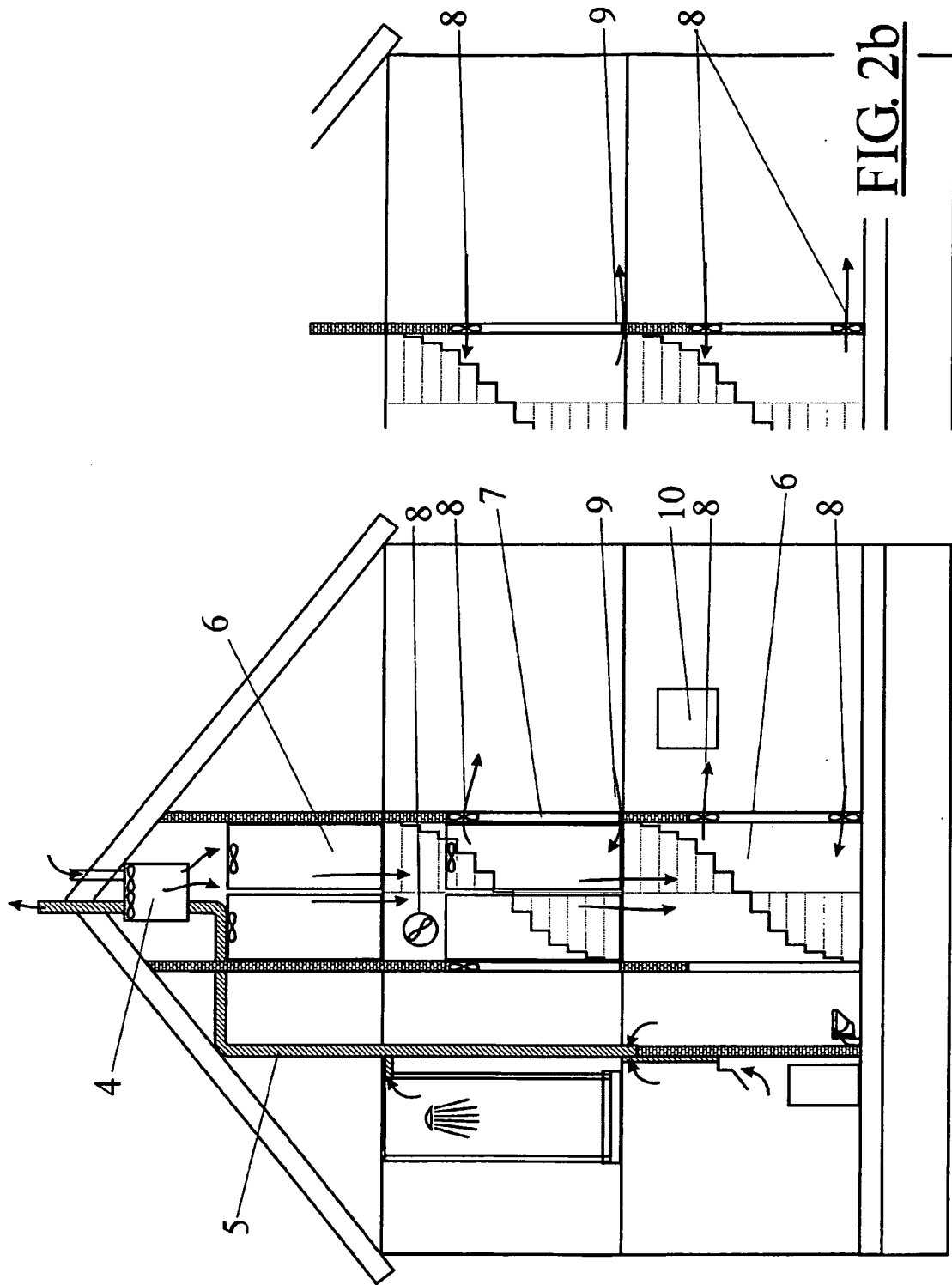


FIG. 2

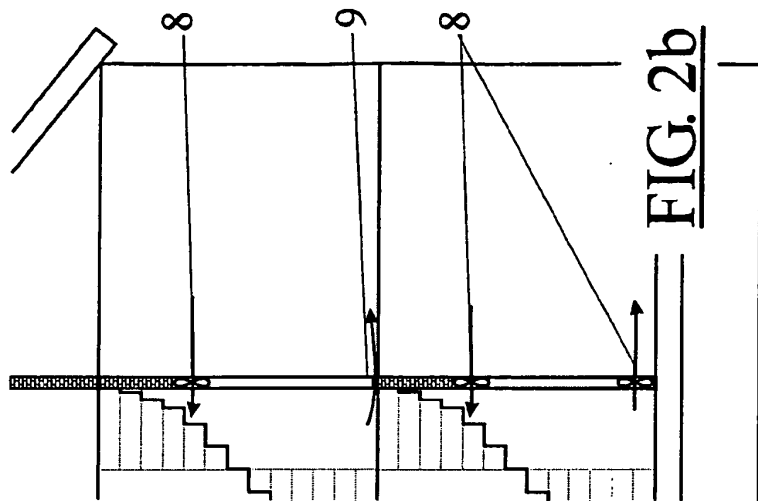


FIG. 2b

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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