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(54) Title: A METHOD AND SYSTEM FOR RENEWING AIR IN A ROOM OF A BUILDING

(57) Abstract

An air renewing system for renewing air in an inner space or room of a building comprises one or more air flow passages (39) extending upwards along at least part of the roof (37) of the building so that the air within the flow passages may be heated by the sun and/or the ambient atmosphere outside the building. Such heating generates an upwards directed air flow through the air passages. The upper end of the air flow passages (39) may communicate with the ambient atmosphere, and the lower end of the air flow passages may be connected to the room to be ventilated. Alternatively, the lower ends of the air flow passages may also be connected to the ambient atmosphere, and in that case the air flow generated may be used for sucking air from the room to be ventilated by ejector effect. Fresh air may flow into the room to be ventilated through air inlet openings, which may, for example, be defined in partition walls, feeding apparatuses (25) extending transversely through the room, or in the floor (17) of the room. The air supplied to the inlet openings may pass a cellar or another underground space in order to be cooled. Further cooling of the inflowing air may be obtained by passing the inflowing air through a water evaporator.
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A METHOD AND SYSTEM FOR RENEWING AIR IN A ROOM OF A BUILDING

The present invention relates to a method of renewing air in an inner space or a room of a building of any kind, such as a dwelling house, a factory or workshop, or a house for keeping cows, pigs, poultry, or other animals. Such houses or buildings often require forced ventilation, which is normally provided by means of fans or air blowers driven by electric motors, which consume electric power.

The present invention provides an air renewing method, or a method of forced ventilation of a room in a house or building, which method does not require supply of electric power.

The method according to the invention comprises generating a flow of air through at least one upwardly extending air passage by heating the air therein and directing said air flow into the ambient atmosphere and past or through at least one air exhaust opening which communicates with said inner space or room, so as to create a sub-atmospheric pressure at said opening. The air flow generated in the upwardly extending air passage causes an ejector effect when passing the air exhaust opening of the room to be ventilated. The subatmospheric pressure created at the air exhaust opening causes air to be sucked out from the room to which the air exhaust opening is connected.

In principle, the air flowing through the air passage may be heated in any suitable manner, for example by means of oil or gas, or heat exchangers, or by the injection of hot steam or gas therein. However, any of these heating methods are energy consuming and therefore less interesting, unless waste heat is available. Therefore, according to the preferred embodiment of the method according to the invention the air in said passage may be heated by the sun and/or the ambient atmosphere. When the weather is hot, or when the building is placed in a location with a warm climate, there is a special need of efficient forced ventilation of the building, and this need is
automatically fulfilled by using the said preferred embodiment of the method according to the invention.

When the air flowing through the air passage is to be heated by the sun, the air passage is preferably defined between heat conducting roofing plates and an underlying layer, which may comprise a heat insulating material. When the heat conducting roofing plates are heated by the sun or the air in the ambient atmosphere, the heat energy is transferred to the air flowing upwards through the air passage. However, because the underlying layer may comprise a heat insulating material, the air in the room to be ventilated need not be heated to any substantial extent.

The said air passage and said exhaust opening may have any suitable cross-section and may extend along any part of the length of the building to be ventilated. However, the air passage and the exhaust opening preferably extend along substantially the total length of the building in order to uniformly distribute the air renewal over the total length of the inner room of the building.

Normally, the said exhaust opening is defined at the top of the roof so that air is sucked out of the inner space or room of the building at that location where the air is relatively warm. However, the method according to the invention also allows removal of air at a lower location of the building. Thus, the lower end of said upwardly extending air passage may communicate with the inner space or room so that the air flowing upwardly through the air passage is at least partly removed from the inner space or room of the building. Alternatively, the lower end of the upwardly extending air passage may communicate with the ambient atmosphere.

The present invention also provides an air renewing system for a building and comprising an air flow passage defined within or adjacent to the roof of the building and extending from a lower end located at or adjacent to the eaves of the building to an upper end located at or adjacent to the top of the roof of the building, first valve means arranged at said lower end for selectively connecting that end of the
flow passage with the inner space of the building or with the ambient atmosphere, and second valve means arranged at said upper end of the flow passage for selectively connecting the upper end of the flow passage with the ambient atmosphere, the upper end of the flow passage being connected to the inner space of the building. When the lower end of the flow passage is in communication with the ambient atmosphere and the upper end of the flow passage is closed by said second valve means, fresh air may be passed into the inner space of the building through the flow passage, and air may be exhausted from the inner space of the building through suitable air passages which may, for example, be defined within partition walls and/or feeding apparatuses as further described below. If, however, the lower end of the flow passage is connected with the inner space of the building, and the upper end of the flow passage is opened to the ambient atmosphere, air may be exhausted from the inner space of the building through the flow passage, and the air passages defined in the feeding apparatuses and/or the partition walls may then be used as inlet passages for fresh air.

The present invention further provides an air renewing or ventilating system for a building and comprising at least one air exhaust opening communicating with an inner space of a room in said building, and at least one upwardly extending air flow passage defined within or adjacent to the roof of the building, and having at its upper end at least one air outlet which communicates with the ambient atmosphere the air outlet and the air exhaust opening being such interrelated that an air flow passing upwards through the flow passage causes air to flow out from said inner space or room through the exhaust opening, so as to create forced ventilation of the inner space of the building.

The lower end or inlet end of the air flow passage may communicate with the ambient atmosphere and/or the said air exhaust opening of the inner space or room of the building so that the air flowing upwards through the flow passage may be air from the inner space of the building or fresh air from the ambient atmosphere outside the building or both. In the first mentioned case the removal of air from
the inner space of the building causes a reduction of the pressure therein so that the removed air is replaced by the inflowing fresh air. However, in a preferred embodiment of the system according to the invention the air outlet of the air flow passage is positioned adjacent to the exhaust opening so that an air flow passing upwards through the flow passage is directed into or past said exhaust opening so as to create a subatmospheric pressure in the exhaust opening.

When the roofing plates are corrugated, the air outlet of the air flow passage are advantageously formed by the corrugations at the upper ends of the upper roofing plates. The air flowing through the air flow passage will then at the upper end thereof be divided into a plurality of spaced air flows which are more efficient in creating a subatmospheric pressure at the exhaust opening than a single coherent air flow.

The air outlet or outlets of the air flow passage and the air exhaust opening or openings may be located at any suitable position of the roof of the building. However, they are preferably located at the ridge of the roof of the building.

In addition to the air exhaust opening, which in the preferred embodiment of the invention is located at the top of the roof, the said air flow passage may comprise an air inlet communicating with said inner space or room and/or the ambient atmosphere. Thus, the air flow passage may comprise a first air inlet communicating with the ambient atmosphere and a second air inlet communicating with said inner space or room, and the system according to the invention may further comprise valve means for selectively closing said first or said second air inlet. When the first air inlet is closed by the valve means, air may be removed from the inner space of the building not only through the air exhaust opening, but also through said second inlet to the air flow passage. When, however, a second air inlet is closed, the fresh air flowing upwardly through the air flow passage is used only as propelling air for causing the desired ejector effect at the air exhaust opening.
In a preferred embodiment of the invention the air inlet or inlets is/are located immediately below the eaves of the building, and the said air passage may then extend from that position to the top of the roof.

When a subatmospheric pressure is created at the exhaust opening communicating with the inner space of the building, fresh air will flow into the space through fresh air inlets which are provided at suitable locations of the building. In order to obtain improved distribution of the fresh air sucked into the building, at least one fresh air inlet passage may extend transversely within the space or room of the building and may have a single elongated or a plurality of spaced fresh air nozzles or openings. If the air flow within the flow passage is reversed, air may be exhausted from the inner space of the building through the nozzles or openings. Furthermore, the air inlet or the air inlet passage may contain cooling means for cooling the fresh air flowing therethrough. These cooling means may comprise a porous water absorbing medium arranged therein and means for supplying water to the porous medium whereby the air will be cooled due to evaporation of water from the porous medium.

In case the house or building to be ventilated is used for housing cattle, poultry, pigs, or other types of animals, one or more low partition walls and/or animal feeding apparatus may be arranged within the building at spaced locations. In such case a fresh air inlet or air outlet passage may preferably extend longitudinally through at least one and preferably more of the partition walls and/or the animal feeding apparatuses. One or more fresh air nozzles or openings may then be positioned at each feeding place and/or air outlet slots may be defined at least along one side of the partition walls.

According to another aspect the present invention provides an air renewing system for buildings for housing animals and having at least one elongated animal feeding apparatus extending through the inner space of the building, said system comprising an air inlet passage which extends through said feeding apparatus and which connects the inner space of the building to the ambient atmosphere at a plurality
of spaced locations or through an elongated, slot-like opening. Thus, the air inlet passage may communicate with the inner space of the building through one or more fresh air inlet or air outlet nozzles or openings, and one or more of these nozzles or openings may then be arranged at each feeding place of the feeding apparatus. The air renewing system may further comprise an inlet passage extending through a partition wall having one or more air inlet or outlet openings defined therein.

When the air renewing system is used in a building at a location, where the climate is cold it may be desirable to heat the fresh inlet air. Therefore, the system according to the invention may comprise heating means for heating the fresh air supplied to the air inlet passage or passages. Such heating means may be arranged in a fresh air supply duct common to a plurality of fresh air inlet passages so that the heating means may be common to all of the air inlet passages. In a preferred embodiment the fresh air supply duct is defined within an elevated inspection bridge extending transversely to and above the feeding apparatuses. In that case, neither the fresh air supply duct nor the fresh air inlet passage will take up extra space, because they are built into installations which are already present in the building. Alternatively, the supply duct may be arranged below the floor surface.

As mentioned above, the building in which the air renewing system according to the invention is installed may be used for housing pigs or other untethered animals. In such case the floor of the pig pen advantageously comprises an apertured first floor part or a grating through which manure may fall down into a manure-receiving channel defined therebelow. According to the present invention the said channel, which is preferably arranged at one end of the enclosure or pen, may then be used as an air inlet passage for supplying fresh air into the building, and the apertures in said first floor part may then define air inlet openings for supplying cool air into the said inner space or room of the building. It has been found that pigs and other animals are inclined to choose such cool and less comfortable parts of the pig pen as the place where they relieve themselves, and the remaining part of the floor may then be well heat insulated, and a heat
insulating, horizontal extending cover plate or wall, which is substantially impervious to air, may then be arranged above a second floor part remote from said first floor part.

As mentioned above, the air exhaust opening may define an inlet opening of the said air flow passage. When the building in which the air renewing system according to the invention is installed is for example a dwelling house, the air flow passage may be arranged or defined in a loft located above and separated from the said inner space or room by a ceiling. When air is caused to flow upwardly through the flow passage by heating the air therein, air is sucked from the inner space or room in the building. Due to the under-pressure created fresh air will flow into the room or space suitably located air supply openings.

The air exhaust opening, which is also the inlet opening for the air flow passage, may be provided in the ceiling of the said inner space or room. In case the building in which the air renewing system is installed has a cellar located below the building, air may be sucked into the inner space or room through an air inlet passage, which comprises the cellar. This means that the fresh air supplied to the inner space of the building will be cool air from the cellar.

According to a further aspect the present invention provides a building comprising a plurality of enclosures intended for housing animals and separated by partition walls which prevent mutual contact between animals housed in different enclosures, each enclosure being partly defined by at least one outer wall part of the building, at least one access opening being formed in this outer wall part. As each enclosure has its own individual access opening or door there are no common paths or routes which are passed by animals from different enclosures. This fact combined with the fact that the partition walls prevent mutual contact between animals in adjacent enclosures, effectively counteracts spreading of infection from animals in one enclosure to those in another.
The use of an air renewing system as that previously described further reduces the spreading of a possible infection, because fresh air will be supplied adjacent to the floor level, while air is exhausted at the top of the building, so that there will be no substantial air flow component in the longitudinal direction of the building.

It is usually desirable to have an opportunity to watch or inspect the animals in the various enclosures. Therefore, an inspection bridge may advantageously extend longitudinally through the building and be located above said partition walls. From such bridge the animals in the various groups may be watched or inspected without any risk of spreading infection from one enclosure to another.

The invention will now be described with reference to the drawings, wherein

Fig. 1 is a cross-sectional view of a building provided with an embodiment of the air renewing system according to the invention, and
Fig. 2 is a side view and partial sectional view of the building shown in Fig. 1,
Fig. 3 is a cross-sectional view of a building provided with a modified embodiment of the air renewing system according to the invention,
Fig. 4 is part of a longitudinally extending sectional view of the building shown in Fig. 3, and
Fig. 5 is a cross-sectional view of a dwelling house with an air renewing system according to the invention.

The building shown in Figs. 1 and 2, which is used for housing pigs 10, comprises a foundation 11 mainly located below ground level 12, heat insulated side and end walls 13 and 14, respectively, a ground wall 15, and a roof structure 16. The floor surface on which the pigs 10 walk around is the upper surface of a floor grating 17, which is located above and vertically spaced from the ground wall 15 so as to define manure receiving spaces 18 between vertical supporting walls 19 which extend between the ground wall 15 and the floor grating 17 for supporting the latter. A manure transporting device 20 may be arranged in each of the spaces 18 for scraping or pushing manure
from these spaces into a transversely extending common manure channel 21 located at one end of the building as indicated in Fig. 2, by means of a scraper 20b which is driven by an electric motor 20a. From this manure channel 21 the manure may be transported to a storage tank, a biogas producing system, or another manure treating plant as desired, by means of a conveyer screw 22, or another suitable transport device.

The floor space of the building shown in the drawings is divided into sections by means of transversely extending partition walls 23 (only one is shown in Fig. 2), which are preferably uniformly spaced along the length of the building. Each of these floor sections may be subdivided into pig pens 24 by means of feeding apparatuses 25 (only one is shown in Fig. 2), which extend parallelly with the partition walls 23. Such feeding apparatuses which should be accessible from both sides, are preferably of the type disclosed in Danish patent application No. 1501/84 filed on the 29th February, 1984 (corresponding to US patent application Serial No. 599 759).

A foot bridge or an inspection bridge 26 and associated hand rails 26a extend longitudinally through the building and is arranged above and supported by the partition walls 23. Steps 27 outside the building lead to a door (not shown), through which access to the bridge 26 may be gained, and doors 28 pivoted along their upper edges are mounted in at least one of the side walls 13 of the building so that each of the pens 24 has at least one door through which the pigs may arrive into and leave the pig pen.

A ventilating mechanism 29 is arranged along the ridge of the roof of the building and supported by struts 30 which are fastened to the upper part of the partition walls 23. The ventilating mechanism comprises a pair of elongated doors or shutters 31 each pivoted along its longitudinal edge so that the shutters are swingable between a closed position shown in solid lines in Fig. 1, and a more or less open position indicated by dotted lines in Fig. 1. The position of the doors or shutters 31 may be adjusted by means of an electric motor 32 having its driving shaft connected to a reciprocable actuating rod.
33 by means of an eccentric 34. The actuating rod 33 is operatively connected to a plurality of spaced linkages 35 adapted to move the doors or shutters between a fully closed and a fully open position when the actuating rod 33 is moved between its fully extended and its fully retracted position by means of the motor 32. It is understood that the motor 32 may be controlled manually or automatically, for example by temperature measuring means, so that the shutters 31 are closed or substantially closed when the temperature within the pig pens is below a predetermined first value, while the shutters are increasingly opened, when the temperature exceeds this value so as to be fully opened, when the temperature reaches a predetermined second value.

The roof structure 16 comprises longitudinally extending laths 36 and roofing plates 37 which are fastened thereto and define the outer roof surface. The roof structure also comprises an underlying, hanging, flexible layer 38 of a heat insulating material, whereby an air flow passage 39 is defined between the roofing plates 37 and the insulating layer 38. As indicated by arrows 40 air may flow into the passage 39 at the lower part of the lower roofing plates. When the sun is shining the roofing plates 37 will be heated and transfer heat to the air in the flow passage 39, whereby the air in the passage is caused to flow upwards and out through a plurality of outlet openings or outlet nozzles 41 (Fig. 2) formed by the corrugations of the roofing plates at the ridge of the roof. The flow of heated air thus directed upwardly through the ventilating openings 41 formed at the ridge of the roof when the shutters 31 are in an open position, generates a subatmospheric pressure within the ventilating opening 42 which communicates with the inner space of the building. Thus, when the ventilating shutters 31 are more or less open and when the roofing plates 37 are heated by the sun, air will flow continuously upwards through the flow passages 39 and create a suction effect or a subatmospheric pressure at the inner side of the ridge of the roof along substantially the total length of the building.

Each feeding apparatus 25 defines therein air inlet ducts 43 and 44. Each of these ducts extends transversely between the oppositely
arranged side walls of the building, and each end of the duct 43 communicates with an air inlet opening 45 formed in the adjacent side walls 13, while each end of the duct 44 communicates with an air inlet opening 46 formed in the adjacent side wall. Each of the air inlet openings 45 and 46 may be closed selectively by means of doors, dampers, valves, or other suitable closing means, not shown. Air outlet openings or nozzles 49 are distributed along both sides of the air inlet duct 43, and at least one nozzle or opening, which may, for example, be in the form of a longitudinally extending slit or slot, is preferably arranged at each feeding place of the feeding apparatus 25. When subatmospheric pressure is generated at the inner side of the ridge of the roof as described above, fresh air is sucked through the air inlet openings 45, the air inlet duct 43 and out into the pig pens through the air outlet openings 49 as indicated by means of arrows in Fig. 2. This means that the fresh air which is sucked into the building, is well distributed over the total floor area so as to avoid draught. As warm, used air is simultaneously flowing out through the ventilating opening 42 due to the ejector effect previously described, air will flow continuously from the floor area upwardly to the ventilating opening 42, and the curved shape of the hanging roof layer 38 counteracts turbulence in the flow.

In order to cool the fresh air flowing into the building through the air inlet openings 45, each of these openings may contain a water evaporizer, such as a water atomizer, or a liquid absorbing, air penetrable material, such as a fibrous paper material 45a. This material may then be continuously wetted, for example by continuously supplying water thereto from a water supply tube (not shown), and the inflowing air will then be cooled due to evaporation of water, when the air passes the water absorbing material. If desired, the air inlet openings 45 at the windward side may be closed so that only the inlet openings at the lee side are kept open.

At winter time and in cold weather the air inlet ducts 44 may be used instead of the air inlet ducts 43. In that case all of the air inlet openings 45 are closed and all of the air inlet openings 46 are kept open, at least at the lee side of the building. Air flowing into the
duct 44 at least through the inlet opening 46 at one end thereof may leave the duct 44 through air outlet openings or nozzles 50 as indicated in Fig. 2.

If the building is at a geographic location with a cold climate it may be necessary to heat the inflowing fresh air at least in winter time. In that case a longitudinally extending air inlet duct 51 may be defined in the inspection bridge 26 as indicated by dotted lines in Fig. 1. Warm, fresh air, which may have been heated by means of a heat exchanger, an electric heating device or the like may then flow through the duct 51 from which it may be distributed to all of the ducts 43 or 44.

Figs. 3 and 4 show a building corresponding to that shown in Figs. 1 and 2, wherein a modified embodiment of the air renewing system according to the invention has been installed. Parts and components of the building and air renewing system shown in Figs. 3 and 4 corresponding to the parts and components of the embodiment shown in Figs. 1 and 2 have been designated by the same reference numerals.

The air renewing system shown in Figs. 3 and 4 comprises a hinged door or shutter 52 arranged below the eaves at each side of the building. Each door 52 is hinged to the adjacent side wall 13 of the building so as to be swingable between a first position shown in solid lines and a second position shown in dotted lines in Fig. 3. In the said first position the walls 52 defines a space 53 below the eaves 54 of the building, and this space is in communication with the flow passage 39 and with the inner space of the building through an opening 55. In their said second position the doors 52 closes the openings 55, and the spaces 53 under the eaves and, consequently, also the flow passages 39 will then be in communication with the ambient atmosphere.

In Fig. 3 a modified embodiment of the ventilating mechanism 29 is shown. The hinged doors or shutters 31 may be moved between an open position shown in solid lines and a closed position shown in
dotted lines in Fig. 3. A rotatably mounted driving shaft 56 extends parallelly with the hinges 57 of the doors 31, and a pair of pivots 58 are mounted on the shaft 56 and located in spaced relationship to the axis of the shaft. As shown in Fig. 3, the pivots 58 may be mounted on a triangular driving element 59 fixed on the shaft 56. The pivots 58 on the driving element 59 are connected to pivots 60 on the doors 31 by means of links 61, and the arrangement of the pivots in relation to the shaft 56 is such that the links 61 extend substantially radially from the axis of the shaft, when the doors 31 are in their fully opened position. As the doors 31 are elongated and normally extend along the length of the roof, a plurality of driving elements 59 and associated links 61 may be arranged at axially spaced positions along the length of the shaft 56. The ventilating mechanism 29 may be operated by rotating the shaft 56, for example by means of a hydraulic or a pneumatic cylinder. Alternatively, the shaft may be rotated by means of an electric motor through a suitable gear mechanism, or by any other suitable driving means.

The partition walls 23 may be hollow so as to define air flow passages 62 (Fig. 4) therein, and slot-like air inlet and/or outlet openings 63 may be defined on both sides of each partition wall and may extend along the length thereof. The air flow passage 62 defined in the partition wall 23 is in communication with the ambient atmosphere through openings (not shown) in the side walls 13 of the building, and a blower or ventilator 64 for providing an air flow through the flow passage 62 may be arranged at each such opening. In order to prevent air flow through the passage 62 due to an incidental pressure difference between the opposite sides of the building, the flow passage 62 may be divided by a central, transverse wall (not shown). The air flow passages or ducts 43 and 44 defined within the feeding apparatuses 25 may similarly be provided with flowers or ventilators 65 and with a transverse wall (not shown).

In the building shown in Figs. 3 and 4, a manure channel 18 is defined only along one side of the building, and only the floor part above that channel is a floor grating. A heat insulating, substantially horizontally extending cover plate or wall 66 is arranged immediately
above the feeding apparatuses 25 at the other side of each pig pen 24 opposite to the manure channel 18. The manure channel 18 may be used as fresh air supply duct so that cold fresh air flows upwardly through the floor grating 17. Thus, the part of the floor formed by the grating 17 will be a cold, less comfortable place, while the place below the heat insulating cover plate 66 will be warm and comfortable. This has the effect that the pigs 10 will tend to choose the floor grating 17 as the place, where they relieve themselves, while they tend to sleep and rest below the cover plate 66.

The air renewing system described above with reference to Figs. 3 and 4 may function as follows:

In winter time and under other cold climatic conditions, the doors 31 of the ventilating mechanism 29 are closed, and the doors 52 below the eaves 54 are in the position shown in dotted lines in Fig. 3. When air is exhausted from the air flow passages defined within the partition walls 23 and/or the feeding apparatuses 25 by means of the ventilators or blowers 64 and 65, the subatmospheric pressure created within the building causes fresh, cold air to flow into the space 53, through the passage 39 and downwards through the ventilating opening 42. The function of the blowers 64 and 65 may be controlled by a computer or by another control system (not shown) in response to signals from a temperature sensor, which may, for example, be placed adjacent to the flowers or at suitable positions within the pig pens, whereby the temperature within the building may be kept at a substantially, constant, desired level.

When the outdoor temperature rises to such a level that it is not possible to keep the temperature within the building or pig pen at the desired level by increasing the efficiency of the ventilators, the computer or control device activates the cylinder or motor of the ventilating device 29 so that the doors 31 are opened completely or partly, and at the same time the doors 62 are moved to the position shown in solid lines in Fig. 3. Air will now be drawn from the inner space of the building through the opening 55 and flow upwards through the passage 39, past the ventilating opening 42, and out into
the atmosphere. Air will also be sucked from the inner space of the building out into the atmosphere through the ventilating opening 42 due to the ejector effect as previously described. Fresh air may now flow into the flow passages defined within the partition walls 23 and the feeding apparatuses 25 and out through the outlets 63 and 49. The position of the doors 31 of the venting mechanism 29 may be controlled by the computer in response to signals from a temperature sensor, which may, for example, be placed below the inspection bridge so that the temperature within the pig pen may be maintained at the desired level. If the doors 31 have been fully opened, and the temperature within the building continues to rise, the blowers 64 and 65 may be started by the computer so that they accelerate the flow of fresh air into the flow passages defined within the partition walls 23 and the feeding apparatus 25. Additionally, fresh air may be supplied through the manure channel 18 as previously described.

Fig 5 shows a further modification of the air renewing system according to the invention installed in a building of the type having a loft 70 defined by the roofing plates 37 and a ceiling 71. The hanging flexible layers 38 are arranged within the loft 70 so that the air flow passages 39 are also defined within said loft. Grids 72 arranged in the ceiling 71 or other suitable openings therein define inlets of the air flow passages 39 and air exhaust openings for exhausting air from a dwelling room 73 defined by the side walls 13, the ceiling 71 and a floor 74. The dwelling room 73 is in communication with a cellar 75 through air supply openings 76 formed in the floor 74, for example by a grid mounted in the floor wall. Air may flow from the ambient atmosphere and into the cellar 75 through air inlet wells 77.

When the air within the air flow passage 39 is heated by the sun or by the ambient atmosphere upwardly directed air flows are generated within the passages 39. This causes air to be sucked from the dwelling room 73 through the grids 72, and the outflowing air will be replaced by fresh air from the ambient atmosphere flowing through the air inlet wells 77 and the cellar 75 and into the dwelling room 73 by the air supply openings 76. Thus, ventilating airflows through the dwelling room 73 will be created as indicated by arrows in Fig. 5.
In time periods, for example at night, where air within the passages 39 is not sufficiently heated, the desired ventilation may be obtained by means of motor driven ventilators 78, which may, for example, be positioned at the inlet ends of the air flow passages 39 and/or in the air inlet wells 77 as shown in Fig. 5. Furthermore, an evaporating device for cooling and humidizing the fresh air, which is introduced into the dwelling room 73 may be provided. This evaporating device may comprise a water atomizer and/or a liquid absorbing air penetrable material 79, such as fibrous paper material. This material may then be continuously wetted, for example by continuously supplying water thereto from a water supply tube 80, and the inflowing air will then be cooled due to evaporation of water, when the air passes the water absorbing material.

It should be understood that various changes and modifications of the embodiment described above with reference to the drawings may be made within the scope of the present invention. Thus, for example, the ventilating system described could be used in connection with buildings for other purposes, and the air inlet ducts 43 and 44 could then be dispensed with so that air is sucked directly into the building through inlet openings formed in the side and/or end walls of the building. Alternatively, air inlet ducts could be arranged within the building in any other desired manner than that described above. Furthermore, when the building is at a location with a very hot climate, the side walls 13 may totally or partly be replaced by curtain-like walls pervious to air. Such curtains may be supported by a grid-like wall structure.
CLAIMS

1. A method of renewing air in an inner space or a room of a building, said method comprising generating a flow of air through at least one upwardly extending air passage by heating the air therein, and directing said air flow into the ambient atmosphere and past or through at least one air exhaust opening which communicates with said room, so as to create a subatmospheric pressure at said opening.

2. A method according to claim 1, wherein the air in said passage is heated by the sun and/or the ambient atmosphere.

3. A method according to claim 2, wherein the air passage is defined between heat conducting roofing plates and an underlying layer, which may comprise a heat insulating material.

4. A method according to any of the claims 1-3, wherein said air passage and said exhaust opening extend along substantially the total length of the building.

5. A method according to any of the claims 1-4, wherein the lower end of said upwardly extending air passage communicates with said inner space or room.

6. A method according to any of the claims 1-4, wherein the lower end of said upwardly extending air passage communicates with the ambient atmosphere.

7. An air renewing system for a building and comprising an air flow passage defined within or adjacent to the roof of the building and extending from a lower end located at or adjacent to the eaves of the building to an upper end located at or adjacent to the top of the roof of the building, first valve means arranged at said lower end for selectively connecting that end of the flow passage with the inner space of the building or with the ambient atmosphere, and second valve means arranged at said upper end of the flow passage for selectively connecting the upper end of the flow passage with the
ambient atmosphere, the upper end of the flow passage being connected to the inner space of the building.

8. An air renewing system for a building and comprising at least one air exhaust opening communicating with an inner space or a room in said building, and at least one upwardly extending air flow passage defined within or adjacent to the roof of the building, and having at its upper end at least one air outlet which communicates with the ambient atmosphere, the air outlet and the air exhaust opening being such interrelated that an air flow passing upwards through the flow passage causes air to flow out from said inner space or room through the exhaust opening.

9. An air renewing system according to claim 8, wherein the air outlet of the air flow passage is positioned adjacent to the exhaust opening so that an air flow passing upwards through the flow passage is directed into or past said exhaust opening so as to create a sub-atmospheric pressure in the exhaust opening.

10. An air renewing system according to any of the claims 7-9, wherein the air flow passage is defined between roofing plates of a heat conducting material and an underlying layer of a heat insulating material.

11. An air renewing system according to any of the claims 7-10, wherein the air flow passage and the air exhaust opening extend along substantially the total length of the building.

12. An air renewing system according to any of the claims 8-11, wherein the roof of the building is formed by corrugated roofing plates and the upper end of said flow passage is defined by the corrugations of the upper roofing plates.

13. An air renewing system according to claim 8, wherein the air outlet of the air flow passage and the air exhaust opening are located at the ridge of the roof of the building.
14. An air renewing system according to claim 8 or 13, wherein said air flow passage comprises an air inlet communicating with said inner space or room and/or the ambient atmosphere.

15. An air renewing system according to claim 14, wherein said air flow passage comprises a first air inlet communicating with the ambient atmosphere and a second air inlet communicating with said inner space or room, said air renewing system further comprising valve means for selectively closing said first or said second inlet.

16. An air renewing system according to claims 14 or 15, wherein said air inlet or inlets is/are located immediately below the eaves of the building.

17. An air renewing system according to any of the claims 7-16, further comprising at least one fresh air inlet and/or an air outlet passage extending transversely within the space or room of the building.

18. An air renewing system according to claim 17, wherein the air inlet passage comprises an inlet end with a porous water absorbing medium arranged therein.

19. An air renewing system according to claim 18, further comprising water supply means for continuously or intermittently supplying water to said porous medium.

20. An air renewing system according to any of the claims 17-19, wherein the fresh air inlet and/or an air outlet passage is defined within a partition wall arranged in said space or room.

21. An air renewing system according to claim 20, wherein an air inlet or outlet slot communicating with the fresh air inlet or air outlet passage is defined at least along one side of the partition wall.

22. An air renewing system according to any of the claims 17-21, wherein said fresh air inlet or air outlet passage is defined within an animal feeding apparatus arranged within said inner space or room.
23. An air renewing system according to claim 22, wherein said feeding apparatus comprises a plurality of separate, spaced feeding places, one or more fresh air nozzles or openings communicating with the fresh air inlet passage being positioned at each feeding place.

24. An air renewing system according to any of the claims 8-23, further comprising valve means for controlling the communication between the ambient atmosphere and said exhaust opening and/or said air outlet of the flow passage and control means for controlling the valve means in response to the temperature of said inner space or room.

25. An air renewing system according to any of the claims 17-23, further comprising reversible air propelling means for causing an air flow in said fresh air inlet and/or outlet passage in a desired direction.

26. An air renewing system according to claims 24 and 25, wherein said control means are adapted to control the function of said air propelling means in response to the temperature in the inner space or room.

27. An air renewing system for a building for housing animals and having at least one elongated animal feeding apparatus extending through the inner space of the building, said system comprising an air passage which extends through said feeding apparatus and which connects the inner space of the building to the ambient atmosphere.

28. An air renewing system according to claim 27, wherein the air passage communicates with the inner space of the building through a plurality of fresh air inlet or air outlet nozzles or openings, one or more of these nozzles or openings being arranged at each feeding place of the feeding apparatus.

29. An air renewing system according to claim 27 or 28, and further comprising heating means for heating fresh air supplied to the air passage or passages.
30. An air renewing system according to claim 29, wherein the heating means are arranged in a fresh air supply duct common to a plurality of air passages.

31. An air renewing system according to claim 30, wherein the fresh air supply duct is defined within an elevated inspection bridge extending transversely to and above said feeding apparatuses.

32. An air renewing system according to any of the claims 27-31, further comprising an air passage extending through a partition wall having defined therein one or more air inlet or outlet openings, which is/are connected to the ambient atmosphere by said air passage.

33. An air renewing system according to any of the claims 27-32, further comprising air propelling means for propelling air through said air passage, and means for selectively reversing the air flow generated by said propelling means.

34. An air renewing system according to any of the claims 7-33, and comprising a manure receiving channel covered by an apertured first floor part, said channel defining an air inlet passage, and the apertures in said floor part defining air inlet openings for supplying cool air into said inner space or room of the building.

35. An air renewing system according to claim 34, wherein a heat insulating horizontally extending cover plate or wall, which is substantially impervious to air, is arranged above a second floor part remote from said first floor part.

36. An air renewing system according to any of the claims 8 and 10-12, wherein the air exhaust opening defines an inlet opening of said air flow passage.

37. An air renewing system according to claim 36, wherein the air flow passage is defined in a loft located above and separated from said inner space or room by a ceiling.
38. An air renewing system according to claim 37, wherein the air exhaust opening is defined in said ceiling.

39. An air renewing system according to any of the claims 36-38, further comprising an air inlet passage for said inner space or room extending through a cellar located below the building.

40. A building comprising a plurality of enclosures intended for housing animals and separated by partition walls which prevent mutual contact between animals housed in different enclosures, each enclosure being partly defined by at least one outer wall part of the building, at least one access opening being formed in this outer wall part.

41. A building according to claim 40 and having an elongated ground plan, said partition walls extending transversely in the building.

42. A building according to claim 40 or 41, wherein an inspection bridge extends longitudinally through the building and is located above said partition walls.

43. A building according to any of the claims 40-42, wherein at least some of the partition walls are constituted by or include a feeding apparatus.

44. A building according to any of the claims 40-43 and comprising an air renewing system according to any of the claims 7-35.

45. A ventilating mechanism to be arranged for example at the top of the roof of a building and comprising a pair of substantially parallelly extending doors hinged at opposite sides so as to be swingable in opposite directions from a closed to an open position and vice versa, a rotatably mounted driving shaft extending parallelly with the hinges of the doors, a pair of pivots arranged on said shaft radially spaced from the axis thereof, and a pair of link members interconnecting a pivot on either one of said doors and a respective pivot of said pair of pivots on the shaft, said links extending substantially radially from the axis of the shaft in the fully open position of the doors.
## International Search Report

**International Application No:** PCT/DK86/00060

### I. Classification of Subject Matter

According to International Patent Classification (IPC) or to both National Classification and IPC:

- F 24 F 5/00, E 04 H 5/00

### II. Fields Searched

**Minimum Documentation Searched**

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<td>E 04 H 5/00, /08; F 24 F 5/00, 7/00, /02- /08, 13/08, /10, /14</td>
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<tr>
<td>Nat Cl</td>
<td>36d: 6/05; 37f: 2/01</td>
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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched

- SE, NO, DK, FI classes as above

### III. Documents Considered to be Relevant

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- “A” document defining the general state of the art which is not considered to be of particular relevance
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- “O” document referring to an oral disclosure, use, exhibition or other means
- “P” document published prior to the international filing date but later than the priority date claimed

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**X** document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

**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.

**A** document member of the same patent family

### IV. Certification

- **Date of the Actual Completion of the International Search:** 1986-09-10
- **Date of Mailing of this International Search Report:** 1986-09-15

International Searching Authority: Swedish Patent Office

Signature of Authorized Officer: Nils Åke Axelsson

*BAD ORIGINAL*
II Fields Searched (cont).

US Cl 98:42

V. OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. Claim numbers ............ because they relate to subject matter not required to be searched by this Authority, namely:

2. Claim numbers ............ because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claim numbers ............ because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This International Searching Authority found multiple inventions in this international application as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. As all searchable claims could be searched without effort justifying additional fee, the International Searching Authority did not invite payment of any additional fees.

Remark on Protest:

- The additional search fees were accompanied by applicant's protest.
- No protest accompanied the payment of additional search fees.
### III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

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