July 6, 1965 C. J. BRESSOUD 3,193,000

UNIT VENTILATOR

Filed Nov. 10, 1961 2 Sheets-Sheet 1

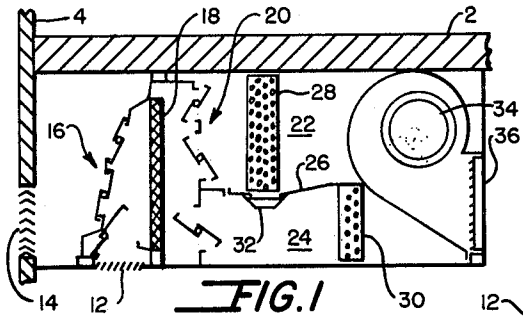


FIG. 1

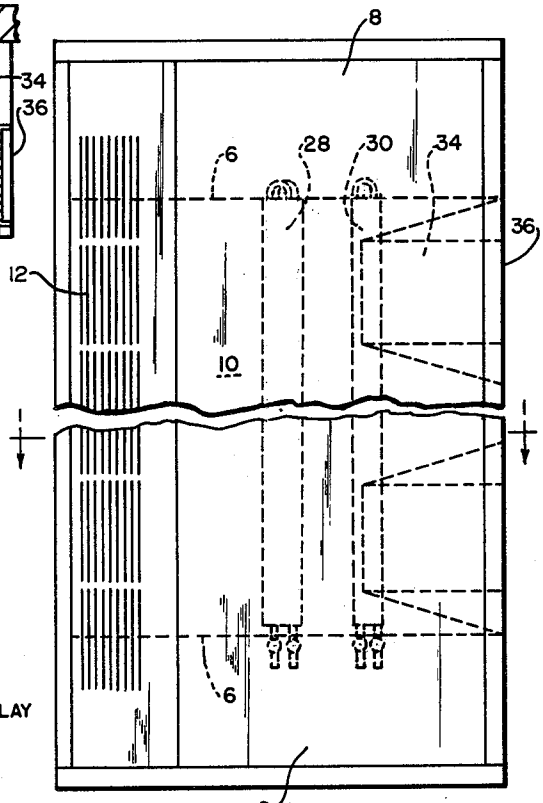


FIG. 2

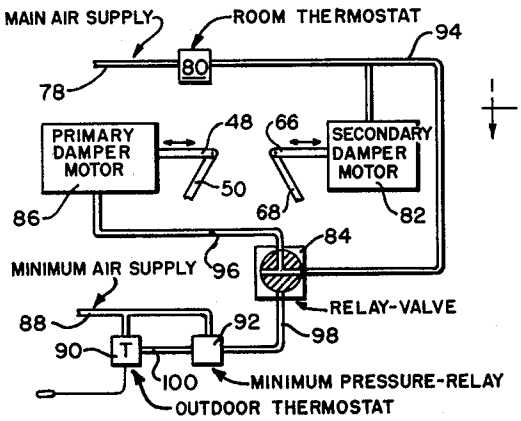
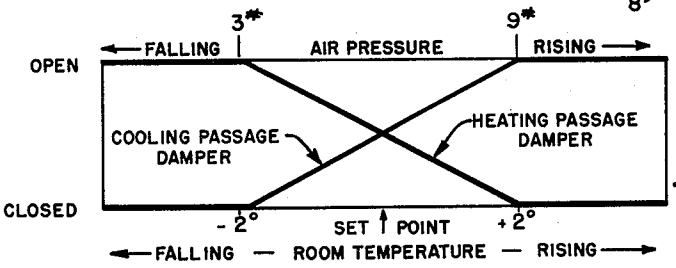
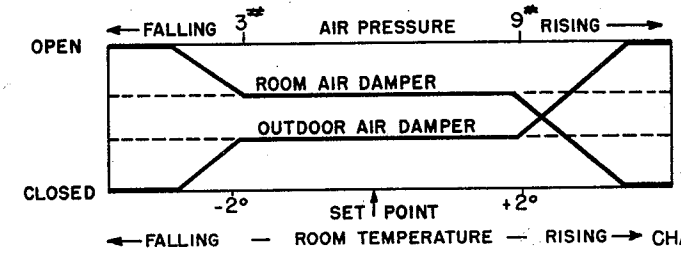


FIG. 5



SECONDARY DAMPER MEANS OPERATION

FIG. 7



PRIMARY DAMPER MEANS OPERATION

FIG. 6

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UNIT VENTILATOR

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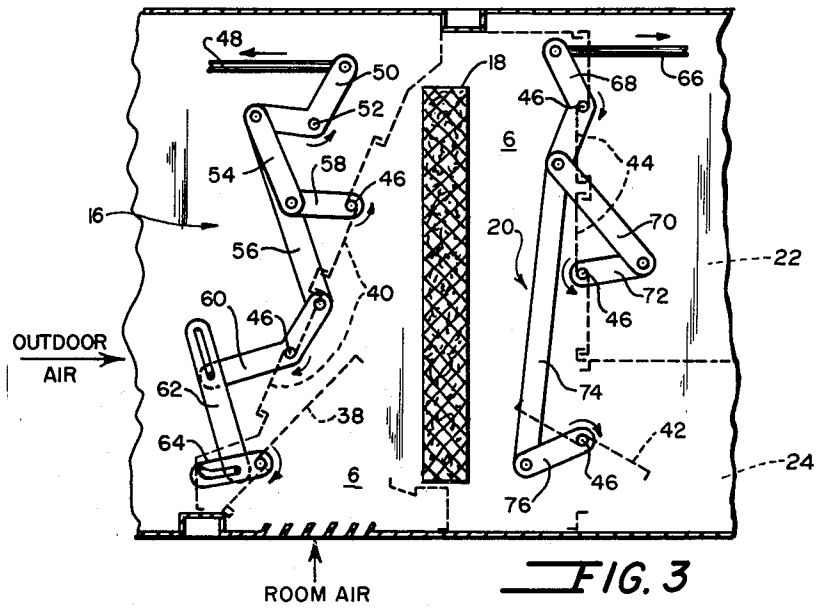

FIG. 3

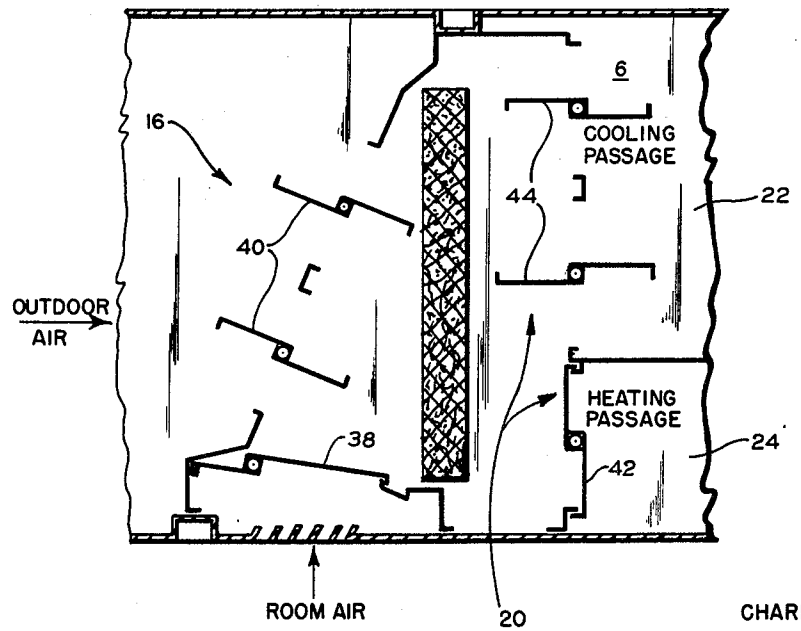

FIG. 4

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UNIT VENTILATOR

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6 Claims. (Cl. 165—16)

This invention relates to room unit ventilators of the type which can mechanically cool air as well as heat it, and which also use outdoor air to ventilate and naturally cool a space.

Unit ventilators which cool air by passing it through a heat exchanger or coil to which chilled water is supplied have been in use for some time. These unit ventilators are characterized as being capable of providing mechanical cooling although they also provide natural cooling during the heating season by admitting outdoor air which is cooler than room air. They normally have a single coil selectively receiving either a heating or a cooling medium. Consequently they are limited to providing heated air or naturally cooled air during the periods when a heated tempering medium is supplied to the coil, and to providing mechanically cooled air when a chilled tempering medium is supplied. Since the heating and cooling loads encountered in different rooms having units on a common piping circuit may be quite different during certain periods, the ability of some of the units to provide air of the proper temperature is precluded during these periods. In other words, on some days some rooms may require heating part of the time while others require a degree of cooling which is not available by the use of outside air alone.

Thus, an object of this invention is to provide a unit ventilator which has a double coil arrangement so that at certain times the unit can either heat or cool the air as needed.

Another object is the provision of a damper system for such a unit ventilator.

Accordingly, the unit ventilator embodying this invention includes separate interior heating and cooling passageways with a heat exchanger in each, primary damper means which controls the ratio of room air to outdoor air admitted to the unit, and secondary damper means which controls what part of the admitted air is directed through one or the other of the interior passageways. With this arrangement, the secondary damper means are operated as face and bypass dampers with no requirement that operation of these dampers be reversed during one season as contrasted to another season. That is, irrespective of whether a heating medium, a chilling medium, or both are supplied, the secondary damper means operate in one direction in response to a rise in room temperature, and in the opposite direction in response to a fall in room temperature. Thus during a transitional season with both a heating and a cooling medium being circulated to each unit ventilator, the effectiveness of the unit ventilator in maintaining a desired room temperature with changing heating and cooling loads is enhanced since the air which bypasses one heat exchanger has its temperature changed in the opposite direction by the other heat exchanger. Further, the unit ventilator embodying the invention retains all of the advantages inherent in conventional unit ventilators such as the ability to use outdoor air to the fullest extent possible for natural cooling.

One embodiment of the invention, by way of example, is illustrated in the accompanying drawings wherein:

FIGURE 1 is a somewhat diagrammatic vertical sectional view of a ceiling mounted unit ventilator embodying the invention, the section corresponding to one taken along the line 1—1 of FIGURE 2;

FIGURE 2 is a bottom view of the unit of FIGURE 1;

FIGURE 3 is a fragmentary side view of that part of the unit containing the dampers and damper linkage with the primary damper means shown in a position closed to outdoor air and the secondary damper means shown in a position to direct all of the admitted air through the heating coil;

FIGURE 4 is a view similar to FIGURE 3 but with the damper linkage deleted and the primary and secondary damper means in positions opposite to those shown in FIGURE 3;

FIGURE 5 is a simplified schematic view of one pneumatic temperature control system for automatically controlling damper operation in response to space temperature variations; and

FIGURES 6 and 7 are graphs illustrating the positions of the primary damper means and secondary damper means under one common cycle of operation with various temperatures in the conditioned room.

Referring to the drawing, in FIGURE 1 a unit ventilator embodying the invention is shown in mounted position with its upper side against a ceiling 2 and its air inlet end against an exterior wall 4 of the room.

In certain respects the unit is of conventional construction. Thus, the interior of the unit is divided by partitions 6 (FIGURE 2) into a pair of opposite end compartments 8 and a central compartment 10 through which the air passes. The end compartments provide space for the fan motor, piping connections, and automatic temperature control components, none of which are shown. At the left of air inlet end or the central compartment as viewed in FIGURE 1, room air and outdoor air are admitted in controlled proportions through bottom panel grille 12 and louvered inlet 14 respectively.

Those parts of the unit in the central compartment will now be considered in order from left to right in FIGURE 1. The primary damper means 16 controls the ratio of room air admitted to outdoor air admitted. The admitted air then passes through an air filter 18. The secondary damper means 20, at the inlet end of an upper air passage 22 and a lower air passage 24 formed by the horizontally extending partition 26, controls the admission of the filtered air to the passages. The upper passage contains a coil 28 adapted to receive a cooling medium only, while a coil 30 adapted to receive a heating medium only is disposed in the lower passage.

The upper passage 22 will hereafter be referred to as the cooling passage, and the lower passage 24 will be referred to as the heating passage, although it will be understood that each passage will at times function simply as a bypass passage when it is not supplied with a tempering medium. The cooling passage is somewhat larger in cross-sectional area than the heating passage to obtain a substantially balanced air flow resistance between the two passages. It is also noted that the heating passage rather than the cooling passage is adjacent the finished front panel of the unit ventilator cabinet so that the possibility of chilling the front panel and thus causing condensation thereon is avoided.

A drip pan 32 underlies the cooling coil 28 to receive condensate therefrom. Details of this drip pan are shown in Millman U.S. application S.N. 97,587 now U.S. Patent 3,102,654, and will not be described in detail herein. Several spaced centrifugal fans 34 draw the air into and through the unit, and then discharge it into the room through outlet grilles 36.

One linkage arrangement suitable for controlling the primary and secondary damper means is shown in FIGURE 3. The primary damper means 16 includes a balanced room air damper 38 and a pair of outdoor air dampers 40 linked to move together. The secondary

damper means 20 includes a damper 42 at the inlet to the heating passage 24, and a pair of dampers 44 linked to move together at the inlet to the cooling passage 22. Each damper is mounted upon its particular shaft 46 which extends through the central compartment and is journalled adjacent its ends in the partitions 6 dividing the central and end compartments so that the dampers can be rotated by turning that end of its shaft protruding into the end compartment.

The connecting linkage for the primary damper means and its operation is described in some detail in Millman U.S. application S.N. 135,341 and will thus be only briefly described herein. A force from the damper operator moving rod 48 to the left at the upper end of the primary damper linkage will cause bell crank 50 to rotate in a counterclockwise direction around fixed pivot point 52 and thus move the outdoor air dampers 40 toward an open position through link 54 and longer link 56 rotating crank 58 and bell crank 60 respectively, each of the latter being fixed to its respective damper shaft 46. The rotation of bell crank 60 permits room air damper 38 to re-position itself toward a closed position (as described in the last-noted Millman application) through slotted link 62 and slotted crank 64 fixed to the room air damper shaft.

The connecting linkage for the secondary damper means is operated from its FIGURE 3 illustrated position by a force from the damper operator moving rod 66 to the right so that bell crank 68 rotates clockwise and link 70 pulls crank 72 counterclockwise. Thus the cooling passage dampers 44 are moved toward an open position since their shafts are fixed for rotation with bell crank 68 and crank 72. Heating passage damper 42 is simultaneously moved toward a closed position by the generally upward motion of long link 74 and clockwise rotation of crank 76 fixed to the damper 42.

FIGURE 3 illustrates the dampers and damper linkage in one extreme position while FIGURE 4 illustrates the dampers in an opposite extreme position. When the dampers are in the FIGURE 4 position, movement of the rods 48 and 66 in the direction opposite to that heretofore noted will result in movement of the dampers back toward their FIGURE 3 position.

One pneumatic temperature control arrangement, by way of example, for controlling the dampers in accordance with temperature variations within the served room is shown in FIGURE 5. The arrangement of FIGURE 5 includes: a main air supply line 78; a room thermostat 80; a secondary damper means operator or motor 82; a relay-valve device 84; a primary damper means operator or motor 86; a minimum pressure air supply line 88; a thermostat 90 responsive to outdoor temperatures; a minimum pressure relay 92; and a series of branch lines 94, 96, 98, 100, connecting certain of the elements.

The general mode of operation of the FIGURE 5 arrangement will now be described in connection with the graphs of FIGURES 6 and 7. The ordinates of each graph indicates the extent of damper opening. The lower abscissas indicate room temperature variations and the upper abscissas the corresponding air pressure variations. Under all conditions the secondary damper motor will receive air pressure directly from the room thermostat while the primary damper motor will, under certain conditions, have an air pressure reflecting conditions other than the room temperature only. Specifically, when the relay 84 is in its illustrated position directly connecting lines 94 and 96, the pressure at both damper motors will be the same. However, when the relay 84 is actuated to its other position, the secondary damper motor will be controlled by the direct acting room thermostat 80 (increasing temperature passes an increasing pressure), while the primary damper motor will have a constant pressure from the minimum air pressure supply line 88.

It will be first assumed that relay-valve 84 is in the position shown in FIGURE 5 so that it passes the same pressure to primary damper motor 86 through line 96 as is imposed on secondary damper motor 82. Beginning with a room temperature below the set point temperature, as the room temperature rises as indicated along the lower abscissa a correspondingly rising air pressure is passed by the room thermostat as indicated along the upper abscissa. When the operating air pressure range to which the damper motors are set is reached, the outdoor air damper begins to open as shown in FIGURE 6 to a minimum outdoor air position which is maintained so long as the room temperature and air pressure remain within predetermined limits. For example, the primary damper motor may be set to maintain a minimum outdoor air position when it receives air pressure within the range of 3–9 p.s.i. with this air pressure range corresponding to room temperature variations of, say, plus and minus 2° from the set point, and the secondary damper motor may be set to move the heating and cooling passage dampers between their extreme positions in the same range of air pressures. Thus with 3 p.s.i. to both damper motors the outdoor air damper is positioned to admit a predetermined minimum percentage of outdoor air, the cooling passage damper is closed and the heating passage damper is fully open.

Then as the room temperature rises to the set point, the air pressure correspondingly rises to 6 p.s.i. so that the damper motors cause the heating and cooling passage dampers to each assume a half open position while the outdoor air damper remains at the minimum percentage of outdoor air position. At 9 p.s.i. the heating passage damper is fully closed and the cooling passage damper is fully open with the outdoor air damper still at a position admitting the minimum percentage of outdoor air. Upon a further rise in room temperature and a corresponding rise in air pressure, the outdoor air damper opens beyond the minimum percentage of outdoor air position to permit the admission of additional outdoor air for cooling. It will be observed from FIGURE 6 that the room air damper positions itself reversely relative to the outdoor air damper position so that as the admission of outdoor air increases, admission of room air decreases, and vice versa.

The operation thus far described is normal during the heating season when a heating medium is supplied to the heating coil 30 and no cooling medium is being circulated to the cooling coil 28. In this case the secondary damper means operates essentially as face and bypass dampers so that the ability to cool the served room when it becomes overheated is restricted to the admission of outdoor air up to 100%. During the periods when some rooms may require heat and other rooms may require a degree of cooling not available with outside air, both a heating and a cooling medium may be circulated to the respective coils. The control operation will be the same under this condition, but it will be appreciated that air passing through the cooling passage will not simply be bypass air without any temperature change, but instead will have its temperature lowered by the cooling coil.

During the cooling season a cooling medium only is circulated to the units. Again referring to FIGURE 5, the outdoor air thermostat 90 responds to outdoor temperatures above a predetermined value and through branch line 100 actuates the minimum pressure relay 92 to pass the minimum pressure of 3 p.s.i. from supply line 88 to line 98 connected to relay-valve 84. This causes relay 84 to be actuated to a position directly connecting lines 98 and 96 and dead ending line 94. Thus the primary damper motor 86 maintains the outdoor air damper in the minimum percentage outdoor air position in response to the constant 3 p.s.i. air pressure (as indicated by the broken line extension of FIGURE 6), and is independent of variations in air pressure in line 94 and secondary damper motor 82 reflecting room temperature variations at the thermostat 80. However, the cooling and heating passage dampers respond in the same way as previously described. That is, with a rising room temperature within the described limit, the heating passage

damper moves toward a closed position and the cooling passage damper moves toward an open position, and vice versa. Consequently, it will be appreciated that irrespective of the temperature character of the medium being circulated, the secondary damper means operates in the same way.

While the control system has been described in terms of a pneumatic arrangement, other systems such as electric and electronic may be used instead. Further, the control system may be arranged to provide cycles other than the described one wherein a minimum percentage of outdoor air is provided, and other conventional variations in control arrangements may be employed. In that connection, valve control of the heating medium may be employed, an airstream thermostat may be used and connected to branch line **96**, the heating medium temperature may be reset in accordance with outdoor air temperatures, other means than the relay arrangement and outdoor thermostat may be used to limit opening of the outdoor air damper during periods of chilled water circulation only, and a camming linkage of the character described in Millman U.S. Patent 2,971,450 may be used to obtain operation of both the primary and secondary damper means with a single damper motor.

I claim:

1. In a room unit ventilator including a cabinet having a room air inlet and an outdoor air inlet, an air outlet, and blower means for inducing the flow of air through said cabinet:

(a) primary damper means movable in a range between one extreme position blocking said room air inlet and an opposite extreme position blocking said outdoor air inlet;

(b) means forming a separate cooling passage and a separate heating passage between said air inlets and said air outlet, each passage having a heat exchanger therein adapted to selectively receive a tempering medium of the character of the passage with said heat exchangers at times simultaneously receiving their respective tempering mediums;

(c) secondary damper means at the inlet end of said passages movable in a range between one extreme position blocking said cooling passage and an opposite extreme position blocking said heating passage;

(d) means operating said primary damper means throughout said range in accordance with departures in room temperature from a desired temperature when said heating passage heat exchanger is receiving a tempering medium, and restricting operation of said primary damper means to a part of said range limiting admission of outdoor air when only said cooling passage heat exchanger is receiving a tempering medium;

(e) and means operating said secondary damper means toward said one and said opposite extreme position to vary in proportioning fashion the air directed through said separate passages in response to departures of said room temperature respectively below and above said desired temperature, irrespective of whether both or only one of said heat exchangers is receiving a tempering medium.

2. In a room unit ventilator including a cabinet having a room air inlet and an outdoor air inlet, an air outlet through which air is discharged into said room, and blower means for inducing the flow of air through said cabinet:

(a) primary damper means displaceable through a range between opposite positions admitting all outdoor air and alternatively all room air to said cabinet;

(b) partition means separating a part of said cabinet interior into separate air heating and air cooling passages containing heat exchangers adapted to selectively receive a heating medium and a cooling medium respectively with said heat exchangers at times simultaneously receiving their respective tempering mediums;

(c) secondary damper means displaceable through a range between opposite positions blocking passage of said admitted air through said heating passageway and alternatively through said cooling passageway;

(d) means controlling said primary and secondary damper means in accordance with the character of the tempering medium supplied to said heat exchangers and in accordance with departures in room temperature from a desired temperature, including

(e) means opearting said primary damper means throughout the entire range in accordance with variations in a room temperature when a heating medium only is supplied to said unit ventilator, and in a range limiting the admission of outdoor air when a cooling medium only is supplied to said unit ventilator irrespective of room temperature variations; and

(f) means operating said secondary damper means throughout its entire range to vary in proportioning fashion the air directed through said separate passages in accordance with departures in room temperature from a selected temperature irrespective of the character of the tempering medium supplied to said unit ventilator.

3. In a room unit ventilator including a cabinet having air inlet means for admitting room air and outdoor air into an inlet end portion of said cabinet, air outlet means at the outlet end of said cabinet, and blower means between said air inlet and air outlet means:

(a) partition means dividing a portion of said cabinet between said inlet and said outlet ends into separate heating and cooling passages;

(b) heat exchange means, adapted to receive a heating medium only, disposed in said heating passage;

(c) heat exchange means, adapted to receive a cooling medium only, disposed in said cooling passage, said heat exchange means at times simultaneously receiving their respective heating and cooling mediums;

(d) primary damper means for said air inlet means displaceable in a range between one and an opposite extreme position blocking the admission of outdoor air and room air respectively;

(e) secondary damper means between said inlet end portion and said heating and cooling passage displaceable to vary in proportioning fashion the ratio of air admitted to said heating passage to air admitted to said cooling passage;

(f) means controlling said primary and secondary damper means in a predetermined relationship in response to departures of room temperature from a selected temperature including;

(g) means operating said secondary damper means to progressively increase and decrease the ratio of air directed through said cooling passage to air directed through said heating passage in response to progressively rising and falling room temperature respectively within a predetermined range, irrespective of whether a heating medium, a cooling medium, or both are being supplied to said heat exchangers.

4. In a room unit ventilator including a cabinet having a room air inlet and an outdoor air inlet, an air outlet, and blower means for inducing the flow of air through said cabinet:

(a) a first set of dampers movable in a range controlling the admission of outdoor air and room air in proportions up to 100% of either;

(b) a cooling passage having a cooling coil and a separate heating passage having a heating coil between said air inlets and air outlet, said cooling and heating passage being in parallel with each other and providing alternate flow paths, said coils being adapted to selectively receive a heating medium and a cooling medium respectively in accordance with the heating

and cooling loads to which said room is subjected, both of said coils at times simultaneously receiving their respective heating and cooling mediums;

(c) a second set of dampers for said cooling and heating passages;

(d) means operating said second set of dampers to increase and decrease in proportioning fashion the ratio of air directed through said heating passage to air directed through said cooling passage in response to a falling and rising room temperature respectively, irrespective of whether both or only one of said coils is receiving its tempering medium;

(e) means operating said first set of dampers throughout said range in accordance with room temperature variations when said heating coil is receiving said heating medium, and restricting operation of said first set of dampers to a part of said range limiting admission of outdoor air when only said cooling coil is receiving said cooling medium.

5. In a room unit ventilator including a cabinet having a room air inlet and an outdoor air inlet, an air outlet, and blower means for inducing the flow of air through said cabinet:

(a) a first set of dampers movable in a range controlling the admission of outdoor air and room air in proportions up to 100% of either;

(b) a cooling passage having a cooling coil and a separate heating passage having a heating coil between said air inlets and air outlet, said cooling and heating passages being in parallel with each other and providing alternate flow paths, said coils being adapted to selectively receive a heating medium and a cooling medium respectively in accordance with the heating and cooling loads to which said room is subjected, said coils at times simultaneously receiving their respective heating and cooling mediums;

(c) a second set of dampers for said cooling and heating passages;

(d) means operating said second set of dampers as proportioning face and bypass dampers in response to departures in room temperature from a selected temperature, irrespective of whether only one or both of said coils receive a tempering medium;

(e) means operating said first set of dampers throughout said range in accordance with room temperature variations when said heating coil is receiving said heating medium, and restricting operation of said first set of dampers to a part of said range limiting admission of outdoor air when only said cooling coil is receiving said cooling medium.

6. In a room unit ventilator including a cabinet having a room air inlet and an outdoor air inlet, an air outlet, and blower means for inducing the flow of air through said cabinet;

(a) primary damper means movable in a range between one extreme position blocking said room air inlet and an opposite extreme position blocking said outdoor air inlet;

(b) means forming a separate cooling passage and a separate heating passage between said air inlets and said air outlet, each passage having a heat exchanger therein adapted to selectively receive a tempering medium of the character of the passage, said cooling passage being of substantially greater cross sectional area than said heating passage, with said heat exchangers at times simultaneously receiving their respective tempering mediums;

(c) secondary damper means at the inlet end of said passages movable in a range between one extreme position blocking said cooling passage and an opposite extreme position blocking said heating passage;

(d) means operating said primary damper means throughout said range in accordance with departures in room temperature from a desired temperature when said heating passage heat exchanger is receiving a tempering medium, and restricting operation of said primary damper means to a part of said range limiting admission of outdoor air when only said cooling passage heat exchanger is receiving a tempering medium; and

(e) means operating said secondary damper means toward said one and said opposite extreme position to vary in proportioning fashion the air directed through said separate passages in response to departures of said room temperature respectively below and above said desired temperature, irrespective of whether both or only one of said heat exchangers is receiving a tempering medium.

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