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METHOD AND APPARATUS FOR AIR CONDITIONING AND VENTILATING SYSTEMS

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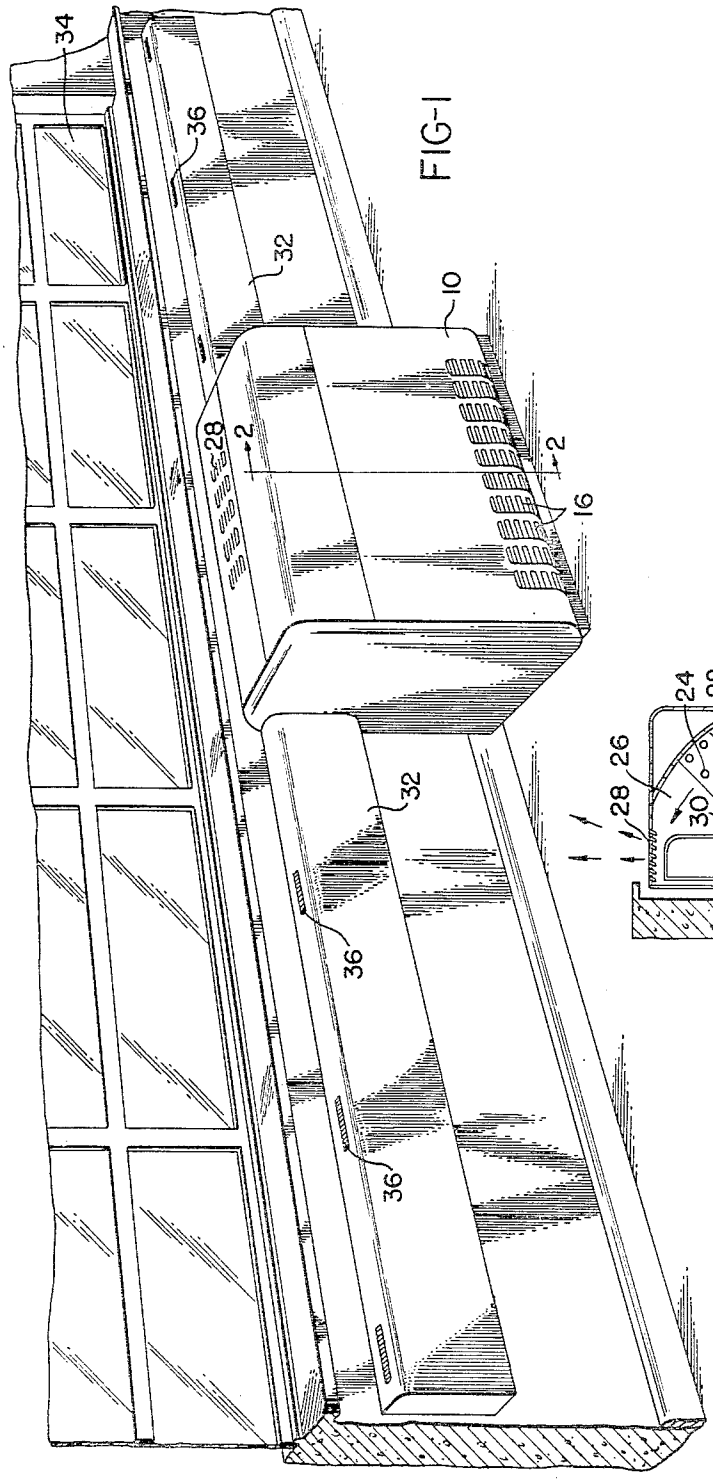


FIG-1

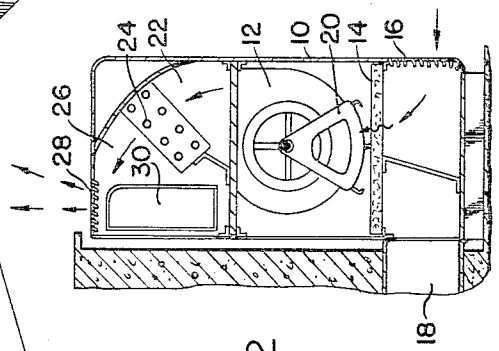


FIG-2

INVENTOR.
SAMUEL W. MILLER
JOHN W. McELGIN
BY Toulmin & Toulmin
ATTORNEYS

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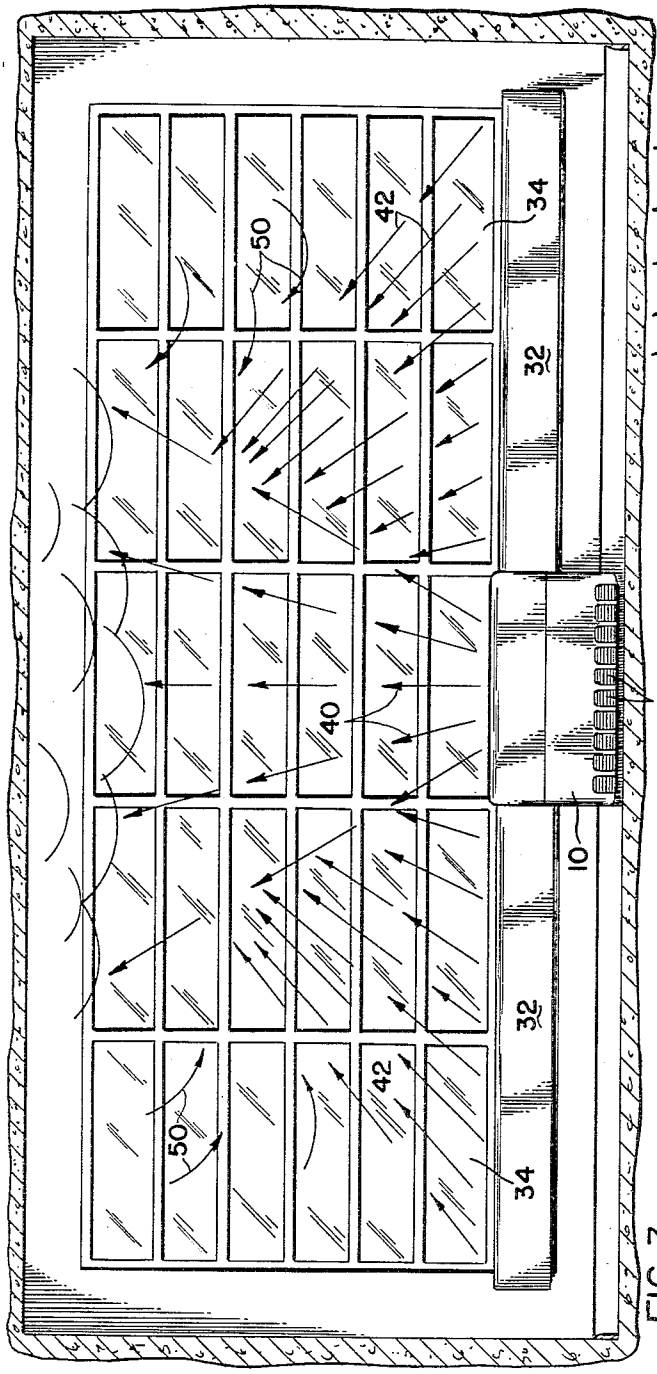


FIG-3

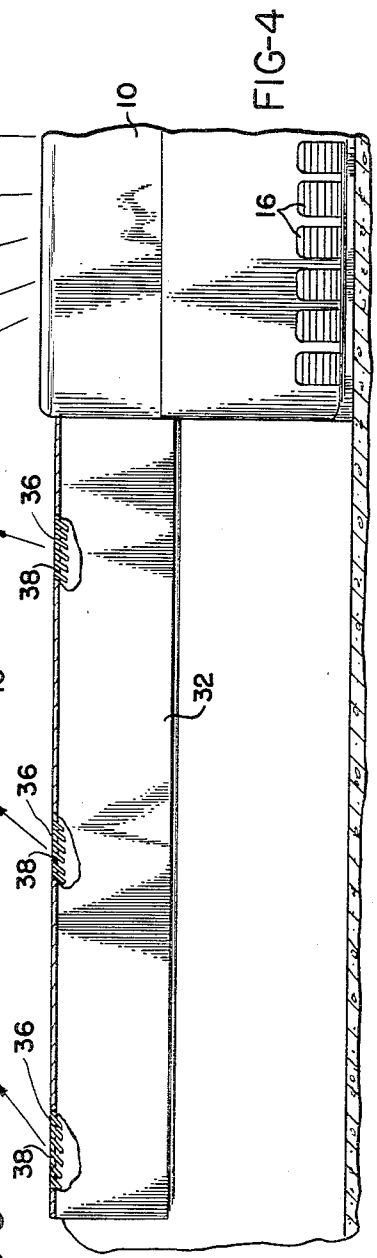
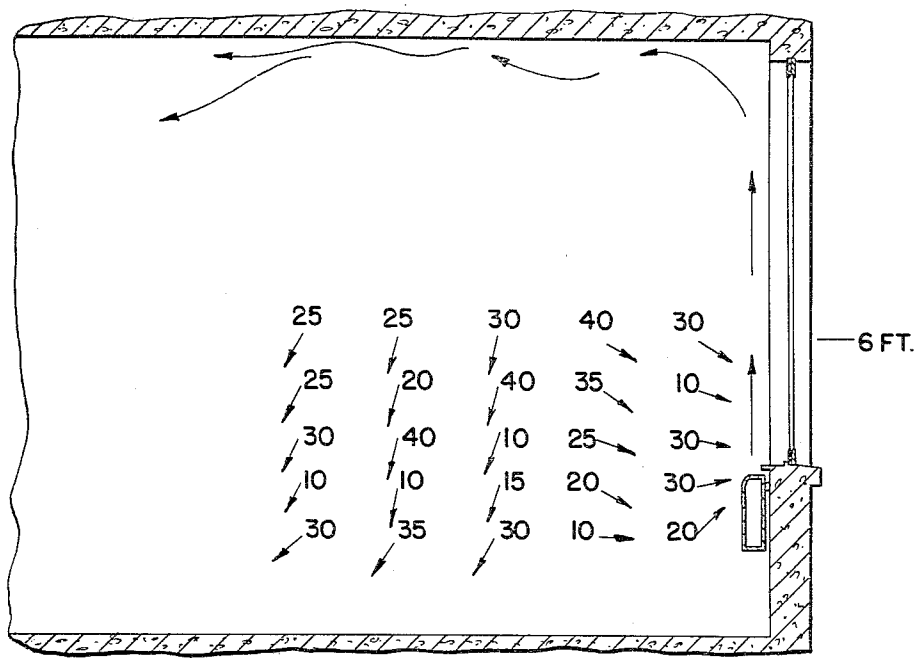


FIG-4

INVENTOR.
SAMUEL W. MILLER
JOHN W. McELGIN
BY Toulmin & Toulmin
ATTORNEYS

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FIG-5



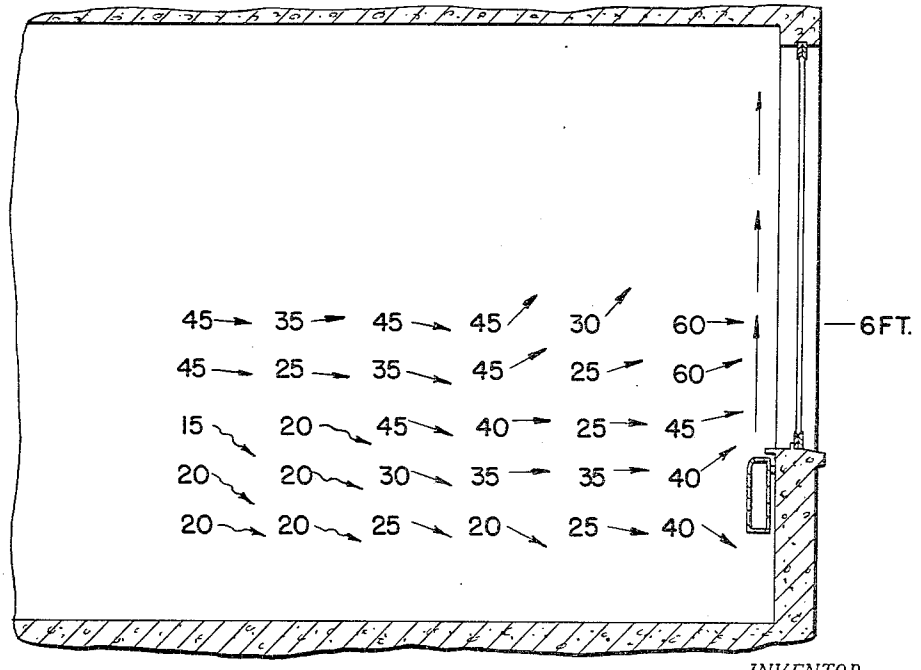


FIG-6

INVENTOR.
SAMUEL W. MILLER
JOHN W. McELGIN
BY Toulmin & Toulmin
ATTORNEYS

United States Patent Office

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METHOD AND APPARATUS FOR AIR CONDITIONING AND VENTILATING SYSTEMS

Samuel W. Miller and John W. McElgin, Philadelphia, Pa., assignors to John J. Nesbitt, Inc., Philadelphia, Pa., a corporation of Pennsylvania

Application April 14, 1953, Serial No. 348,772

6 Claims. (Cl. 98—38)

This invention relates to airconditioning and ventilating systems, and particularly to a system of this nature which is located in its entirety within a room such as a classroom having extensive window area.

In the heating and ventilating of rooms such as classrooms wherein at least one wall is generally almost entirely window area, particular problems have been encountered in conditioning the air in the room without setting up objectionable drafts while at the same time properly counteracting downdrafts from the windows.

In dealing with this problem it has been found that it is not too difficult to set up a heating system for supplying warm air to the room in such a manner as to produce comfortable conditions and counteract the downdraft from the windows. However, the systems which have heretofore operated satisfactorily in this respect have been at fault when operating on a ventilating and cooling cycle in that objectionable drafts are set up and the downdraft from the windows was not properly counteracted.

Attempts to solve this problem by discharging the conditioning air along the sills of the windows has not proved generally satisfactory because an air ventilating unit of the type that can be located within a classroom must, of necessity, operate extremely quietly. A unit of this nature is, therefore, a low resistance unit, and any attempt to distribute the entire discharge therefrom along the sill line of the windows leads to resistance which results in noisy operation of the unit, and which, of course, is not acceptable. Such units are also quite bulky and have never been entirely satisfactory on both heating and cooling cycles.

Having the foregoing in mind, it is a primary object of the present invention to provide a heating and ventilating system for use in a room having a large window space which will eliminate the difficulties referred to above.

Another object is the provision of a unit-ventilator type heating and cooling system for use in a classroom of the nature referred to which will be quiet in operation.

A further object is the provision of a unit system of the nature referred to in which the operation of the system is satisfactory on both heating and cooling cycles in that objectionable drafty conditions are entirely eliminated.

A particular object of this invention is the provision of an arrangement of a unit heating and cooling system of the nature described for combating window downdrafts on both the heating and cooling cycles of the unit.

Another particular object is the provision of an arrangement in an airconditioning system of the nature referred to for combating window downdrafts on heating and cooling cycles or the like with a minimum amount of blown air.

These and other objects and advantages of this invention will become more apparent upon reference to the following specification taken in connection with the accompanying drawings, in which:

Figure 1 is a perspective view showing a windowed wall of a classroom having an airconditioning system according to the present invention mounted therein;

Figure 2 is a vertical sectional view indicated by line 2—2 on Figure 1;

Figure 3 is an elevational view looking at the windowed wall of the room showing the airflow pattern from the airconditioning unit;

Figure 4 is a fragmentary view showing the air discharge jets located in the ducts extending along the sills of the windows;

Figure 5 is a sectional view through the room showing the airflow pattern which obtains when the unit is on a heating cycle; and

Figure 6 is a view similar to Figure 5 but shows the airflow pattern within the room when the unit is on a cooling cycle.

Referring to the drawings somewhat more in detail, in Figures 1 and 2 it will be seen that the system according to this invention comprises a central unit **10** having therein a blower **12** adapted for drawing air in through a filter **14** from the opening **16** that communicates with the interior of the room being conditioned and the opening **18** leading to the outside. A damper **20** controls the airflow through the said openings to the inlet of the fan, and is itself controlled by a system which forms no part of this invention but which is well known in the art.

Blower **12** discharges into a passage **22** through a heating coil **24** into space **26**. Space **26** has a louvered opening **28** into the interior of the room at the top of unit **10**, and at each side of unit **10** the wall enclosing space **26** has an aperture **30**, to each of which is connected a duct **32** leading along the sill lines of the windows **34**.

According to the present invention each of ducts **32** is provided with a plurality of spaced jets **36** which are louvered openings, as will be seen in Figure 4, and wherein the louvers comprise the blades or vanes **38** arranged so that the discharged air is directed generally inwardly toward the vertical center line of unit **10**.

The jet airflow pattern that obtains when the unit is in operation is illustrated in Figure 3 wherein it will be noted that the blast from unit **10** is directed upwardly and outwardly as indicated by the arrows **40**, whereas the blasts from the several jets **36** is directed upwardly and inwardly as indicated by the several arrows **42**.

By prolonged tests and experimentation, in which a number of different arrangements were tried out, it has been found that the arrangement briefly described above has the advantage of providing for a system that is quiet in operation, one that effectively combats window downdrafts during both heating and cooling cycles, and one which adequately conditions the air in the entire room without producing objectionable drafty conditions within the room.

By way of describing the actual conditions encountered in the installation and operation of a unit according to this invention, it may be considered that average modern classrooms have a length of about 30 feet and of a width from 25 to 35 feet. With the unit **10** taking up about 5 feet, the ducts **32**, when extending from wall to wall, would be about 12½ feet long on each side of the unit.

Based on a total quantity of a thousand cubic feet per minute of air supplied to the room, and with the criteria of comfort in the occupied zone established as a maximum velocity of 50 feet per minute of the the air, it was found that, with a division of air between the main unit **10** and the ducts **32** so that about 65 percent of the air was discharged through the main unit and about 35 percent of the air was discharged through the ducts, a suitable system meeting the requirements referred to above was obtained.

This division of air between the main unit and the ducts, however, only produces satisfactory conditions with the jet arrangement illustrated. With spaced openings along the ducts so arranged that the discharge therefrom was

vertical, there was a spilling out between the openings of the window downdraft which produced an objectionable situation in the vicinity of the windows.

During experiments discharging the bulk of the air along the window sills, with a continous louvered slot along the ducts, the downdraft from the windows was successfully combated on both heating and cooling cycles, but velocities in the occupied zone were created running as high as 95 feet per minute, and which represents an extremely drafty condition.

Experimentations with the continuous louvered slot to the direction of discharge thereof and the velocity of air discharge did not produce satisfactory results because it merely shifted the zone of high velocities about within the occupied portion of the room.

A still further difficulty encountered with the continuous louvered slot system was that it completely trapped all window downdraft behind it, and a low pressure air was created between the jet from the slot and the window and the airstream was, accordingly, deflected toward the window and considerable of the velocity energy thereof was lost.

The breaking up of the continuous louvered slots into jets had a tendency to offset this loss of energy, but the drafty zone remained within the room and, furthermore, under certain conditions, window downdrafts would spill out between the jets into the room.

Various other experiments dealing with special angular and curved grills for these jet openings were carried out, and while each produced a somewhat different type of airstream and, in certain cases, tended to reduce the velocity in the occupied zone, none thereof reduced the drafts in the occupied zone to an acceptable level. Further tests and experimentation with the airflow divided in the manner referred to between a unit ventilator and side ducts developed the principle of the present invention of directing the jets in the ducts upwardly and inwardly so that toward the top of the room the entire air discharge would tend to merge and mushroom out across the ceiling and flow across the room and downwardly therethrough without any drafty conditions beyond acceptable limits being set up within the room.

In a set up of the nature referred to it was found that the airflow through the ducts at a volume of 15 cubic feet per minute per linear foot thereof proved successful in overcoming the downdraft from the windows and in adequate heating and cooling the room without creating any objectionable drafty conditions within the occupied zone.

In this connection reference may be had to Figure 5 which illustrates a typical heating cycle, and it will be noted that no air velocities are encountered below the 6 foot level in excess of 40 feet per minute.

In Figure 6 the same arrangement is shown on a cooling cycle, and it will be noted that there is only a limited area quite close to the windows and also between the 5 foot and 6 foot level where any of the velocities exceed 45 feet per minute. This system, accordingly, operates on both heating and cooling cycles without there being any objectionable drafts in any of the occupied zone of the room.

The airstream from the unit ventilator and the side sill line ducts combined, as illustrated in Figure 3, exhibits the same general characteristics as the blast discharged from a unit ventilator alone.

A particular advantageous characteristic of the system of this invention is that the downdraft at the extreme ends of the windows, and which portions of the windows are not covered by the jet blanket, is drawn into the jet-stream, as indicated by the curved arrows 50 in Figure 3, even when the system is on a cooling cycle whereby downdraft at these extreme ends of the windows is prevented.

The angular discharge of the jets likewise is extremely effective in preventing the escape of the downdraft from between the jets as is practically always experienced when the jets are directed vertically upwardly.

The system according to this invention, in essence, comprises the discharging of the bulk of the total airflow from a unit ventilator located about the center of the outside wall and with the balance of the air supply being distributed along the adjacent windows at the sill line through ducts extending from opposite sides of the unit and with the air supplied along the windows being given an angular direct sweeping across the windows toward the airstream from the unit so as to combine therewith and form a single airstream in the region of the ceiling.

Our experiments indicate that about 65 percent of the air supply should be discharged from the unit ventilator and about 35 percent through the ducts, but it will be understood that these amounts would, of course, vary with the particular installation and are not to be considered as limited but, rather, as merely exemplary of the manner in which a system according to this invention is set up to operate.

In the described system of this invention wherein the airflow is divided in the manner described by a unit ventilator and side ducts extending therefrom, the advantage obtains that quiet operation can be had at all times because the amount of air discharged through the side ducts does not require any substantial increase in the operating speed of the fan or the fan pressure. At the same time, the window downdrafts are offset on both the heating and cooling cycles, no extremely high air currents are to be found in the occupied zone of the room, and the installation is compact and relatively inexpensive.

It will be understood that this invention is susceptible to modification in order to adapt it to different usages and conditions, and, accordingly, it is desired to comprehend such modifications within this invention as may fall within the scope of the appended claims.

We claim:

1. In an airconditioning system of the nature described; a unit ventilator having a blower therein and an opening for the discharge of blown air into the room being conditioned, heat exchanger means between said blower and said opening, and ducts communicating with said unit between said heat exchanger means and said opening and extending laterally from said unit, and jet openings spaced along the top of said ducts, said jets directing streams of air therethrough so as to converge at a point on the ceiling vertically above the unit ventilator, the relative resistance to airflow through said opening and through said jet openings being such that about 65 percent of the air from the blower passes through said opening and about 35 percent thereof passes through said jet openings.

2. In an airconditioning system of the nature described; a unit ventilator adapted for being positioned along a windowed wall of a room to be conditioned, said ventilator comprising a blower and an opening for the discharge of blown air into the said room in a vertical plane, ducts communicating with said unit ventilator between the said blower and the said opening therein and extending laterally from said unit along the sills of the windows in the said wall of the room, and jet openings spaced along the top of said ducts and directed upwardly to provide for jets of blown air that sweep across the said windows and combat the downdraft thereon, said jet openings being louvered, and said louvers being arranged to direct the jets inwardly toward the vertical center line of said unit ventilator so that the airstreams from said jets and the airstream from the opening in said ventilator tend to combine in a single airstream adjacent the ceiling of the room.

3. In an airconditioning system of the nature described; a unit ventilator adapted for being positioned about midway along a windowed wall and having an inlet opening into the room and another inlet opening to the outside atmosphere, a blower in the unit for drawing air into the unit through said inlet openings,

an outlet opening for discharging the blown air into the room parallel to said windowed wall, ducts extending along the sill line of the windows on the said one wall of the room and communicating with the unit between the said blower and the said outlet opening thereof, and jet openings spaced along the top of said ducts for discharging jets of blown air therefrom, said jet openings being provided with louvers that direct the jets upwardly generally parallel with said windows and at such an angle so as to be directed at the ceiling at a point vertically above the center line of said unit whereby the streams of air from said jet openings sweep across the windows and combat the downdrafts therefrom and tend to unite with the airstream from the outlet opening of the unit ventilator adjacent the ceiling of the room to form a single airstream, and said ducts and said jet openings therein being of such a size that about 35 percent of the air blown by said blower is discharged through said jet openings.

4. In a method of conditioning the air in a room having a windowed wall; blowing air in about the center of the said wall and conditioning the air, directing a major portion of the blown air upwardly in front of the windows in the center of the windowed wall, distributing the remainder of the air along the windowed wall at the window sills, and directing the said remainder of the air upwardly and inwardly in front of the windows in the form of a plurality of spaced jets whereby a curtain of conditioned air is provided in front of the windows.

5. In a method of conditioning the air in a room of which one wall is substantially all window area; blowing and conditioning air, discharging about 65% of the

blown air upwardly in front of the windows in the center of the wall, distributing about 35% of the blown air along the sill line of the windows, and directing the said 35% of the air upwardly and inwardly in front of the windows in the form of spaced relatively high velocity jets whereby a curtain is formed across the windows that prevents downdrafts therefrom.

6. In a method of conditioning the air in a room of which one wall is substantially all window area; blowing and conditioning air, discharging about 65% of the blown air upwardly in front of the windows in the center of the wall, distributing about 35% of the blown air along the sill line of the windows, directing the said 35% of the air upwardly in front of the windows in the form of spaced relatively high velocity jets whereby a curtain is formed across the windows that prevents downdrafts therefrom, and inclining said jets inwardly toward the vertical center line of said one wall whereby the said jets combine with the main blast of air toward the ceiling in about the center of the wall whereby the velocity of air currents within the room is maintained within tolerable limits under all conditions of operation of this system.

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