Oct. 20, 1959 F. G. BAKER ET AL 2,909,043

AIR CONDITIONING UNIT

Filed Jan. 6, 1958 3 Sheets-Sheet 1

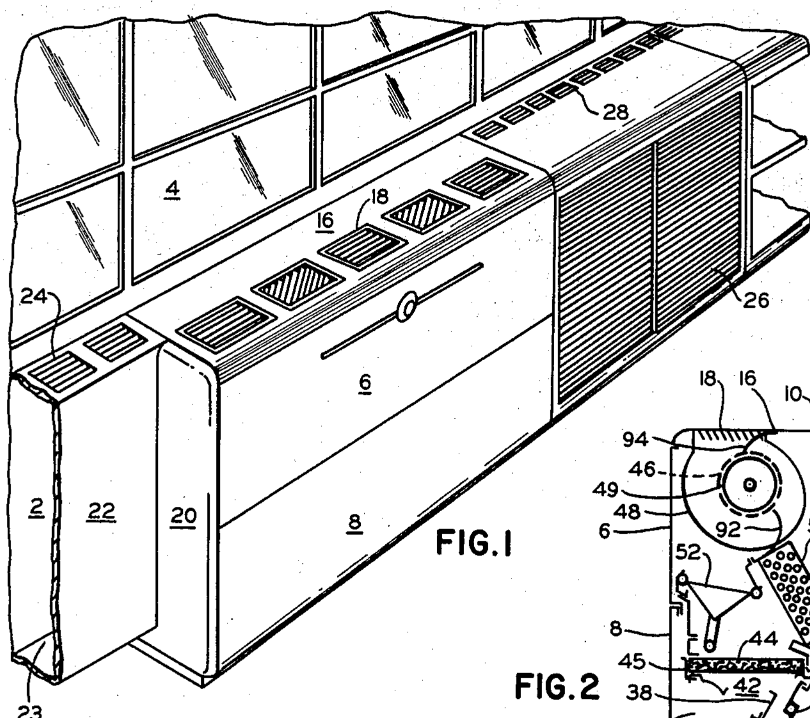

FIG. 1

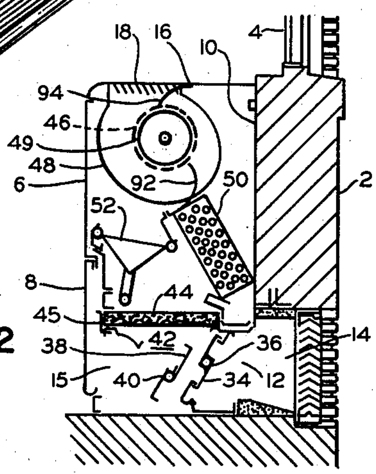

FIG. 2

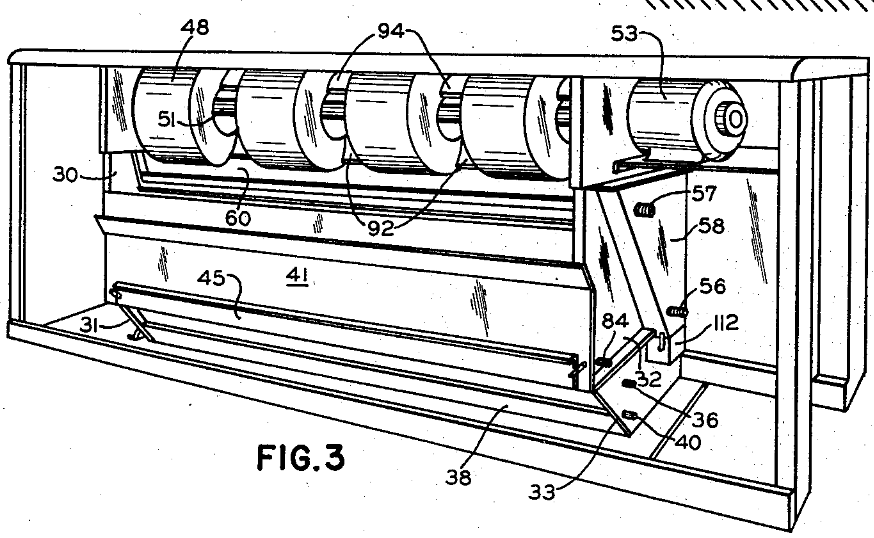

FIG. 3

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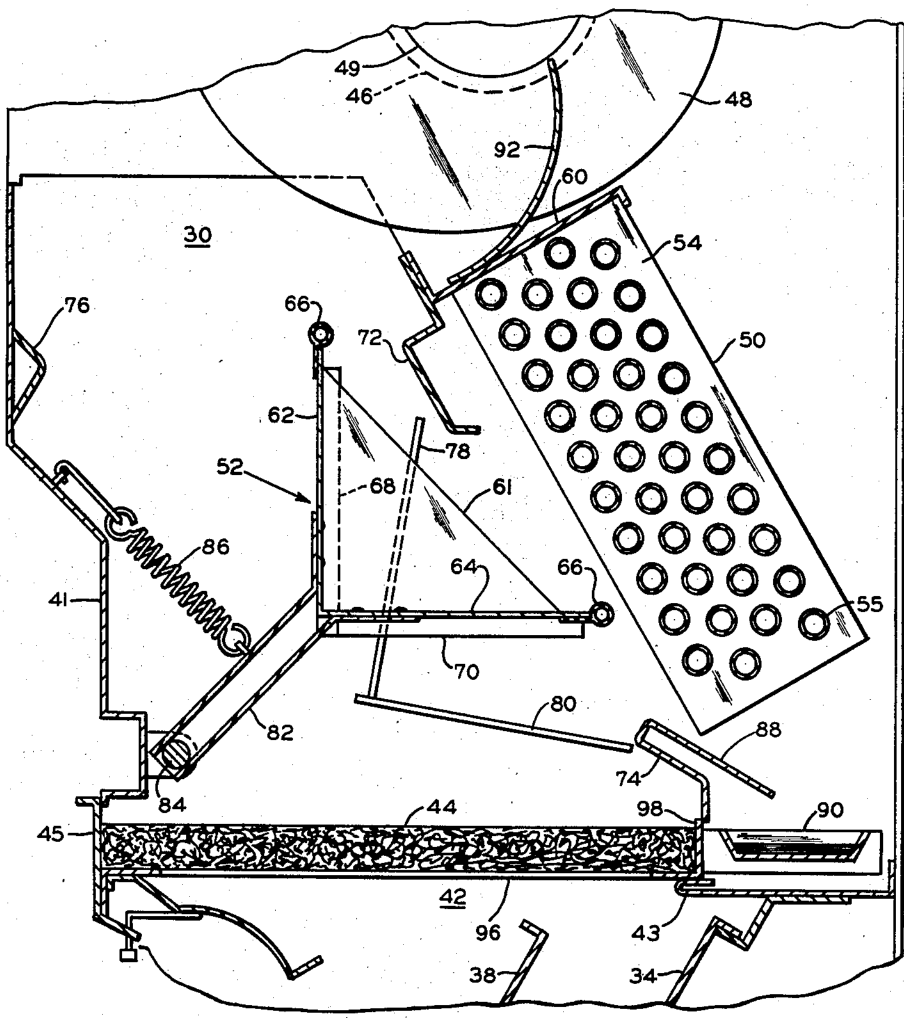

FIG. 4

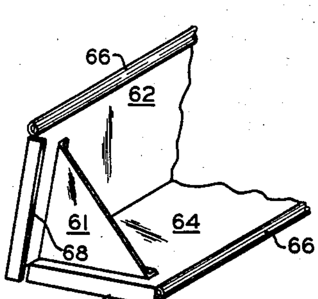

FIG. 5

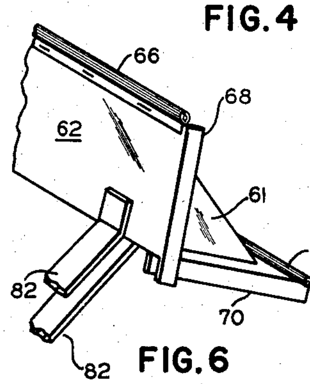

FIG. 6

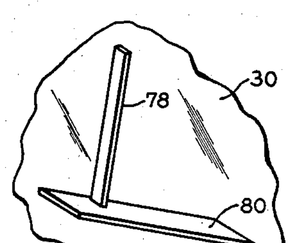

FIG. 7

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AIR CONDITIONING UNIT

Filed Jan. 6, 1958

3 Sheets-Sheet 3

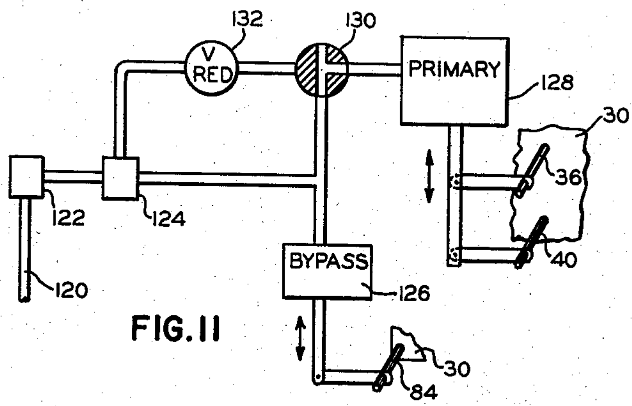


FIG. 11

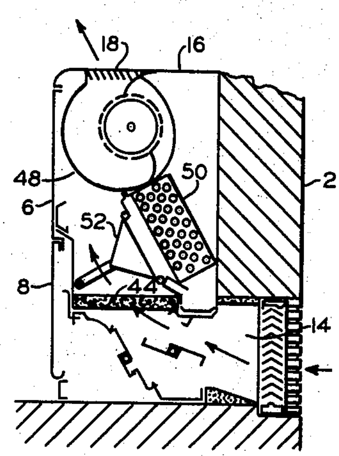


FIG. 10

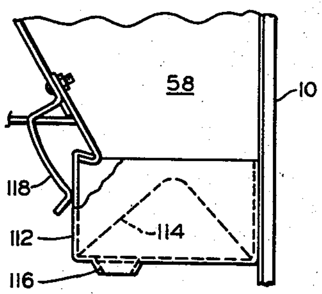
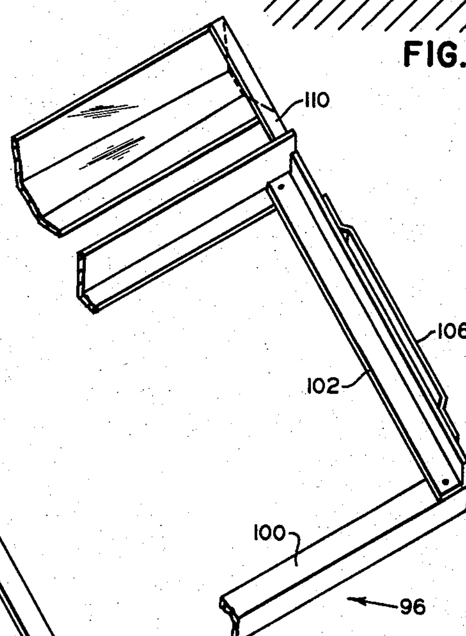


FIG. 9



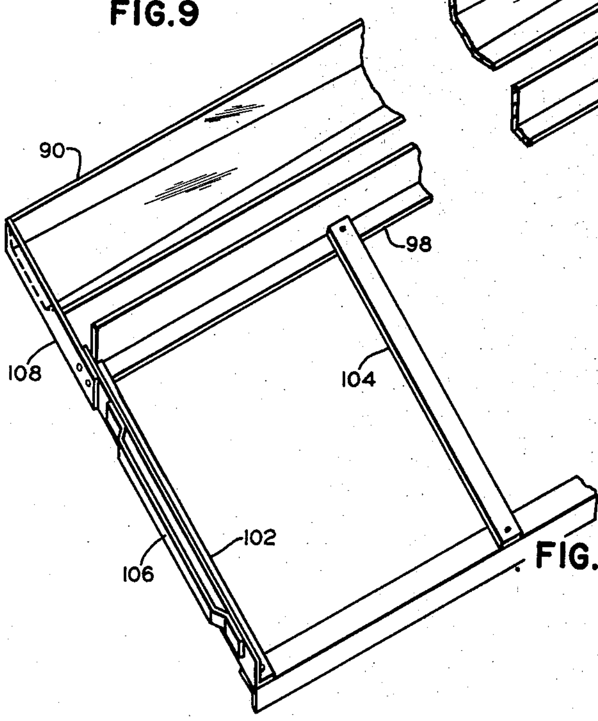


FIG. 8

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United States Patent Office

2,909,043

Patented Oct. 20, 1959

2,909,043

AIR CONDITIONING UNIT

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Application January 6, 1958, Serial No. 707,371

14 Claims. (Cl. 62—285)

This invention relates to air conditioning apparatus and more particularly to air conditioning apparatus of the unit ventilator type.

Unit ventilators are commonly used for heating, ventilating and cooling school classrooms or other highly occupied areas. While such units heretofore usually have had a heat exchanger capable only of increasing the temperature of air flow through the unit and therefore have been ineffective for cooling purposes when the outside temperature is at or above the desired indoor temperature, it has recently been proposed to use a heat exchanger of the character adapted to selectively receive either a hot or a chilled tempering medium. This permits operation of the unit for cooling purposes when the outdoor air temperature is near or above the desired room temperature. The apparatus of this invention is of this general character.

One object of this invention is the provision of a unit ventilator having a bypass damper for directing and controlling the air flow through the unit.

Another object is to provide a unit ventilator of the bypass damper type in which variations in air discharge due to bypass damper displacement are minimized.

Another object is to provide a unit ventilator of generally improved construction and arrangement of components to obtain a relatively high air flow capacity and in which a single air filter is used for filtering the total air flow.

A further object is to provide a unit having an improved condensate drainage arrangement.

A still further object is the provision of a unit ventilator affording a high degree of dehumidification in a cooling operation and in which odor pickup from the heat exchanger is minimized due to bypass damper control as distinguished from valve control of the heat exchanger.

In accordance with the present invention, a unit ventilator is arranged with a heat exchanger disposed intermediate the air inlet and outlet means, and bypass damper means disposed adjacent the upstream face of the heat exchanger to cooperate therewith for controlling the direction of air flow through the unit ventilator. Drip pan means are mounted in an operative position to receive condensation from the surface of the heat exchanger and frame means are secured to the drip pan and extend transversely across a passageway through which air flows from the air inlet means to the chamber housing the heat exchanger and cooperating bypass damper means.

These and other features contemplated by this invention will be described in detail in connection with the accompanying drawing wherein one embodiment is illustrated, and wherein:

Figure 1 is a perspective view illustrating the unit ventilator installed in one advantageous arrangement along an outside wall of a room;

Figure 2 is a somewhat diagrammatic, vertical sectional view through the unit ventilator, this view showing the dampers in a position to permit the introduction of all room air and direct it through the heat exchanger;

Figure 3 is an isometric view of the unit ventilator with outer panels removed to show the general arrangement of the interior;

Figure 4 is a fragmentary vertical sectional view illustrating certain interior details of the unit ventilator and showing the bypass damper in an intermediate position;

Figure 5 is a fragmentary isometric view of the right end of the bypass damper; this view being one looking generally from the open side of the trough portion;

Figure 6 is also a fragmentary isometric view of the right end of the bypass damper, this view looking generally from the apex side of the trough portion;

Figure 7 is a fragmentary isometric view of the left vertical partition carrying ledges adapted to be engaged by the left end of the bypass damper;

Figure 8 is a broken isometric view of the filter frame-drip pan assembly;

Fig. 9 is a fragmentary elevational view illustrating the condensate accumulator mounted in the right end compartment of the unit ventilator;

Figure 10 is a somewhat diagrammatic, vertical sectional view illustrating the dampers displaced to extreme positions opposite to their positions in Figure 2;

Figure 11 is a simplified schematic diagram of an automatic temperature control system for the unit ventilator;

Referring to the drawing, the unit ventilator is mounted typically against an outside room wall 2 provided with windows 4. The cabinet of the unit includes a front wall which may be in the form of detachable upper and lower front panels 6 and 8, a rear wall 10 having an outdoor air inlet 12 registering with an outdoor air passageway 14 in the room wall, a room air inlet 15, a top wall 16 having air outlet openings 18, and end panel 20 shown as partially closing the left end of the cabinet. A duct 22 forming a passageway 23 with the wall 2, and having an openwork grille 24 on its top is also connected to the left end of the unit and places the left end compartment of the cabinet in communication with the passageway 23. The abutting end of a flanking utility cabinet 26 partially closes the right end of the unit, the utility cabinet being provided with a false back to form a right passageway having grille 28 at its top . With this arrangement, room air may be drawn into the unit from the lower end of the windows.

A pair of vertical partitions 30 and 32 (Figure 3) spaced inwardly from the cabinet ends divide the interior of the cabinet into a center section and right and left hand end compartments as viewed in Figures 1 and 3. The end compartments are commonly used to house temperature control components and to provide space for the supply and return piping for delivering tempering fluid to the heat exchanger. As may be seen in Figure 3, the lower front edges 31 and 33 of the vertical partitions 30 and 32 respectively, are inclined rearwardly and downwardly to provide communication between the end compartments and the room air inlet 15 of the center section. Thus, room air may be drawn from adjacent the lower ends of the windows through grilles 24 and 28, through the flanking passageways along the wall, into the end compartments and thence into the center section. The purpose of such an arrangement is primarily for trapping cold drafts which flow downwardly along the inner surface of the windows in cold weather, and is explained in detail in Hubbard U.S. Patent 2,723,616. In the event the flanking passageway is not used, the lower front panel 8 may be provided with grilles or louvers which permit the room air to be drawn directly into the room air inlet 15, or the end panels may be louvered to place the end compartments in communication with room air if no utility cabinets flank the unit.

The lower portion of the center section, which will be referred to hereinafter as the primary damper section, includes an outdoor air damper **34** fixedly mounted on shaft **36** to rotate therewith, and a room air damper **38** fixedly mounted on shaft **40** to rotate therewith, both shafts **36** and **40** having their ends rotatably journalled in bearings secured to the vertical partitions **30** and **32**. On at least one end, the shafts project into the end compartment a sufficient distance to permit mechanical connections to suitable damper operating mechanisms.

The primary damper section of the unit ventilator includes formed cross members secured at their ends to the vertical partitions and extending transversely across the primary damper section in a position for engagement by the outer flanged edges of the outdoor and room air dampers when they are rotated to extreme positions to block either the admission of outdoor air or room air. The details of construction of the primary damper section are described in the aforesaid Hubbard U.S. Patent No. 2,723,616.

The upper portion of the center section (Figure 4) is covered by a front panel assembly **41** and is in communication with the primary damper section through passageway **42** which has its rear edge defined by baffle **43**. An air filter **44** is disposed across this passageway to filter all air leaving the primary damper section. Hinged door **45** permits access to the air filter and its frame.

The upper portion also contains a number of laterally spaced centrifugal fans **46** in individual scroll-like housings **48** (Figure 3) having opposite annular inlets **49**, a heat exchanger or coil **50**, and a bypass damper **52**. The fans **46** are mounted on a common shaft **51** which is driven by electric motor **53**. The air flow induced by the fan operation is admitted to the primary damper section, flows upwardly through the passageway **42** and filter **44** and is thence directed, by the bypass damper **52**, depending upon its position, through the coil, or around the coil or in varying proportions in either path, and is discharged by the fans into the room through outlets **18**.

If both heating and cooling operations are contemplated, the coil **50** is of the type adapted to receive a forced tempering medium such as hot or chilled water. As can be seen in Figure 4, it includes a plurality of closely-spaced, vertically-disposed fins **54** mounted on tubes **55** which are normally serpentine and extend transversely through the fins. A supply connection **56** and a return connection **57** (Figure 3) are connected to the source of forced hot or chilled water. Coils of this general type are conventional and well known in the art, and therefore will not be described in detail.

The coil (Figures 2, 3 and 4) is mounted in the center section in inclined relation to the vertical front and rear walls and with its lower edge adjacent the rear wall **10**. The ends of the coil project slightly through and are supported by the right and left hand vertical partitions. A sheet metal cap **58** is secured to each of the vertical partitions to close the ends of the coil and seal the vertical partitions. The top edge of the coil carries a panel **60** which extends between the vertical partitions and the front and rear faces of the coil are open to permit air flow between the fins and in a front to rear direction when not prevented by the bypass damper **52**.

The bypass damper **52** shown somewhat diagrammatically in Figure 2 and in more detail in Figures 4–6, includes an extended area extremity which serves as an air directing or baffling portion which extends transversely between the vertical partitions **30** and **32**, and a stem portion, which supports the baffling portion. The air baffling portion may conveniently be made by bending a single sheet along its longitudinal center line to provide a structure which is trough-like in cross section. The opposite ends of the trough are closed by triangular members **61** which also serve for bracing. Both the forward trough face **62**, and the rearward face **64**, have a flexible sealing strip **66** secured to their free transverse edge, and each has a clockwise directed flange or blade **68** and **70** respectively at each end. The strips **66** seal

against transverse members **72** and **74** in the clockwise or bypass position of the damper, and against transverse members **72** and **76** in the damper's counterclockwise or tempering position. These blades **68** and **70** are disposed so that when the bypass damper is rotated to its bypass position, the edges of the blades will engage and seal against the faces of ledges **78** and **80** respectively (Figure 7) these ledges being disposed in a generally right angle relationship to each other and secured to the inner surface of both vertical partitions **30** and **32**.

As may be noted from Figures 5 and 6, the rearward face **64** is somewhat shorter than forward face **62** so that the blades **70** are spaced inwardly from the partitions slightly more than the blades **68**. In this same connection, ledges **78** are narrower or, in other words, project inwardly from the partitions less than ledges **80** so that the blades **70** will clear ledges **78** but engage ledges **80** when the bypass damper is rotated to its extreme clockwise position.

It is to be noted that the disposition of the ledges **78** and **80** and the arrangement of the bypass damper **52** result in the trough face **64** lying in a plane, when the bypass damper is in its bypass position, which tends to direct air flow away from the coil or towards the front of the unit. This arrangement results in improved control by minimizing uncontrolled heat pickup.

Referring to Figures 4 and 6, the stem portion of the bypass damper includes legs **82** secured by rivets or the like to the outer faces of the trough at opposite ends thereof, and one intermediate leg, also designated **82**. The stem portion is open except for these legs so that when the bypass damper is in any position other than its extreme counterclockwise position, air may flow through the stem portion to bypass the coil.

Each leg is rigidly attached to the circumference of shaft **84** which is suitably journalled in the vertical partitions **30** and **32** and has one end projecting therethrough for attachment to damper operating linkage. The intermediate leg **82** is provided with means for securing one end of a tension spring **86** which has its other end secured to the front structure of the cabinet. This spring is selected to provide the proper tension for balancing the weight of the bypass damper.

The transverse member **74** (Figure 4), which cooperates with one of the sealing strips **66** to provide a seal when the bypass damper is displaced to its extreme clockwise position, includes a rearwardly and downwardly directed upper surface **88** which underlies the lower front corner of the coil. When the coil is supplied with chilled water for a cooling operation, condensate forming on the coil from the dehumidification of the air flow drains on to this surface **88** and flows into a drain pan **90** which will be described in more detail hereinafter.

The panel **60** which covers the top of the coil has a plurality of vanes **92** secured to its upper surface and spaced to register with the spaces between the fan housings **48**. The vanes are arcuate in cross section, extend rearwardly and upwardly between the housings and are directed generally towards the fan shafts **51**. Oppositely disposed complementary vanes **94**, (Figures 2 and 3) are secured to the under surface of the top panel **16** and are directed forwardly and downwardly towards the fan shaft.

As illustrated in Figure 4, the coil and bypass damper assemblies are spaced upwardly from the primary damper section a distance sufficient to accommodate an air filter **44** and drip pan **90** therebetween. The passageway **42** interconnecting the primary damper section and upper part of the center section is arranged to receive a tray-like frame **96** (Figure 8) in which the air filter **44** may be supported. The frame may conveniently be constructed of a rear angle **98**, a front angle **100**, and end angles **102**, all cooperating to form a rectangular open-faced frame. To increase the rigidity of the frame, one or more strips **104** may be secured to the front and rear angles. Proper positioning of the frame in an endwise direction between the vertical partitions 30 and 32 can be obtained by providing resilient bridge members 106 on the opposite end angles 102, these members 106 engaging the inner surfaces of the vertical partition when the frame is inserted. Positioning of the frame in a front to rear direction may be facilitated by having the vertical leg of rear angle 98 project above the other perimetric members so that the upper marginal edge of the leg engages a downwardly directed flange of member 74 (Figure 4) when the frame is inserted in the passageway. The front angle 100 has its vertical leg directed downwardly so that the frame 96 is forwardly open, thereby permitting the removal or insertion of the air filter 44 without removing the frame 96 from the passageway 42.

The drip pan 90 (Figure 8), which is generally in the form of a trough, is secured to frame 96 by a left end strap 108 which also serves to close the left end of the drip pan and a right end strap 110 which overlies the open right end of the pan. As may be seen, the bottom of the pan slopes downwardly from its closed end to its open end while the upper edges of the pan lie in a level plane so that the pan bottom becomes progressively narrower and deeper in the direction of its open end. This construction not only causes condensate which falls into the pan to flow to the open end, but also results in the condensate flow accelerating towards the open end so that any particulate matter in the condensate will tend to be retained in the condensate rather than settling therefrom.

The condensate flows out of the open right end of the drain pan 90 into a cup-like accumulator 112 (Figures 3 and 9) mounted in the right end compartment. The accumulator is provided with a screen 114 for trapping any relatively large particles in the condensate and has a bottom outlet 116 through which the condensate may pass into any suitable drain pipe. To permit detachment of the accumulator for cleaning the screen 114, the front wall of the accumulator is flanged at its upper edge and releasably engages an oppositely directed flange of the coil end cap 58. A spring clip 118 holds the accumulator in its proper position.

The function of the vanes 92 and 94, which are disposed between the fan housings 48, is to control the direction of air flow into the inlets 49 of the housings. It has been found that with the described and illustrated structure and disposition of the coil 50, bypass damper 52 and housings 48, the use of these vanes permits the spacing between adjacent housings to be substantially decreased without a corresponding decrease in volume of air discharged from the unit.

Operation

In operation of the unit ventilator, the fans are operated continuously to discharge a relatively constant quantity of air into the room while the room is occupied.

The displacement of the primary dampers controls the relative proportions of room air and outdoor air admitted to the unit ventilator, and the displacement of the bypass damper controls the relative proportions of the admitted air which is directed through and around the coil. In this connection, the primary dampers can be displaced between one extreme position wherein all room air and no outdoor air is admitted to the unit ventilator, Figure 2 illustrating this position of the primary dampers, and an opposite extreme position wherein all outdoor air is admitted, Figure 10 illustrating this opposite extreme position. The bypass damper may likewise be displaced between opposite extreme positions, Figure 2 illustrating the bypass damper in a position for directing all of the air through the coil while Figure 10 illustrates the bypass damper position for directing air around the coil. The flow arrows of Figure 10 indicate the flow path of 100% outdoor air bypassing the coil.

The dampers may be controlled in one type of operation with automatic temperature control components arranged as shown in Figure 11. A pneumatic supply

line 120 is arranged to supply a first air pressure for a heating operation and a second and different pressure for a cooling operation. The room thermostat 122 sets itself for direct acting operation (increase in pressure passed upon an increase in temperature) when receiving the first pressure, and sets itself for reverse acting operation (decrease in pressure passed upon and increase in temperature) when receiving the second pressure. The room thermostat is connected by suitable branch lines through low limit thermostat 124 to a bypass damper operator 126 which is connected to rotate bypass damper shaft 84 by suitable linkage. The primary damper shafts 36 and 40 are connected by suitable linkage for rotation by primary damper operator 128 which is connected pneumatically through three way valve 130 and low limit thermostat 124 to room thermostat 122.

The low limit thermostat is effectively out of the circuit except when the discharge temperature of the air flow in a heating type of operation falls below a minimum limit. It then operates to vary the pressure in the branch lines connected thereto so that the dampers are displaced to increase the discharge air temperature.

The bypass damper operator 126 is adjusted to operate within a predetermined pressure range of, say, 5 to 10 p.s.i., and the primary damper operator 128 is adjusted to rotate the primary dampers within a range of, say, 3 to 12 p.s.i., with the primary damper operator being adjusted to maintain the primary dampers at a predetermined position within an intermediate range of, for example 6 to 9 p.s.i.

For a cooling operation, the three way valve 130 is switched to a position wherein the primary damper operator 128 is connected to the room thermostat 122 through the pressure reducing valve 132 and low limit thermostat 124 which is set to be inoperative in a cooling operation. The pressure reducing valve 132 functions to limit the pressure to primary damper operator 128 to that pressure which will permit the introduction of a limited quantity of outdoor air. The bypass damper operator 126 operates within the same pressure range as in a heating operation, it being understood that with the room thermostat operating as a reverse acting instrument, the pressure received by the bypass damper operator varies inversely with the temperature sensed at the room thermostat.

In a heating operation, while the room temperature is being brought up towards the desired temperature, the primary dampers are controlled to block the outdoor air inlet 12 so that only room air is introduced into the unit. The coil 50 is supplied with a heating medium (preferably of a temperature controlled in accordance with the outdoor temperature for better control and to avoid the use of a valve), and the bypass damper 52 is positioned to direct the entire air flow through the coil. This position of the dampers is shown in Figure 2. As the room temperature closely approaches the desired temperature, the outdoor air damper and room air damper are simultaneously displaced by rotating the shafts 36 and 40 to permit the introduction of a predetermined quantity of outdoor air which is mixed with the room air admitted to the unit. In the type of operation identified as A.S.H.A.E. Cycle Y, the primary dampers remain in this position within a predetermined temperature range corresponding to the pressure range of 6 to 9 p.s.i., and do not operate to change the proportions of outdoor and room air unless the room temperature drops below or exceeds the limits of this temperature range. Within approximately this same temperature range, the bypass damper is displaced back and forth between its extreme positions to control the relative quantities of air directed through and around the coil. Specifically, within this range, upon an increase in room temperature, the bypass damper is moved to increase the quantity of air bypassing the coil, and upon a decrease in room temperature, the bypass damper is moved to increase the quantity of air directed through the coil. Upon an increase in room temperature above the upper temperature limit in which a minimum quantity of outdoor air is introduced, the bypass damper is maintained in a position in which all air bypasses the coil and the primary dampers are moved to a position to increase the outdoor air and decrease the room air, thereby obtaining cooling with outdoor air.

In a cooling operation, the primary dampers are positioned to introduce a limited amount of outdoor air, or none at all, and the bypass damper is operated, within a predetermined temperature range, to increase the quantity of air directed through the coil (which now receives a cooling medium) upon an increase in room temperature, and to decrease the quantity of air directed through the coil upon a decrease in temperature. With a room temperature above the upper limit of this temperature range, the bypass damper will be positioned to direct all of the air through the coil, while with a room temperature below the lower limit of the temperature range, all air will be directed to bypass the coil.

The invention claimed is:

1. In an air conditioning unit for a room: a cabinet having air inlet means for admitting outdoor air and room air into said cabinet, and air outlet means through which air is discharged from said cabinet; blower means for inducing air flow through said cabinet; primary damper means for controlling the proportions of outdoor and room air admitted to said cabinet; heat exchange means mounted between said air inlet means and said air outlet means, with its lower edge adjacent the rear wall of said cabinet and its upstream face extending upwardly and forwardly across a portion of said cabinet interior to define generally, along its upper forward edge, the rear boundary of a bypass passageway; and means for directing the flow of air to said air outlet means, including bypass damper means having a trough-like extremity forming an air baffling portion displaceable from a first extreme position wherein the upstream face of said heat exchange means is covered by said trough-like extremity to an opposite extreme position wherein said bypass passageway is covered by said trough-like extremity.

2. The air conditioning unit of claim 1 including: means for limiting the displacement of said bypass damper means at said first extreme position, said limiting means being in the form of inwardly projecting ledge means cooperating with the ends of said extremity to seal against air flow through said heat exchange means.

3. The air conditioning unit of claim 1 wherein: said trough-like extremity of said bypass damper includes a face portion disposed, when said bypass damper is displaced to its first extreme position, to deflect air flow in a direction away from said heat exchange means.

4. The air conditioning unit of claim 3 wherein: said trough-like extremity is generally triangular in cross-section and is supported by an openwork frame pivotally supported along an axis adjacent the front of said cabinet and generally opposite the upstream face of said heat exchange means.

5. The air conditioning unit of claim 4 including: means for substantially balancing said bypass damper.

6. The air conditioning unit of claim 1 wherein: said blower means comprise individual, spaced centrifugal fans within scroll-like housings having opposite annular air inlets, said housing being mounted adjacent said air outlet means; and said air flow directing means include vanes disposed between adjacent housings.

7. The air conditioning unit of claim 6 wherein: said directing vanes include upper and lower, oppositely-disposed arcuate baffles.

8. In an air conditioning unit: a cabinet having air inlet means for admitting outdoor air and room air into its lower portion, and having air outlet means in its upper portion; blower means for inducing air flow through said cabinet; heat exchange means adapted to receive a cooling medium, said heat exchange means being disposed with its lower edge adjacent the rear wall of said cabinet and inclined forwardly across a portion of said cabinet interior; damper means associated with said air inlet means and said heat exchange means for controlling the flow of air through said cabinet; drip pan means disposed below the lower edge of said heat exchange means to receive condensate from said heat exchange means; frame means secured to said drip pan means and extending forwardly therefrom across an air flow passage interconnecting said lower and upper cabinet portions; means for slidably supporting said frame means and drip pan means in said position; and access means on the front of said cabinet to permit said frame means and drip pan means to be removed forwardly from said cabinet.

9. The air conditioning unit of claim 8 wherein: said frame means includes means to support an air filter unit in a position extending across said interconnecting air flow passage.

10. The air conditioning unit of claim 8 wherein: said frame means includes means on its periphery for positioning said frame means.

11. The air conditioning unit of claim 9 wherein: said frame means is open along its front edge so that said air filter unit may be removed or inserted without disassociating said frame means from said cabinet.

12. The air conditioning unit of claim 8 wherein: said drip pan means is relatively shallow with its bottom elevated on its closed end, and becomes progressively deeper and narrower in the direction of its open end.

13. The air conditioning unit of claim 12 including: an upwardly open cup-like condensate accumulator disposed in the end compartment of said cabinet to underlie the open end of said drip pan means; and means for releasably securing said accumulator in said position.

14. In an air conditioning unit for a room: a cabinet including air inlet means for admitting outdoor air and room air into its lower portion, and air outlet means for discharging conditioned air from its upper portion; a series of spaced centrifugal blowers associated with said air outlet means; primary damper means mounted in said lower portion for controlling the admission of outdoor air and room air into said lower portion; a panel extending forwardly from the rear wall of said cabinet to define the rear edge of a passageway interconnecting said lower and upper cabinet portions; heat exchange means adapted to selectively receive a medium of one temperature character for a cooling operation and of another temperature character for a heating operation, said heat exchange means having its lower edge disposed above and spaced from said panel and its upstream face inclined forwardly to extend across a portion of said cabinet upper portion; a bypass damper including a trough-like extremity and an openwork frame portion, said bypass damper being rotatably mounted on an axis generally opposite the upstream face of said heat exchange means to permit displacement thereof between first and second extreme positions wherein the air flow is directed through and around said heat exchange means respectively; and, a drip pan-filter frame assembly slidably mounted in said cabinet with the drip pan disposed between said panel and the lower edge of said heat exchange means and the filter frame extending across said interconnecting passageway.

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