March 5, 1963 R. W. ABBOTT 3,079,768

CONDENSATE DISPOSAL ARRANGEMENT FOR AIR CONDITIONING APPARATUS

Filed Oct. 25, 1961

FIG. 1

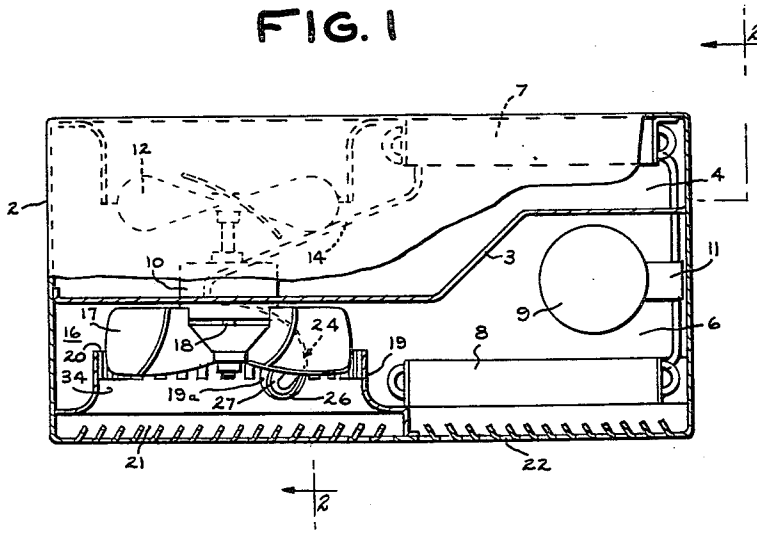


FIG. 2

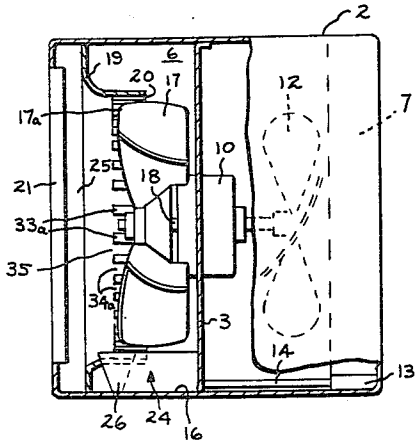
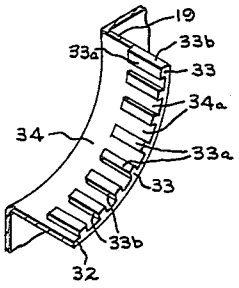


FIG. 3



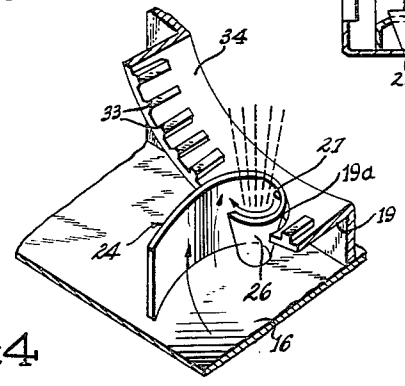


FIG. 4

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CONDENSATE DISPOSAL ARRANGEMENT FOR AIR CONDITIONING APPARATUS

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The present invention relates to air conditioning apparatus and more particularly to an arrangement for disposing of water which condenses out of the air stream circulated through the cooling unit of an air conditioning apparatus.

Although the invention is particularly applicable to condensate disposal means utilized in reversible-flow type air conditioners which are used as a means for cooling air in the summer and as a source of heat in the winter, it will be understood that the invention is also applicable to the ordinary air conditioner that is permanently installed in an outer wall of an enclosure and is used only for ventilating or exhaust purposes during the winter months. For purposes of illustration, however, the invention will be shown and described in connection with a room air conditioner which may be utilized for both heating and cooling an enclosure.

Some of these units employ a reversible-type refrigeration system containing two heat exchangers, one located within an inner compartment of a unit which is exposed to indoor air and a second heat exchanger which is located in an outer compartment which is exposed to outdoor air. A pair of fans are usually provided in the unit for circulating separate air streams from the enclosure and from the outdoors respectively through the inner and outer compartments of the unit. One problem associated with units of this type is the disposal of condensate water which condenses out of the air stream being circulated over the evaporator. It is the usual practice to collect this water in a sump positioned in the outer compartment of the conditioning unit.

Means must be provided in the conditioning unit for disposing of this condensate water as it collects within the sump of the unit. Various arrangements have been previously used for this purpose, one of which is set forth in patent application S.N. 118,730 filed June 21, 1961 jointly by the present inventor and W. J. Preising and assigned to the assignee of the present application. The water disposal arrangement of the above-mentioned patent application is adapted to lift water droplets out of the condensate sump and deliver them to the outdoor fan where they are further atomized and carried out of the unit by the air stream being circulated by the fan. The present invention is an improvement over the above-mentioned joint application which was made prior to the present invention and which is to be regarded as prior art with respect to the present application.

In a condensate disposal arrangement wherein water is deposited onto the fan, a great deal of water is sprayed by the fan onto the surfaces of the fan orifice plenum which surrounds the fan. This water drains down the surfaces of the fan orifice plenum into the lower portions of the conditioning unit where it is collected and again delivered to the fan by the water lifting device. The rate of water disposal can be greatly enhanced in this type of condensate disposal arrangement by causing the water on the orifice surface to become entrained in the air stream directly from this surface rather than draining back into the lower portions of the conditioner.

Accordingly, it is an object of the present invention to provide an improved condensate water disposal arrangement for use in an air conditioner of the self-contained type.

A further object of the present invention is to provide an improved fan and fan orifice arrangement designed to aid the atomization of water delivered onto the fan orifice surface by a condensate disposal means.

More specifically, it is an object of the present invention to provide a new and improved fan orifice structure adapted to take advantage of air flow characteristics of an axial flow fan to atomize condensate water delivered on to the surface of the fan orifice.

Further objects and advantages of the invention will become apparent as the following description proceeds, and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In carrying out the objects of the present invention, there is provided an air conditioning unit of the self-contained type including a refrigeration system having an evaporator which frequently condenses water out of an air stream circulated thereover for cooling purposes. The unit is provided with at least one compartment having openings through which outdoor air may be circulated by means of a fan mounted within the compartment. In order to direct outdoor air onto the fan, the compartment is provided with a fan orifice member having an inner surface adjacent the trailing edge of the orifice member surrounding at least the forward portions of the fan blades. Means are provided in the unit for collecting condensate water forming on the evaporator and depositing this water on the surface of the orifice member. The surface of the orifice member is provided with a plurality of upraised water barrier segments that obstruct the flow of water around the surface of the orifice member and which cooperate with the fan blades to spray, in small droplets, the condensate water collected between the segments.

For a better understanding of the invention reference may be had to the accompanying drawing in which:

FIGURE 1 is a plan view partially in cross-section of an air conditioner having the condensate disposal arrangement of the present invention;

FIGURE 2 is a partial elevation view taken along line 2—2 of FIGURE 1 illustrating the arrangement of the condensate water collection sump and one means for lifting water onto the condenser fan orifice member;

FIGURE 3 is a perspective of a small portion of the fan orifice member showing in detail the construction thereof; and

FIGURE 4 is a perspective view taken from the downstream side of the fan orifice illustrating the operation of the vortex-type water lifting device.

Referring now to FIGURE 1, there is shown an air conditioner of the reversible refrigerant flow type which is adapted to be positioned within an opening in an outer wall of an enclosure. The unit comprises a casing 2 divided by the barrier 3 into an inner compartment 4 and an outer compartment 6 within which there are mounted respectively an indoor heat exchanger 7 and an outdoor heat exchanger 8. The heat exchangers 7 and 8 are connected in refrigerant flow relationship with a compressor 9 also positioned within the outer compartment 7. In the illustrated embodiment of the invention, the refrigeration system is provided with a reversing valve 11 which may be selectively operated to reverse the flow of refrigerant to the heat exchange units 7 and 8. Suitable expansion means (not shown) is provided between the heat exchangers 7 and 8 for expanding liquid refrigerant from condenser pressure to evaporator pressure during flow of refrigerant in either direction through the system. One expansion means well known in the art for this purpose is a capillary which may be used to expand refrigerant in either direction during flow of refrigerant through the system.

When the conditioner is in operation, air is drawn from within the room and circulated by an air moving means or fan 12 through the inner compartment 4 of the conditioner and passed over the heat exchanger 7. The fan 12 is driven by a motor 10 mounted in the barrier 3. During operation of the unit on cooling cycle, the heat exchanger 7 is operated as an evaporator and moisture from the air being circulated over the heat exchanger 7 is condensed onto the coil surfaces of the heat exchanger 7. Means are provided for collecting this condensate water and delivering it to a condensate sump 16 formed in the base of the unit in the outer compartment of the air conditioner. More specifically, as seen in FIGURE 2, these means include a suitable drip tray 13 from which condensate water is delivered to the sump 16 through means of an insulated conduit 14. The water receptacle or sump 16, in the embodiment of the invention shown in the drawings, forms the entire bottom of the case 2 in the outer compartment 6 of the conditioner.

In order to circulate an outdoor air stream through the unit, or through the outer compartment 6, there is provided an air circulating means or fan 17 which is, in the illustrated embodiment of the invention, also driven by the motor 10 through means of the shaft 18. The outdoor fan 17 draws outdoor air into the unit through suitable openings formed in the outer portions of the case. In the embodiment of the invention illustrated, an inlet opening 21 delivers air into an orifice member 19 which directs the air onto the fan 17 and which separates the upstream and downstream portions of the compartment 6. Air is circulated by the fan 17 inwardly through the orifice opening toward the barrier 3, where it is diverted radially along the barrier into the remaining portions of the outer compartment 6. In the embodiment of the invention shown, the outdoor air then flows through the right hand portion (as seen in FIGURE 1) of the outer compartment 6 where it passes through the heat exchanger 8 and is discharged to the outdoors through the outlet opening 22.

During operation of the unit on the heating cycle, the outdor compartment heat exchanger 8 is employed as an evaporator or cooling unit and condenses moisture out of the outdoor air being circulated thereover. Condensate water, collecting on the coils of the outdoor heat exchanger 8, then drains into the bottom of the outer compartment 6 or into the sump 16 which is formed by the bottom of the outer compartment.

It should be noted that the water receptacle or sump 16 may take on any desirable form and is, of course, not limited to the arrangement wherein the water receptacle forms the entire bottom of the outer portion of the case. However, inasmuch as the present water disposal arrangement envisions the spraying of water into the outer compartment, it is desirable that the sump be adapted to collect water in this compartment which may not be evaporated or carried out of the compartment by the air stream circulated therethrough so that the water may be again returned to the water disposal means.

In accordance with the present invention means are provided for delivering condensate water onto the inner surface 34 of the orifice member 19. In the illustrated embodiment of the invention as may best be seen in FIGURE 4, water is lifted from the condensate sump and thrown into the fan and onto the surface of the orifice member 19 by an air reaction device, such as that described in the aforementioned joint application S.N. 118,730 of the present inventor and Mr. W. J. Preising. While many means may be utilized for accomplishing this purpose, such as a pump arranged in the sump 16, the illustrated arrangement utilizes an air vortex generator 24 which diverts a small portion of the air flowing from the outdoor fan 17 (omitted in FIGURE 4) and creates a stabilized air vortex or whirling mass of air directed upwardly through a suitable hole or notch 19*a* formed in the lower portion of the orifice member 19. As described in the aforementioned joint application, the vortex generator 24 is reversely looped at one end to form an eye section 26 of spiral or C-shaped cross-section. The inner wall surface 27 of the eye section 26 is slanted or flared outwardly from the bottom thereof toward the top to define a substantially inverse shaped frusto-conical cavity communicating at its lower or smaller end with water in the sump 16. The wall 27 slants from a relatively small opening at the bottom thereof to relatively large opening at the top and causes air diverted by the generator to flow in a generally circular path and to swirl about an axis passing through the center of the eye section as illustrated by the arrows in FIGURE 4, and discharges upwardly through the hole 19*a* formed in the orifice member. Water is drawn into the lower portion of the eye section 26 of the vortex generator and is lifted, in small droplets represented by the dotted lines in FIGURE 4, by the vortex created in this air stream to carry these droplets onto the forward surface of the orifice member 19 and into the fan 17. Some of the water thrown onto the fan 17 is also sprayed outwardly onto the rearward surface of the orifice member 19. In this manner, whenever the outdoor fan 17 is rotating, a small amount of the air is diverted into the eye section 26 of the vortex generator 24 to lift water onto the surface of the orifice member 19 for disposal as will be hereinafter explained.

Referring now to FIGURE 3, there is shown a partial cross-sectional view of the orifice member 19 of the present invention. It will be noted that toward the rear or trailing edge 32 of the orifice member 19, it is provided with a plurality of water barrier members comprising longitudinal upraised segments or protuberances 33. The longitudinal barrier segments 33 have sides 33*b* protruding sharply upwardly from the surface 34 of the orifice surface and are spaced around the entire circumference thereof. In the illustrated embodiment the segments 33 are straight members and are rectangular in shape. However, curved segments having other cross-sectional shapes may be utilized so long as they provide an obstruction to the flow of water which tends to flow around the surface of the orifice member 19 in the direction of fan rotation. The protuberances 33 are spaced evenly around the inner circumference of the orifice 19 and are disposed, in the preferred embodiment of the invention, generally parallel to the axis of the orifice.

An orifice member 19 of this general structure has been manufactured out of plastic with the upraised segments formed integrally with the member. However, the orifice may obviously be formed of any structural material and the segments 33 attached in any well known manner such as by soldering or brazing. Thus, as may be seen upon reference to FIGURE 3, the trailing surface of the orifice member 19 takes on a substantially spline-shaped appearance with adjacent segments 33 having passages or grooves 34*a* therebetween.

It has been found that water deposited upon the surface of an orifice member, not provided with water barrier segments, merely flows around the inner surface of the orifice in the direction of rotation of the fan. Although some of the water might be blown off the trailing edge of such an orifice, the major portion of the water merely flows around the surface of the orifice to the bottom portions of the orifice and then drains into the sump. The water barrier segments break up this flow of water in a circular path around the surface of the orifice. In the arrangement of the present invention, the sides 33*b* of the barrier segments obstruct the flow of water around the surface 34 of the orifice and cause the water to collect in the grooves or passages 34*a* between the adjacent segments.

It is well known in the art that all axial flow fans have a certain amount of radial air flow from the fan blades thereof. Thus, as may be seen in the FIGURE 3 of the drawing, the fan blades of the outdoor fan which sweep rather closely adjacent the upper surfaces 33*a* of the protuberances 33 have a certain amount of radial flow dis-

charging from these blades toward the surface of the orifice member. As this radial flow encounters the sides 33*b* of the protruding segments 33, it is diverted toward the trailing edge 32 of the orifice and flows along the grooves or passages 34*a* on the trailing surface. This air flow forces water collecting in the grooves 34*a* between the upraised members 33 to be swept rearwardly and carried off trailing edge 32 of the orifice member. The sweeping action of the fan blades over the segments 33 also creates a turbulent condition in the areas adjacent the segments 33 which aids the action and breaks up the water, collecting in the grooves 34*a*, into finely atomized particles which are then carried out of the air conditioner by the air stream flowing through the outer compartment.

The water droplets sprayed from the passages or grooves 34*a* of the orifice member encounter the air stream being circulated by the fan 17 through the outer compartment and become entrained in this air stream. The water droplets are then carried onto other components in the outer compartment, such as onto the heat exchanger 8, or are carried by the air stream to the outdoors through the opening 22. Any droplets, falling or draining to the floor or sump 16 in the outer compartment, are returned to the vortex generator 24, or to whatever means are used to raise the water onto the orifice member. It may be desirable for this purpose to slant the floor of the receptacle or sump 16 toward the vortex generator 24 to assure rapid disposal of all water in the outer compartment.

It will be understood that, while a mixed flow fan is illustrated in the drawings, a conventional axial flow fan will work effectively to break up the water droplets collecting on the orifice member 19. A mixed flow fan does however have a greater component of radial air flow than the conventional axial flow fan and, in this respect, forms a desirable combination with the previously described orifice structure.

While in accordance with the patent statutes there has been shown and described what at present is considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention and it is, therefore, the intent of the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A self-contained air conditioner for conditioning the air within an enclosure comprising a casing, means dividing said casing into an inner compartment having openings communicating with enclosure air and an outer compartment having openings communicating with outdoor air, an evaporator in said casing adapted to condense moisture out of an air stream circulated thereover, a condensate sump in said outer compartment, means for collecting and conveying condensate water from said evaporator to said condensate sump, an axial flow fan in said outer compartment having a plurality of fan blades adapted to circulate outside air through said outer compartment, an orifice member for directing outdoor air into said outer fan and having an inner surface surrounding at least the leading edges of said fan blades, means for lifting water out of said condensate sump and depositing said water onto the said inner surface of said orifice member, and a plurality of water barrier members disposed around the inner surface of said orifice member adjacent the trailing edge thereof to present an obstruction to the flow of water around the inner surface of said orifice member and causing said water to be blown off the trailing edge of said orifice member.

2. A self-contained air conditioner for conditioning the air within an enclosure comprising a casing, means dividing said casing into an inner compartment having openings communicating with enclosure air and an outer compartment having openings communicating with outdoor air, an evaporator in said casing adapted to condense moisture out of an air stream circulated thereover, a condensate sump in said outer compartment, means for collecting and conveying condensate water from said evaporator to said condensate sump, an axial flow fan in said outer compartment having a plurality of fan blades for circulating outdoor air through said outer compartment, an orifice member for directing outdoor air into said fan and having an inner surface surrounding at least the leading edges of said fan blades, means for lifting water out of said condensate sump and depositing said water onto the inner surface of said orifice member, and a plurality of longitudinal water barrier members spaced around the trailing surface of said orifice member, said water barrier members protruding from said surface of said orifice member and extending from the trailing edge of said orifice member toward the upstream portions thereof so that they obstruct the flow of water around the inner surface of said orifice member in the direction of rotation of said fan thereby causing water to collect in the space between said barrier members to be swept off the trailing edge of said orifice by radial flow air discharged against said surface of said orifice by said axial flow fan.

3. A self-contained air conditioner for conditioning the air within the enclosure comprising a casing, means dividing said casing into an inner compartment having openings communicating with enclosure air and an outer compartment having openings communicating with outdoor air, an evaporator in said casing adapted to condense moisture out of an air stream circulated thereover, a condensate sump in said outer compartment, means for collecting and conveying condensate water from said evaporator to said condensate sump, an axial flow fan in said outer compartment having a plurality of fan blades adapted to circulate a stream of outside air through said outer compartment, an orifice member for directing outdoor air into said fan and having an inner surface adjacent its trailing edges thereof surrounding at least the leading edges of said fan blades, means for lifting water out of said condensate sump and depositing said water onto said inner surface of said orifice member, a plurality of slender upraised water barrier members spaced evenly around said inner surface of said orifice member with relatively short spaces provided between said barrier members, said slender water barrier members extending from the trailing edge of said orifice member in the upstream direction and protruding from the surface of said orifice member to obstruct the flow of water around the inner surface of said trailing edge of said orifice member in the direction of rotation of said fan, said barrier members being so constructed and arranged as to cooperate with said surface of said orifice member to divert radial air flow from said fan through said spaces between said barrier members toward the trailing edge of said orifice member so that water is blown from the spaces between said barrier members into the air stream circulated through said outer compartment.

4. The air conditioning unit of the type set forth in claim 3 in which said slender barrier members are disposed substantially parallel to the axis of said orifice member and are provided with side surfaces arranged substantially normal to the surface of said orifice member.

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