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CONDENSATE DISPOSAL ARRANGEMENT FOR AIR CONDITIONING APPARATUS

Filed Oct. 25, 1961

FIG. 1

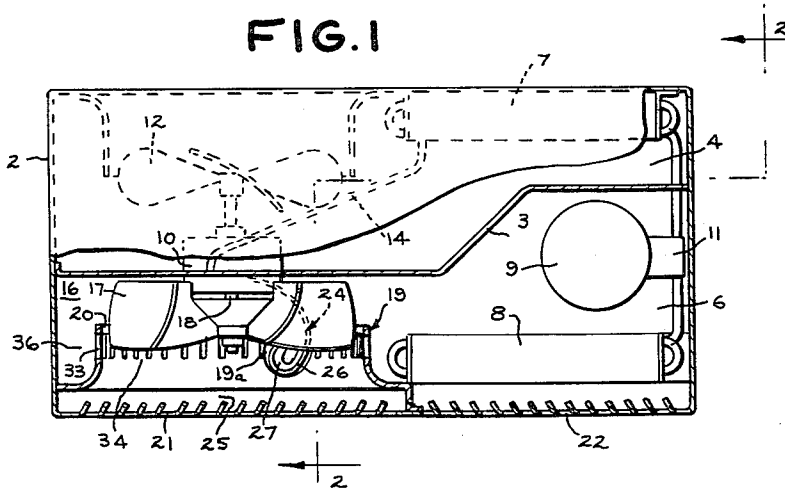


FIG. 2

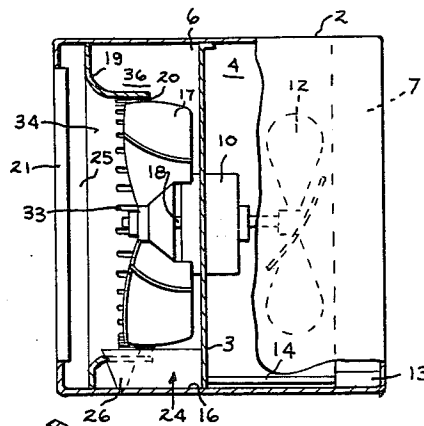


FIG. 3

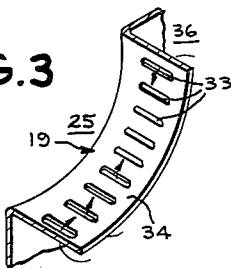


FIG. 4

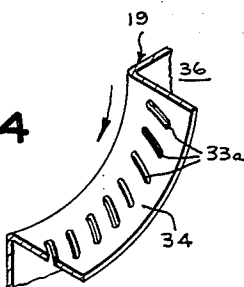
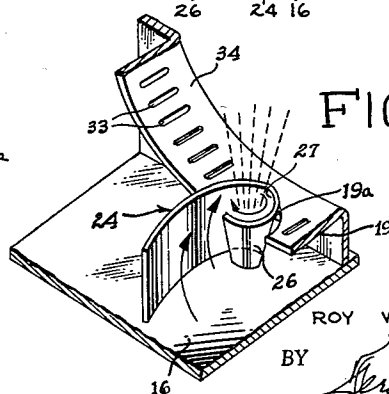


FIG. 5



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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.

One problem associated with air conditioning units of the type adapted for mounting in the outer wall of an enclosure is the disposal of condensate water which condenses out of the air stream being circulated over the evaporator of the air conditioner. Some means is usually provided in the air conditioning unit for disposing of the condensate water to the outside. Drains or conduits leading to the outside from the conditioner have been used but are considered undesirable in self-contained units of this type because they require additional conduits or other structure to carry the water away from the side of the building. Various arrangements have previously been used for entraining condensate water in the air stream being circulated through the outer compartment and in this way transferring the water onto the condenser of the refrigeration system in the outer compartment, or carrying the water to the outdoors in this air stream.

One of these arrangements is set forth in the patent application S.N. 118,730 having a filing date of June 21, 1961 and filed jointly by the present inventor and Mr. 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 invention.

In a condensate disposal arrangement wherein condensate water is distributed onto the fan, a great deal of water is sprayed by the fan onto the inner surfaces of the fan orifice member which directs the outdoor air stream into the fan. The water drains down the surfaces of the orifice member into the lower portion of the conditioning unit where it is again collected and delivered to the fan by some water lifting device, such as that disclosed in the aforementioned patent application. The rate of water disposal in an arrangement of this type can be enhanced by causing the water on the surface of the orifice member 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 arrangement whereby water delivered to the fan orifice surrounding a fan may be entrained in the air stream directly from the orifice surface rather than draining back into the lower portions of the conditioner.

Another object of the present invention is to provide an improved fan orifice designed to cause water droplets collecting on the surface of the orifice to be blown off the surface of the orifice and back onto the fan blades for further atomization by the fan.

Further objects and advantages of the invention will become apparent as the following description proceeds, and the features of novelty which characterize the inven-

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tion 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 a conventional air conditioning unit of the self-contained type adapted for mounting in an outer wall of an enclosure and including a refrigeration system having an evaporator which frequently condenses water out of the air stream being circulated therethrough for cooling purposes. The unit is provided with an outer compartment having openings communicating with outdoor air. A fan is provided for circulating outdoor air over components of the refrigeration system located in the outer compartment. A fan orifice member directs outdoor air into the fan and is provided with a surface surrounding at least the forward portions of the fan blades. The orifice member divides the outer compartment into an upstream or low pressure region and a downstream high pressure region. Means are provided in the unit for collecting condensate water forming on the evaporator of the unit and for depositing this water onto the fan blades and surface of the orifice member. In order to dispose of water which collects on the surface of the orifice member, a plurality of slots are provided around the orifice member through which air flows from the high pressure side of the orifice member to the low pressure side and blows droplets of water from the surface of the orifice member back onto the fan to be further atomized thereby.

For a better understanding of the invention reference may be had to the accompanying drawings 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 condensate fan orifice member;

FIGURE 3 is a perspective view of a small portion of the fan orifice member showing the slots arranged around the circumference thereof;

FIGURE 4 is a perspective view similar to FIGURE 3 illustrating another arrangement of the slots in the orifice member; and

FIGURE 5 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 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 a 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 6. 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 6 and 8. Suitable expansion means (not shown) is provided between the heat exchangers 7 and 8 for expanding liquid refrigerant from condensate pressure to evaporator pressure during flow of refrigerant in either direction through the system. One well known expansion means is a capillary which may be used in the system to expand refrigerant regardless of the direction of refrigerant flow 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. Fan 12 is

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driven by a motor 10 mounted in the barrier 3. During operation of the unit on the 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 may be 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.

In order to circulate air from the outdoors through the unit or through the outer compartment 6, there is provided an axial flow fan 17 which is, in the illustrated embodiment of the invention, also driven by the motor 10, mounted in the barrier 3, through means of the shaft 18. The outdoor fan 17 draws outdoor air into the unit through suitable openings formed in the outer portion of the case. More specifically, air enters the unit through inlet opening 21 and an orifice member 19 directs the air onto the fan 17. The orifice member 19 divides the upstream and downstream portions of the compartment 6 to provide a region 25 of relatively low pressure upstream from the fan 17 and a relatively high pressure region 36 on the downstream side of the orifice member 19 or in the downstream portions of the compartment 6. The fan blades direct the air stream rearwardly against the barrier 3 where it is diverted into other portions of the outer compartment 6. It will be understood that the air pressure at all places in the region downstream from the orifice member is of substantially high pressure as compared to the air pressure ahead of or upstream from the fan 17 in the region 25. This is because of the air resistance in the heat exchanger 8, which converts the velocity head produced by the fan into a pressure head in the portions of the outer compartment 6 downstream from the fan. Air forced through the heat exchanger 8 is then discharged to the outdoors through the outlet opening 22.

During operation of the unit on the heating cycle, the outdoor compartment heat exchanger 8 is employed as an evaporator or cooling unit and condenses moisture out of the air stream being circulated thereover. Condensate water, collecting on the coils of this heat exchanger, then drains into the bottom of the outer compartment 6 or into the sump 16 which forms 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 an arrangement wherein it 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 again be returned to the water disposal means.

In accordance with the present invention there is provided a means 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 FIG. 5, water is lifted from the condensate sump and distributed 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 other means may be employed for 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, as indicated by the arrows in FIG. 5, and creates a stabilized air vortex or whirling mass of air which is directed upwardly through a suitable hole or notch 19a formed in the orifice member 19. As described in the

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aforementioned 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 end with water in the sump 16. In other words, the wall 27 slants from a relatively small opening at the bottom of the eye section 26 to a relatively large opening at the top and causes air diverted by the generator to flow in a generally enlarging circular path to swirl about an axis passing through the center of the eye section and to discharge upwardly through the notch 19a formed in the orifice member.

Water is drawn into the lower portion of the eye section 26 of the vortex generator, which extends into water within the sump 16, and is lifted by the stabilized air vortex onto the surface 34 of the orifice member 19. As was pointed out in the aforementioned joint application, much of the water is thrown in droplets (as indicated by the dotted lines in FIG. 5) onto the fan member 17. Some of the water thrown onto the fan 17 is, of course, atomized and carried rearwardly into the compartment 6 and onto other components therein or carried out of the compartment in the air stream flowing therethrough. Some of the water is, however, sprayed from the fan 17 onto the surface 34 of the orifice member 19. In this manner, whenever the outdoor fan 17 is rotated, a great deal of water is delivered to the inner surface 34 of the orifice member 19 for disposal as will be hereinafter explained.

In FIGURE 3, there is shown a partial cross sectional view of the orifice member 19 of the present invention. It will be noted that the orifice member has a plurality of longitudinal slots or openings 33 provided therein. These slots 33 extend completely through the orifice member 19 and communicate respectively with the high pressure air on the downstream side (designated in FIGURE 3 by the reference numeral 36) of the orifice member 19 and with the low pressure air in the region 25 upstream from the fan or adjacent the fan blades. Air flows through the slots in the direction of the arrows shown in FIGURE 3. Water, which collects on the surface 34 of the orifice member 19, is blown around the surface 34 of the orifice member 19 in the direction of the rotation of the fan 17. This water encounters the slots 33 and the air recirculating therethrough and is blown in droplets or sheared off of the edges of the slots 33 into the fan 17 or into the air stream blown by the fan 17.

Referring now to FIGURE 4, there is shown another embodiment of the orifice member 19 in which the slots formed therein and designated 33a are arranged at an angle or slant with respect to the axis of the orifice opening or axis of the fan. By disposing the slots 33a at an angle or slant with their rear or downstream ends sloping in the direction of rotation of the fan 17 (as indicated by the arrow in FIGURE 4) it is possible to cause all of the water not carried off of the edges of the slots 33 to be forced along the surface of the orifice member toward the trailing edge thereof rather than flowing toward the upstream side thereof and draining downwardly into the bottom of the case. This causes the water to build up on the trailing edge surface 34 and overflow onto the downstream ends of the slots 33a. The water is then carried out of the slots by the air flowing therethrough and blown into the fan 17 to be atomized thereby.

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.

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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 outdoor air through said outer compartment, an orifice member for directing outdoor air into said fan and cooperating with said fan to divide said outer compartment into a relatively low pressure region on the upstream side of said orifice member and a relatively high air pressure region on the downstream side of said orifice member, said orifice member 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 said inner surface of said orifice member, a plurality of slots extending through said orifice member around the periphery of said surface surrounding said fan through which air from the downstream side of said orifice flows into the upstream side thereof towards said fan and blows water droplets from the edges of said slots onto said fan to be atomized thereby.

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 the 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 outdoor air through said outer compartment, an orifice member for directing outdoor air into said fan and cooperating with said fan to divide said outer compartment into a relatively low pressure region on the upstream side of said orifice member and a relatively high air pressure region on the downstream side of said orifice member, said orifice member 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 said inner surface of said orifice member, a plurality of slender longitudinal slots extending through said orifice member around the periphery thereof through which air from said high pressure region on the downstream side of said orifice flows into said low pressure region on the upstream side of said fan orifice, said slots being slanted with respect to the axis of said fan with said downstream portions of said slots sloping in the direction of the rotation of said fan so that water on the surface of said fan orifice member upon encountering said slots is blown from the surface of said orifice member onto said fan to be atomized thereby.

3. A self-contained air conditioner for conditioning the air within an enclosure comprising a casing, a barrier 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 con-

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dense 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 mounted in said outer compartment and having a plurality of fan blades adapted to draw air through said openings in said outer compartment and direct said air stream towards said barrier, an orifice member for confining the flow of said outdoor air stream into said fan and cooperating with said fan to divide said outer compartment into a relatively low pressure region on the upstream side of said orifice member and a relatively high air pressure region on the downstream side of said orifice member between said orifice member and said barrier, said orifice member 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 said inner surface of said orifice member, a plurality of slots extending through said orifice member around the surface thereof adjacent said fan blades through which air from said high pressure region on the downstream side of said orifice member flows through said orifice member into said low pressure region on the upstream side of said fan so that water on the surface of said fan orifice member is blown by said air flowing through said slots onto said fan to be atomized thereby.

4. 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 the enclosure air and an outer compartment having openings communicating with outdoor air, an axial flow fan in said outer compartment having a plurality of fan blades adapted to circulate an outdoor air stream through said outer compartment, a heat exchanger in said outer compartment through which said air stream flows from said fan, an orifice member for directing outdoor air into said fan and cooperating with said fan to divide said outer compartment into a relatively low pressure region on the upstream side of said orifice member and a relatively high air pressure region on the downstream side of said orifice member between said fan and said heat exchanger, an evaporator in said casing adapted to condense moisture out of the 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, means for lifting water out of said condensate sump and depositing said water onto said inner surface of said orifice member, a plurality of slots extending through said orifice member around the periphery thereof through which air from said high pressure region on the downstream side of said orifice member may flow through said slots towards said fan so that water on the surface of said fan orifice member is blown by air flowing through said slots onto said fan to be atomized thereby.

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