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ROOM AIR CONDITIONER CONDENSATE DISPOSAL

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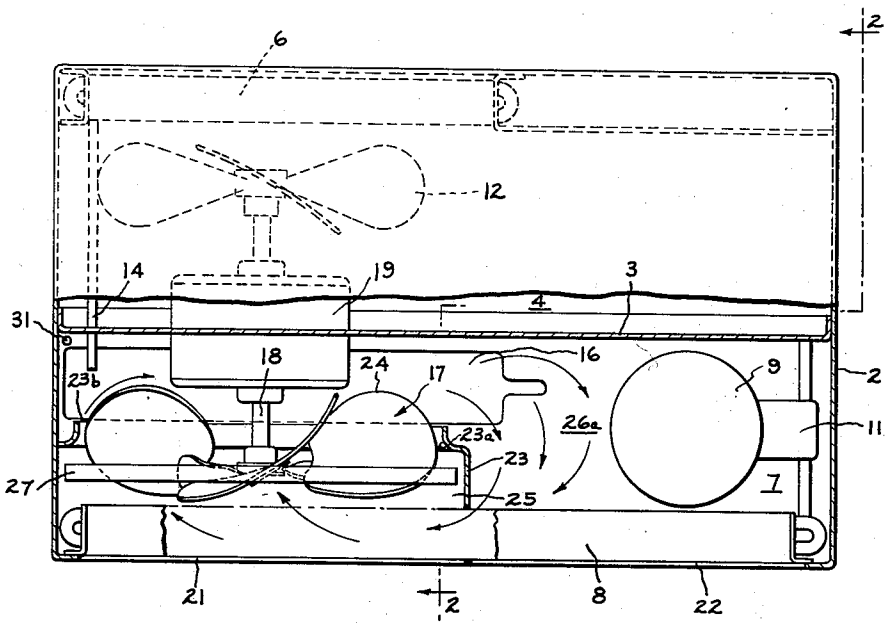

FIG. 1

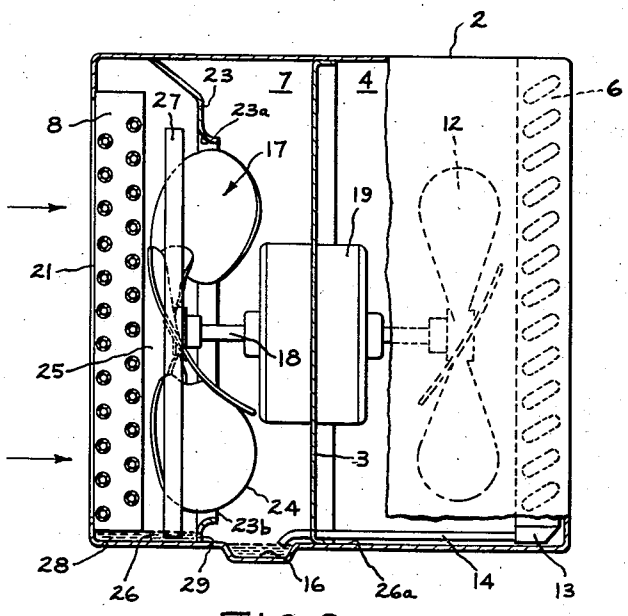

FIG. 2

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ROOM AIR CONDITIONER CONDENSATE DISPOSAL

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4 Claims. (Cl. 62—280)

The present invention relates to a rom air conditioning apparatus and more particularly to an arrangement for disposing of the condensate water from the sump of such apparatus even though the sump may at times be exposed to freezing weather conditions.

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 and used only for ventilation 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 the unit and exposed to indoor air while the other heat exchanger is located in an outer compartment which is exposed to the outdoor air. Fans or blowers are provided in the unit for circulating separate streams of air from the enclosure and the outdoors through the inner and outer compartments respectively. The refrigeration system is reversible for heating or cooling air circulated from the enclosure. A sump, normally positioned in the outer compartment of the conditioning unit, is utilized for collecting condensate water which condenses out of the air passing over the heat exchanger being utilized as an evaporator. In order to dispose of condensate water collecting within the sump, many conditioners employ a slinger ring which is attached to and surrounding the periphery of the fan in the outer compartment. The slinger ring extends or dips into the condensate water in the sump and, during rotation of the fan, throws water out of the sump onto the other components of the outer compartment; preferably onto the heat exchanger in the outer compartment.

In an air conditioning unit having the above-described type of slinger ring, there is a possibility, when the unit is used during the winter months, that the slinger might become frozen solidly within ice which forms in the condensate sump when the outdoor temperature drops below freezing. In such a case, the fan is prevented from rotating by the ice around the slinger and this either causes the fan motor to overheat or results in some other serious damage to the mechanical parts of the unit. In the ordinary non-reversible type air conditioners which remain mounted during the winter time and which are utilized for exhausting air from the enclosure, rain water and snow sometimes leak into the outer compartment of the unit and into the sump to become frozen solidly around the slinger on the fan. In such a case, when the conditioner is turned on to exhaust air from the enclosure or to provide ventilation for the enclosure, damage to the fan motor or other components could result.

It is, therefore, an object of the present invention to provide an improved condensate disposal arrangement of the type including a fan slinger which cannot become frozen into ice formed by the condensate water when the outdoor temperature drops below freezing.

It is another object of the present invention to provide

an air conditioning apparatus having an improved condensate disposal arrangement including a slinger, attached to the outer compartment fan, and a sump so arranged with respect to the fan and slinger that condensate water in the sump is in contact with the slinger only when the fan is in operation.

More specifically, it is an object of the present invention to provide an air conditioning unit having an improved condensate disposal arrangement in which the water in the condensate sump is caused to overflow onto an upper level in the proximity of the slinger by the air stream flowing through the outer compartment of the unit.

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 part of this specification.

In carrying out the objects of the present invention there is provided an air conditioning apparatus which is housed within a casing divided by a barrier into inner and outer compartments. The apparatus employs a refrigeration system including a pair of heat exchangers, one located within the inner compartment and the other located within the outer compartment. A fan is provided in the outer compartment and disposed downstream from the outer heat exchanger for circulating outside air through this heat exchanger and the outer compartment. An orifice plenum is provided between the fan and the outer heat exchanger for directing air into the fan. A condensate sump is disposed in the outer compartment at a level below the bottom of the chamber formed by the orifice plenum and adjacent thereto and means are provided for collecting condensate water from either of the heat exchangers and delivering the water to the condensate sump. The sump is positioned directly beneath at least the trailing edges of the fan blades so that air from the fan is blown along the top of the condensate water in the sump to force the water toward one end of the sump where it overflows the top of the sump onto the level of the bottom of the orifice plenum and through water inlets in the bottom of the orifice plenum into the bottom of the low pressure chamber between the outer heat exchanger and the fan. In order to remove this overflowing water there is provided, on the forward or upstream portions of the fan, a slinger ring which extends downwardly adjacent the bottom of the chamber and which dips into the water flooding from the sump into the bottom of the chamber to sling the water into the upper portions of the casing into the air stream. Whenever the fan is not operating all of the water in the chamber between the heat exchanger and the fan flows back into the sump so that there is no water left in the chamber to freeze around the slinger ring.

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

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

Fig. 2 is a partial elevation view taken along line 2—2 of Fig. 1 illustrating the arrangement of the condensate water collection sump and the level of the bottom of the orifice plenum relative to that of the sump.

Referring now to Fig. 1, there is shown an air conditioner of the reversible refrigerant flow type which is arranged to be positioned within an opening in an enclosure. The unit comprises a casing 2 divided by a barrier 3 into an inner compartment 4 and an outer compartment 7 within which there are mounted respectively an indoor heat exchanger 6 and an outdoor heat exchanger 8. The heat exchangers 6 and 8 are connected in refrigerant flow relationship with a compressor 9 also positioned in the outer compartment 7. In the illustrated

embodiment of the invention, the conditioner is provided with a reversing valve 11 which may be selectively operated to reverse the flow of refrigerant to the heat exchanger units 6 and 8. 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 6. The fan 12 is driven by a motor 19 mounted in the barrier 3. During operation of the unit on the cooling cycle, the heat exchanger 6 is operated as an evaporator and moisture from the air being circulated over the heat exchanger 6 is condensed onto the coil surfaces of the heat exchanger and drains downwardly into a suitable drip tray 13 from which it is delivered by means of an insulated conduit 14 to a condensate collection sump 16 formed in the base of the unit in the outer compartment 7 of the air conditioner.

In order to circulate outside air through the outer compartment, a fan 17 is provided which is driven by the motor 19 through the shaft 18. When the unit is operated, the outer compartment fan 17 circulates outside air inwardly through the inlet opening 21 and over the left-hand portion of the heat exchanger 8, as seen in Fig. 1. The outside air flows inwardly against the barrier 3 and is diverted radially along the barrier into the remaining portions of the outer compartment 7. In the embodiment of the invention shown, the outside air is then passed through the right-hand portion (as seen in Fig. 1) of the heat exchanger 8 and is then discharged to the outdoors through the outlet opening 22. When the air conditioning unit is operated on the cooling cycle, the outside air passing over the heat exchanger 8 cools this unit which is then operated as a condenser. When the unit is operating on the heating cycle, the reversing valve 11 reverses the flow of refrigerant to the heat exchangers 6 and 8 thereupon utilizing the heat exchanger 6 as a condenser and the heat exchanger 8 as an evaporator. During heating, air from within the room is blown by the fan 12 over the heat exchanger 6 to absorb heat from this unit while outside air is blown over the heat exchanger 8 which then acts as an evaporator to absorb heat from this air. The heat removed from the air by the heat exchanger 8 is then utilized, via the refrigeration system and the heat exchanger 6, to warm the room. During the heating cycle, the outer compartment heat exchanger 8, which is operated as an evaporator, condenses moisture out of the outside air. The condensed water drips from the heat exchanger 8 into the outer compartment 7 and drains into the condensate collection sump 16.

As thus far described, this air conditioner with its reversible heat exchange system forms no part of the present invention, but is intended only to be illustrative of one type of air conditioner to which this invention is particularly well adapted. It is not intended to limit the invention only to air conditioners of the reversible refrigerant flow type, as the invention is also very useful in the ordinary type air conditioner which may be permanently mounted in a wall or window of a room to provide ventilation and exhausting of air during the winter months. As will now be described, the invention deals with an arrangement for disposing of the condensate water which accumulates in the air conditioner sump during either the heating or cooling cycle operation.

As may be seen in the drawings, the heat exchanger 8, in the outer compartment, is disposed upstream from the fan 17. In other words the air must first flow through the heat exchanger 8 before being drawn into the fan and, because of the resistance to air flow of the heat exchanger 8, there is normally a low pressure area directly in front of the fan 17. In order to prevent the recirculation of air from the other portions of compartment 7 into this low pressure area and to provide a smooth entry for the air from the heat exchanger 8 into the fan 17, an orifice plenum 23 is provided between the fan and the left-hand portion of the heat exchanger 8. The chamber 25, encompassed by the orifice plenum 23 between the fan and the heat exchanger 8, is, during normal operation of the unit, at a much lower or negative air pressure than that found in the remaining portions of the outer compartment 7. The lower pressure of this area plays an important part in disposing of condensate water from the air conditioning unit as will be more fully explained hereinafter in the specification.

It will be noted that the condensate collection sump 16 is arranged directly beneath the trailing edges 24 of the fan 17 and lies directly behind the orifice plenum 23. As may be seen in Fig. 2, the bottom 26 of the orifice plenum is at the level of the bottom surface 26*a* of the casing 2. The sump 16 is formed as a depression in the bottom of the casing and is therefore slightly below the level of the bottom 26*a* of the casing or of the bottom 26 of the plenum chamber 25 which is at the same level as the bottom 26*a* of the casing. The sump 16 is so arranged that its maximum water level is just below the level of the bottom 26 of the orifice plenum. That is, if water were to overflow the condensate collection sump 16, it would overflow onto the level of the bottom 26*a* of the case or onto the level of the bottom 26 of the plenum chamber 25.

During operation of the fans of the air conditioning unit, the air stream entering the outer compartment 7 is pulled into the compartment through the heat exchanger 8 and into the orifice 23*a* of the orifice plenum 23. As stated previously, in the illustrated embodiment of the invention the air stream flows rearwardly against the barrier 3 where it is diverted radially into the remaining portions of the compartment. As will be noted in Fig. 2, the trailing edges 24 of the fan extend downstream toward the barrier 3 beyond the edge 23*b* of the orifice 23*a* and for a short distance above the sump 16. These trailing edges 24 of the fan 17 which extend downstream beyond the orifice 23*a* promote a certain amount of radial flow outwardly from the periphery of the fan blades and this, in combination with the radial flow created by the barrier, creates a vortex or swirling of air around the outer periphery of the fan in this portion of the outer compartment 7. With the fan rotating in a counterclockwise direction for pulling air into the unit, as shown in the illustrated embodiment of the invention, the vortex or air stream is also swirling in a counterclockwise direction. This creates an air stream or blast of air flowing over the sump in a direction from left to right, as viewed in Fig. 1, or toward the viewer in Fig. 2.

Whenever water is within the sump, the blast of air flowing from the blades of the fan causes the water to be pushed along the condensate sump 16 from left to right or in the direction of the air flowing over the top of the sump. This blast of air causes the water to build up in the right-hand portion of the sump 16 and to overflow the sump onto the level of the bottom 26*a* of the case. The flooding water flows in the direction illustrated by the arrows in Fig. 1 onto the bottom 26*a* of the case which is, of course, at the same level as the bottom 26 of the plenum chamber 25. Water flows over the bottom of the case, as indicated by the arrows in Fig. 1, in the same general direction as the air flows through the outer compartment and, since the chamber defined by the orifice plenum is at a lower pressure than the remaining portions of the outer compartment, the flooding water tends to flow through openings (not shown) in the bottom of the plenum and through an opening 28 underneath the outer heat exchanger 8.

During rotation of the fan 17, condensate water builds up on the bottom 26 of the orifice plenum chamber to a depth sufficient to contact the lowest portions of a slinger ring 27 which is connected to the forward or upstream portions of the fan 17. The slinger ring 27 extends downwardly into the orifice plenum and is rotated by the fan with the outer periphery of the slinger moving very closely adjacent to the bottom 26 of the orifice

plenum. When there is a sufficient build up of water on the bottom 26 of the plenum chamber, it is picked up by the slinger 27 and thrown around the sides of the chamber formed by the orifice plenum and into the upper portions of the casing. The water becomes entrained in or evaporated by the air stream flowing through the outer compartment and is carried by this air to the outside. During summer operation, water, which is thrown into the upper portions of the casing by the slinger 27 and which collects on the heat exchanger 8, is vaporized by the heat given off by this heat exchanger and helps to cool this heat exchanger.

Whenever the unit is turned off and the fans are stopped, the water which has collected in the bottom of the orifice plenum seeks the lowest level within the outer compartment and, therefore, flows in a direction toward the condensate sump 16 which, as stated previously, is at a lower level than the bottom 26 of the plenum chamber or the remaining portions of the outer compartment. A plurality of holes 29, only one of which is shown in Fig. 2, are provided in the orifice plenum 23 adjacent the bottom 26 through which water may drain from the plenum chamber back into the condensate sump 16. The water drains from the bottom 26 of the plenum chamber 25 and leaves the lowest portion of the slinger 27 substantially above and free from any water remaining in this portion of the conditioner. Thus, if the fans are turned off when the outdoor temperatures go below freezing, the water flows back into the condensate sump 16 leaving the slinger 27 free from water, thereby eliminating any possibility of its becoming frozen into the ice which subsequently forms from the water.

It will be noted that, due to the low pressure in plenum chamber 26, there is no flow of water through the holes 29 toward the sump 16 during operation of the fans 17. The difference in the pressure in the area directly downstream from the fan behind the orifice plenum 23 and that in the plenum chamber 25 causes air to flow through these holes 29 in a direction from the area behind the fan toward the chamber 25 thereby preventing any flow of water in the opposite direction.

As a further safeguard against freezing of the slinger 27 whenever there is a tremendously large build-up of water in the outer compartment 7 of the unit, such as is likely to occur whenever rain or snow have been blown into the outer compartment, or, in the reversible refrigerant flow type units when the outer heat exchanger is defrosted thereby melting the ice formed on this unit which drains down into the outer compartment, there is provided an overflow drain hole 31 in the bottom of the outer compartment 7. This hole 31 is positioned on the same level as the bottom 26 of the chamber 25 or on the same level as the bottom 26*a* of the outer casing. In order to prevent water from entering this drain hole during normal conditions of operation, the drain hole is positioned at the end of the sump not likely to be exposed to overflow condensate water. In other words, the drain hole 31 is disposed in the casing at the same level as the top of the condensate collection sump 16 and at the end of the sump opposite from the direction that the air stream is being forced over the top of the sump by the rotation of the fan blades. This arrangement always keeps the water in the sump from flowing toward the drain hole except when the fan 17 is not rotating. Whenever the fan 17 stops rotating and the amount of water within the sump and on the upper levels of the outer compartment, such as on the bottom 26 of the chamber 25 and on the bottom 26*a* of the case 2, is sufficient to overflow the sump, then the overflow water will drain through the drain hole 31.

In the embodiment of the invention shown, the air flow from the fan 17 is directly against the barrier 3 and, although not considered absolutely essential to the invention, this arrangement does promote the most desirable type of air flow over the condensate sump 16. Thus, as may be seen in Fig. 1, the only direction in which air can flow along the barrier 3 is toward the right-hand portions of the compartment 7. Therefore, the action of the fan blades in combination with the resultant air flow from the barrier 3 causes the air flowing over the condensate sump 16 to continually be from left to right. However, this arrangement of the barrier and the fan blades is not considered to be an absolutely essential feature since the fan blades themselves if positioned properly with respect to the sump can promote sufficient air flow in one direction over the sump to attain overflow of the water from the sump. As long as the trailing edges of the fan blades extend downstream beyond the edge 23*b* of the orifice 23*a* and the sump is properly positioned with respect to the periphery of the fan, there will always be a stream of air in one direction over the top of the sump. In a tested embodiment of the invention of the type illustrated by the drawings, with the barrier 3 positioned closely behind the fan 17 and with the trailing edges of the fan extending 1½ inches beyond the edge 23*b* of the orifice opening 23*a*, it was found that 4 inches was the maximum permissible distance between the top of the sump and the lowest point on the fan periphery.

Furthermore, although the location of the sump and fan adjacent one side of the case, as shown in the illustrated embodiment of the invention, enhances the flow of air over the sump in one direction, the fan and sump can be disposed at any place in the compartment, such as in the center of the compartment. Merely by adjusting the distance between the top of the sump and the periphery of the fan, it is possible to obtain a sufficient air flow across the top of the sump in one direction which will cause the water in the sump to overflow at one end or the other of the sump depending upon the direction of rotation of the fan.

By the present invention there has been provided a self-contained air conditioning apparatus having an improved condensate disposal arrangement of the fan slinger type for removing condensate water which collects in the unit from the moisture condensing on the heat exchangers of the unit. This simple arrangement completely eliminates the possibility of freeze-up of the condensate slinger attached to the periphery of the fan blades as well as the damage likely to result to the fan motor or other components of the air conditioning unit from such a freeze-up.

While in accordance with the patent statutes there has been shown and described what at present is considered to be the preferred embodiment of this 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 adapted to be mounted in an aperture in an outer wall of said enclosure, a barrier in said casing dividing said casing into an inner compartment having a side exposed to the enclosure and an outer compartment having a side exposed to the outdoors, inner and outer heat exchangers mounted respectively in said inner and outer compartments, air inlet and outlet openings in said outer compartment, a fan for circulating outside air through said outer compartment and over said outer heat exchanger, said fan being positioned downstream from said outer heat exchanger, means including an orifice plenum between said outer heat exchanger and said fan for directing air into said fan from said outer heat exchanger and for creating a chamber between said outer heat exchanger and said fan, a condensate water collection sump positioned in said

casing at a level below the bottom of said chamber with the top of said sump being on the same level with the bottom of said chamber, means for collecting condensate water from said heat exchangers and delivering said water to said condensate sump, said sump also being positioned directly beneath at least the trailing edges of said fan blades so that air from said fan is blown along the top of said condensate water in said sump to force said water toward one end of said sump causing said water to overflow said sump onto the level of the bottom of said chamber, water inlets at the bottom of said orifice plenum for permitting condensate water overflowing said sump to flow into the bottom of said chamber between said outer heat exchanger and said fan, and a slinger ring connected to the upstream portions of said fan and extending into the bottom of said chamber for picking up the overflow water in the bottom of said chamber and slinging said water into the upper portions of said case.

2. A self-contained air conditioner for conditioning the air within an enclosure comprising a casing adapted to be mounted in an aperture in an outer wall of said enclosure, a barrier in said casing dividing said casing into an inner compartment having a side exposed to the enclosure and an outer compartment having a side exposed to the outdoors, inner and outer heat exchangers mounted respectively in said inner and outer compartments of said casing, air inlet and outlet openings in said outer compartment, a fan for circulating outside air through said outer compartment and over said outer heat exchanger, said fan being positioned downstream from said outer heat exchanger and being so disposed that air from said fan is directed against said partition and diverted radially along said partition into said remaining portions of said outer compartment, means including an orifice plenum between said outer heat exchanger and said fan for directing air into said fan from said outer heat exchanger and for creating a lower pressure chamber between said outer heat exchanger and said fan, a condensate water collection sump positioned in said case at a level below the bottom of said low pressure chamber with the top of said sump being on the same level with the bottom of said chamber, means for collecting condensate water from said heat exchangers and delivering said water to said condensate sump, said sump being positioned directly beneath at least the trailing edges of said fan blades so that air from said fan is blown along the top of said condensate water in said sump to force said water toward one end of said sump thereby causing said water to overflow said sump onto the level of the bottom of said low pressure chamber, water inlets at the bottom of said orifice plenum for permitting condensate water overflowing said sump to flow into the bottom of said low pressure chamber between said outer heat exchanger and said fan, and a slinger ring connected to the upstream portions of said fan and extending downwardly adjacent said bottom of said low pressure chamber for picking up the overflow water in the bottom of said chamber and slinging said water into the upper portions of said case.

3. A self-contained air conditioner for conditioning the air within an enclosure comprising a casing adapted to be mounted in an aperture in an outer wall of said enclosure and including a bottom, top and side walls, a barrier in said casing dividing said casing into an inner compartment having a side exposed to the enclosure and an outer compartment having a side exposed to the outdoors, inner and outer heat exchangers mounted respectively in said inner and outer compartments, air inlet and outlet openings in said outer compartment, a fan for circulating outside air through said outer compartment over said outer heat exchanger, said fan being positioned downstream from said outer heat exchanger and disposed adjacent one side wall of said casing, means including an orifice plenum between said outer heat exchanger and said fan for directing air into said fan from said outer heat exchanger and for creating a low pressure chamber between said outer heat exchanger and said fan, a condensate water collection sump positioned in said case at a level below the bottom of said low pressure chamber with the top of said sump being level with the bottom of said chamber, means for collecting condensate water from said heat exchangers and delivering said water to said condensate sump, said sump also being positioned directly beneath at least the trailing edges of said fan blades so that air from said fan is blown along the top of said condensate water in said sump to force said water toward the end of said sump remote from said side wall of said casing thereby causing said water to overflow said sump onto the level of the bottom of said low pressure chamber, water inlets at the bottom of said orifice plenum for permitting condensate water overflowing said sump to flow into the bottom of said low pressure chamber, and a slinger ring connected to the upstream portions of said fan and extending downwardly adjacent the bottom of said low pressure chamber for picking up said overflow water in the bottom of said chamber and slinging said water into the upper portions of said case.

4. A self-contained air conditioner for conditioning the air within an enclosure comprising a casing adapted to be mounted in an aperture in an outer wall of said enclosure and including a bottom, top and side walls, a barrier in said casing dividing said casing into an inner compartment having a side exposed to the enclosure and an outer compartment having a side exposed to the outdoors, inner and outer heat exchangers mounted respectively in said inner and outer compartments, air inlet and outlet openings in said outer compartment, a fan for circulating outside air through said outer compartment over said outer heat exchanger, said fan being positioned downstream from said outer heat exchanger and disposed adjacent one side wall of said casing, said fan being rotatable in a direction so that said fan blades are moving away from said one side wall during the lower half of their rotational cycle, means including an orifice plenum between said outer heat exhanger and said fan for directing air into said fan from said outer heat exchanger and for creating a low pressure chamber between said outer heat exchanger and said fan, a condensate water collection sump positioned in said case at a level below the bottom of said low pressure chamber with the top of said sump being level with the bottom of said low pressure chamber, means for collecting condensate water from said heat exchangers and delivering said water to said condensate sump, said sump also being positioned directly beneath at least the trailing edges of said fan blades adjacent said one side wall of said case so that air from said fan is blown along the top of said condensate sump in a direction away from said one side wall to force said water toward the end of said sump remote from said one side wall thereby causing said water to overflow said sump onto the level of the bottom of said low pressure chamber, water inlets at the bottom of said orifice plenum for permitting condensate water overflowing said sump to flow into the bottom of said low pressure chamber, a slinger ring connected to the upstream portions of said fan and extending downwardly adjacent the bottom of said low pressure chamber for picking up said overflow water in the bottom of said chamber and slinging said water into the upper portions of said case, and drain means positioned close to the end of said sump adjacent said one side wall of said casing, said drain means having an inlet on the same level as the bottom of said low pressure chamber whereby excess water in said sump drains from said case through said drain means when said fan is not operating.

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