Aug. 30, 1938. R. H. FOLSOM 2,128,641

DEHUMIDIFIER

Filed April 13, 1937

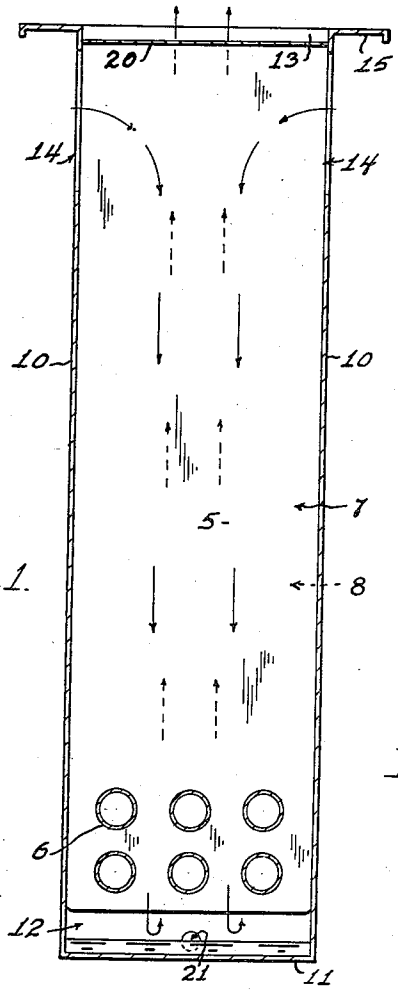


Fig. 1.

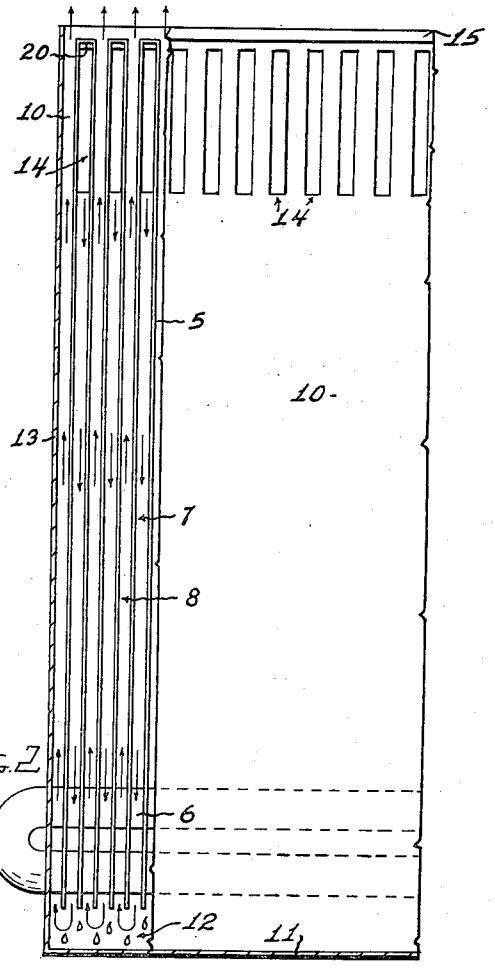


Fig. 2

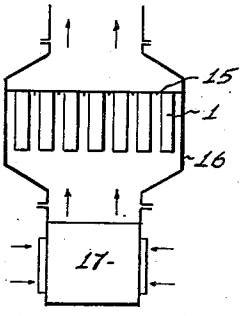


Fig. 3.

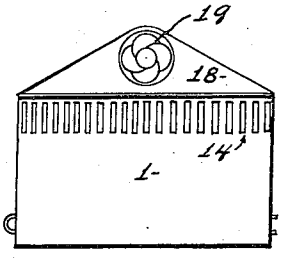


Fig. 4.

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DEHUMIDIFIER

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2 Claims. (Cl. 62—140)

My invention relates to air conditioning and has for its primary object to provide a dehumidifier, and particularly one for dehumidifying interior or recirculated air, in which all of the refrigeration expended is employed directly in lowering the temperature of the air from its dew point downwardly so that the dew point of an interior space may be controlled independently from the dry bulb temperature thereof.

It will be understood in the consideration of this invention that whereas full summer air conditioning is high in first cost and also in operating cost, dehumidifying without sensible cooling will provide comfort if properly carried out. It is therefore another object of the invention to so greatly reduce first cost and operating costs of dehumidifiers that those who cannot afford full summer cooling and dehumidifying may enjoy the luxury of dew point control at relatively small cost.

It will also be understood that usual cooling units expend a relatively large amount of refrigeration in cooling down to the dew point, and expend little refrigeration in cooling below the dew point then being maintained in the room. Also it will be understood that frequently too much cooling effect is produced in order to reasonably control the dew point. It is a further disadvantage of usual cooling plants, of the smaller types particularly, that they do not maintain dew points as low as is most conducive to comfort but usually effect some compromise between sensible cooling and dehumidifying.

It is therefore an object of this invention to provide a unit of the class described which in comparatively small sizes will act to dehumidify an interior without producing any appreciable sensible cooling effect; it being known that the human body will act as its own cooling plant when surrounded by suitably dry air.

A very important object of this invention, from the standpoint of low first cost is the provision of a mass-production article of manufacture which may be combined singly or in multiple with a refrigeration plant, a cold water supply or the like, to provide a highly efficient dehumidifier of any size from that suited only to a small room to that large enough to control the dew point of the interior of a large office building, hotel, apartment house, hospital, or the like.

Other objects and advantages of this invention will appear hereinafter.

I have illustrated my invention in the accompanying drawing in which:

Figure 1 is a vertical section of a unit or article of manufacture which incorporated in a duct system and supplied with a fan and refrigerant, will provide a complete dehumidifier for carrying out the invention and its objects.

Figure 2 is a view mainly in side elevation of the said unit; this view showing a part of the housing removed to reveal interior parts and to show the relationship of the heat-transfer surfaces.

Figure 3 is a diagram showing how several of these units may be used in a plenum chamber to provide a large dehumidifying plant.

Figure 4 is a face view of a small room dehumidifying unit constructed from a single unit such as shown in Figures 1 and 2.

The numeral 5 indicates a plurality of heat-transfer plates which, like the fins or extended surfaces of any refrigeration coil, are arranged in spaced parallel relationship. Each plate or fin divides the adjacent space into a corresponding reheating space or channel 8, and a corresponding pre-cooling space or channel 7. At one end spaced pairs of these plates are joined as by the integral web 20 so that the pre-cooling channels 7 are blocked-off at that end.

Near the inner end of the assembly of fins or plates 5, I provide, in this embodiment, a refrigeration coil 6 which passes several times thru the fins so that the inner end of the unit 1 is in reality an extended-surface dehumidifier coil. This dehumidifier is unique in that the fins extend in one direction a very appreciable distance away from the coil and provide a counter-current interchanger extending outwardly from the refrigerated end. It will be understood that, as in common practice, the coil is to be supplied with refrigerant and maintained at a temperature slightly above the freezing point of water; 35 degrees, for example altho only those portions of the fins 5, which are in the immediate vicinity of the coil will be refrigerated.

For the fin and coil assembly just described I provide an open-end box-like housing comprising side walls 10, 10, end walls 13, 13, and a water tight bottom wall 11. The fins fit snugly in this casing with the coil-end innermost but spaced a short distance from the bottom wall 11 to provide thereat a drip-chamber 12. This chamber is provided with the drain-opening 21 to carry away all precipitated moisture and drip from the coil 6 and adjacent portions of the fin. The extreme side edges 5a of the fins may be soldered to the walls 10, 10, in the usual manner to provide a decidedly rigid unit in which the fins are additionally alined and secured by

the webs 20 and the coil 6. With the fins in the housing the channels 7 and 8 respectively are completely defined; all channels intercommunicating with the chamber 12 and only the channels 8 opening out thru the top or outer open end of the casing or housing.

The channels 7 are each provided near the upper end with inlet ports 14, 14; one such port in each of the walls 10, 10, for each channel. Thus the pre-cooling channels 7 provide the communication between the chamber 12 and any air at the sides of the unit near the upper end, while the channels 8 provide communication between chamber 12 and the upper open end of the housing. Therefore, when a suitable differential is created air will flow in thru ports 14, down thru the channels 7, over the coil, into the chamber 12, then over the coil again and on thru the channels 8 and out at the top or outer end of the housing.

The air leaving the coils 6 is quite cold and in moving out thru the reheating channels 8 will be reheated in the act of pre-cooling air then moving inwardly thru the channels 7. In Figure 3 I have shown a plurality of units 1, joined in spaced relationship by their flanges 15 and fitting across a plenum chamber 16. This chamber is supplied by a common quite type blower 17 which forces air to the openings 14, 14 of the units 1. In Figure 4 I have shown a single unit 1 provided at the top with a suction hood 18 which in turn is provided with a fan 19. This fan operates to draw air from the upper end of the housing or unit 1 and thus induces air thru ports 14, 14. This unit may be placed directly within a room, while the large plant shown in Figure 3 may be used to dehumidify large amounts of recirculating air brought to it thru the duct system (not shown) common to large air-conditioned buildings. It will be apparent hereinafter that so much dehumidification is provided that only relatively small amounts of air need be circulated, and the first cost and operating cost for air-moving and refrigeration combined is low, as compared with plants which both cool and dehumidify.

It will be understood that the predetermined air velocity thru channels 7 and 8 shall be relatively low, due to the relatively great length thereof, so that undue fan-load is not created. It will also be understood that relationship of total surface of fins 5, to total surface of fins immediately adjacent the coils 6, is quite important to produce desired results. For example: if it is assumed that the unit shall operate at a predetermined air velocity and shall operate at maximum efficiency when the dry blub is at 80 degrees and a dew point of 55 degrees is to be main-tained in the space or interior which is being served, then the units should each perform as follows:—Air going in thru passages 7 should be pre-cooled thru a range of 25 degrees so as to reach the coil 6 at a temperature of 55 degrees; which temperature represents its dew point or saturation temperature. Now in passing first inwardly over the coil and adjacent fins, and then in again passing outwardly over the other sides of these fins, the air should be cooled a few degrees below 55 degrees; such as down to 45 degrees for example so that very appreciable lowering of the dew point is accomplished and so that the air entering passages 8 will then be cold enough to suitably pre-cool air coming in thru channels 7. Accordingly the outgoing air will be reheated thru a range of 25 degrees and will return to the room or duct, as the case may be, at a temperature of 70 degrees; this notwithstanding the fact that it was temporarily lowered to 45 degrees. This 70 degree return air will have very little cooling effect but will have a very appreciable evaporating effect before it reaches a dew point of 55 degrees. Under the conditions just assumed the interchanger shall act to pre-cool and reheat passing air thru a range of 25 degrees while operating at a 10 degree differential; which 10 degree temperature differential is produced by the refrigeration coils in the act of dehumidifying the air. The coil and adjacent fins are thus required to show a cooling coefficient of .50 in order to cool saturated air from 55 degrees to 45 degrees with a refrigeration temperature of 35 degrees. Of course the unit 1 may be designed for any other condition but a unit performing as assumed above will be found to meet practically all comfortable conditions. The unit may also be used for dehumidifying very humid atmospheric air and will act to pre-cool incoming air, sometimes even below its dew point, so that minimum refrigeration is used.

It will be understood that the coil 6 and adjacent fins alone, under the conditions assumed above, would be incapable of reducing the same amount of 80 degree air down to 45 degrees. In fact in the unit 1 much less refrigerated surface and coils are required per unit volume of air than are required in other cooling and dehumidifying units, and thereby the added cost of the interchanging, non-refrigerated portions of the fin, is partially offset. By confining all refrigeration expenditure to that required for cooling only below dew point it becomes possible in the majority of instances to control and maintain a decidedly comfortable dew point with a total first cost and a total operating cost about 33% that of providing both cooling and dehumidification. Also it will be understood that where the dew point of an interior is within the comfort range sensible cooling can be very economically carried out with the use of cool ground water or cooling-tower water.

The invention is not limited to the embodiments described; these embodiments being selected to illustrate the invention by reason of their simplicity and low cost. If higher air velocity should be used in unit 1 the fin surfaces near the coil 6 should be warped so as to prevent rising air from carrying water up into channels 8. It will also be obvious to those skilled in the art that instead of the coils 6 the lower ends of the fins 5 may be refrigerated by being sprayed with cold water such as is used in the air-washer types of dehumidifiers. Where a large building has individual refrigeration "on tap" in each room, the unit shown in Figure 4, one in each room, will give individual dew point control and will be more agreeable to tenants since they may vary the humidity of the room as they require. It is frequently said, in regard to summer discomfort that it is not the heat but the humidity which gives discomfort. It will be apparent now that this invention makes it possible to lower the humidity of a room or of an entire building without involving the high first cost and high operating cost of the usual "air-conditioning" unit or plant.

I claim:

1. As an article of manufacture, a refrigeration coil and a plurality of spaced parallel fins to said coil forming extended surfaces therefor and continuing in one direction to provide counter-current heat exchange surfaces remote from said coil, means connecting the remote ends of spaced pairs of said fins, a housing enclosing the coils and fins and providing respectively air inlets for the spaces

enclosed by said connected pairs of fins and air outlets for the spaces between the connected pairs of fins; said housing further providing a drip chamber enclosing all the fin ends adjacent to the coil and providing intercommunication thereat between the corresponding end of all passages.

2. In a dehumidifier, a refrigeration coil and a plurality of spaced parallel fins to said coil forming extended surfaces therefore and further forming counter-current heat exchange surfaces remote from said coil; said fins providing alternately arranged precooling and reheating passages respectively, and means for moving air inwardly thru said precooling passages and thence outwardly thru said reheating passages; said coil acting to cool air passing from the precooling passages to the reheating passages sufficiently to cause air passing thru said reheating passages to appreciably precool air passing thru said precooling passages.

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