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HUMIDIFICATION PREVENTER FOR ANHYDROUS AIR-COOLERS

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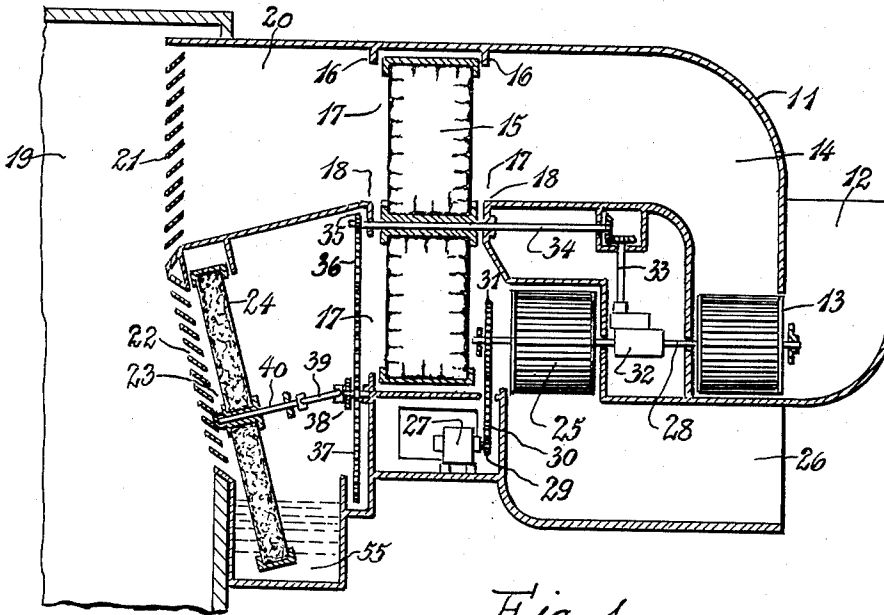


Fig. 1.

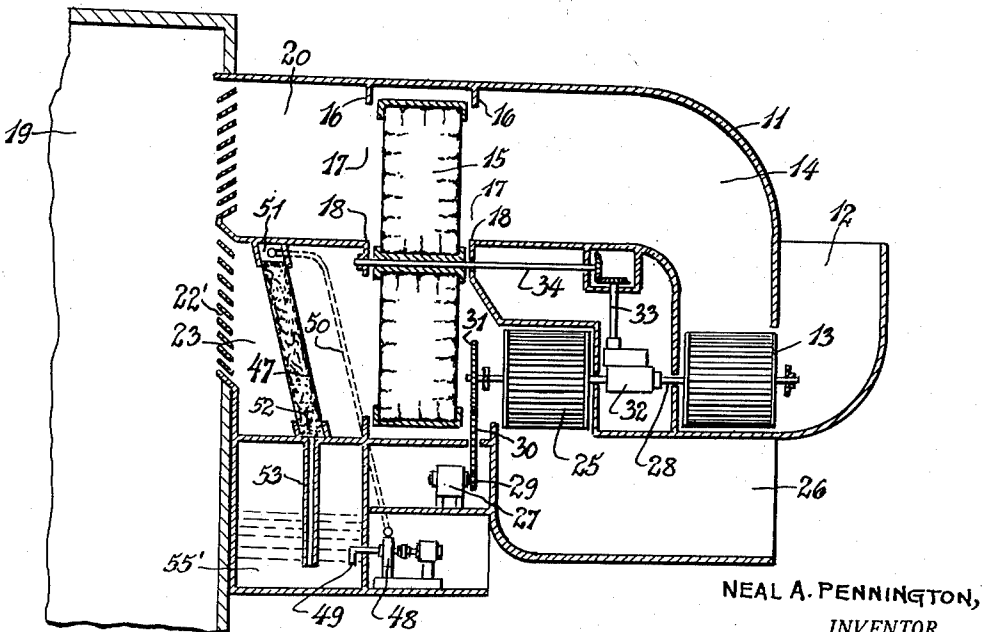


Fig. 2.

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UNITED STATES PATENT OFFICE

2,566,366

HUMIDIFICATION PREVENTER FOR
ANHYDROUS AIR COOLERS

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9 Claims. (Cl. 62-139)

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My invention relates to new and useful improvements in air-conditioning apparatus, and more particularly to improvements in that type of air-conditioning apparatus shown and described in various copending applications of mine (especially: Serial No. 513,167 filed December 6, 1943, now abandoned; Serial No. 640,792, filed January 12, 1946, now Patent No. 2,464,766, granted March 15, 1949; Serial No. 676,962, filed June 15, 1946; and Serial No. 694,972, filed September 5, 1946, now Patent No. 2,527,569 granted October 31, 1950), the common feature of all of which is to evaporatively cool certain air, and then cool the incoming air by anhydrous heat-exchange with the thus cooled certain air.

Still more particularly, my invention relates to new and useful means for preventing the unintended humidification of the incoming air in such apparatus, and for rendering more uniform the distribution of the evaporative liquid in the evaporative cooling means of such apparatus, and for increasing the efficiency of such cooling means in proportion to its thickness, and for reducing the air-resistance of such cooling means.

In addition to the objects above stated, I have worked out a number of novel and useful details, which will be readily evident as the description progresses.

My invention consists in the novel parts and in the combination and arrangement thereof, which are defined in the appended claims, and of which one embodiment is exemplified in the accompanying drawings, which are hereinafter particularly described and explained.

Throughout the description the same reference number is applied to the same member or to similar members.

Figure 1 is a vertical longitudinal section of one variant of my present invention, namely as applied to air-conditioning apparatus having a rotating water-pad, and no pump.

Figure 2 is a vertical longitudinal section of a second variant of my present invention, namely as applied to air-conditioning apparatus having a non-rotating waterpad, and a pumped water-circuit.

These two figures are in general similar to Figures 1 and 4 respectively of my copending application, Serial No. 53 (sic), filed January 2, 1948, now Patent No. 2,499,411 granted March 7, 1950.

Referring now to Figure 1, we see that 11 is the main container of my invention, in which 12 is an air-inlet from outdoors. 13 is a centrifugal fan, which impels incoming air into passage 14,

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and thence at about 600 feet per minute through the upper portion of rotating heat-transfer pad 15, which is similar to the "aluminum-wool pad" of my copending application, Serial No. 640,792, containing a packing of highly heat-absorbent material as there described, and rotating at a speed of about 30 R. P. M.

This pad 15, like the corresponding pad of the earlier case, rotates in a casing 16, each face of which has two sectorial orifices 17, separated from each other by a bridge 18.

The incoming air, after having been thus anhydrously cooled by heat-exchange by this heat-transfer pad 15, passes into the space 19 through passage 20 and louvres 21. The "incoming" air need not necessarily all, or even in part, come from outdoors as shown. Suffice it to say that it is the air which is being air-conditioned, for the purpose of air-conditioning the space into which this particular air, or some of it, is admitted.

Certain air passes from space 19 through louvres 22 into passage 23, where it encounters water-pad 24, rotating at a speed of about 3 R. P. M. partly in water-trough 55 and partly in passage 23. This water-pad 24 is sectorially constructed like similar pads in my copending application, Serial No. 640,792, the sectors (as there) being packed with excelsior or other water-absorbent material. This "certain" air preferably, but not necessarily is derived from the space being conditioned, and hence in my specification, although not in my claims, will be referred to as "outgoing" air.

This outgoing air, having been evaporatively cooled in water-pad 24, cools heat-transfer pad 15, through which it is sucked by centrifugal fan 25 at about 600 feet per minute, and then is impelled into air-outlet 26, through which it is discharged outdoors or into the attic.

Motor 27 drives shaft 28 through pulley 29, belt 30, and pulley 31.

Shaft 28 drives the two fans, 13 and 25, at a high rate of speed. Also, through gear reduction 32, shaft 28 drives shaft 33, and thereby shaft 34, at about 30 R. P. M., thus driving heat-exchange pad 15 (keyed to shaft 34) at about 30 R. P. M.

Through pulley 35, belt 36, and pulley 37, shaft 34 drives shaft 38 at about 3 R. P. M. Shaft 38, through flexible joint 39, drives shaft 40, and hence water-pad 24 (keyed to shaft 40), at the same speed.

Thus far I have described nothing beyond the disclosures of my earlier applications. The de-

parture therefrom will be described and explained after my description of the second variant of my present invention.

Turning now to Figure 2, we see the second variant of my present invention. It is identical to my first-described variant, except as follows:

A fixed water-pad 47 is substituted for the rotating water-pad 24 of the first variant. This pad 47 is kept moistened by pump 48 drawing water from tank 55' through pipe 49, and delivering this water through pipe 50 to trough 51, whence the water seeps down through pad 47. So much of this water as does not evaporate in its downward passing through pad 47, is collected in trough 52, and thence passes through pipe 53 back into tank 55' again.

Thus far I have described nothing beyond the disclosures of my earlier applications.

In some of my earlier commercial installations, although theoretically my apparatus ought to cool the incoming air absolutely anhydrously (inasmuch as the basic inventive concept of my series of inventions was the paradoxical-sounding anhydrous evaporative cooling of air), yet sometimes, especially when (in an endeavor to increase the efficiency of the unit) I would increase the rate of water supply to the water-pad, or the rate of air-flow, I would find that the incoming air was being delivered to the enclosure with a slight although objectionable amount of moisture added, and thus not anhydrously cooled as it was theoretically supposed to be.

After considerable perplexity and investigation, I discovered that this counter-paradox was due to the fact that the outgoing air, in addition to absorbing moisture up to about 95% relative humidity, was also blowing or entraining a fine spray out of water-pad 24 (or 47) onto heat-transfer pad 15. This spray remained in suspension while in passage 23, due to the outgoing air being practically saturated, and collected in infinitesimal droplets on the aluminum-wool of heat-transfer pad 15. But when rotated into passage 14, by the rotation of pad 15, these droplets promptly evaporated into the dry incoming air, thus producing the undesirable humidity which was plaguing me.

I met this situation by tilting the top of the water-pad (either the rotating type 24 of Figure 1, or the fixed type 47 of Figure 2) toward the source of the outgoing air, i. e., toward the left in the two figures. This has the following effect.

As the water at the top of either type of pad trickles downward toward the bottom of the pad, so much of the water as drips from strand to strand of the excelsior packing of the pad, is subjected to two sets of forces, namely a horizontal force due to the impact of the current of outgoing air on the drops of water, and a vertical force due to gravity. The resultant of these two forces impels the water diagonally downward to the right.

In the vertical pads of my prior constructions, this resultant force sometimes causes the dripping water to concentrate on the right-hand face of the pad and then to blow clear.

Entirely apart from the undesirable spray-effect, already mentioned, and even when this does not occur, the concentration of the water on the right-hand face of the pad has the further disadvantage of reducing the efficiency of the pad by locating the least water where the most evaporation ought to take place (namely near the left-hand face of the pad, where the air is driest), and by locating the most water

where the least evaporation ought to take place (namely near the right-hand face of the pad, where the air is practically saturated). This requires a thicker pad to accomplish the same amount of cooling, and this added thickness unnecessarily impedes the current of air.

Slanting the pads as shown, causes a more nearly uniform distribution of water in the pad, and eliminates the spray effect.

The degree of tilt is a pragmatic matter, depending on the relative magnitude of the two forces. Inasmuch as the horizontal force is a function of the square of the linear dimensions of the dripping droplets (i. e. the cross-sectional area thereof), whereas the vertical force is a function of the cube thereof (i. e. proportional to the weight thereof), the direction of the resultant force will depend upon the size of the dripping droplets, which in turn will be somewhat dependent upon the density of packing of the excelsior. The direction of the resultant force will also vary with the velocity of the air.

Any appreciable inclination of the water-pad will be of advantage. Further inclination will be of further advantage. The production of spray will cease before ideal distribution is reached. Still further inclination will result in water dripping off the rear of the pad, which will require provision for disposal of this waste-water, and anyway will be messy. Furthermore, a pad-inclination of more than is needed will take up space unnecessarily.

With air-speed and density of packing employed by me, I have found an inclination of about 15 degrees to be sufficient, and hence ideal.

Having now described and illustrated two forms of my present invention, I wish it to be understood that my invention is not to be limited to the specific forms of arrangements of parts herein described and shown.

I claim:

1. An air-conditioning unit, comprising: two air-passages; an air-permeable evaporative-liquid-holding pad, extending across the first passage; means to continuously supply evaporative liquid to this pad; a pad comprising sectors of air-permeable non-hygroscopic highly heat absorbent material, this pad being rotatably mounted in such manner as to carry each sector successively across each of the two passages; means for impelling a stream of air in the first passage, first through the evaporative-liquid-holding pad and then through the non-hygroscopic pad, whereby this first stream of air may be first cooled by evaporation and then may cool the non-hygroscopic pad; and means for impelling air in the second passage through the non-hygroscopic pad, whereby this second stream of air may be cooled by the non-hygroscopic pad, and may then pass into the space to be conditioned; this air-conditioning unit being characterized by the fact that the top of the evaporative-liquid-holding pad is appreciably tilted from the vertical toward the side from which the air enters the pad.

2. An air-conditioning unit, according to claim 1, further characterized by the fact that, taking into consideration the nature, arrangement, and thickness of packing of the material of the evaporative-liquid-holding pad, the rate of supply of water thereto, and the velocity of air there-through, the direction of the resultant of the force of gravity on the droplets percolating through said pad and of the force of the air

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stream on said droplets will lie approximately parallel to the faces of the pad.

3. An air-conditioning unit, according to claim 1, further characterized by the fact that the slant of the evaporative-liquid-holding pad is approximately 15 degrees from vertical.

4. An air-conditioning unit, according to claim 1, in which the evaporative-liquid-holding pad and the means to continuously supply evaporative liquid thereto comprise: a tank; a pad comprising sectors of air-permeable evaporative-liquid-holding material, this pad being rotatably mounted in such manner as to carry each sector successively through the tank beneath the liquid level therein and across the first air-passage; and means for rotating this pad.

5. An air-conditioning unit, according to claim 1, in which the evaporative-liquid-holding pad and the means to continuously supply evaporative liquid thereto comprise: a tank; a fixed pad; a pump and conduits, adapted to extract liquid from the tank and deliver it to the top of this pad; and means to convey liquid from the bottom of this pad back to the tank again.

6. In an evaporative-cooling apparatus, the combination of: an air passage; means for impelling air therethrough; an air-permeable evaporative-liquid-holding pad, extending across the passage, and having its top appreciably tilted from the vertical toward the side from which the air enters the pad; and means to continuously supply evaporative liquid to this pad.

7. An air-conditioning unit, according to claim

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6, in which the evaporative-liquid-holding pad and the means to continuously supply evaporative liquid thereto comprise: a tank; a pad comprising sectors of air-permeable evaporative-liquid-holding material, this pad being rotatably mounted in such manner as to carry each sector successively through the tank beneath the liquid level therein and across the air-passage; and means for rotating this pad.

8. An air-conditioning unit, according to claim 6, in which the evaporative-liquid-holding pad and the means to continuously supply evaporative liquid thereto comprise: a tank; a fixed pad; a pump and conduits, adapted to extract liquid from the tank and deliver it to the top of this pad; and means to convey liquid from the bottom of this pad back to the tank again.

9. An air-conditioning unit, according to claim 6, further characterized by the fact that the slant of the evaporative-liquid-holding pad is approximately 15 degrees from vertical.

NEAL A. PENNINGTON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,092,810	McLean	Sept. 14, 1937
2,431,389	Fleisher	Nov. 25, 1947
2,464,766	Pennington	Mar. 15, 1949