

Feb. 12, 1946.

O. J. KUENHOLD, SR

2,394,698

EVAPORATOR

Original Filed Oct. 6, 1938

3 Sheets-Sheet 1

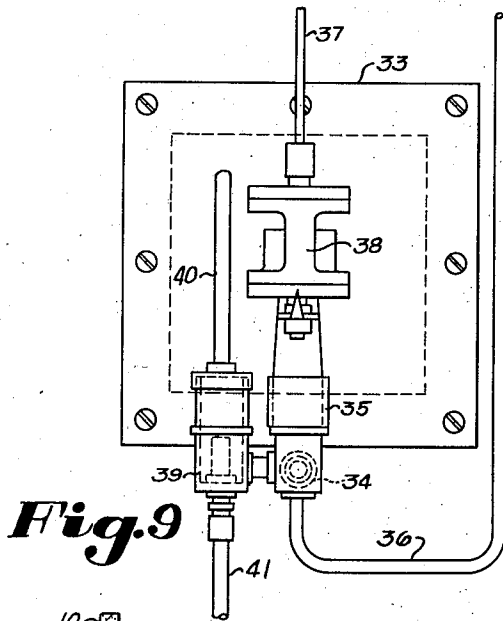


Fig. 9

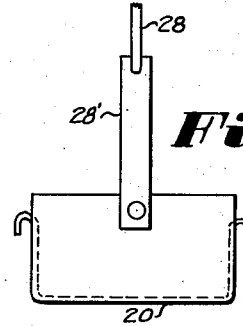


Fig. 10

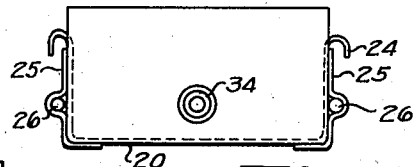


Fig. 11

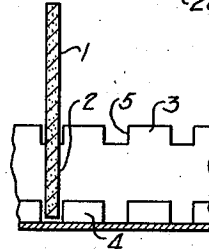


Fig. 2

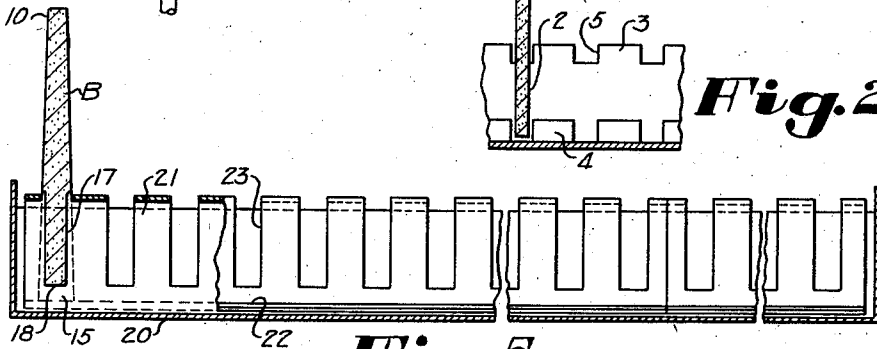


Fig. 5



Fig. 4

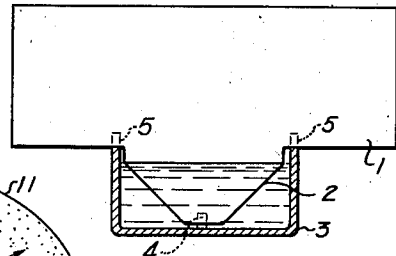


Fig. 1

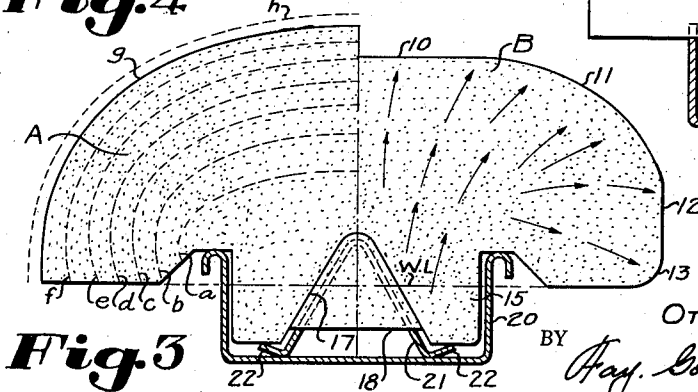


Fig. 3

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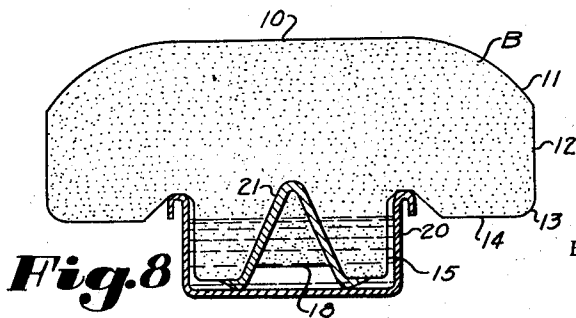
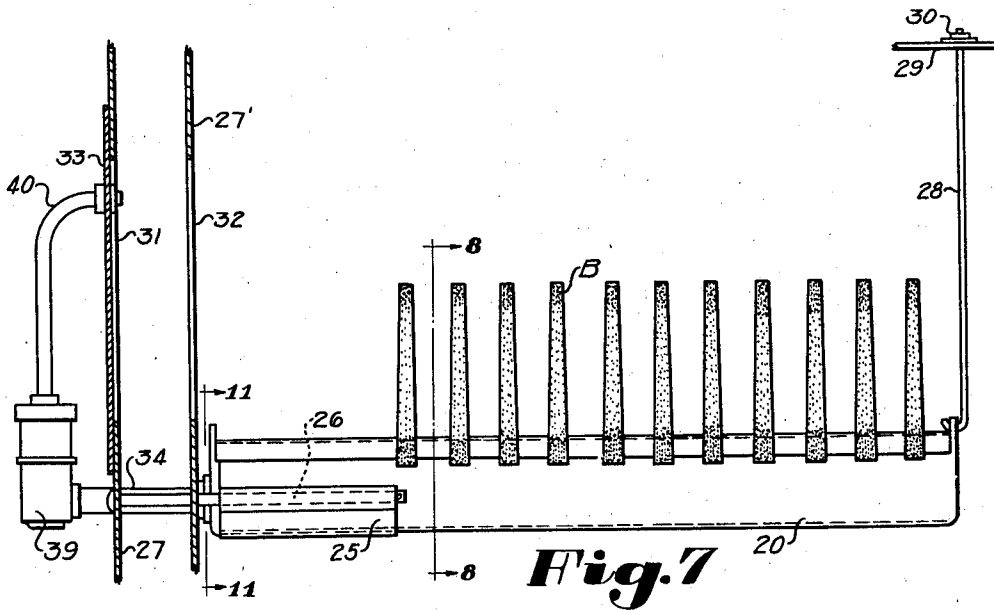
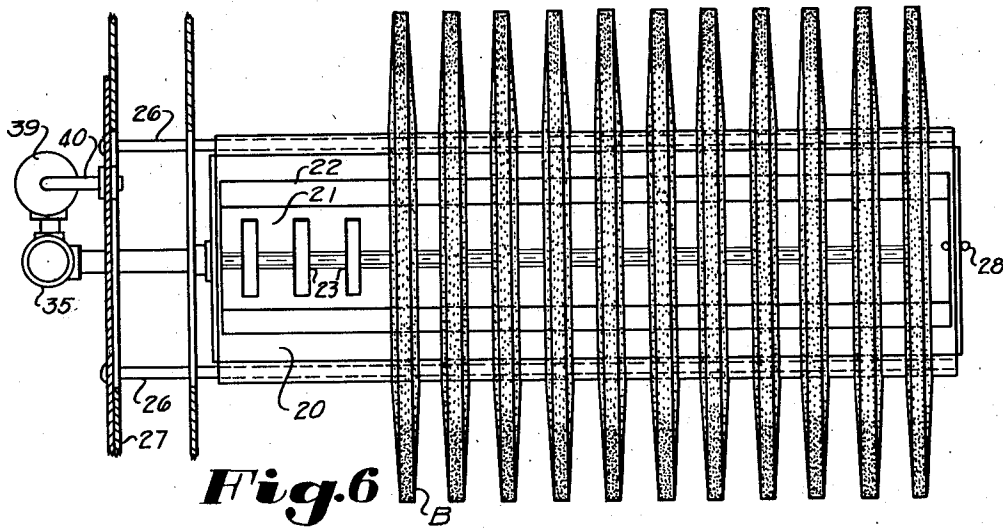
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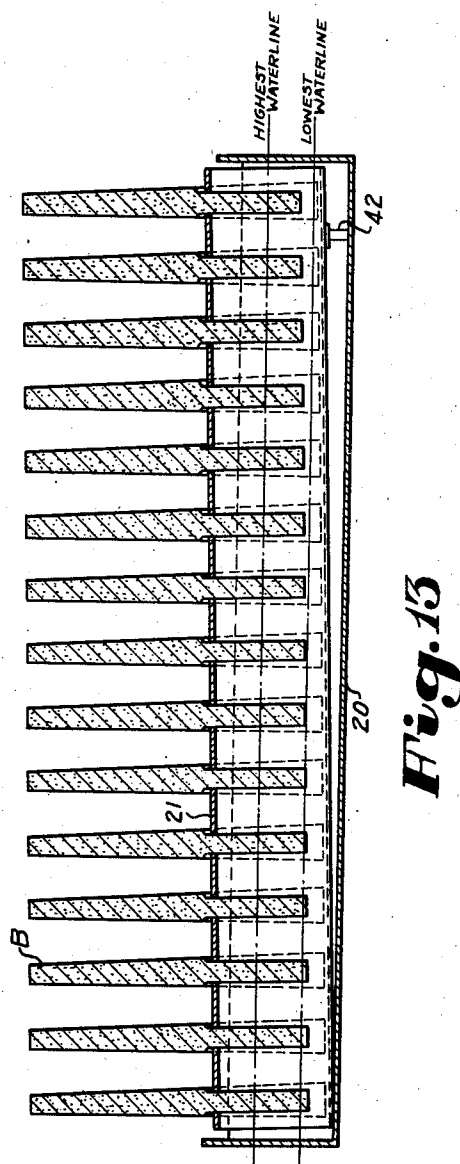
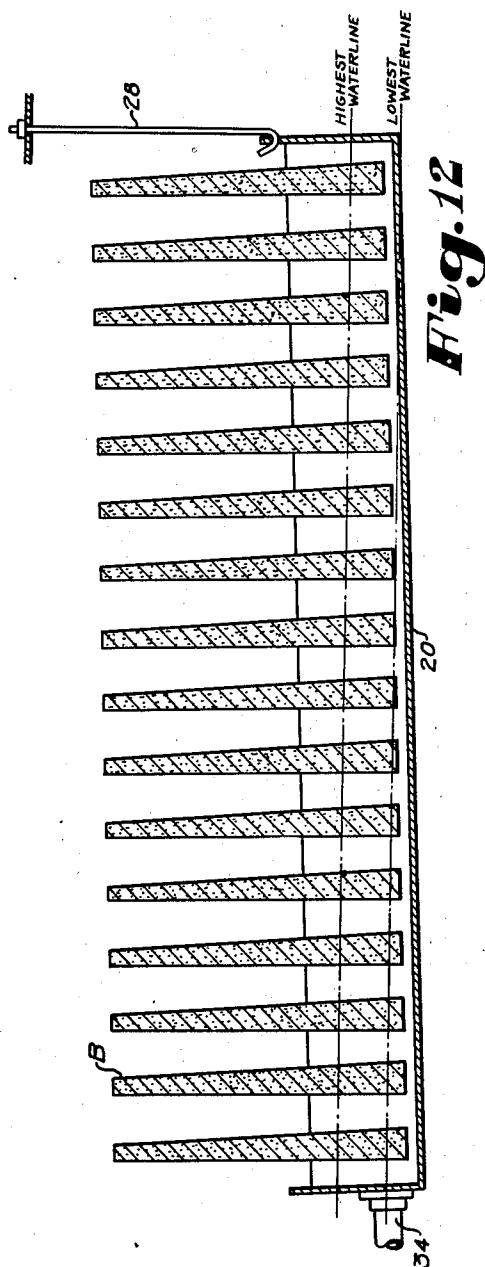
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EVAPORATOR

Original Filed Oct. 6, 1938

3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,394,698

EVAPORATOR

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Continuation of application Serial No. 340,827, June 15, 1940, which is a division of Serial No. 233,631, October 6, 1938. This application August 7, 1942, Serial No. 453,990

11 Claims. (Cl. 261-104)

The present invention relates to an evaporating device particularly adapted for use in the heating, ventilating and air conditioning art, and is of the type wherein evaporation of water and its entrainment in a passing air stream is obtained by means of porous, ceramic plates disposed in a substantially vertical position in a water reservoir. The subject matter of the present application constitutes an improvement in my United States Letters Patent No. 2,166,414, granted July 18, 1939, for "Humidifying system." The present application is a continuation of my divisional application Serial Number 340,827, filed June 15, 1940, said divisional application being a division of my application Serial Number 233,631, filed October 6, 1938, and issued April 1, 1941, as United States Letters Patent No. 2,236,538.

The general object and nature of my present invention is to provide an evaporator of the type indicated having a much greater evaporation rate capacity and increased life or period of service. Additional objects and advantages of the invention shall become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims.

The annexed drawings and the following description set forth in detail certain mechanism embodying the invention, such disclosed means constituting, however, but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawings—

Fig. 1 is a view illustrating an evaporating plate and water pan as heretofore disclosed in my aforesaid patent and upon which the present application constitutes an improvement; Fig. 2 is a sectional view taken upon a plane normal to that of Fig. 1; Fig. 3 is a partially diagrammatic figure of an evaporator plate and water pan and is for the purpose of aiding in the explanation of the principle of my invention; Fig. 4 is a top plan view of one-half of one of the evaporating plates having the improved construction; Fig. 5 is a longitudinal sectional view of the water pan and supporting rack with one of the evaporating plates shown in position; Fig. 6 is a top plan view of the evaporator embodying the principle of my invention; Fig. 7 is a side elevational view thereof; Fig. 8 is a cross-sectional view taken substantially along the line 8-8 of Fig. 7; Fig. 9 is an end elevational view of the cover plate and water feed apparatus for the evaporator; Fig. 10 is a right

hand end elevation of the water pan; Fig. 11 is a cross-sectional view taken substantially along the line 11-11 of Fig. 7; Fig. 12 is a longitudinal sectional view showing one means of varying the height of the evaporating plates with respect to the water level; and Fig. 13 is a longitudinal sectional view showing an alternative means of varying the height of the evaporating plates with respect to the water level.

Now referring to Figs. 1 and 2, it will be seen that the porous, ceramic evaporating plate 1 shown therein is in the form of a rectangle with a central downwardly extending tongue 2 contacting with the water in the water pan or reservoir 3. Projections 4 are provided in the bottom of the pan for engaging with the tongue 2 and notches 5 are provided in the upper edges of the pan 3 for engaging with the body portion of the plate 1. The above illustrated and described construction is further set forth and claimed in my aforesaid Patent No. 2,166,414.

Porous, ceramic evaporating plates operate generally upon the principle of absorbing water from the water by capillary action, thus presenting exposed wet or moistened surfaces for contact with a passing air stream.

Now referring to Fig. 3, there is shown therein an evaporating plate consisting generally of the two half portions A and B. A series of dotted line curves *a* to *h* inclusive represent the upper limits of the wet or moistened area of the plate at the following time intervals after the dry plate has been inserted in the water pan with the level maintained at the line marked WL, viz.:

	Upper limit of water penetration	Time interval
		Minutes
a.....		1/4
b.....		1/2
c.....		3/4
d.....		1
e.....		1 1/4
f.....		2
g.....		2 1/2
h.....		3

These curves *a* to *h* inclusive represent a careful copy of pencil lines made on the face of the plate during actual test. Curve *g* corresponding to the 2 1/2 min. interval was selected for the outline of the ideal form of plate shown at A. For practical consideration and for commercial form, the form B has been found suitable. In this latter form of evaporating plate, the top edge 10 is horizontal with the curved corner 11 merging into the straight, vertical edge 12, thence to the curved

corner 13 and the bottom, straight edge 14. The downwardly extending tongue 15 has an inverted V-shaped recess 17 for fitting into the slots of the supporting rack 21. A straight edge portion 18 extends across the mouth of the inverted V-shaped recess 17 at a distance slightly inwardly removed therefrom and presents an abutting edge adapted to bear against the bottom of the slots of the rack 21. The latter is laid upon the bottom of the water pan 20 and is also of inverted V-shaped cross-section with the upwardly extending marginal edges 22 which also contact with the bottom edges of the tongue portion 15 of the evaporating plate B. Transverse slots 23 are provided at intervals in the rack 21 for spacing the plates B.

I have made the discovery that if the plate is of tapered cross-section, thicker at the bottom than at the top, as indicated in the transverse section of the plate in Fig. 5, the rapidity of capillary advance of water in the plate is considerably increased. I have further discovered that if the plate is progressively thinner from the water surface upward and outward so that the curves *a* to *h* inclusive would represent contour lines of progressively reduced thickness toward the outermost edges at top and sides, as indicated by top view Fig. 4, the capillary advance of the water laterally would be more rapid and the curves *a* to *h* inclusive would extend out further laterally. This means that the plate can be extended laterally substantially as shown at 12, 13 and 14, and still remain as wet in service at the extreme lateral edges as it does in the rectangular form of Figs. 1 and 2. In other words, more evaporation could be secured per plate without danger of the outer edges remaining insufficiently moist for efficient evaporating service and durability. The tapering of the plate as described not only adds to the efficient evaporation per plate but extends its period of efficient service as will be more fully explained later.

All city supplied water contains dissolved mineral salts and floating matter such as algae and iron oxides (rust). All city supplied water passes through iron pipes and the rust so formed by action of the water and its contents upon the inner walls of the iron mains and pipes. The floating matter in the water enters and clogs the inlet pores of the plates.

Any mineral salts dissolved in the water freely enters the inlet pores and is carried by the capillary flow outward toward the outer edges of the plates. The water itself is evaporated from the surfaces of the plates but the soluble salts accumulate on the outer edges of the plates. As the rapid water evaporation from the surfaces of the plates reduces their temperature, the mineral accumulations on the outer edges of the plates remains soft, porous, moist and easily brushed off from time to time—each year or two normally.

Besides the mineral salts which remain permanently soluble as above described, city supplied water also contains calcium and magnesium carbonates which remain dissolved in the water if the water also contains carbon dioxide, as is almost invariably the case. But an action takes place which seems to be as follows: When the water enters the pan where it is warmed somewhat by the warm air circulating around and past the pan and plates, the carbon dioxide begins to escape and continues to do so after the water enters the plates. The calcium and magnesium carbonates can then no longer be held in solution by the water, consequently they are deposited in the plates, especially near the inlet end, gradually ac-

cumulating and cutting down the pore area until water can no longer pass through the inner pores of the plates as fast as the plates can evaporate it.

A third type of clogging action occurs but this occurs either in plates not having correct outline or when plates considerably clogged by calcium and magnesium carbonates as described in the preceding paragraph are continued in service. In either one of these two cases, the outermost areas of the plates, last to receive the water, become dry. Evaporation then occurs from the innermost areas of the plates, these areas being bounded respectively by lines defined by mineral salts which are deposited along these lines and block the flow of water past these lines within the plates.

To prevent the first named type of clogging, that is clogging of the inlet pores of the plate by floating matter in the supplied water, I have found it practically imperative to provide a water filter containing a filter medium composed of the same porous material as the plates. Such a filter medium can be conveniently installed in either of the feed lines 36 or 37. This filtering medium thus passes floating matter that will not clog the inlet pores of the plates but stops floating matter that would clog the inlet pores of the plates. The filter is then cleaned from time to time which is very much easier to do than to remove and clean all the plates.

There will then still remain in the water floating oxides formed by action of the water upon the inner wall of the metal tubing from the filter to the water pan. This too would clog the inlet pores of the plate within possibly a couple months but to extend this time limit to a full season or two, I provide much greater inlet area such as indicated at 15, than is actually necessary. In this way I am able to extend the active efficient service period of the inlet surface up to a time when internal plate clogging makes attention to this phase necessary.

The internal plate clogging due to calcium and magnesium carbonate deposits is provided against as follows: The uptake area is increased by the widening of the pan and plate as described in the preceding paragraph and also by the tapering of the plate, making it thicker toward the inlet area, as has been described, this tapering adds considerable to the active service period of the plate before internal clogging accumulates to the point where evaporation is impaired. The more rapid and therefore more effective capillary flow induced by the tapering formation also helps to extend the active life of the plate for other but not yet known reasons.

In addition to the steps taken as above described two other steps are taken to cope with internal deposits. I have found that certain solvents and acids such as hydrochloric acid readily converts calcium and magnesium carbonates to highly soluble salts such as chlorides which can then be washed out with water substantially as if the deposits were sugar. I therefore make the plates of a material which is unaffected by hydrochloric acid and other calcium or magnesium carbonate solvents. In addition I make the plates of a material having rather coarse capillarity to facilitate the washing out process and at the same time provide ample voids for accumulation of internal deposits so that longest possible active service period is attained.

I have furthermore discovered that if, while the plates are in service, a solvent such as acetic acid or hydrochloric acid in relatively small and harmless quantity is added to the water in the

pan from time to time, it converts insoluble accumulations in the plates to soluble salts and the capillary flow within the plates thereupon carries the said accumulations, then in soluble form, to the surface and toward the outer edges of the plates.

Figs. 6 and 11 illustrate the evaporator as assembled in a heating furnace bonnet or plenum chamber. The guides 25 on the sides of the pan 22 engage with the support rods 26 which extend through to the outer wall 27 of the furnace. A hook bolt 28 connects the inner or right hand end of the pan 20 to the ceiling or top wall 29 of the furnace and is attached by means of the nut 30. As shown in Fig. 10, an extension strip 28' may be used in the event that the hook bolt 28 is not of sufficient length. Openings 31 and 32 are provided in the inner and outer furnace walls 27 and 27' respectively for access to the evaporator pan 20 and plates B. A cover plate 33 extends over the outside wall opening 31. A feed pipe 34 leads into the left hand or front end of the pan 20 from the feed cup 35. The water supply, if previously controlled, as from a remote control source such as a water feed regulator located in the space to be heated, may be led into the feed cup 35 through the line 36; on the other hand, if the water feed is to be by way of a direct control instrument such as indicated at 38, the water feed line may be located as indicated at 37. A water level equalizer cup 39 has an air tube 40 which passes through the cover plate 33 and connects the cup 39 with the air pressure in the interior of the furnace. The overflow pipe 41 leads to a drain from the equalizer cup 39.

Referring now to Figs. 12 and 13, my invention also includes means for rapidly increasing the rate of evaporation in proportion to the rate of introduction of water to the pan 20. In Fig. 12, the right hand end of the pan 20 is elevated by means of shortening the support rod 28. In Fig. 13, the supporting rack 21 is elevated by means of the lug 42 placed between the bottom of the rack 21 and the bottom of the pan 20 in the right hand end. The range of the highest and lowest water levels are indicated in legends in Figs. 12 and 13. It has been found that where rapidly increased rates of evaporation are desired that a mere change in water level is not sufficient to meet the conditions of demand and operation. By means of varying the distance of the bottoms of the plates B with respect to the water level range; or in other words, by varying the depth of immersion of the plates, a greatly increased evaporating rate is obtainable in proportion to the rate of water supply or rate of elevation of the water level. This result is explainable by the fact that there is a substantial difference in the rate of evaporation by an individual plate between depth of immersion corresponding to a substantial amount of water immersion of the bottom of the plate and to a mere minimum wetting of the bottom of the plate respectively. In other words, when the water level substantially coincides with the bottom of the plate, the evaporating rate of the latter is greatly reduced as compared to its evaporating rate when the water level is higher. As shown in the accompanying drawings, the bottom of the highest plate substantially coincides with the lowest water level, so that such highest plate will at all times receive some wetting action and will thereby not become completely dry. I have found that this relative positioning of the height of the highest plate with respect to the lowest water level is of advantage, since when the

plates are permitted to become alternately wet and dry, there exists a tendency for the creation of increased lime deposits in the plates. The tilting of the pan such as shown in Fig. 12, or the tilting of the plate supporting rack such as shown in Fig. 13 illustrate two methods of achieving the foregoing results and advantages.

I claim:

1. An evaporating plate composed of a porous material adapted to absorb water, comprising a lower portion adapted to be inserted in a body of water, and an upper portion extending upwardly and outwardly therefrom, the outer terminal edge of said last-named portion having a contour conforming substantially to the line of advance of water of absorption from said body, said plate being of decreasing cross-sectional thickness from its water contacting portion to said terminal edge.

2. An evaporating plate composed of a porous material adapted to absorb water, comprising an intermediate lower portion adapted to be inserted in a body of water and upper and lateral portions extending upwardly from and to both sides of said intermediate portion, the outer terminal edge of said upper and lateral portions having a contour conforming substantially to the line of advance of water of absorption from said body of water, said plate being of decreasing cross-sectional thickness from its water contacting portion to said terminal edge.

3. A vapor diffusing plate formed of capillary material, and rigid and self-supporting, and comprising a lower portion to be positioned in a body of water and an upper portion to be positioned above the water, and having at least part of said upper portion of less thickness than at least part of said lower portion, and the margin of said upper portion remote from the body of water having such contour that water progressing from the body of water will reach all points of said margin substantially simultaneously.

4. In a vaporizing device comprising a receptacle adapted to contain water and having a pair of spaced sides, and a body of water within said receptacle having its surface not above a predetermined level appreciably below the upper edges of said sides: a vapor diffusing plate, formed of capillary material, positioned transversely of said sides, and comprising a lower portion positioned in the water, an upper portion extending upwardly from said lower portion a substantial distance above the upper edges of said sides, said upper portion including oppositely extending lateral portions extending a substantial distance laterally of said sides respectively, and including depending portions extending downwardly from said lateral portions respectively exteriorly of said sides and terminating not lower than said predetermined level, thereby to provide additional vapor diffusing area within the non-siphoning limits of extent.

5. In a vaporizing device comprising a receptacle adapted to contain water and having a pair of spaced sides, and a body of water within said receptacle having its surface not above a predetermined level appreciably below the upper edges of said sides: a vapor diffusing plate, formed of capillary material, positioned transversely of said sides, and comprising a lower portion positioned in the water, an upper portion extending upwardly from said lower portion a substantial distance above the upper edges of said sides, said upper portion including oppositely extending lateral portions extending a substantial distance later-

ally of said sides respectively, and including depending portions extending downwardly from said lateral portions respectively exteriorly of said sides and terminating not lower than said predetermined level, thereby to provide additional vapor diffusing area within the non-siphoning limits of extent, and the margin of said upper portion remote from the body of water having such contour that water progressing from the body of water will reach all points of said margin substantially simultaneously.

6. In a vaporizing device comprising a receptacle adapted to contain water and having a pair of spaced sides, and a body of water within said receptacle having its surface not above a predetermined level appreciably below the upper edges of said sides: a vapor diffusing plate, formed of capillary material, positioned transversely of said sides, and comprising a lower portion positioned in the water, an upper portion extending upwardly from said lower portion a substantial distance above the upper edges of said sides, said upper portion including oppositely extending lateral portions extending a substantial distance laterally of said sides respectively, and including depending portions extending downwardly from said lateral portions respectively exteriorly of said sides and terminating not lower than said predetermined level, thereby to provide additional vapor diffusing area within the non-siphoning limits of extent, and said upper portion being progressively thinner at successive lines of front of water advance.

7. A vapor diffusing plate, formed of capillary material, and comprising a lower portion to be positioned in a body of water, and an upper portion to be positioned above the water, said upper portion extending upwardly and laterally with respect to said lower portion to an outer terminal margin remote from the body of water, said margin extending from points upwardly remotest to points laterally remotest from said lower portion, the upward extent and lateral extent of said upper portion being such and the contour of said margin being such that water progressing from the body of water will reach all points of said margin substantially simultaneously.

8. A vapor diffusing plate, formed of capillary material, and comprising a lower portion to be positioned in a body of water, and an upper portion to be positioned above the water, said upper portion extending upwardly and laterally to both sides with respect to said lower portion to an outer terminal margin remote from the body of water, said margin extending from points upwardly remotest to points laterally remotest from the respective sides of said lower portion, the upward extent and lateral extents of said upper portion being such and the contour of said margin being such that water progressing from the

body of water will reach all points of said margin substantially simultaneously.

9. A vapor diffusing plate, formed of capillary material, and comprising a lower portion to be positioned in a body of water, and an upper portion to be positioned above the water, said upper portion extending upwardly and laterally with respect to said lower portion to an outer terminal margin remote from the body of water and being progressively thinner at successive lines of front of water advance, said margin extending from points upwardly remotest to points laterally remotest from said lower portion, the upward extent and lateral extent of said upper portion being such and the contour of said margin being such that water progressing from the body of water will reach all points of said margin substantially simultaneously.

10. A vapor diffusing plate, formed of capillary material, and comprising a lower portion to be positioned in a body of water, and an upper portion to be positioned above the water, said upper portion extending upwardly and laterally to both sides with respect to said lower portion to an outer terminal margin remote from the body of water and being progressively thinner at successive lines of front of water advance, said margin extending from points upwardly remotest to points laterally remotest from said lower portion, the upward extent and lateral extent of said upper portion being such and the contour of said margin being such that water progressing from the body of water will reach all points of said margin substantially simultaneously.

11. In a vaporizing device comprising a receptacle adapted to contain water and having a pair of spaced sides, and a body of water within said receptacle having its surface not above a predetermined level appreciably below the upper edges of said sides: a vapor diffusing plate, formed of capillary material, positioned transversely of said sides, and comprising a lower portion positioned in the water, an upper portion extending upwardly from said lower portion a substantial distance above the upper edges of said sides, said upper portion including lateral portions extending a substantial distance laterally of said sides, and including depending portions extending downwardly from said lateral portions respectively exteriorly of said sides and terminating not lower than said predetermined level, thereby to provide additional vapor diffusing area within the non-siphoning limits of extent, said upper portion being progressively thinner at successive lines of front of water advance, and the margin of said upper portion remote from the body of water having such contour that water progressing from the body of water will reach all points of said margin substantially simultaneously.

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