Oct. 3, 1933. P. A. SCHERER ET AL 1,928,912

HEAT EXCHANGE APPARATUS

Filed June 24, 1930 3 Sheets-Sheet 1

Fig. 1.

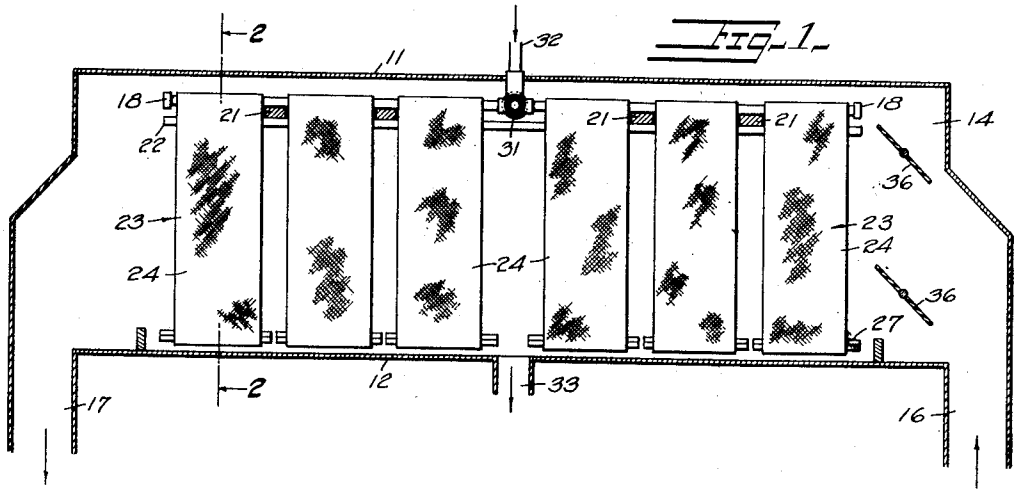


Fig. 2.

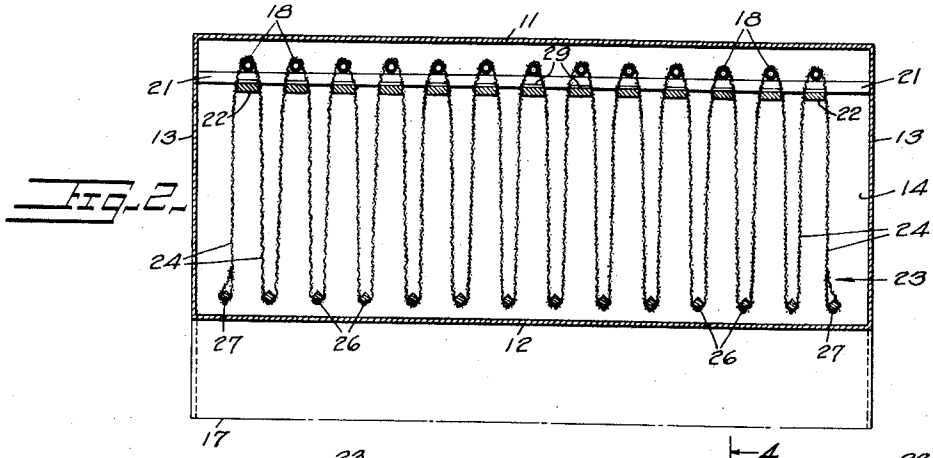
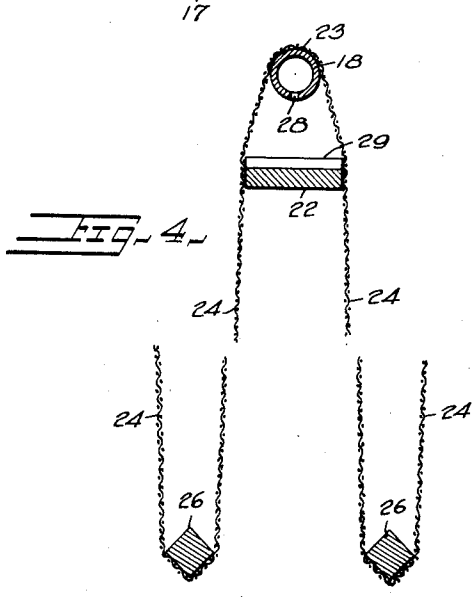


Fig. 4.



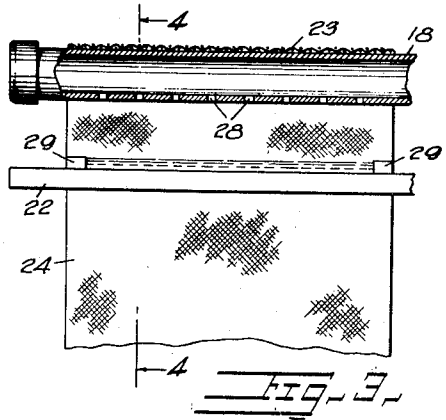


Fig. 3.

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HEAT EXCHANGE APPARATUS

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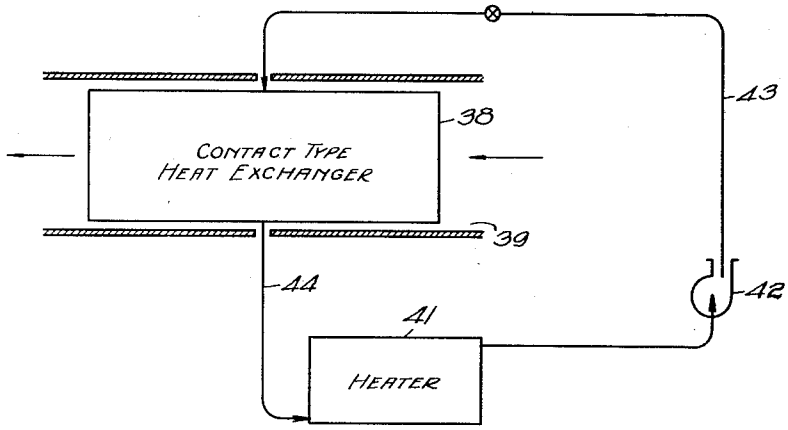


Fig. 5.

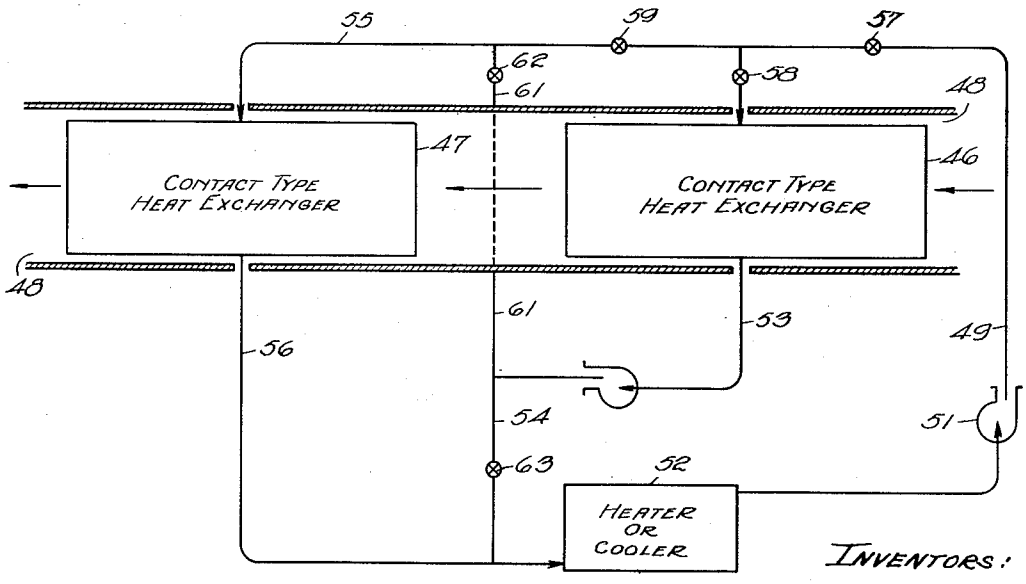


Fig. 6.

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HEAT EXCHANGE APPARATUS

Filed June 24, 1930 3 Sheets-Sheet 3

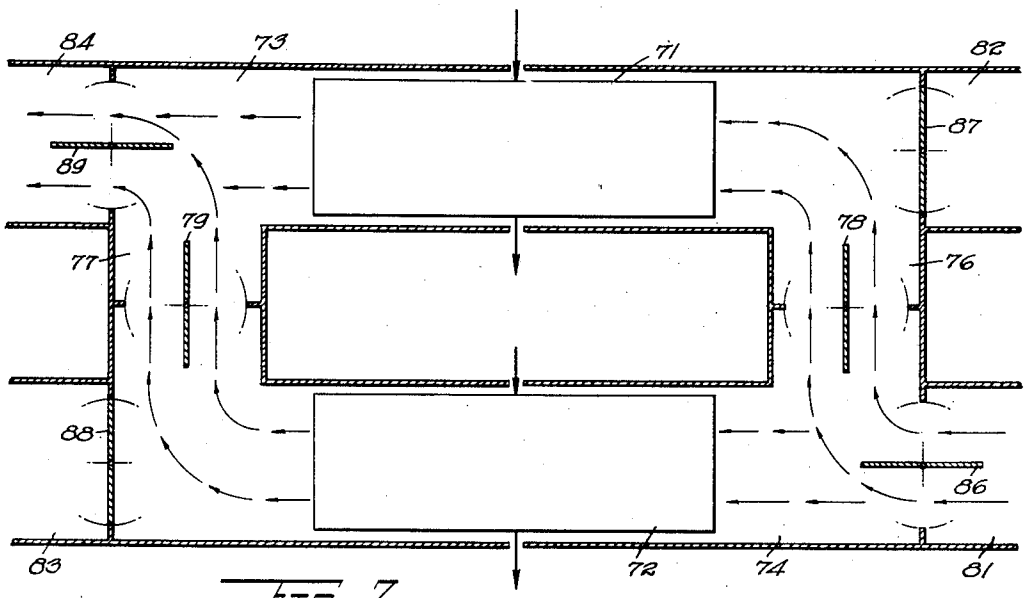


Fig. 7.

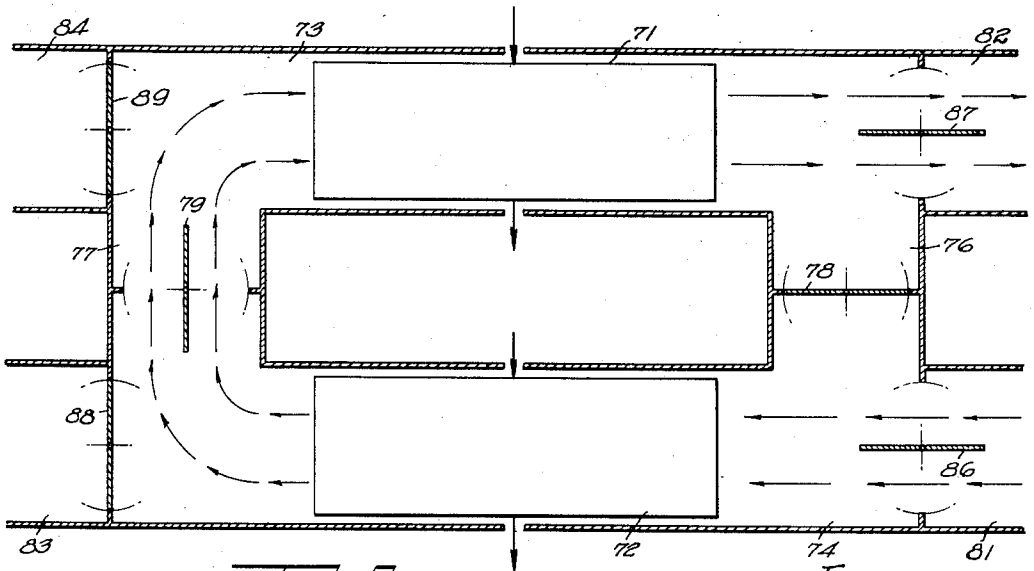


Fig. 8.

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UNITED STATES PATENT OFFICE

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HEAT EXCHANGE APPARATUS

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Application June 24, 1930. Serial No. 463,542

7 Claims. (Cl. 261—103)

This invention relates generally to apparatus for effecting contact between gases and liquids, particularly for the purpose of effecting an exchange of heat.

It is an object of the present invention to generally improve upon apparatus of the above character whereby heat can be exchanged between liquid and gas more efficiently, and whereby such apparatus can be constructed and maintained at a minimum of expense.

It is a further object of the invention to devise a novel apparatus of the above character whereby air or other gas can be brought into contact with a liquid and conditioned. For example in one desirable application to be presently described air is heated by being brought into contact with a heated chemical solution, and at the same time the air is conditioned as to its humidity.

Further objects of the invention will appear from the following description in which the preferred embodiments of the invention are set forth in detail in conjunction with accompanying drawings. It is to be understood that the appended claims are to be accorded a range of equivalents consistent with the state of the prior art.

Referring to the drawings:

Figure 1 is a side elevational view in cross section, illustrating a heat exchange apparatus embodying principles of the present invention.

Fig. 2 is a cross sectional view taken along the line 2—2 of Fig. 1.

Fig. 3 is an enlarged detail illustrating a part of the heat exchange apparatus shown in Figs. 1 and 2.

Fig. 4 is a cross sectional detail taken along the line 4—4 of Fig. 3.

Fig. 5 is a diagrammatic view illustrating a system which can incorporate the apparatus of Figs. 1 to 4 inclusive.

Fig. 6 is a diagrammatic view illustrating a system which can also incorporate the apparatus of Figs. 1 to 4 inclusive.

Figs. 7 and 8 illustrate diagrammatically a system for controlling the flow of gas or air into contact with a plurality of heat exchange units.

The various features of the invention can be best explained by first describing the heat exchange apparatus illustrated in Figs. 1 to 4 inclusive. Thus we have shown an enclosure formed by upper and lower walls 11 and 12, and side walls 13, which serve to define a passageway 14 for flow of air or other gas. One end of passageway 14 is in communication with a conduit or duct 16, thru which the air or other gas can be introduced. The other end of passageway 14 communicates with an exhaust duct or conduit 17. Within passageway 14 we arrange sheets of cloth together with means for continually maintaining these sheets saturated with liquid, and these cloths are arranged so as to afford a large area for contact with the gas with a minimum of flow resistance.

In the specific form illustrated the parts within passageway 14 consist of a plurality of parallel spaced liquid delivery pipes 18, which preferably extend in a general horizontal position as shown in Fig. 1. These pipes can rest upon suitable spaced cross bars or members 21. For a purpose which will be presently explained, other members 22 extend beneath the liquid delivery pipes 18, and preferably these members 22 extend in a general horizontal direction parallel to pipes 18 as shown in Fig. 1. Members 22 can be conveniently supported by cross members 21, and in practice can be formed of wooden strips. A plurality of strips 23 of suitable material which can be readily saturated by liquid, as for example canvas, are draped over the liquid delivery pipes 18. These strips are draped in such a manner that depending loops are formed between adjacent liquid delivery pipes, thus forming cloth sheets 24 depending from the side edges of each member 22. Sheets 24 can be suitably tensioned by providing bars 26 within each loop, and the end sheets of each strip can be similarly tensioned by bars 27.

As shown more clearly in Fig. 4 each liquid delivery pipe 18 is provided with suitable slots or openings 28, to deliver liquid to the upper surfaces of its corresponding member 22. As shown in Fig. 3, cleats or equivalent members 29 can be fastened upon members 22 adjacent the side edges of each strip 23, so that an appreciable depth of liquid will be maintained upon members 22 between the cleats. It is apparent that this construction forms liquid troughs, each trough having two sides formed by the cloth strips or equivalent porous material.

As shown in Fig. 1, for supplying liquid to pipes 18, these pipes can be connected with a common header pipe 31, which in turn is connected to the liquid supply pipes 32. As liquid drips or runs off of the cloth strips, it can be collected upon the bottom wall or floor 12 and drained away thru pipe 33.

In order to explain the mode of operation of the apparatus described above, it will be presumed that cold brine solution is being supplied thru pipe 32 and that air is being circulated thru passageway 14 for introduction into a refrigerat-

ing chamber or compartment. The cold brine solution is delivered by pipes 18 to the upper surfaces of members 22, and the upper portion of each depending sheet 24 is therefore in intimate contact with a head of brine solution maintained between members 29. The brine solution is therefore delivered uniformly across the entire width of each sheet 24, so that the depending portion of the sheet is kept continuously and uniformly saturated. The brine solution is prevented from running down between the side edges of member 22 and the adjacent portions of sheet 24, which might result in improper saturation of the sheets, both because of the fact that the sheets are tensioned and because these wet sheets adhere to the side edges of member 22. In fact the liquid is delivered in a most efficient manner into and thru the pores of the cloth. The air passing thru passageway 14 comes into intimate contact with the liquid with which the cloths are saturated, and because of the relatively large exposed area of the liquid, the brine solution efficiently absorbs heat from the air. The air can flow thru passageway 14 with relatively high velocity, without disturbing the cloth sheets, due to the fact that these sheets are normally tensioned. With respect to the flow of air it should be noted that the air flow can be controlled and better distributed by providing adjustable vanes 36 in the entrance portion of passageway 14.

It is apparent that while the novel heat exchanger described above gives good results and is highly desirable as an exchanger for use in a refrigerator system to cool air circulated thru a storage compartment or chamber, it is also capable of use with other apparatus or systems where it is desired to secure intimate contact between gas and liquid. For example it can be utilized where chemical action is effected between gas and liquids or to secure a transfer of heat from a gas to a liquid, rather than the converse transfer as in a refrigerating system, or it can be employed for condensing vapor from gaseous fluid. In Fig. 5 we have indicated a system utilizing heat exchange apparatus such as described above in a system for heating air or other gas. In this case the heat exchange apparatus is represented diagrammatically at 38, and forms a passageway 39 thru which the air or gas is caused to flow. Liquid supplied to the heat exchanger is caused to flow thru a suitable heater 41, and is delivered by pump 42 to the heat exchanger 38, thru pipe 43. From the heat exchange apparatus the liquid can be returned to the heater thru pipe 44.

A system of the type illustrated in Fig. 5 can be advantageously employed for the purpose of heating air to be supplied to rooms or buildings. In this connection we prefer to circulate a liquid of such a nature that it will serve to automatically condition the air heated by passage thru passageway 39. Thus we can circulate a chemical solution, such as a solution of calcium chloride in water. Such a solution has the characteristic of absorbing moisture from air in contact with the same in the event that the air is saturated with moisture; or if the air is relatively dry, a certain amount of moisture will be imparted to it by the chemical solution. Thus in the system of Fig. 5 if chemical solution having suitable characteristics like calcium chloride is employed, the air caused to flow thru passageway 39 is not only heated to a desired temperature, but the air will also be conditioned as to humidity and the humidity maintained within certain predetermined limits without the use of an additional humidity control.

In place of utilizing a single heat exchange unit of the type illustrated in Figs. 1 to 4 inclusive, we can utilize a plurality of such units for securing greater capacity. When a plurality of units are employed it is possible to control the flow of liquid in such a manner as to control the amount of heat imparted to the gas or air, or to control the temperature of the gas or air treated. Thus as shown in Fig. 6 we have shown two heat exchange units 46 and 47, which are arranged to effect an exchange of heat with respect to air or other gas flowing thru passageway 48. Pipe 49, serves to conduct liquid to unit 46, and pump 51 serves to introduce liquid into this pipe from heater or cooler 52. Pipes 53 and 54 serve to return liquid from unit 46 back to the heater or cooler 52. By means of branch pipe 55, liquid can also be diverted from pipe 49 to the unit 47, and pipe 56 can serve to return liquid from unit 47 back to the heater or cooler 52. A suitable arrangement of valves can be employed for changing the relationship of units 46 and 47 with respect to the circulating system. For example valves 57 and 58 are shown in pipe 49, and valve 59 in branch pipe 55. Branch pipe 61 serves to connect some point between valve 59 and unit 47 with a point between pipes 54 and 56. Pipe 61 is controlled by valve 62, and pipe 54 by valve 63.

Assuming that liquid is being circulated and that it is being cooled by device 52, by opening valves 57, 58, 59 and 63, while valve 62 is closed, the cold liquid will flow in two parallel paths thru units 46 and 47, so that both units are maintained at substantially the same temperature. Assuming now that it is desired to decrease the capacity of the system, valve 58 can be closed so that the air passing thru passageway 48 will be cooled only by unit 47. Another alternative is to open valves 57, 58 and 62, and close valves 59 and 63. In this case the liquid will be circulated thru the units 46 and 47 in series, so that unit 46 will be maintained at the lowest temperature and unit 47 at a somewhat higher temperature. Air flowing first thru unit 47 and then thru unit 46 will therefore be efficiently cooled in stages by contacting successively with liquid at successively lower temperatures.

As shown in Figs. 7 and 8 it is also possible to effect control of a heat exchange system of the above character by controlling the manner in which the gas or air is brought into contact with a plurality of heat exchange units. Thus we have shown units 71 and 72 connected with any suitable liquid supply system, as for example a suitable cold brine circulating system of a refrigerating installation, and which form passages 73 and 74 for flow of gas or air. The ends of passages 73 and 74 are connected by header conduits or passages 76 and 77, which are shown provided with suitable valves 78 and 79. Passageway 76 is shown in communication with conduits 81 and 82, and passageway 77 in communication with conduits 83 and 84. These conduits are shown controlled by suitable valves 86, 87, 88 and 89.

Assuming that the arrangement of Fig. 7 is being employed in a refrigerating system and that cold brine is being supplied to units 71 and 72, valves 86, 78, 79 and 84 can be opened, and air to be contacted with the cold brine introduced thru conduit 81 and removed thru conduit

84. Thus air will flow thru both of the units 71 and 74 in parallel. If the air is to be cooled to a lesser degree, valve 79 can be closed so that the air is only passed thru unit 71. As indicated in Fig. 8, by opening valves 86, 79, and 87, while valves 78, 88, and 89 are closed, air can be introduced thru conduit 81 and removed thru conduit 82. In its passage air will then flow first thru unit 72, and thereafter thru unit 71. Such an arrangement may make for better efficiency, particularly where the brine introduced into unit 71 is at a lower temperature than the brine introduced into unit 72.

We claim:

1. In apparatus of the character described, a plurality of spaced parallel liquid delivery pipes arranged in a substantially horizontal position, a strip of cloth draped over said pipes to provide depending loops below said pipes, a plurality of spaced members parallel to said pipes, each member being disposed below a corresponding pipe, the edges of each of said members being in contact with adjacent portions of the cloth, and means for normally tensioning the depending cloth loops.

2. In apparatus of the character described, a substantially horizontal liquid delivery pipe, a substantially horizontal member disposed below said pipe whereby liquid from the pipes is delivered to the upper surface of the same, and a strip of cloth draped over the pipe and contacting with the edges of said member, said cloth thereby forming two sheets depending from the edges of said member.

3. In an apparatus of the character described, depending sheets of material capable of being saturated by a liquid, means for supporting said sheets in spaced relationship, means for supplying liquid between said sheets, and a member below said liquid supply means and having its side edges in contact with said sheets, whereby a head of liquid is formed on the upper surface of said member by liquid distributed thereon from said supply means, said head being in contact with said sheets to saturate the same.

4. In an apparatus of the character described, depending sheets of material capable of being saturated by a liquid, means for supporting said sheets in spaced relationship, means for supplying liquid between said sheets, a member below said liquid supply means and having its side edges in contact with said sheets, whereby a head of liquid is formed on the upper surface of said member by liquid distributed thereon from said supply means, said head being in contact with said sheets to saturate the same, and means adjacent the ends of said member forming a trough with said sheets to maintain the head.

5. In an apparatus of the character described, depending sheets of material capable of being saturated by a liquid, means for tensioning and supporting said sheets in spaced relationship, means for supplying liquid between said sheets and adjacent the upper portions thereof, a member adjacent the upper portions of said sheets and below said liquid supply means, said member having its side edges in contact with said sheets whereby a head of liquid is formed on the upper surface of said member by liquid distributed thereon from said supply means and said head being in contact with said sheets to saturate the same, and means adjacent the ends of said member forming a trough with said sheets to maintain the head.

6. In an apparatus of the character described, depending sheets of material capable of being saturated by a liquid, means for supporting said sheets in spaced relationship, a member having its edges in contact with said sheets, and means for distributing liquid upon said member, whereby a head of liquid is formed upon the upper surface of said member, said head being confined by and in contact with said sheets for a substantial distance above the level of said upper surface to saturate said sheets.

7. In an apparatus of the character described, depending sheets of material capable of being saturated by a liquid, means for tensioning and supporting said sheets in spaced relationship, a member having its edges in contact with said sheets, means for distributing liquid upon said member, and means adjacent the ends of said member forming a trough together with said sheets, to maintain a head of liquid upon the upper surface of said member to saturate said sheets.

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