June 20, 1944. W. E. BELINE 2,352,069

DISTILLING APPARATUS

Filed July 22, 1942 2 Sheets-Sheet 1

Fig. 1.

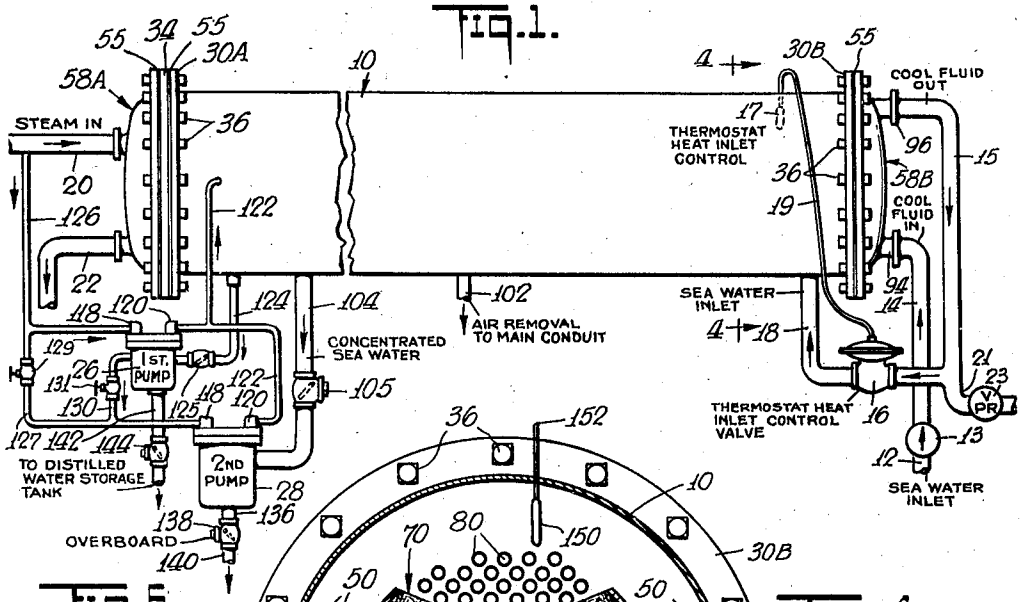


Fig. 5.

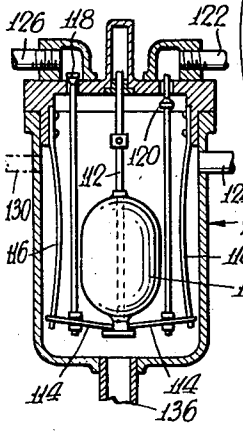


Fig. 4.

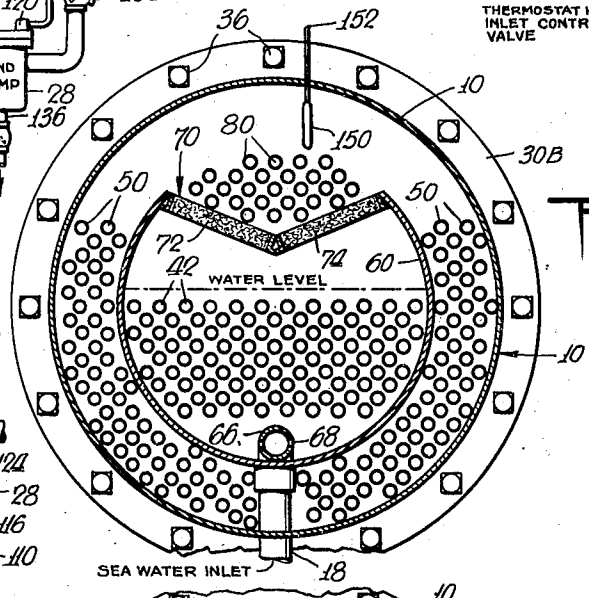
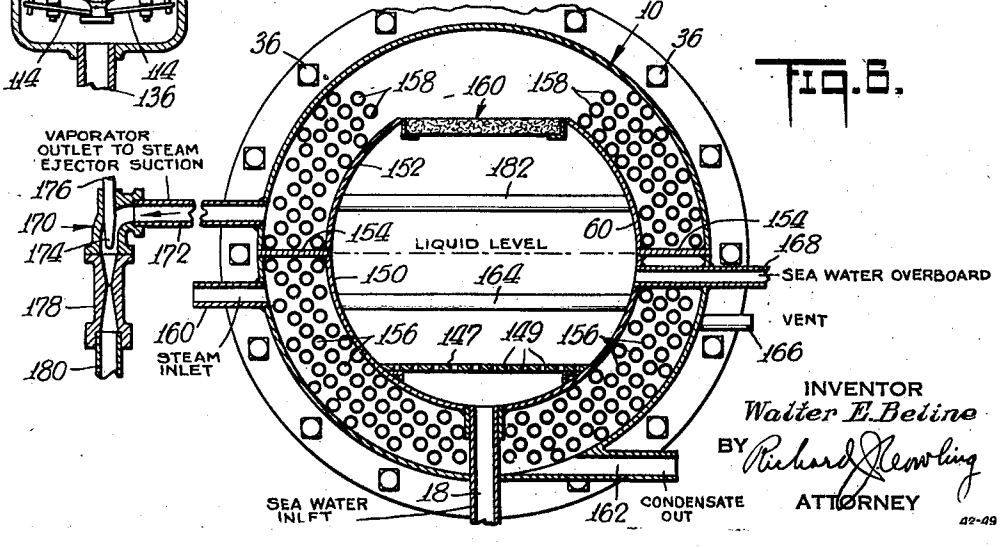


Fig. 6.



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DISTILLING APPARATUS

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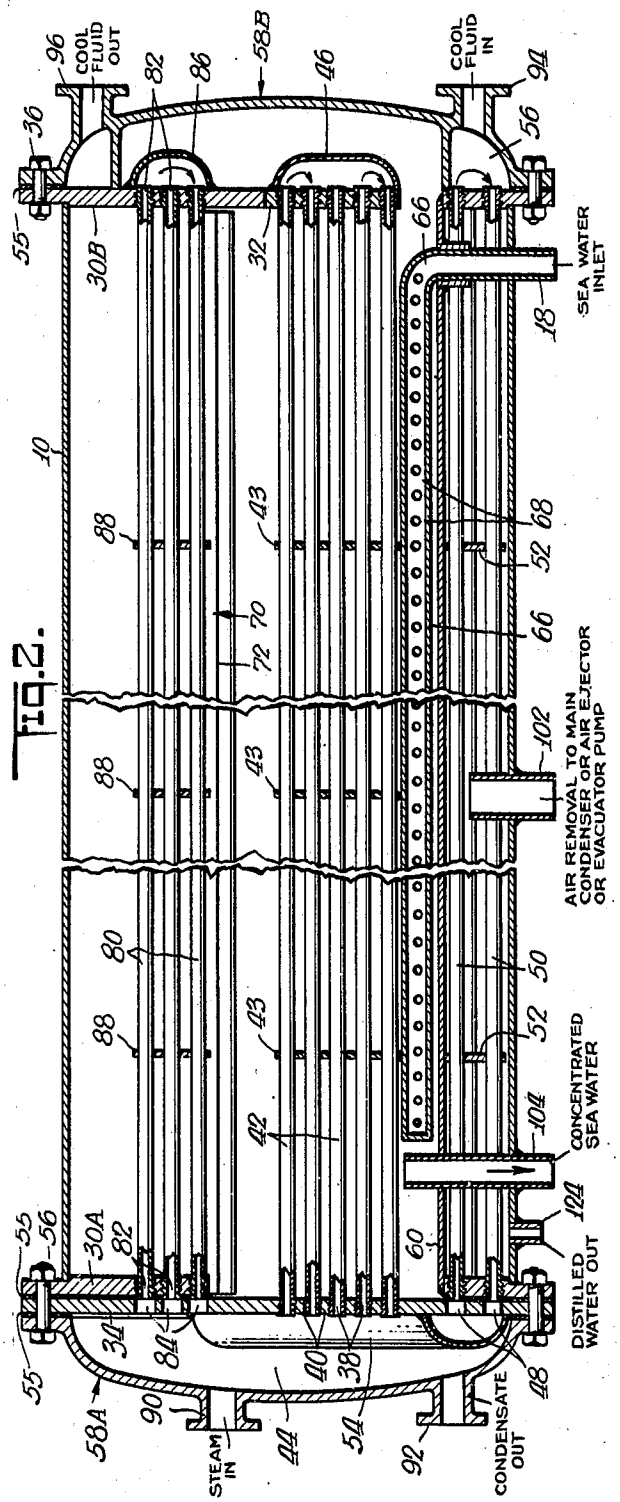


Fig. 2.

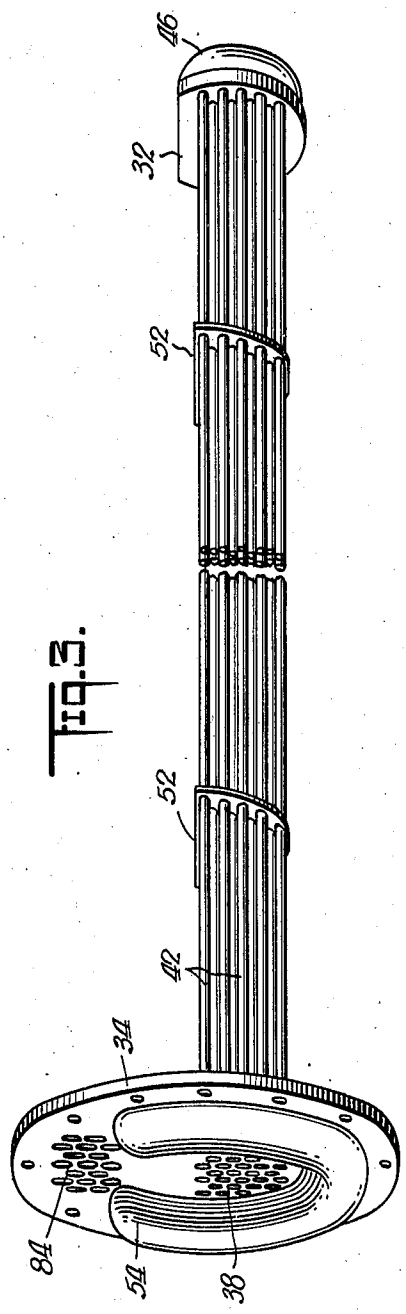


Fig. 3.

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DISTILLING APPARATUS

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Application July 22, 1942, Serial No. 451,897

17 Claims. (Cl. 202—187)

The present invention relates generally to a low pressure distilling apparatus, and it has relation particularly to a submerged tube type, film type or flash type distilling apparatus whereby a pure liquid is produced automatically and continuously from an impure or contaminated liquid.

Heretofore, such distilling plants have consisted generally of interconnecting separate distilling units and separate condensing units, which separated units required considerable space for installation, connection and operation. Such installations are highly objectionable and disadvantageous, especially on board ship where space is extremely limited. With the present invention I have been able to obviate these objections and disadvantages by devising a construction in which the distilling and condensing units are combined integrally in a novel and efficient manner into a single compact tank or vessel.

One object of the present invention is to provide a new and novel construction for a distilling apparatus, which requires but a minimum of installation and operating space.

A further object of the invention is to provide a complete distilling and condensing apparatus within a single tank or vessel, which is highly efficient in operation and designed to operate automatically and continuously.

Another object of the invention is the provision of a novel arrangement of operating automatic control devices whereby a definite ratio is maintained between the quantity of pure liquid produced and concentrated liquid discharged so that a definite control is effected over the concentration of the liquid remaining in the distilling tank, which in turn keeps the operation efficient and the rate of scaling at a minimum.

A further object of the invention is to provide an arrangement wherein the incoming impure liquid is first utilized to condense the superheated vapor, whereby it becomes preheated before being introduced into the distilling unit for vaporization.

Another object of the invention is to provide an arrangement whereby the amount of contaminated liquid being delivered to the distilling tank is controlled automatically by the temperature of the superheated vapor.

Other and further objects and advantages of the invention, which result in simplicity, economy and efficiency, will be apparent from the following detailed description, wherein preferred forms of embodiment of the invention are shown, reference being had for illustrative purposes to the accompanying drawings, forming a part hereof, wherein like numerals indicate like parts, in which:

Fig. 1 is a diagrammatic elevational view of a typical distilling apparatus circuit constructed in accordance with the principles of the invention;

Fig. 2 is an enlarged longitudinal axial sectional view of the tank or vessel shown in Fig. 1, with portions being broken away to reduce the length of the view and with the external control pipe connections being left off for the sake of clarity;

Fig. 3 is a perspective view of a sub-assembly showing the removable unit including the steam tubes used in heating the liquid to be subsequently distilled;

Fig. 4 is a cross-sectional view of the tank or vessel shown in Fig. 1, the same having been taken along the lines 4—4 thereof, looking in the direction of the arrows;

Fig. 5 is a detailed sectional view of one of the automatic displacement pumps shown in Fig. 1, which are used in controlling the removal of the distillate and the concentrated liquid from the system; and

Fig. 6 is a cross-sectional view similar to Fig. 4 showing a modified form of construction which my invention may assume.

Referring now to the drawings, and particularly to Figs. 1 to 4, thereof, there is shown a submerged tube type distilling unit including a tank 10, within which is mounted both the distilling and condensing units.

Looking at the right end of the tank 10, the contaminated liquid or distilland, which, for example, may be sea water, is first brought into the system through a pipe 12 by a conventional suction pump 13, whereupon it is forced through an inlet pipe 14, and through the head 58B into the condensing tubes of the condenser unit hereinafter to be described. After passing through the condensing system, the sea water, which has absorbed some heat in condensing the steam vapor to distillate in the condenser, is withdrawn through an outlet pipe 15. The outlet pipe 15 has a thermostatic heat control valve 16, which is capable of delivering the discharging condensing water to the distilling system when water is required therein through the inlet pipe 18. When the valve 16 is closed the discharging condensing water will be by-passed overboard through a discharge line 21 having a conven-

tional spring loaded valve 23. In this arrangement the sensible heat gained by the water during the condensing operation is utilized, thereby increasing the efficiency of the system by reducing the total heat input necessary to causing distillation.

The thermostatic expansion valve 16, which is used to control or regulate the amount of sea water covering the steam tubes 42 in the trough 60, is of a conventional construction. It regulates the flow of incoming sea water to the trough 60 in accordance with load conditions. It is not strictly speaking "thermostatic" in operation, except in the sense that it is responsive to superheat changes in the water vapor as it passes over the superheated tubes. By superheat I mean a vapor having a temperaure higher than the temperature corresponding to its pressure at saturation. The amount of superheat is, of course, the temperature increase above the temperature at saturation at the existing pressure. The remote bulb 17 of the thermal heat control valve 16 is mounted within the tank 10 in the path of the vapor passing over the series of superheating tubes 80, and is connected by a suitable capillary tube 19 to the valve 16. The valve 16 is adjustable, and may be set so as to cause flow of sea water into the trough 60 through the pipe line 18 and inlet pipe 66 when the superheat temperature rises beyond a given point, and, when the superheat temperature decreases due to the inrush of cool sea water, to shut off the flow of sea water into the pipe 18 and by-pass it out of the system through the overboard discharge line 21.

The heating system for the distilling unit is shown at the left end of the tank 10, and consists of an inlet steam pipe 20, which is suitably connected to the necessary distilling tubes, and an outlet pipe 22 through which the steam heating condensate leaves the system. A suitable conventional steam trap (not shown) is, of course, mounted in the outlet pipe 22.

In the operation of a distilling plant wherein pure water is to be made continuously from sea water, it is recognized that a definite relationship must be maintained between the salinity of the sea water and the maximum concentration of the brine in the distilling unit in order to have an efficient operation. Average sea water contains about $\frac{1}{32}$ part, by weight, of solid matter in every thirty-two pounds of sea water. The concentration of brine in the distilling unit, within limits, has a direct bearing on the quality of the distillate. For an efficient operation the density of the brine discharge overboard should never exceed 1.5/32. Since the concentration of the brine in the trough 60 will have a definite relationship to the quantity of brine pumped overboard and the amount of fresh water being produced, it is essential that a suitable automatic control be established for keeping this ratio constant and within efficient limits. A series of conventional automatic displacement pumps 26 and 28 are used to control the discharge of brine in proportion to the production of distillate. The pump 28, having a capacity equal to twice that of the pump 26, will permit twice as much brine concentrate to be discharged from the system as distillate delivered to the pure water storage tank. The detailed operation of these automatic displacement pumps 26 and 28 will be hereinafter more fully described.

With reference now to Figs. 2 to 5, wherein the details of construction of the various parts are best shown, the tank 10, which is of a cylindrical construction, has welded at its opposite ends suitable stiffener rings 30A and 30B. The ring 30A has its central area suitably apertured to receive a series of conventional steam tubes 42, which are welded, brazed or otherwise suitably fastened therethrough. The ring 30B has its corresponding central area separated therefrom to form a plate-like section 32, which is removable. The plate-like section 32 is correspondingly apertured for receiving the opposite ends of the steam tubes 42. Longitudinally spaced sustaining plates 43 sustain the respective positions of the tubes 42 intermediate their lengths. A tube sheet member 34 is adapted to be secured removably by bolts 36 against the stiffener ring 30A mounted on the left end of the tank 10. The intermediate portion of the tube sheet 34 is provided with a series of suitably arranged apertures 38 forming webs 40 to provide for steam passages connecting with each of the steam tubes 42, each of which is open at its opposite ends into suitable steam boxes 44 and 46. The pattern of the series of steam tubes 42 is best shown in Fig. 4.

The lower circumferential edge portions of the stiffener rings 30A and 30B have a series of apertures 48 therethrough into which are fitted suitable water tubes 50. The tube sheet 34 is apertured corresponding to the pattern arrangement of the water tubes 50 to provide a passageway therethrough, whereby the water tubes 50 may empty into a semi-circular cupped box 54, which is welded to the outer side of the tube sheet 34, to form a suitable chamber for said tubes. The opposite ends of the water tubes 50 are mounted through the stiffener ring 30B and empty into a suitable chamber 56 (Fig. 2) integrally formed in the head 58B. The water tubes 50 have longitudinally spaced sustaining plates 52 for sustaining their respective positions at intervals intermediate their length. This arrangement permits the circulation of cold incoming water back and forth through the water tubes 50 to cause the superheated vapor passing thereover to condense the distillate.

The tube sheet 34, including its semi-circular cupped box 54, the series of steam tubes 42, their sustaining plates 43, the removable end plate 32 and its adjoining cupped box 46, are all formed integrally into a unit, which unit is removable and may be longitudinally withdrawn from the vessel 10 when the head 58A is removed therefrom. Removal of this unit is essential periodically to properly clean and remove the scale formed on the exterior surfaces of the steam tubes 42. This removable unit is best shown perspectively in Fig. 3 of the drawings.

As best shown in Fig. 4, all of the steam tubes 42 are enclosed within an open top trough 60, mounted concentrically of and in spaced relation to the outer tank or shell 10 in any suitable manner. The trough 60 extends longitudinally of the tank 10 from the stiffener ring 30A to the stiffener ring 30B, and its arcuate ends are continuously welded to the inward plane surfaces of said rings, forming an air tight and water tight compartment within said tank 10. The trough 60 may be braced or otherwise supported intermediate its end in any suitable manner, such as, for instance, by radial sustaining blocks (not shown). There is provided an inlet pipe 66, having a series of longitudinally spaced perforations 68 therein, through which the incoming sea water may be evenly distributed longitudinally of the bottom of the trough 60 without undue surging. It is desirable to prevent undue surging of the incoming

water as it enters the trough 60 and flows over and around the steam heating tubes 42, because the forming vapor will have a tendency to carry the mist or droplets over into the condensing chamber. The inlet pipe 66, with its inlet perforations 68 spaced above the floor of the trough 60, provides a suitable space for the collection of any scale which may crack off and fall away from the steam heating tubes 42. This construction prevents any accumulation of scale from closing off the inlets for the incoming sea water.

A filtering partition is angularly mounted across the open top of the trough 60. This partition 70 completely closes the open top of the trough 60 and serves to arrest and return any liquid spray or droplets from passing out of the water heating chamber of the trough 60 such as may be caused by ebullition of the boiling salt water. This filtering partition 70 consists of two separate rectangularly shaped panels or frame members 72 and 74 suitably welded or otherwise fastened angularly to the upper edges of the trough 60. Each panel sustains two spaced confining sheets of woven wire between which is confined a layer of metal, wool or other suitable filtering material.

Within the space immediately above the filtering partition 70, there extends a series of spaced superheating steam tubes 80, which are suitably mounted in apertures 82 extending through the stiffener rings 30A and 30B. Correspondingly spaced apertures 84 in the tube sheet 34 (Fig. 2) are in open communication with the steam chamber 44 formed by the head 58A. A cupped box 86 is welded to the stiffener ring 30B over the open ends of the tubes 80 extending therethrough, forming a steam chamber therefor, which will permit the circulation of the steam between the open ends of adjacent tubes. The tubes 80 have a series of longitudinally spaced sustaining plates 88 for supporting them in proper spaced relation throughout their length.

Each end of the tank 10 is closed by removable heads 58A and 58B. The head 58A, closing the left hand end of the tank 10, which is best shown in Fig. 2, is secured to the stiffener ring 30A by the same bolts 36 that hold the tube sheet 34 in position. Suitable gaskets 55 are used in assembling these several parts in order to make the system steam, air and water tight. The head 58A is cast with an integral steam inlet connection 90 and outlet connection 92. The head 58B, closing the right hand end of the tank 10, is likewise secured to the stiffener ring 30B by similar bolts 36, and has a suitable gasket 55 mounted therebetween. The head 58B is constructed so as to provide an inlet connection 94 and an outlet connection 96. It is to be understood that the heads 58A and 58B may be constructed in different ways so as to provide the desired number of water or steam passes through the several series of tubes without departing from the scope of the invention.

In operation of the apparatus, the vapor from the boiling sea water in the trough 60 rises upwardly through the filter 70, passing around and over the superheated tubes 80. Any condensate or other foreign substances which may unaccountably be carried by the vapor through the filter 70, will be driven out of the vapor by its superheating, and will, of course, be gravitationally deposited on top of the angularly positioned filter panels 72 and 74, which are so constructed as to provide a collecting reservoir for such foreign substances.

The superheated vapor then moves over and around the condensing water tubes 50, disposed in the concentric annular space between the outer surface of the trough 60 and the inner surface of the tank 10. The condensing water tubes 50 are connected with the head 58B in such a manner that cool water entering the inlet 94 is passed back and forth between these tubes until it reaches the outlet 96. The condensate from the condensing vapor gravitates to the bottom of the tank 10, and is withdrawn therefrom through an outlet pipe 124 and pump 26, which permits its passage to the storage tank (not shown).

Air or other non-condensible gases formed in the condensing chamber are adapted to be removed through a suction connection 102, which leads from a point spaced from the bottom of the tank 10 and from a point spaced from the distilled water outlet 124. The suction connection 102 is intended to be connected to a suitable evacuation pump (not shown).

A concentrated brine outlet connection 104, extending through the tank 10 into the trough 60, provides a means for draining the concentrating brine forming in the trough 60 due to evaporation of a portion of the sea water therein.

Steam for heating the steam tubes 42 and 80 enters through the steam inlet 90, passing through the head 58A and into the heating tubes 42 for heating the sea water and into the heating tubes 80 for superheating the vapor through their openings 38 and 84, respectively, in the tube sheet 34. The condensate, which forms during these several heating operations, will gravitate downwardly and leave the apparatus through the outlet 92, which, of course, must be provided with a suitable steam trap (not shown). The sustaining plates 43 and 88, respectively, are constructed or arranged so as to permit the passage of condensate therethrough.

As already has been explained, it is necessary to control the discharge of concentrated brine in proportion to the production of distillate or pure water. Accordingly, a suitable pump 28 is placed in the concentrated brine discharge line 104, which is operably connected with the pump 26. The capacity of the pump 28 is twice that of the pump 26 so that twice as much concentrated brine will be discharged from the system as distillate produced. Of course, this ratio may be changed merely by substituting pumps of different capacities, depending, for example, upon the impurity of the water being distilled, without departing from the scope of the invention. The pump 28, which is shown in sectional detail in Fig. 5, has a float 110, which is guided for vertical movement by a stem 112. A toggle mechanism, comprising two toggle levers 114 hinged together and sustained at their remote ends by leaf springs 116, which tend to approach each other and are forced outwardly by the toggle levers 114, form a quick throw mechanism by means of which the float 112 closes the valves 118 and 120 selectively. The normal condition is with the float 110 down, at which time the valve 120 is open and the interior of the pump is at subatmospheric pressure because the valve 120 is connected by the equalizing pipe line 122 to the condensing chamber of the apparatus, being the low side of the system. Thus, the concentrated brine or distilland may enter freely through the pipe 104, pass through the check valve 105 and into the pump 28, and when the accumulation of brine is of a sufficient depth, it will cause the

float 110 to rise. This movement of the float 110 causes the toggle to shift, opening the valve 118 and closing the valve 120. This shift cuts off the connection to the "low" side of the system by way of the line 104, and subjects the interior of the pump to the "high" pressure side through the valve 118 and pipe line 130 connected through the pump 26 and line 126, to the steam inlet pipe 20. It follows that when the float 110 is in its upward position the brine concentrate or distilland in the pump 28 is forced to flow into the pipe 136, through the check valve 138 and into the line 140 for discharge overboard.

The pump 26 is identical in construction and operation to the pump 28, except that it is half as large, and its "high" pressure side, or valve 118, is connected by a pipe 126 directly to the steam inlet 20. The pump 26 has an additional connecting line 130 from its float chamber to the valve 118 of the pump 28, which additional connection is indicated in dotted lines in the pump 28 in Fig. 5. The distillate produced may enter the pump 26 freely through the pipe line 124 and check valve 125, and, when the accumulation is of a sufficient depth to cause its float 110 to rise, whereupon the distillate will be forced to flow out through the line 142 and the check valve 144 to the storage tank.

It will thus be apparent that the high and low sides of these automatic displacement pumps are never freely connected with each other, but the pressure differential is availed of to transfer the several liquids from their respective systems to their desired discharge lines. These automatic displacement pumps are conventional commercial pumps chosen for illustrative purposes. Equivalent devices (not all of which are pumps) are well known to those skilled in the art and may be substituted.

It will be noted that the pumps 26 and 28 are so connected that one of them may, if so desired, be operated at any time without the other. This is accomplished by connecting the line 126 directly to the line 130 by a by-pass line 127. A manually operable control valve 129 is mounted in the line 127, and a similar valve 131 is mounted in the line 130, between the line 127 and the pump 26. By closing the valve 131 the pump 28 is cut off from the pump 26, and by opening the valve 129 in the by-pass line 127 the pump 28 is connected directly to the "high" pressure side of the apparatus, or steam line 20, through the pipe lines 126 and 127.

After considerable use the apparatus will have to be cleaned in order to remove the scale formed on the outer surfaces of the tubes 42 in the trough 60. This may be readily accomplished by removing the head 58A, opening the left end of the tank 10, whereupon the tube sheet 34 may be withdrawn with its water box 54, tubes 42, plates 45 and water box 46 as an integral unit, which is best shown in Fig. 3. The tubes 42 are mounted in the trough 60 in what is known as a "floating head construction," a term which is well understood in the art and requires no further explanation herein.

In the modification shown in Fig. 6, the tank 10 is provided with what is known conventionally as a flash type distilling unit. The trough 60 is provided with a baffle plate 147 having apertures 149, but is devoid of steam heating tubes. The annular space between the tank 10 and trough 60 is divided into two separate and distinct upper and lower sections, 150 and 152, by suitable radial partitioning plates 154. The lower section is adapted to receive a series of water tubes 156 for preheating the sea water to be discharged into the trough 60. The upper section is adapted to receive a series of condensing tubes 158 for condensing the vapor arising from the trough 60. The upper open end of the trough 60 is closed by a filter member 160, which is similar to the filter member 70 previously described, but of a more simple construction, having only one panel member.

The sea water enters the water tubes 156 through a suitable connection in one of the heads (not shown) but like the head 58B in the previously described construction, and after preliminary heating is passed through the inlet pipe 18, filling the space below the baffle plate 147, and entering into the trough 60 through the openings 149 therein. This water, being about at its vaporization temperature, flashes off into vapor, which vapor passes upwardly through the filter member 160 into the condensing chamber 152. The steam for heating the water tubes 156 enters through the pipe 160, and flows around between the tubes 156. The condensate from the steam flows out through outlet pipe 162. A series of longitudinally spaced equalizer tubes 164 passing through the water chamber in the trough 60, connects both upper sides of the steam chamber containing the tubes 156, and serves to increase circulation of the steam therein. A vent 166 connected to the lower chamber containing tubes 156 serves to let the air formed therein out of the steam condensing chamber. A drain 168 permits a steady flow of sea water overboard from the trough 60, preventing the formation of any brine concentration therein.

The upper half of the concentric space between the trough 60 and tank 10 contains condensing tubes 158 which has cold sea water flowing therethrough. The sea water for the tubes 158 enters and leaves through suitable inlet and outlet connections formed in the opposite head (not shown), but like the head 58A of the previously described apparatus. When the system is operating below atmospheric pressure, a conventional steam ejector suction unit 170, consisting of a nozzle 174, having a high pressure steam inlet 176 and an ejector diffuser 178, is required to withdraw the air and other non-condensible gases from the condensing unit. The outlet 178 may be connected by a pipe 180 to the low pressure sea water preheater inlet 160, which effects an efficient operation by utilization of the discharge steam vapor as a means of preheating the sea water. It will be obvious that the movement of the steam at high pressure passing the outlet of the pipe 172 in the nozzle 170 will act as a pumping means to withdraw any air or other non-condensible gases from the condensing chamber which is at sub-atmospheric pressure to discharge the same at atmospheric or higher pressure. The upper chamber 152 is likewise provided with a series of longitudinally spaced equalizer tubes 182 passing through the upper half of the trough 60. These equalizer tubes 182 serve to increase the efficiency of the circulation in said chamber 152. It is believed this brief description of the modified form of the invention is sufficient to enable one skilled in the art to understand its full construction and operation, especially when coupled with the complete description given in connection with the original apparatus.

While I have specifically described for illustrative purposes the conversion of sea water to

fresh water, it is to be understood that the invention is not to be so construed as being so limited. The features of the apparatus are applicable generically to various other distillation problems, and its application to such other uses is to be understood to be within the realm of the present invention.

Although I have described in detail only two forms which the invention my assume, it will be apparent to those skilled in the art that the same is not to be so limited, but that various other modifications may be made therein without departing from the spirit thereof or from the scope of the appended claims.

What I claim is:

1. A distilling apparatus comprising in combination an elongated tank of substantial length as compared to its width dimension having an elongated trough structure adapted to hold a substantial volume of liquid mounted within said tank and in spaced relation thereto, said elongated trough structure extending substantially the length of the tank and being open at the top throughout its length, means for supplying a liquid to said elongated trough structure, means for causing the liquid retained in said elongated trough structure to vaporize, condensing means mounted in the lower part of the space between said tank and trough structure for condensing the vapor passing thereover, and means for removing the condensate from said tank.

2. A distilling apparatus comprising in combination a tank having a trough structure mounted therein in spaced relation thereto, and adapted to hold a substantial volume of liquid, said trough structure having an open top throughout its length, means for supplying a liquid to said trough, means for causing the liquid retained in said trough structure to vaporize, vapor filtering means mounted over the open top of said trough structure, heating means mounted above said filtering means for superheating said vapor passing through said filtering means, means mounted in the lower part of the space between said tank and trough structure for condensing the vapor passing therethrough, and means for removing the condensate from said tank.

3. A distilling apparatus comprising in combination a tank having in combination therewith a trough mounted therein in spaced relation thereto for retaining a substantial volume of a liquid said trough having an open top substantially throughout its length, a heating means in said trough, means including a vapor filter for closing the open top of said trough, heating means positioned above said filter for superheating the vapor passing therethrough, condensing means mounted in the space between said trough and tank for condensing the superheated vapor, means for automatically controlling the flow of liquid to said trough, and means for removing the condensate from said tank.

4. A distilling apparatus comprising a tank having in combination therewith a trough mounted therein in spaced relation thereto for retaining a liquid, said trough having an open top substantially throughout its length, a removable heating means in said trough, means including a filter for closing the open top of said trough, heating means positioned above said filter for superheating the vapor passing therethrough, condensing means mounted in the space between said trough and tank for condensing the superheated vapor, means for automatically controlling the flow of liquid to said trough, and means for removing the condensate from said tank.

5. A distilling apparatus comprising a cylindrical tank having in combination therewith a trough mounted concentrically therein in spaced relation thereto for retaining a distilland, said trough having an open top substantially throughout its length, a heating means in said trough, means including a filter for closing the open top of said trough, heating means positioned above said filter for superheating the vapor passing therethrough, condensing means mounted in the space between said trough and tank for condensing the superheated vapor, means for automatically controlling the flow of liquid to said trough, and automatic means for preventing the concentration of the distilland in the trough by removing a portion thereof proportionately to the amount of condensate produced.

6. A distilling apparatus comprising a cylindrical tank having in combination therewith a trough mounted concentrically therein in spaced relation thereto for retaining a liquid, said trough having an open top substantially throughout its length, a heating means in said trough, means including a filter for closing the open top of said trough, heating means positioned above said filter for superheating the vapor passing therethrough, condensing means mounted in the space between said trough and tank for condensing the superheated vapor, means including a thermostatic heat control valve responsive to the degree of superheat of said vapor for automatically controlling the flow of liquid to said trough, means for removing the condensate from said tank, and automatic means for preventing the concentration of the distilland in the trough by removing a portion thereof proportionately to the amount of condensate produced.

7. A distilling apparatus comprising a cylindrical tank having concentrically mounted therein in spaced relation a cylindrical trough adapted to retain a distilland, said trough having an opening in its top substantially throughout its length, means including a thermostatically controlled valve responsive to changes in the superheat temperature of the vapor from the distilland for supplying additional distilland to said trough, means for preventing undue surging of said liquid as it enters said trough, heating means removably mounted within said trough for heating the liquid therein, means including a filter for closing the open top of said trough, heating means mounted between said filter and the tank for superheating the distilled vapor, means mounted between said trough and tank for condensing said superheated vapor, means for removing the liquid condensed from said superheated vapor, and means for removing a portion of the liquid in said trough to prevent an accumulation of concentrated liquid therein.

8. A distilling apparatus comprising a cylindrical tank having in combination therewith a trough mounted concentrically therein in spaced relation thereto for retaining a liquid, said trough having an opening in its top substantially throughout its length, a heating means in said trough, means including a filter for closing the open top of said trough, heating means positioned above said filter for superheating the vapor passing therethrough, condensing means mounted in the space between said trough and tank for condensing the superheated vapor, means for automatically controlling the flow of liquid to said trough, means for automatically removing the condensate from said tank, and means operatively associated with said condensate removal

means for removing a portion of the liquid from said trough to prevent the concentration of the same therein.

9. A distilling apparatus comprising a cylindrical tank having in combination therewith a trough mounted concentrically therein in spaced relation thereto for retaining a liquid, said trough having an open top substantially throughout its length, a heating means in said trough, means including a filter for closing the open top of said trough, heating means positioned above said filter for superheating the vapor passing therethrough, condensing means mounted in the space between said trough and tank for condensing the superheated vapor, means for automatically controlling the flow of liquid to said trough, means including an automatic displacement pump for removing the condensate from said tank, and means including a second automatic displacement pump for removing a portion of the liquid from said trough to prevent the concentration of the same therein.

10. A distilling apparatus comprising a cylindrical tank having concentrically mounted therein in spaced relation an open top cylindrical trough adapted to retain a liquid, means for automatically controlling the supply of liquid to said trough, means extending the length of said trough and spaced from the bottom thereof for delivering said liquid uniformly into said trough, heating means mounted between said filter and the tank for superheating the vapor, means mounted between said trough and tank for condensing said superheated vapor, means for removing the air from said condensing chamber, means for removing the liquid condensed from said superheated vapors, and means for automatically removing liquid from said trough in proportion to the amount of condensate produced in order to prevent an accumulation of concentrated liquid therein.

11. A distilling apparatus comprising in combination a tank having a trough structure mounted therein in spaced relation thereto, said trough structure having an open top substantially throughout its length, means for supplying a liquid to said trough, means for dividing the space between said tank and said trough into separate compartments, means mounted in one of said compartments for heating the liquid to be delivered to said trough, means for discharging a portion of the liquid in said trough to prevent the concentration thereof, means mounted in the other of said compartments for condensing the vapor formed in said trough, and means for withdrawing the condensate from said last mentioned compartment.

12. A distilling apparatus comprising in combination a tank having a trough structure mounted therein in spaced relation thereto, said trough structure having an open top substantially throughout its length, means for supplying a liquid to said trough, means for dividing the space between said tank and said trough into separate compartments, means mounted in one of said compartments for heating the liquid to be delivered to said trough, means for removing the air or other non-condensible gases from said trough, filtering means closing the open top of said trough, means mounted in the other of said compartments for condensing the vapor formed in said trough, and means for withdrawing the condensate from said last mentioned compartment.

13. A distilling apparatus comprising in combination a tank having a trough structure mounted therein in spaced relation thereto, said trough structure having an open top substantially throughout its length, means for supplying a liquid to said trough, means for dividing the space between said tank and said trough into separate compartments, means connecting opposite sides of each compartment for increasing the circulations therein and tending to equalize any differences in pressure building up in the opposite sides of said compartments, means mounted in one of said compartments for heating the liquid to be delivered to said trough below atmospheric pressure to cause said heated liquid therein to vaporize, means mounted in the other of said compartments for condensing the vapor formed in said trough, and means for withdrawing the condensate from said last mentioned compartment.

14. A distilling apparatus comprising in combination a tank having a trough structure mounted therein in spaced relation thereto, said trough structure having an open top substantially throughout its length, means for supplying a liquid to said trough, means for dividing the space between said tank and said trough into separate compartments, longitudinally spaced means connecting opposite sides of each of said compartments for facilitating the flow therein and tending to equalize any differences in pressure building up in the opposite sides of said compartments, means mounted in one of said compartments for heating the liquid to be delivered to said trough, means including a steam ejector for withdrawing air and other non-condensible gases from the condensing chamber, means mounted in the other of said compartments for condensing the vapor formed in said trough, and means for withdrawing the condensate from said last mentioned compartment.

15. A distilling apparatus comprising in combination a tank having a trough structure mounted therein in spaced relation thereto, said trough structure having an open top substantially throughout its length, means for supplying a liquid to said trough, means for dividing the space between said tank and said trough into separate compartments, means mounted in one of said compartments for heating the liquid to be delivered to said trough, filtering means closing said open top trough, means mounted in the other of said compartments for condensing the vapor formed in said trough, means for removing continuously a portion of the liquid from said trough to prevent brine concentration therein, and means for removing the condensate from said condensing compartment.

16. A distilling apparatus comprising in combination a tank having a trough structure mounted therein in spaced relation thereto, said trough structure having an open top substantially throughout its length, means for supplying a liquid to said trough, means for dividing the space between said tank and said trough into separate compartments, means mounted in one of said compartments for heating the liquid to be delivered to said trough, means including a high pressure steam ejector for withdrawing air and other non-condensible gases from said condensing chamber when the same is below atmospheric pressure, means mounted in the other of said compartments for condensing the vapor formed in said trough, means for continuously discharging a portion of the liquid from said

trough, and means for withdrawing the condensate from said last mentioned compartment.

17. A distilling apparatus comprising in combination a tank having a trough structure mounted therein in spaced relation thereto, said trough structure having an open top substantially throughout its length, means for supplying a liquid to said trough, means for dividing the space between said tank and said trough into separate compartments, filtering means closing the open top of said trough structure, means mounted in one of said compartments for heating the liquid to be delivered to said trough, means including a high pressure steam ejector for withdrawing air and other non-condensible gases from said condensing chamber when the same is below atmospheric pressure, means mounted in the other of said compartments for condensing the vapor formed in said trough, means for continuously discharging a portion of the liquid from said trough, and means for withdrawing the condensate from said last mentioned compartment.

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