Jan. 30, 1945. E. P. WORTHEN ET AL 2,368,588

APPARATUS FOR EVAPORATING AND DISTILLING

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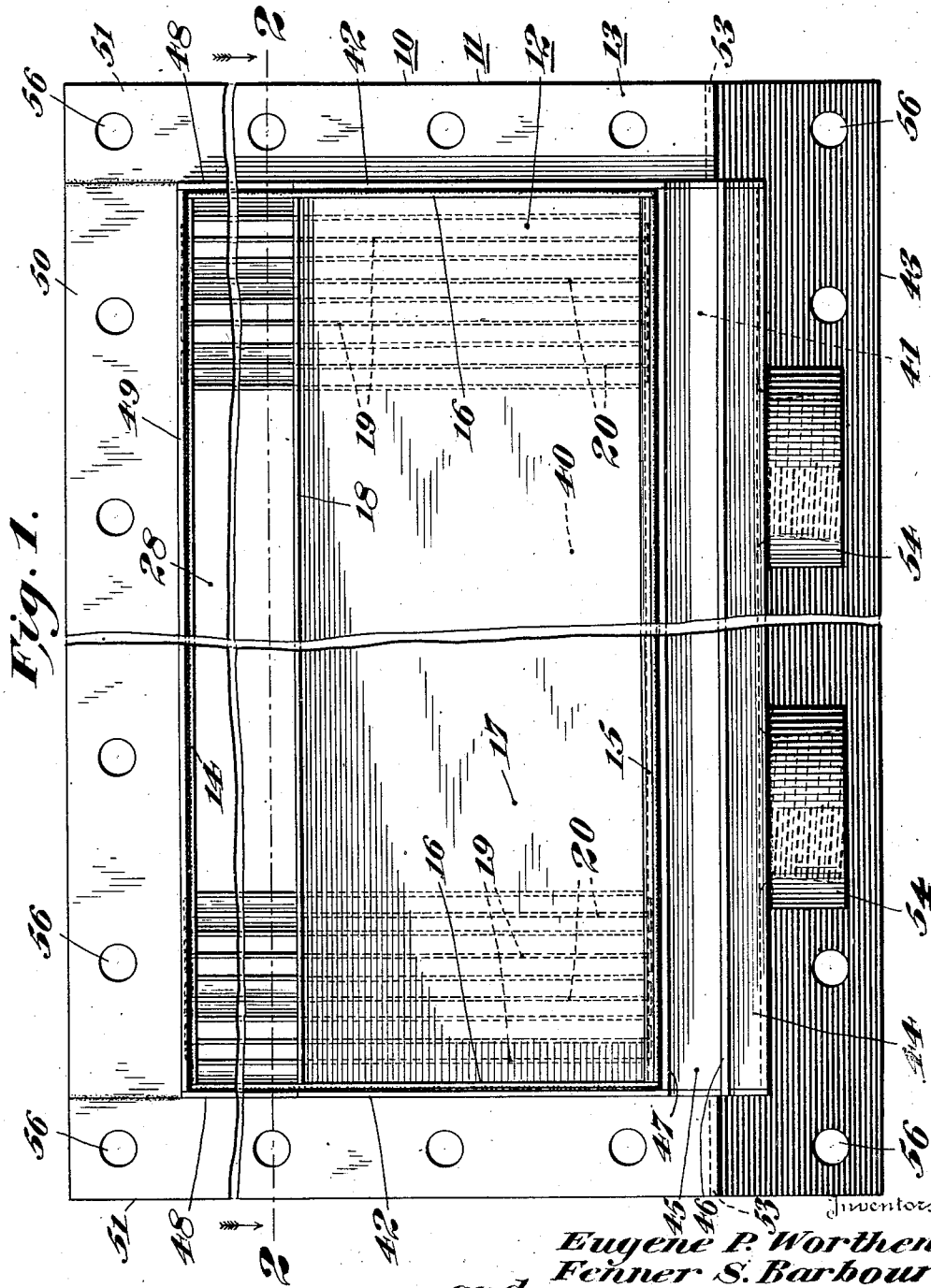



Fig. 1.

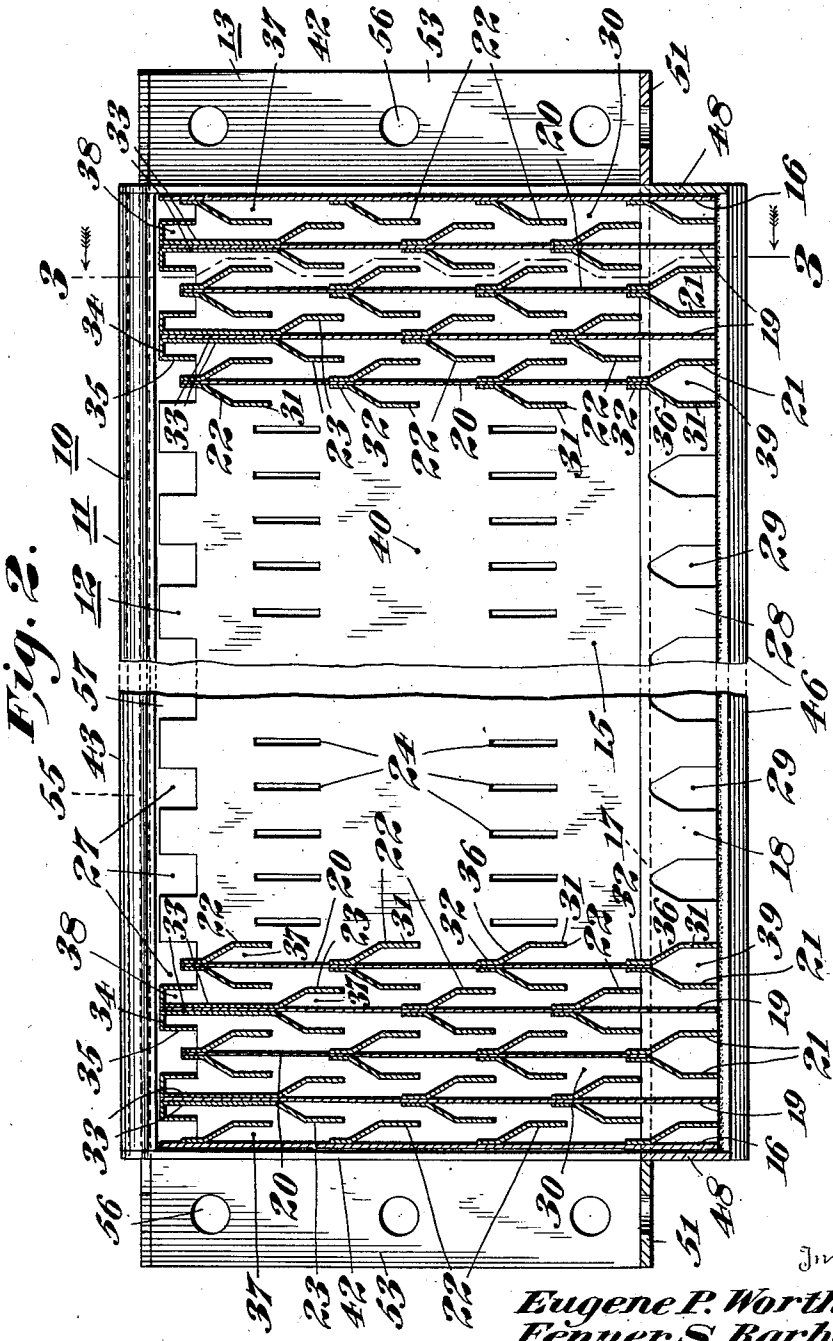
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APPARATUS FOR EVAPORATING AND DISTILLING

Filed May 27, 1942 5 Sheets-Sheet 2

Fig. 2.



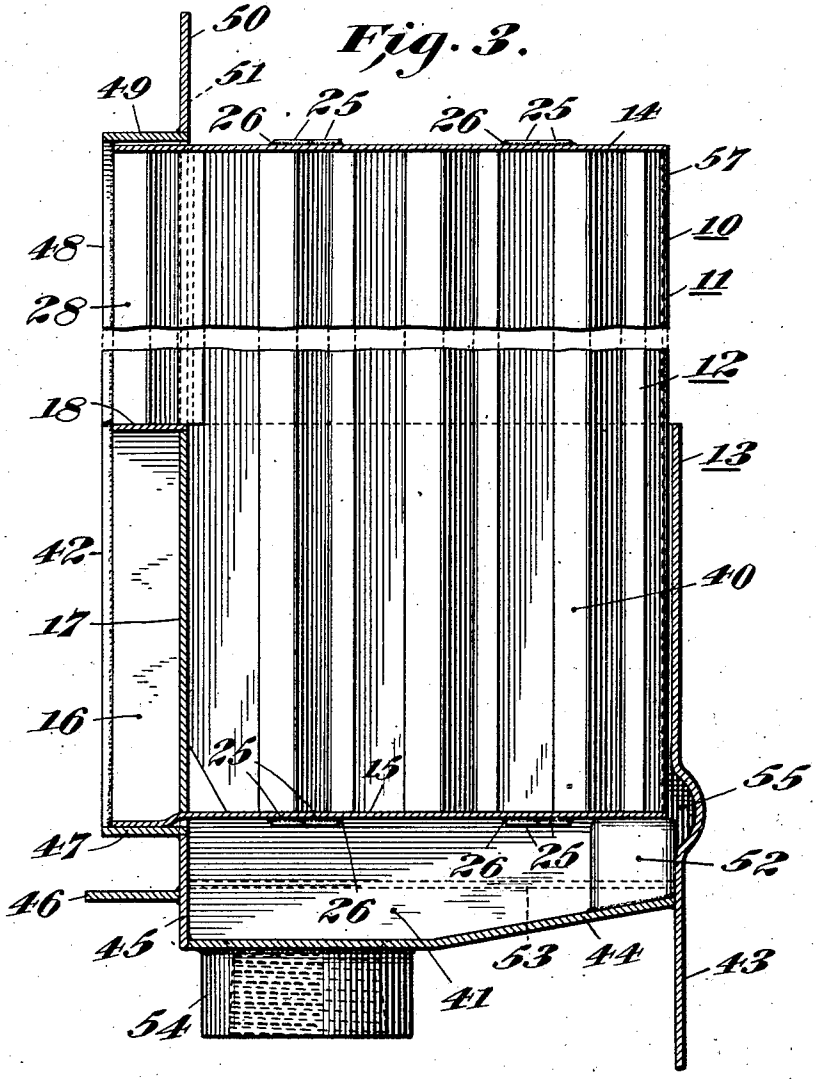
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APPARATUS FOR EVAPORATING AND DISTILLING

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Fig. 3.



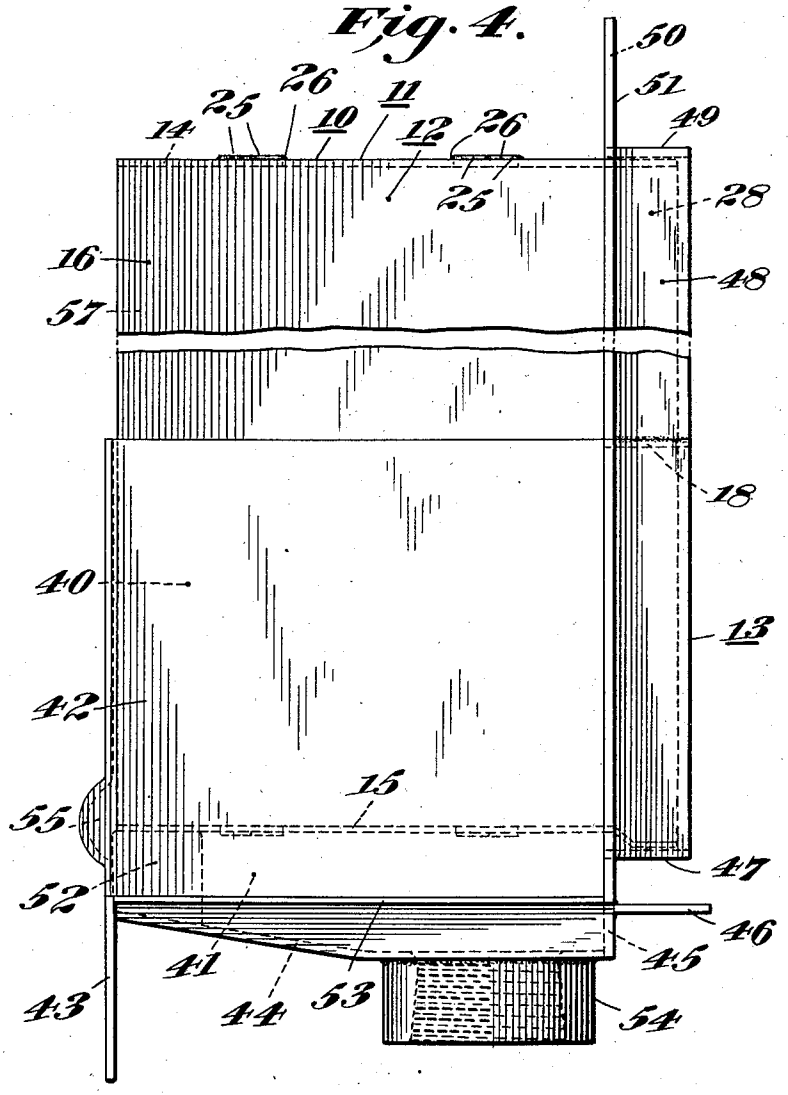

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APPARATUS FOR EVAPORATING AND DISTILLING

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Fig. 4.




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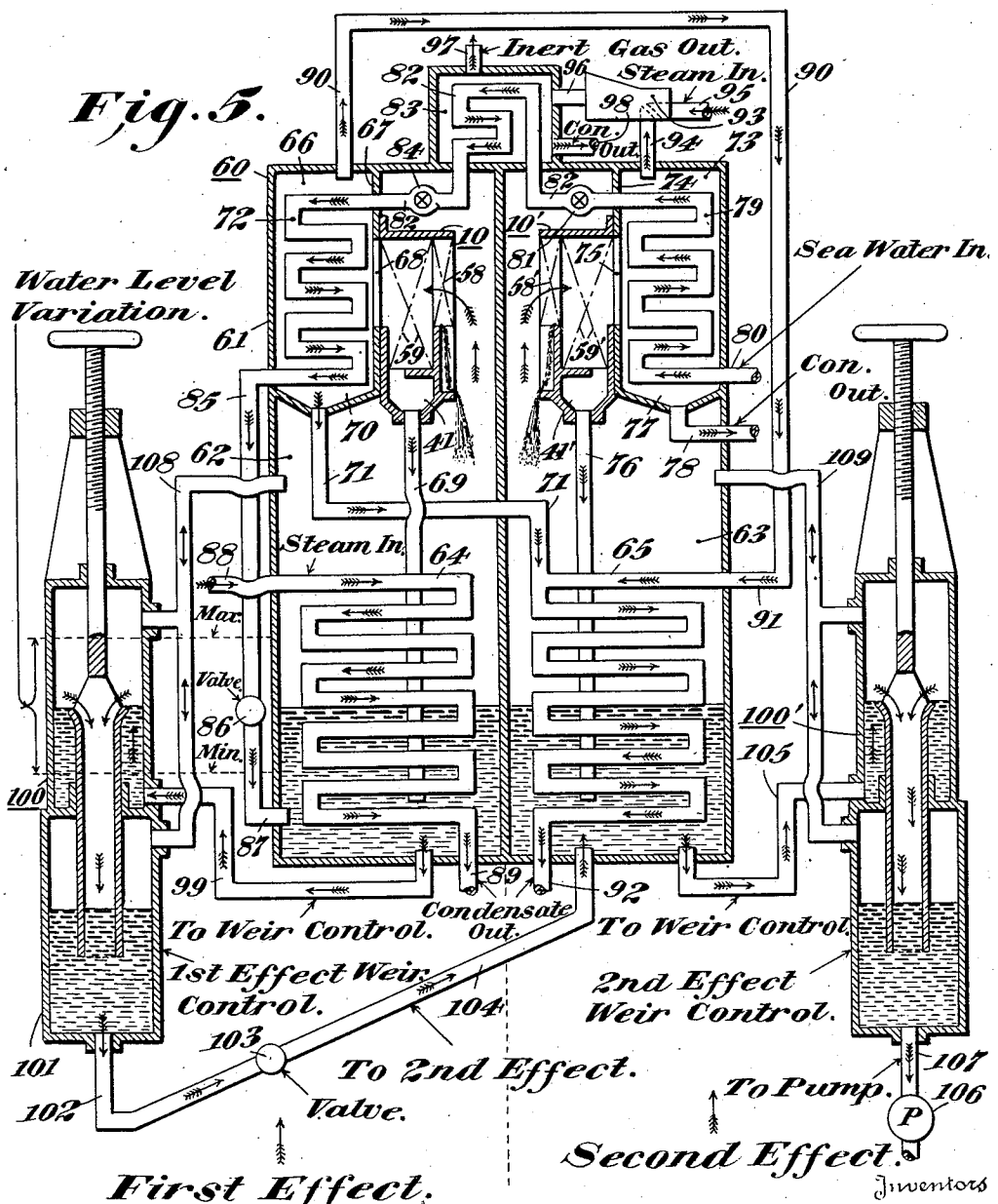
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APPARATUS FOR EVAPORATING AND DISTILLING

Filed May 27, 1942 5 Sheets-Sheet 5

Fig. 5.




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Patented Jan. 30, 1945 2,368,588

# UNITED STATES PATENT OFFICE

2,368,588

## APPARATUS FOR EVAPORATING AND DISTILLING

Eugene Porter Worthen, East Weymouth, Fenner Smith Barbour, Wollaston, and Stephen Roger Putnam, Quincy, Mass., assignors, by mesne assignments, to Buena Vista Iron Company, a corporation of New Jersey

Application May 27, 1942, Serial No. 444,676

6 Claims. (Cl. 202—174)

This invention relates to an improved apparatus for evaporating and distilling, and especially to such apparatus as is intended for use on board ships and the like where it is necessary to supply the fresh or pure water demands from sea water. Such demands are occasioned by the losses of fresh water occurring due to the operation of the ship's machinery, such as condenser, turbine, boiler, auxiliary engines, and the like, together with the ship's human needs, such as drinking water.

The invention relates more particularly to changes and improvements in the means for the production of pure water in evaporating and distilling apparatus and in the embodiment of said means as an improvement affecting the method of operation of the apparatus shown and described in Letters Patent of the United States, No. Re. 21,129, granted to Benjamin Fox et al. June 27, 1939, and improvement thereon shown and described in co-pending patent application Serial No. 441,184, filed April 30, 1942, by one Eugene Porter Worthen.

The said co-pending application Serial No. 441,184 shows and discloses feed control means whereby liquid may be supplied to the evaporating and distilling apparatus in constant substantial excess of that removed by evaporation in said apparatus, with the result that a considerable increase in generated vapor of permissible salinity is possible over that possible in an apparatus of equal volumetric size built according to the said U. S. Letters Patent No. Re. 21,129.

Accordingly, the main object of our invention is to provide in a water evaporating and distilling apparatus highly efficient means for separating water containing salt from the vapor generated within said apparatus and which is characterized particularly by novel separating elements and by having in a single separating unit a plurality of qualitative drainage means to the body of distilland below.

In our improved design of apparatus for evaporating and distilling sea-water we have three stages of qualitative precipitation from the vapor generated therein as follows: First, as the generated vapor rises within the evaporator chamber it enters the inlet to our improved separator and in the entrance region thereof separating elements are provided which operate to remove a large portion of the liquid and of any detritus entrained in the generated vapor. These entrance elements discharge their entrained liquid and detritus directly to the body of the distilland below. Second, we provide interior separating elements which entrain the remaining liquid and detritus in suspension within the vapor and discharge them to a collecting chamber within the separator and from thence they are discharged downward by means of a pipe to within the body of the distilland below. Third, the purified vapor leaving the separator enters the feed water heater compartment and is there condensed, and the condensate thereof is piped off for use. We have found that the efficiency of our design of separator with its qualitative plural discharges is sufficient to eliminate the need of intermediate baffles usually placed between the separator and the surface of the distilland. We thus have an attendant saving in weight of apparatus.

Another object, therefore, of our invention is to eliminate the need of intermediate baffle means between the separator attached to the feed heater means and the body of distilland whereby weight is saved as well as contributing to an extremely stable and easily operated plant.

We have also found that by providing the entrance separating elements with their free discharge direct to the body of the distilland below that the largest part of the liquid and particularly of the solid detritus is therein eliminated from the generated vapor, which leaves the interior separating elements free of flooding and therefore more efficient in the final purification of the generated vapor on its way to condensation in the feed heater or distilling chambers.

It is a further object, therefore, of our invention to provide novel separating elements of high efficiency for effecting entrainment of water containing salt rapidly with respect to their extent and without atomization within the vapor stream.

Other objects and advantages will be apparent from the following description, wherein reference is made to the accompanying drawings illustrating the preferred embodiment of our invention and wherein similar reference numerals designate similar parts throughout the several views.

Figure 1 is a front elevation of the separator unit;

Fig. 2 is a section taken along the lines 2—2 of Figure 1 viewed in the direction of the arrows, and with certain of the division plates removed;

Fig. 3 is a section taken along the lines 3—3

of Figure 2 viewed in the direction of the arrows;

Fig. 4 is a left end side elevation; and

Fig. 5 is a drawing representing in diagrammatic form the flow system of the liquids to be distilled, the heating fluids therefor, and the condensate collecting means in an evaporating and distilling apparatus embodying our invention.

Referring now to Figures 1 to 4, inclusive, of the drawings, the numeral 10 designates the separator unit comprising a casing 11 preferably made of brass plates brazed together. The casing 11 is a box-like structure comprising the separating compartment 12 and the casing structure 13.

The separating compartment 12 is a built-up unitary structure comprising a top plate 14, drain plate 15, side plates 16, front plate 17, splash plate 18, division plates 19, division plates 20, and baffle hooks 21, 22, and 23. The top plate 14 and the drain plate 15 have provided therein a plurality of spaced slots 24 (Figure 2). The division plates 19 and 20 have along their top and bottom edges lugs 25 spaced lengthwise to register with the slots 24. By placing the lugs 25 in their respective slots, and bending them over and brazing them in place, as shown in Figure 3 at 26, the division plates 19 and 20 are held in alternate spaced vertical parallel relation between the top plate 14 and the drain plate 15. The drain plate 15 is also provided with openings 27 along the rear edge for a purpose to be hereinafter described. The baffle hooks 21, 22, and 23 are brazed to the inner sides of the side plates 16 and to both sides of the division plates 19 and 20 in alternate staggered relationship. The baffle hooks 21 are positioned in the inlet opening 28 of the separating compartment 12 and extend vertically between the top plate 14 and the splash plate 18. The inlet opening 28 is preferably in height about two-thirds that of the separating compartment 12. The splash plate 18 is provided with openings 29 in registry with and is brazed to the bottom ends of the baffle hooks 21 for a purpose to be hereinafter described. The front plate 17 is set in from the front edges of the top, drain, and side plates a distance equal to the width of the splash plate 18 for a purpose to be hereinafter described. The baffle hooks 22 and 23 extend between the top plate 14 and the drain plate 15.

It will be noted that the division plates 19 and 20 with side plates 16 form a series of vertical parallel narrow passageways 30 extending from the front to the rear of the separating compartment 12. It will also be noted that the alternate staggered positioning of the baffle hooks between these plates forms a sinuous continuous passageway somewhat as indicated by the dot-and-dash line 3—3 of Figure 2, and that opposed to each turn of the sinuous passageway are forewalls 31 of each of the baffle hooks. The baffle hooks 21 and 22 each having attaching walls 32 while baffle hooks 23 have attaching walls 33 and rear hook walls 34 and 35. In each case the forewalls are spaced from and joined to the attaching walls by an integral sloping wall 36. The forewalls and attaching walls are parallel to each other and to the division walls and side walls. There is thus formed between the baffle hooks and the walls to which they are attached right trapezium-shaped pockets 37 having their acute angled end closed. The slope of the walls 36 with respect to the division walls and side walls, to which they are respectively attached, is preferably of the order of approximately one-third of a right-angle for a purpose to be described hereinafter. The top ends of the hook baffles 22 and 23 rest against the top plate 14, while their lower ends rest upon the drain plate 15, whereby the pockets 37 and 38 formed by the walls 31 and 36 and walls 34 and 35, respectively, are open only along their front right-angled vertical face. The pockets 39 formed by the walls 31 and 36 of the hook baffles 21 are likewise open along their front right-angled vertical face, and by reason of the openings 29 in the splash plate 18 are open at their lower ends. It will be noted that the preferred narrow-wise width of the pockets 37 and 38 is approximately that of one-half of the width of space between adjacent division walls, and that the open width of the pockets 39 is approximately that of the width of space between adjacent division walls, whereby the respective forewalls are practically in line along the centerline between any two division walls. The significance of the specific design of the baffle hooks 21, 22, and 23 and their relation to adjacent elements will be more fully described hereinafter.

The casing structure 13 is a built-up unitary structure and forms a mounting for the separating compartment 12 and in conjunction therewith establishes a settling chamber 40 within the separating compartment 12, and a drain pot chamber 41 just below the separating compartment 12. The casing structure 13 comprises case side plates 42, back plate 43, bottom plate 44, drain pot front plate 45, baffle flange 46, case front lower flange 47, case front side flanges 48, case front top flange 49, top attaching flange 50, side attaching flanges 51, supports 52, lower attaching flanges 53, and drain pipe bosses 54. The case side plates 42, together with flanges 47, 48, and 49 re-enforced by the flanges 50, 51 and front plate 45 form a frame within which, when the separating compartment 12 and the casing structure 13 are assembled together, the front end of the separating compartment 12 is supported. When thus assembled the rear end of the separating compartment 12 is supported upon the bottom plate 44 through the intermediary supports 52.

The drain pot chamber 41 is enclosed by the case side plates 42, back plate 43, bottom plate 44, and drain pot front plate 45 of the casing structure 13, and by the drain plate 15 of the separating compartment 12. The rear of the settling chamber 40 is communicated with the rear of the drain pot chamber 41 by way of the openings 27 in the rear edge of the drain plate 15, and by way of a dished channel 55 formed in the back plate 43. Bolt holes 56 in the attaching flanges 50, 51, and 53, and in back plate 43 provide means for mounting the separator unit 10 within the evaporating and distilling apparatus 60. The back plate 43 closes off the lower portion of the rear of the separating compartment 12 thereby leaving a vapor outlet opening 57 of preferably the same height as the inlet opening 28, and also acts as the rear closing wall of the settling chamber 40.

In the Figure 5 the separator unit 10 has been shown diagrammatically and it will be understood that reference numbers thereon refer to the equivalent structure in Figures 1 to 4, inclusive, hereinbefore described. For convenience the entrance separating elements are collectively indicated on Figure 5 by dot-and-dash crossed lines 58, and the interior separating elements are

collectively indicated by dot-and-dash crossed lines 59.

We now refer to Figure 5 wherein we have shown in diagrammatic form our separator embodied in a modified apparatus of the type hereinbefore referred to and which in the original form is shown and described in detail in the Letters Patent of the United States No. Re. 21,129, and with respect to certain modifications involving the weir control is shown and described in the co-pending patent application Serial No. 441,184, filed April 30, 1942, by one Eugene Porter Worthen.

In Figure 5 the numeral 60 designates the evaporating and distilling apparatus unit. This unit 60 comprises the container shell 61 for the body of sea-water to be evaporated and distilled, and also acts as the mounting for the various units required to accomplish the said evaporation and distillation. The container shell 61 is divided into two compartments or chambers, the left hand one of which as viewed in Figure 5 we designate as the first effect evaporator chamber 62; and the right hand one we have designated as the second effect evaporator chamber 63. Further sub-division of these chambers will be hereinafter described.

Contained within the lower halves of the first effect evaporator chamber 62 and of the second effect evaporator chamber 63 are the first effect heater 64 and the second effect heater 65, respectively.

Within the first effect evaporator chamber 62 at the top thereof is the vapor feed heater chamber 66. Supported on an inner wall 67 of the chamber 66 is the first effect vapor separator 10. The vapor feed heater chamber 66 communicates with the first effect evaporator chamber 62 through an orifice 68 in the wall 67 and through the separator elements 58 and 59. The separator 10 comprises the drain pot 41 and a discharge conduit 69 extending downwardly to the lower part of the chamber 62. The feed heater chamber 66 comprises a drain space 70 and a discharge conduit 71 to be hereinafter more fully described. Contained within the vapor feed heater chamber 66 is the first effect vapor feed heater 72.

Within the second effect evaporator chamber 63 at the top thereof is the distilling condenser chamber 73. Supported on an inner wall 74 of the chamber 73 is the second effect vapor separator 10'. The distilling condenser chamber 73 communicates with the second effect evaporator chamber 63 through an orifice 75 in the wall 74 and through the separator elements 58' and 59'. The separator 10' comprises the drain pot 41' and a discharge conduit 76 extending downwardly to the lower part of the chamber 63. The distilling condenser chamber 73 comprises a drain space 77 and a discharge conduit 78 to be hereinafter more fully described. Contained within the distilling condenser chamber 73 is the distilling condenser 79.

The distilling condenser 79 comprises a conduit having as an inlet 80 for sea-water that is to be evaporated and distilled and which conduit continues on through the distilling condenser chamber 73 as the condenser 79 to comprise a branch outlet connection conduit 81 and a continuing connection conduit 82. Forming a part of the apparatus 60 is the air ejector condenser chamber 83. The conduit 82 passes through the chamber 83 as a heat exchange means therein and continues on as a conduit to comprises a branch outlet connection conduit 84 just outside the vapor feed heater chamber 66. The first effect vapor feed heater 72 comprises a conduit having as an inlet the continuing conduit 82 and which conduit continues on through the vapor feed heater chamber 66 as the first effect vapor feed heater 72 to an outlet conduit 85. The conduit 85 comprises a stop-valve 86 and a discharge connection 87 into the bottom of the first effect evaporator chamber 62.

The first effect heater 64 comprises a conduit having an inlet 88 for steam and which conduit continues on through the lower half of the first effect evaporator chamber 62 as the heater 64 to an outlet connection 89.

Communicating with the interior of the vapor feed heater chamber 66 is outlet conduit 90 which continues on as an exterior conduit to enter the second effect evaporator chamber 63 as the inlet connection 91 to the second effect heater 65.

The second effect heater 65 is also communicated with the drain space 70 by means of the discharge conduit 71 as an inlet and after continuing on through the lower half of the second effect evaporator chamber 63 it leaves the bottom thereof as an outlet conduit 92.

Air ejector 93 communicates with the top of the distilling condenser chamber 73 by means of conduit 94, and is supplied with operating steam through conduit 95. The air ejector 93 discharges to the air ejector condenser chamber 83 through conduit 96. The air ejector condenser chamber 83 communicates with the atmosphere by means of outlet conduit 97, and is provided with a drain conduit 98.

Outlet conduit 99 communicates the bottom of the first effect evaporator chamber 62 with the first effect weir control unit 100. The hotwell 101 of the weir control unit 100 is communicated with the bottom of the second effect evaporator chamber 63 through outlet 102, valve 103, and conduit 104.

Outlet conduit 105 communicates the bottom of the second effect evaporator chamber with the second effect weir control unit 100'. The second effect weir control unit 100' is communicated with the pump 106 by means of conduit 107.

The weir control units 100 and 100' are maintained in vapor pressure balance with their respective evaporator chambers 62 and 63 by means of conduits 108 and 109, respectively.

We will now describe the operation of our improved apparatus for evaporating and distilling sea-water as used on board ships. Water is pumped from the sea chest to the distilling condenser 79 by way of the conduit 78. After passing through the circulating conduit of the distilling condenser 79, where it serves its function as a cooling agent, a large part of the water is automatically deflected through the outlet conduit 81 to be discharged overboard, while the remainder required for distilling purposes circulates through the circulating conduit 82 of the air ejector condenser chamber 83. Between the air ejector condenser chamber 83 and the vapor feed heater chamber 66 a branch outlet conduit 84 is provided in the conduit 82 to provide for an emergency discharge overboard. The conduit 82 becomes the circulating conduit of the first effect vapor feed heater 72 in the chamber 66, and passing therefrom continues exteriorly of the apparatus 60 by way of conduit 85, valve 86, and conduit 87 through which the distilling water is discharged into the bottom of the first effect

evaporating chamber 62 where it becomes the distilland thereof.

In the passage of the distilling water as just described heat has been accumulated therein from the distilling condenser chamber 73, the air ejector condenser chamber 83, and the vapor feed heater chamber 66. At the same time exhaust steam from the ship's auxiliaries is flowing into the inlet conduit 88 to and through the circulating conduit of the first effect heater 64, and discharges as condensate through the outlet conduit 89 to the ship's drain tank (not shown).

The exhaust steam flowing through the heater 64 is sufficient to vaporize a portion of the distilland within the chamber 62. As the vapor rises from the surface of the distilland in chamber 62 it passes to the top thereof and enters the first effect vapor separator 10. Passing through the separator 10 the entrained water in the vapor is extracted and returned to the main body of the distilland below.

We will now describe in greater detail the specific features of our invention in the method of operation of the evaporating and distilling apparatus that results from the embodiment therein of our separator characterized, as we have stated hereinbefore, by its novel separating elements and by having in a single separating unit a plurality of qualitative drainage means.

As already set forth hereinbefore we have provided in our separator a large number of separating elements mounted upon vertical division walls in such a manner that vapor passing through the separator from its inlet to its outlet is forced to travel in comparatively thin vertical streams between the division walls and by reason of the staggered positioning of the separating elements the thin vertical streams are constrained to travel a gently sinuous path of shallow corrugated cross-section. This sinuous path is further characterized in that by reason of the length of the forewalls 31, of the sloping walls 36, and of the length of division wall between each successive baffle hook the sinuous path is one broadly of a succession of short straight sections of flow alternately parallel to and sloped to the through-flow line. These short straight sections of flow are important since they tend to project the entrained droplets and detritus quickly into the pockets from forward parallel flow and from the sloping flow the droplets are projected against the walls at a low angle of incidence so that atomization is minimized and the water attaches itself as a film to the wall surfaces and under the influence of the vapor flow is forced into the angle of the trapezium-shaped pockets where, the vapor flow being neutralized, the gathered liquid flows downward by force of gravity. It will also be noted that the advancing flow of saturated vapor through the separator at no time meets opposed surfaces to create atomization of the water droplets. Only the thin edges of the forewalls are opposed at a normal angle, the flow at all other points meets surfaces at a low angle of incidence. It should also be noted that the angle at which the outer surface of the baffle hooks change is so gradual that the water film thereon is not blown off to re-enter the vapor stream but adheres as a film on the walls until gathered in the neutral angles of the pockets.

Our separator is also characterized by plural qualitative drains. As hereinbefore set forth the entrance baffle hooks 21 set off pockets 39 which are adapted to discharge from their bottom ends through openings in the splash plate 18 directly downward to the body of distilland below. These entrance separating elements we have indicated broadly in Figure 5 by the dot-and-dash lines 58. The remaining interior separating elements designated in Figure 5 by dot-and-dash lines 59, as hereinbefore set forth, are adapted to drain from their bottom ends onto a drain plate, and discharge from the rear of the drain plate into a drain pot and thence downward by pipe to the body of distilland below. Another feature, also hereinbefore set forth, is in setting off a lower third of the interior separating elements by means of front and rear walls to form a settling chamber of neutralized vapor flow to facilitate the drainage of the liquid entrained therein.

These features of plural qualitative drainage are very important and are the result of considerable experimentation and development work. We have found that in the usual design of separators with a single discharge means the greater proportion of entrained liquid and detritus extracted occurs in the first line of separating elements and that the flooding of these first separating elements detracts from the efficiency of the succeeding separating elements and from the efficiency of the separator as a whole. By assuring rapid and thorough drainage of the first line of separating elements the remaining ones are more effective in purifying the vapor stream. Furthermore, drainage of the latter separating elements and the thoroughness of purification was found advanced by the provision of the settling chamber protected from the passing vapor stream and by having its liquid discharge only at the rear thereof. This latter arrangement was found to preclude picking up and carrying onward to the condensers moisture from the last rows of separating elements due to circulating currents of vapor.

Leaving the separator unit 10, the vapor now thoroughly purified, passes into the vapor feed heater chamber 66 and flows over and around the circulating conduit of the heater 72 thus heating the flowing distilling water therein. The condensate formed from the vapor during this heating of the distilling water is collected in the drain space 70 and is discharged therefrom through the discharge conduit 71 to the second effect heater 65. The dried vapor meanwhile flows outward from the chamber 66 through the conduit 90, to and through the circulating conduit of second effect heater 65, and forming condensate therein joins with the condensate received through conduit 71 from the vapor feed heater chamber 66 and both are discharged for use as fresh water through the outlet conduit 92.

We now come to that feature in our apparatus that is shown and described in the co-pending patent application Serial No. 441,184, filed April 30, 1942, by one Eugene Porter Worthen. This comprises the adjustable weir control means for controlling the distilling water whereby all the distilling liquid coming from the first effect vapor feed heater 72 is passed through the apparatus in a constant flow without disturbing the height of level of the distilland as selected by the operator of each effect. The height of level of the distilland in either effect may be raised or lowered as desired without affecting the flow, or if desired the rate of flow may be modified without affecting the height of level selected. The first effect weir control device 100 is adapted to continuously receive the excess distilland from the first effect evaporator chamber 62 by way of the conduit 99 and to discharge it to the second

effect evaporator chamber 63 through conduit 102, valve 103, and conduit 104. The level of the distilland in the second effect evaporator chamber 63 is maintained by the weir control device 100' which receives the continuous flow of excess distilland therefrom by means of the conduit 105 and discharges it to the pump 106 through the conduit 107.

A portion of the distilland in the second effect evaporator chamber 63 is vaporized by the heat of the vapor from the first effect flowing through the second effect heater 65 as hereinbefore described. The vapor as it rises from the main body of distilland in the chamber 63 passes to the top thereof and enters the second effect separator 100'. This separator operates in the same manner as does separator 100 for the first effect and need not be further described. Passing through the separator 100' the entrained water in the vapor is extracted and returned to the main body of the distilland below. The dried vapor passes on to the distilling condenser chamber 73 and flows over and around the circulating conduit of the heater 79 thus heating the distilling water therein. The condensate formed from the vapor during the heating of the distilling water is collected in the drain space 77 and is discharged for use therefrom through the discharge conduit 78. The dried vapor meanwhile flows outward from the chamber 73 through the conduit 94 to the air ejector 93. The air ejector is functioned by a steam jet fed from a connection to the auxiliary steam line (not shown) and tends to create a vacuum in the distilling condenser chamber 73 thus acting to draw off the remaining vapor as just described, and also to establish a pressure differential with respect to the first effect evaporator chamber 62, which results in maintaining the feed water pressure flow, and in obtaining low pressure evaporation in the second effect evaporator chamber 63. The air ejector 93 discharges by way of conduit 96 into the air ejector condenser chamber 83, where, in a manner well known to the art, the non-condensing vapors are exhausted to the atmosphere through the outlet conduit 97, and the condensate formed in the chamber 83 is discharged to the ship's drain tank (not shown) through the drain conduit 98.

It will now be apparent that we have devised a novel apparatus for evaporating and distilling, especially applicable to marine purposes but it will be manifest that it is useful and valuable for application to other fields. We have shown that by means of our improved design of separator we have provided a very compact and efficient device which when combined with the apparatus shown and described in the co-pending application Serial No. 441,184, filed April 30, 1942, by one Eugene Porter Worthen, and herein incorporated has proven by actual tests to have doubled the productive capacity of a similar apparatus shown and described in the U. S. Patent No. Re. 21,129, to which the Worthen application and the present one are improvements.

Although we have described and illustrated our invention in considerable detail, we do not wish to be limited to the exact and specific details thereof as shown and described, but may use such modifications in, substitutions for, or equivalent thereof, as are embraced within the scope of our invention, or as are pointed out in the claims.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A multiple effect evaporating and distilling apparatus, comprising a first compartment and a second compartment within a single container, each of said compartments being adapted to contain a body of liquid separated by a common wall, each of said compartments having a liquid vaporizing portion and a vapor condensing chamber, a vapor separator unit communicating said liquid vaporizing portion with said vapor condensing chamber, said vapor separator unit comprising a casing having plural qualitative drains for discharging entrained liquid to said liquid vaporizing portion and vertical division walls defining a plurality of narrow conduits passing through said separator, each said conduit comprising a plurality of flat liquid intercepting forewalls disposed in spaced vertical relation approximately along the center-line plane of said conduit, the rear edges of the forewalls attached alternately to opposed adjacent division walls by a connecting wall having a low angle of incidence to said division walls, heater means within said first compartment for heating and vaporizing liquid therein, means for conveying feed liquid in preheat heat interchanging relationship successively with vapor in the vapor condensating portion of said second compartment and the vapor condensating portion of said first compartment whereby said vapors in both compartments are condensed while preheating said feed liquid, means for conveying feed liquid thus preheated into the liquid vaporizing portion of said first compartment and comprising means to control the operating rate of flow of said feed liquid to said first compartment in constant substantial excess of that removed by evaporation in said apparatus, means for conveying heated liquid from said first compartment into said second compartment and comprising a weir discharge means and a hotwell for receiving the excess liquid from said first compartment whereby the liquid level in said first compartment may be maintained regardless of the operating rate of liquid flow and a restraining means for said liquid flow, means for conveying vapor from said first compartment into heat interchanging relationship with the liquid in said second compartment for vaporizing liquid therein, means for collecting for use condensates formed in both said first and said second compartments, means for maintaining a vapor pressure differential between the two compartments, and a conduit system comprising a weir discharge means and a conduit for receiving the excess liquid flow from said second compartment whereby the liquid level in said compartment may be maintained regardless of the operating rate of liquid flow, and a pump to remove the liquid from the last mentioned conduit.

2. A multiple effect evaporating and distilling apparatus, comprising a first compartment and a second compartment within a single container, each of said compartments being adapted to contain a body of liquid separated by a common wall, each of said compartments having a liquid vaporizing portion and a vapor condensing chamber, a vapor separator unit communicating said liquid vaporizing portion with said vapor condensing chamber, said vapor separator unit comprising a casing having plural qualitative drains for discharging entrained liquid to said liquid vaporizing portion and vertical division walls defining a

plurality of narrow conduits passing through said separator, each said conduit comprising a plurality of flat liquid intercepting forewalls disposed in spaced vertical relation approximately along the center-line plane of said conduit, the rear edges of the forewalls attached alternately to opposed adjacent division walls by a connecting wall having a low angle of incidence to said division walls, heater means within said first compartment for heating and vaporizing liquid therein, means for conveying feed liquid in preheat heat interchanging relationship successively with vapor in the vapor condensating portion of said second compartment and the vapor condensating portion of said first compartment whereby said vapors in both compartments are condensed while preheating said feed liquid, means for conveying feed liquid thus preheated into the liquid vaporizing portion of said first compartment and comprising means to control the operating rate of flow of said feed liquid to said first compartment in constant substantial excess of that removed by evaporation in said apparatus, means for conveying heated liquid from said first compartment into said second compartment and comprising a weir discharge means and a hotwell for receiving the excess liquid from said first compartment whereby the liquid level in said first compartment may be maintained regardless of the operating rate of liquid flow and a restraining means for said liquid flow, means for conveying vapor from said first compartment into heat interchanging relationship with the liquid in said second compartment for vaporizing liquid therein, means for collecting for use condensate formed in the vapor condensing portion of said second compartment, means for maintaining a vapor pressure differential between the two compartments, and a conduit system comprising a weir discharge means and a conduit for receiving the excess liquid flow from said second compartment whereby the liquid level in said compartment may be maintained regardless of the operating rate of liquid flow, and a pump to remove the liquid from the last mentioned conduit.

3. A multiple effect evaporating and distilling apparatus, comprising a first compartment and a second compartment within a single container, each of said compartments being adapted to contain a body of liquid separated by a common wall, each of said compartments having a liquid vaporizing portion and a vapor condensing chamber, a vapor separator unit communicating said liquid vaporizing portion with said vapor condensing chamber, said vapor separator unit comprising a casing having plural qualitative drains for discharging entrained liquid to said liquid vaporizing portion, heater means within said first compartment for heating and vaporizing liquid therein, means for conveying feed liquid in preheat heat interchanging relationship successively with vapor in the vapor condensating portion of said second compartment and the vapor condensating portion of said first compartment whereby said vapors in both compartments are condensed while preheating said feed liquid, means for conveying feed liquid thus preheated into the liquid vaporizing portion of said first compartment and comprising means to control the operating rate of flow of said feed liquid to said first compartment in constant substantial excess of that removed by evaporation in said apparatus, means for conveying heated liquid from said first compartment into said second compartment and comprising a weir discharge means and a hotwell for receiving the excess liquid from said first compartment whereby the liquid level in said first compartment may be maintained regardless of the operating rate of liquid flow and a restraining means for said liquid flow, means for conveying vapor from said first compartment into heat interchanging relationship with the liquid in said second compartment for vaporizing liquid therein, means for collecting for use condensates formed in both said first and said second compartments, means for maintaining a vapor pressure differential between the two compartments, and a conduit system comprising a weir discharge means and a conduit for receiving the excess liquid flow from said second compartment whereby the liquid level in said compartment may be maintained regardless of the operating rate of liquid flow, and a pump to remove the liquid from the last mentioned conduit.

4. A multiple effect evaporating and distilling apparatus, comprising a first compartment and a second compartment within a single container, each of said compartments being adapted to contain a body of liquid separated by a common wall, each of said compartments having a liquid vaporizing portion and a vapor condensing chamber, a vapor separator unit communicating said liquid vaporizing portion with said vapor condensing chamber, said vapor separator unit comprising a casing having plural qualitative drains for discharging entrained liquid to said liquid vaporizing portion, heater means within said first compartment for heating and vaporizing liquid therein, means for conveying feed liquid in preheat heat interchanging relationship successively with vapor in the vapor condensating portion of said second compartment and the vapor condensating portion of said first compartment whereby said vapors in both compartments are condensed while preheating said feed liquid, means for conveying feed liquid thus preheated into the liquid vaporizing portion of said first compartment and comprising means to control the operating rate of flow of said feed liquid to said first compartment in constant substantial excess of that removed by evaporation in said apparatus, means for conveying heated liquid from said first compartment into said second compartment and comprising a weir discharge means and a hotwell for receiving the excess liquid from said first compartment whereby the liquid level in said first compartment may be maintained regardless of the operating rate of liquid flow and a restraining means for said liquid flow, means for conveying vapor from said first compartment into heat interchanging relationship with the liquid in said second compartment for vaporizing liquid therein, means for collecting for use condensate formed in the vapor condensing portion of said second compartment, means for maintaining a vapor pressure differential between the two compartments, and a conduit system comprising a weir discharge means and a conduit for receiving the excess liquid flow from said second compartment whereby the liquid level in said compartment may be maintained regardless of the operating rate of liquid flow, and a pump to remove the liquid from the last mentioned conduit.

5. A multiple effect evaporating and distilling apparatus, comprising a first compartment and a second compartment within a single container, each of said compartments being adapted to con-

tain a body of liquid separated by a common wall, each of said compartments having a liquid vaporizing portion and a vapor condensing chamber, a vapor separator unit communicating said liquid vaporizing portion with said vapor condensing chamber, said vapor separator unit comprising a casing having plural qualitative drains for discharging entrained liquid to said liquid vaporizing portion and vertical division walls defining a plurality of narrow conduits passing through said separator, each said conduit comprising a plurality of flat liquid intercepting forewalls disposed in spaced vertical relation approximately along the center-line plane of said conduit, the rear edges of the forewalls attached alternately to opposed adjacent division walls by a connecting wall having a low angle of incidence to said division walls, heater means within said first compartment for heating and vaporizing liquid therein, means for conveying feed liquid in preheat heat interchanging relationship successively with vapor in the vapor condensating portion of said second compartment and the vapor condensating portion of said first compartment whereby said vapors in both compartments are condensed while preheating said feed liquid, means for conveying feed liquid thus preheated into the liquid vaporizing portion of said first compartment, means for conveying heated liquid from said first compartment into said second compartment, means for conveying vapor from said first compartment into heat interchanging relationship with the liquid in said second compartment for vaporizing liquid therein, means for collecting for use condensates formed in both said first and said second compartments, and means for maintaining a vapor pressure differential between the two compartments.

6. A multiple effect evaporating and distilling apparatus, comprising a first compartment and a second compartment within a single container, each of said compartments being adapted to contain a body of liquid separated by a common wall, each of said compartments having a liquid vaporizing portion and a vapor condensing chamber, a vapor separator unit communicating said liquid vaporizing portion with said vapor condensing chamber, said vapor separator unit comprising a casing having plural qualitative drains for discharging entrained liquid to said liquid vaporizing portion and vertical division walls defining a plurality of narrow conduits passing through said separator, each said conduit comprising a plurality of flat liquid intercepting forewalls disposed in spaced vertical relation approximately along the center-line plane of said conduit, the rear edges of the forewalls attached alternately to opposed adjacent division walls by a connecting wall having a low angle of incidence to said division walls, heater means within said first compartment for heating and vaporizing liquid therein, means for conveying feed liquid in preheat heat interchanging relationship successively with vapor in the vapor condensating portion of said second compartment and the vapor condensating portion of said first compartment whereby said vapors in both compartments are condensed while preheating said feed liquid, means for conveying feed liquid thus preheated into the liquid vaporizing portion of said first compartment, means for conveying heated liquid from said first compartment into said second compartment, means for conveying vapor from said first compartment into heat interchanging relationship with the liquid in said second compartment for vaporizing liquid therein, means for collecting for use condensate formed in the vapor condensing portion of said second compartment, and means for maintaining a vapor pressure differential between the two compartments.

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