Dec. 19, 1967 W. R. WILLIAMSON 3,359,182

DISTILLATION APPARATUS WITH THE CONDENSER SUPPORTED BY THE STILL

Original Filed July 3, 1967 3 Sheets-Sheet 1

FIG. 1

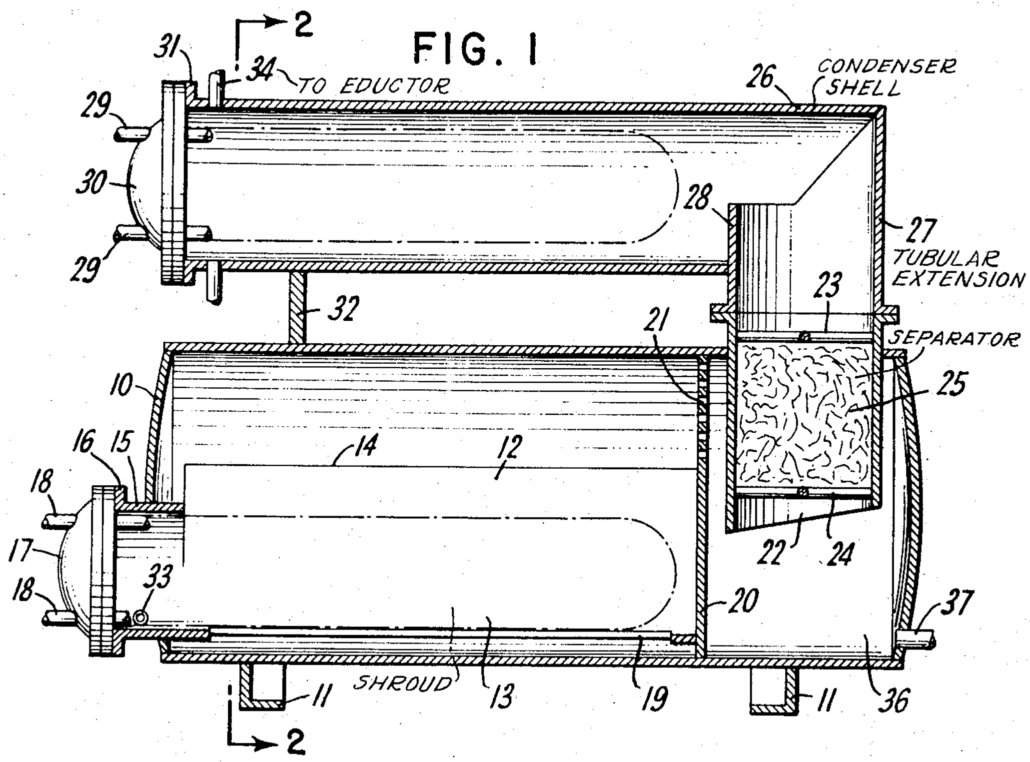

FIG. 2

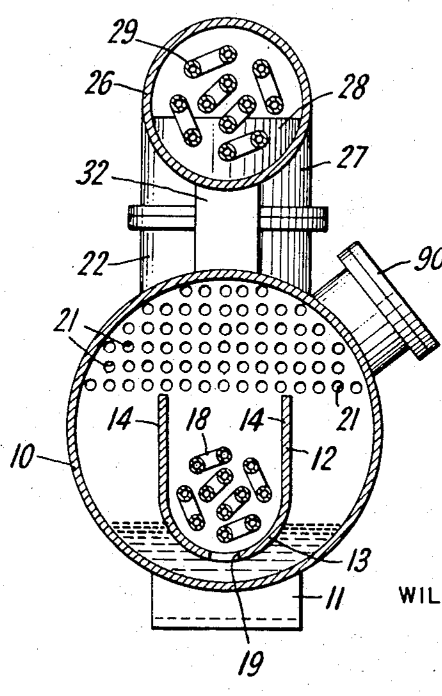

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FIG. 3

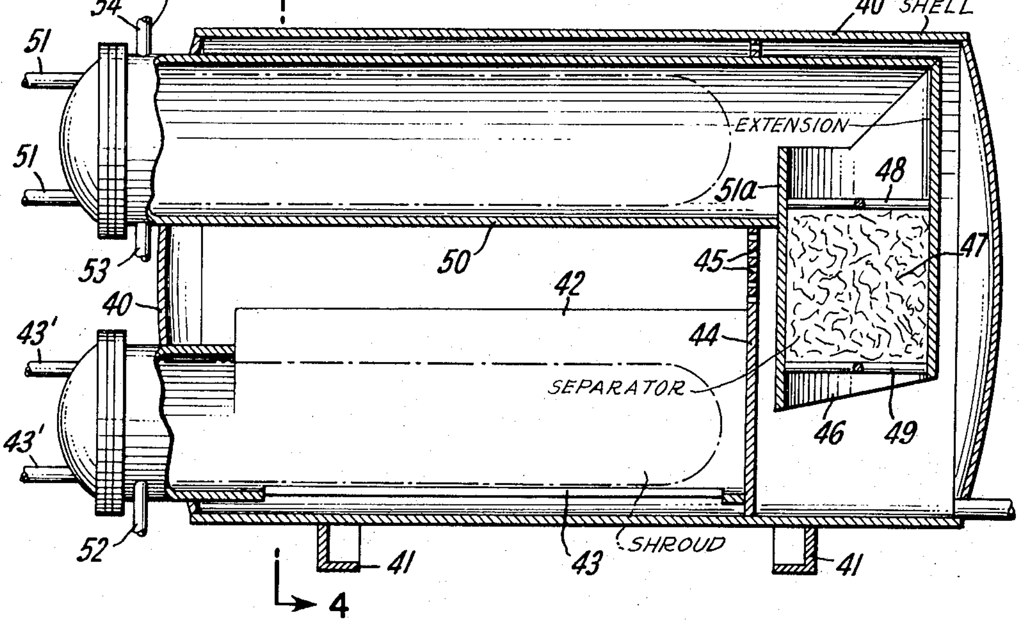

FIG. 4

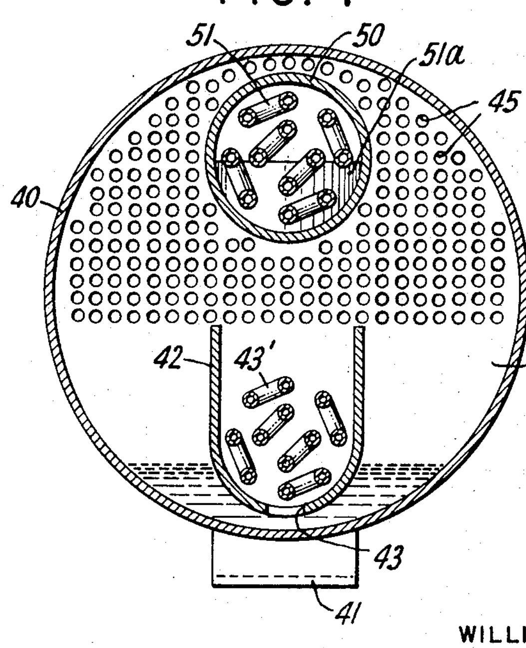

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FIG. 5

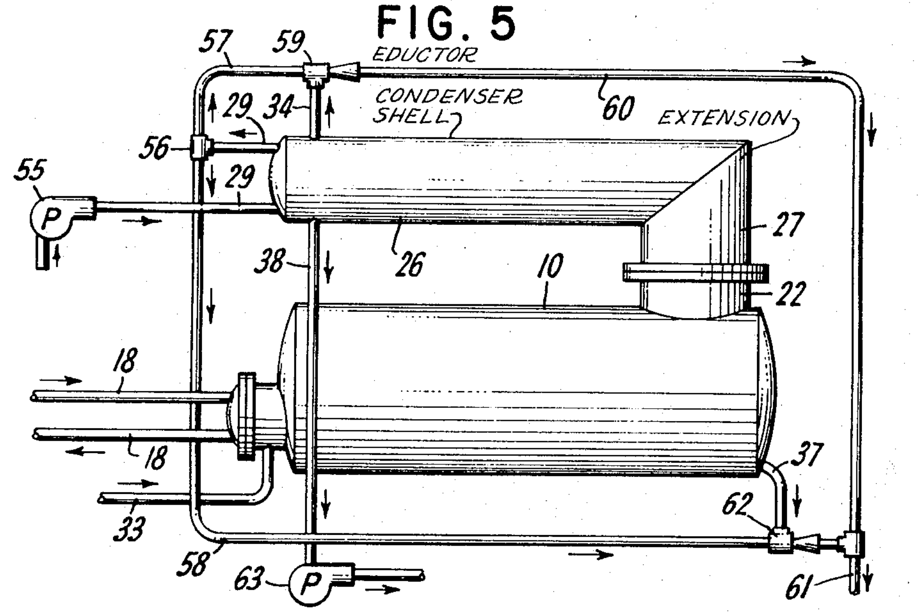
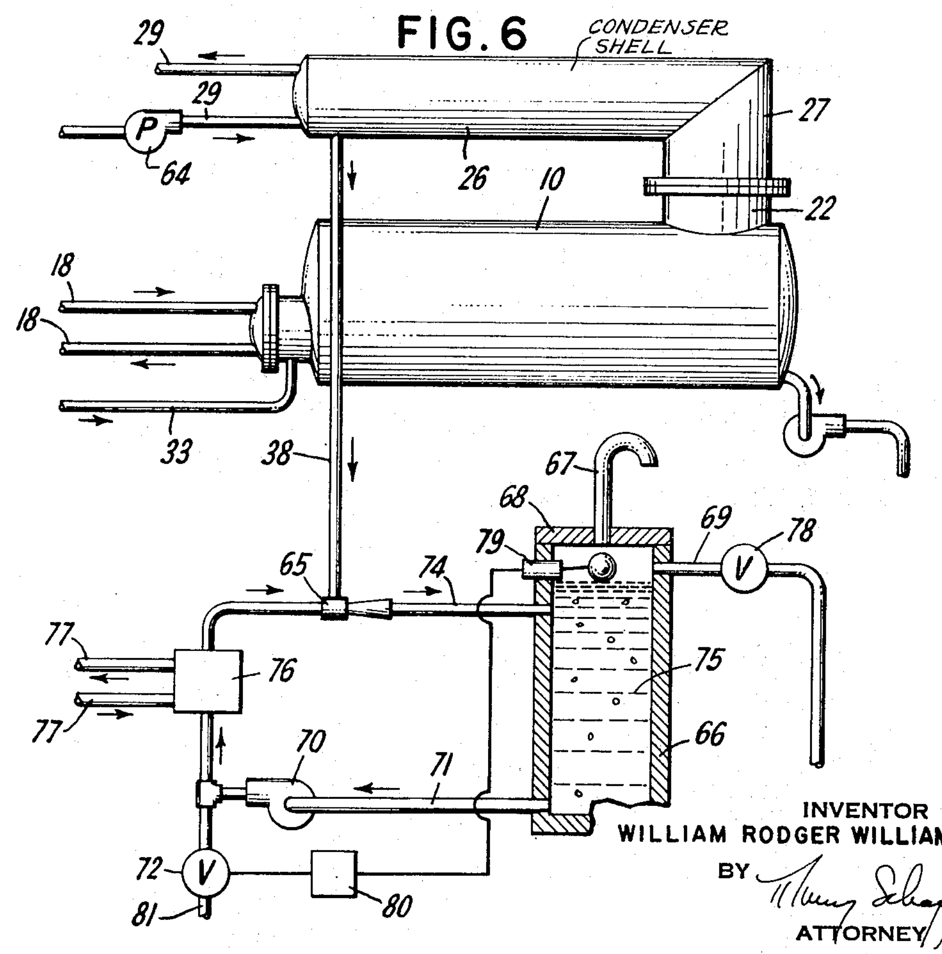


FIG. 6



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DISTILLATION APPARATUS WITH THE CONDENSER SUPPORTED BY THE STILL

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Original application July 3, 1967, Ser. No. 292,667, now Patent No. 3,302,373, dated Feb. 7, 1967. Divided and this application June 22, 1966, Ser. No. 592,239
13 Claims. (Cl. 202—189)

ABSTRACT OF THE DISCLOSURE

A distillation plant comprising an evaporation shell and a condensing shell horizontally disposed one above the other. The evaporation shell being divided into two chambers by a vertical bulkhead perforated at its upper portion, evaporation taking place in one chamber and the steam passing through the bulkhead into the second chamber and thence into the condenser.

This invention relates in general to distillation apparatus and, more particularly, to a distilling plant for sea water and the like.

This is a divisional application of Ser. No. 292,667, filed July 3, 1963.

An object of this invention is to provide a horizontal and laterally chambered evaporator which will provide distillate in an associated condenser which will be of equal purity to that produced in vertically disposed, multichambered conventional apparatus.

Another object of this invention is to provide a distillation apparatus which may occupy as little as one half the cubic space required by equivalent conventional distillation apparatus having a completely vertical relationship between the chambering and baffling elements.

A further object of this invention is to provide a means for removing distillate from a high vacuum distillation apparatus using a relatively inexpensive pump which is operated by fluid at atmospheric pressure.

Many other objects, advantages and features of invention reside in the particular construction, combination and arrangement of parts involved in the embodiments of the invention and its practice as will be understood from the following description and accompanying drawing wherein:

FIGURE 1 is a longitudinal, vertical section through a distillation apparatus according to the first embodiment of this invention with the heating and condensing tube bundles broken away and with the areas occupied by the heating and condensing tube bundles outlined by broken lines;

FIGURE 2 is a vertical section taken on line 2—2 of FIGURE 1;

FIGURE 3 is a longitudinal, vertical section through a second embodiment of this invention with the heating and condensing tube bundles broken away and with the areas occupied by the heating and condensing tube bundles outlined by broken lines;

FIGURE 4 is a vertical section taken on line 4—4 of FIGURE 3;

FIGURE 5 is a side view of the distillation apparatus of this invention connected by pumps and piping to a plentiful raw water supply for cooling the condenser and performing other functions; and

FIGURE 6 is a side view of the distillation apparatus of this invention connected to an air water separator which uses a vacuum pump operable by fluid at atmospheric pressure to remove condensate and non-condensibles from the condenser.

Referring to the drawing in detail, FIGURES 1 and 2 show the generally cylindrical shell **10** which rests upon

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the supports **11**. Extending into one end of shell **10** is the U-shaped shroud **12** which has a rounded bottom portion **13** and two upstanding side walls **14**. A longitudinal slot **19** extends along the bottom of shroud **12**. If it is desired, more than one slot **19** may be formed in the bottom of shroud **12**, however, the total area of the single slot **19** or a plurality of slots **19** should be no greater than 25 percent of the open area of shroud **12** disposed above the slot or slots **19**.

Shroud **12** assumes a cylindrical shape at one end **15** where it projects through the shell **10**. End **15** carries the flange **16** to which a cover plate **17** may be fixed in any conventional and suitable manner. The heating coils **18** extend through and are supported by the cover plate **17**. Although the heating coils **18** are shown broken away in FIGURE 1, the space that they would occupy is indicated by a broken line.

The inwardly disposed end of shroud **12** butts against the baffle **20** which extends transversely across the entire shell **10**. The upper portion of baffle **20** contains a large number of perforations **21**. If it is desired, the perforated and the solid portions of baffle **20** may be fabricated from separate sheets of metal which are welded together. The unperforated portion of baffle **20** must be of a sufficient height to assure the complete wetting of the heating coils within shroud **12**, and this height is about 125 percent of the tube bundle height.

An outlet pipe **22** extends downward into shell **10** beyond baffle **20** and below the lowermost perforations **21**. A plate **90**, which may contain a glass window for inspection or viewing purposes, may be secured to a tubular extension from a suitable location in shell **10**. Sets of bars **23** and **24** are welded or otherwise fixed within the outlet pipe **22** to position a wire mesh separator **25** within it.

The tubular condenser shell **26** extends horizontally from an upward tubular extension **27** fixed to the top of outlet pipe **22**. Extension **27** includes a swash plate **28** which extends above the bottom of condenser shell **26**. The cooling coils **29** pass through and are supported by the dome-shaped end plate **30** which is bolted to a flange **31** at the end of condenser shell **26**. A condenser support brace **32** is welded or otherwise fixed between the shell **10** and the condenser shell **26** to support it.

The first embodiment of this invention operates in the following manner. Water to be treated is fed into the outer end of shroud **12** through the pipe **33**. Heating water is supplied through the heating coils **18** while a suitable vacuum is drawn within the entire apparatus through the tube **34** by conventional means (not shown). Water is fed into the evaporator at a rate of from two to three times the rate of evaporation at a vacuum of about 26 inches Hg. Boiling water mixed with steam in a turbulent state rises between the side walls **14** of shroud **12** to fall downward between the walls **14** and the shell **10**. This rapid circulation upward in the shroud **12** and downward between the shell **10** and the shoud **12** promotes a high heat transfer rate.

FIGURE 2 shows the low static head of water **35** to be treated within the shell **10**. Since the area of slot **19** restricts the entrance of water into the shroud, a static pressure head cannot build up over the heating tubes **18** to raise the boiling point at high vacuum. Thus the configuration shown greatly reduces any elevation in boiling point at deep vacuum.

Excess liquid in the form of steam and small droplets passes to the second chamber **36** through the apertures **21** in baffle **20**. Within chamber **36** steam or vapors must make a 180 degree reversal after moving downward about the outside of outlet pipe **22** to flow upward through it. Larger liquid droplets cannot make this reversal and fall by gravity to the base of chamber **36**. Any fine mist entrained with the steam or vapor coheres on the mesh separator **25** to form larger droplets that fall back into chamber **36**. As liquid concentrates collect in chamber **36**, they are pumped out through pipe **37**.

The dry steam now passes laterally from the extension portion **27** over the swash plate **28** into the condenser **26** where it contacts the cooling coils **29** to condense. The pure condensate is then pumped out through the pipe **38**. Non-condensibles may also be pumped out through pipe **38** or they may be drawn out through pipe **34** using a separate pump as will be hereinafter explained.

Referring now to FIGURES 3 and 4, the second embodiment of this invention includes a shell **40** resting upon the supports **41**. A U-shaped shroud **42** for the heating coils **43'** extends within shell **40** as in the previous embodiment. Formed in the bottom of shroud **42** are one or more longitudinal slots **43** which are less than 25 percent of the area of the open space of shroud **42** above them. Shroud **42** butts against the transverse plate **44** which contains the perforations **45**, the height of the lowest of which is at least 125 percent that of the bundle of tubes **43'**.

Behind plate **44** is the outlet pipe **46** which extends below the lowermost perforations **45** and contains the mesh separator **47** held in place by the sets of bars **48** and **49**. The upper end of outlet pipe **46** has the condenser shell **50** extend horizontally from its protruding through the end of shell **40**. Cooling coils **51** extend into condenser shell **50** in front of the swash plate **51** formed by an upper portion of outlet pipe **46**.

The second embodiment of this invention operates in the same manner described for the first embodiment. Fluid to be treated is introduced into the neck of the evaporator shroud **42** through the pipe **52**. Condensate is drawn off through pipe **53** and non-condensibles may be drawn off through pipe **54**. The second embodiment of this invention provides a single compact unit containing both an evaporator and a condenser. It is desirable to use the same materials of construction for the evaporator and the condenser when a single shell **40** is used for both. The heating and condensing tube bundles, whose positions are shown by broken lines, may be made of any standard sheet and tube construction and can be made so that the heating and condensing tubes are interchangeable.

Referring now to FIGURE 5, where there is a plentiful supply of raw water which may be used as a cooling medium, this invention may be coupled to auxiliary equipment in the following manner. A pump **55** supplies raw water at about 40 pounds per square inch to the cooling or condensing coils **29**. As this water flows from the coils **29**, it enters a T fitting **56** from which it flows into pipes **57** and **58**. Pipe **57** leads to an air eductor **59** which draws non-condensibles through pipe **34** from the condenser shell **26**. This water and the non-condensibles then flow from eductor **59** through pipe **60** to a drain pipe **61**. Raw water flowing through pipe **58** passes to the eductor **62** which draws brine or other concentrates through pipe **37** and passes them into waste line **61**. A separate pump **63** may draw distillate through pipe **38** from condenser shell **26**.

Referring now to FIGURE 6, if the raw water supply is limited, a closed refrigeration system, or a hot and cold gas system may be used for evaporating and condensing the water to be treated. For example, a refrigerant may be compressed and passed through the heating coils **18** and expanded and passed through the cooling coils **29**. Alternatively, hot exhaust gases may be passed through the heating coils **18** and cooling air delivered by blower **64** through the cooling coils **29**. In either case, the apparatus of this invention may be connected in the following manner. Tube **38** leads to an eductor **65** which draws both distillate and non-condensibles from the condensing shell **26** and delivers same through a pipe **74** to an air water separator tank **66**. The tank is vented to the atmosphere through tube **67** which passes through tank cover **68**. An overflow tube **69** leads from the upper portion of the air water separator **66**. A pump **70** draws water or distillate from the air water separator **66** through pipe **71** and discharges same through a T fitting **82** into a vertical line **83**. A valve **72** in the lower end of line **83** is normally closed so that fluid from pump **70** passes through pipe **73** to eductor **65** and pipe **74** to enter the air water separator **66** below the level of the fluid **75** within it. Thus pump **70**, which may be a relatively inexpensive pump having an intake below the level of fluid **75** in the air water separator **66**, is not as costly as a high vacuum pump and need not draw any vacuum. Pump **70** provides enough fluid under pressure to operate eductor **65** to draw distillate and non-condensibles from the condenser shell **26**. To operate properly, the eductor **65** must discharge below the surface of the fluid or distillate **75** within the air water separator **66**. Within the air water separator **66**, bubbles of non-condensibles rise to the surface and escape to the atmosphere through tube **67**. As distillate accumulates within the air water separator **66**, it overflows through tube **69** and may be collected.

Referring further to FIGURE 6, a cooling jacket **76** having a cooling fluid circulated through it through the tubes **77** may cool the fluid passing through pipe **73** and thus cool the liquid within the air water separator **66**. The cooling of fluid **75** enables the air water separator **66** to function more effectively.

If it is desired to have pump **70** deliver distillate under pressure, a valve **78** in tube **69** may be closed and a level switch **79** installed in the air water separator **66**. Level switch **79** activates a control **80** which closes valve **72** as the level of fluid **75** within air water separator **66** falls below a given level. Conversely, as distillate accumulates within the air water separator **66**, the level switch **79** actuates the control **80** to open valve **72** so that some of the condensate under pressure from pump **70** will be delivered through pipe **81** and thus removed from the system.

While this invention has been disclosed in the best forms known, it will nevertheless be understood that these are purely exemplary and that modifications in the construction, arrangement and combination of parts and the substitution of equivalents may be made without departing from the spirit of the invention except as it may be more limited in the appended claims.

What is claimed is:

1. A distillation apparatus comprising, in combination, a horizontally disposed evaporator shell, a transverse baffle dividing said shell into a first and a second chamber, said baffle being perforated in its upper portion, a horizontally disposed shroud within said shell extending substantially the length of said first chamber close to the bottom of said shell, said shroud having two side walls and a bottom portion extending between said side walls, said bottom portion containing at least one longitudinal slot, the total area of slot in said bottom portion being less than 25 percent of the area between said side walls of said shroud, a horizontally disposed bundle of heating coils within said shroud, a steam outlet pipe in said second chamber extending from below the lowermost perforations of said baffle, a condenser shell extending horizontally from the upper portion of said outlet pipe, a horizontal bundle of cooling coils within said condenser shell, and a water separator within said outlet pipe.

2. The combination according to claim **1** wherein said condenser shell is disposed above and parallel to said evaporator shell and said outlet pipe extends through the top of said evaporator shell.

3. The combination according to claim **1** wherein said condenser shell is disposed within said elevator shell and extends parallel to and above said shroud within said evaporator shell, said condenser shell extending through the perforated portion of said baffle.

4. The combination according to claim **1** wherein the height of the lowermost perforation in said baffle is 125

percent that of the height of said bundle of heating coils.

5. The combination according to claim 1 with the addition of an air water separator vented to the atmosphere, a tube for removing condensate and non-condensibles leading from the bottom of said condensing shell, an eductor connected to said tube leading from said condenser shell, a pump, a tube leading from near the bottom of said air water separator to said pump, a tube leading from said pump to said eductor, a tube leading from said eductor to said air water separator below the level of fluid within said air water separator, and means bypassing fluid from said pump when the fluid within said air water separator rises above a given level.

6. The combination according to claim 5 wherein said means bypassing fluid comprises an overflow tube leading from said air water separator.

7. The combination according to claim 5 wherein said means bypassing fluid comprises a fluid level switch in said air water separator, a control unit connected to said fluid level switch, a bypass line from said pump and a valve in said bypass line activated by said control unit.

8. A distillation apparatus comprising, in combination, a horizontally disposed cylindrical outer shell, a transverse baffle dividing said outer shell into first and second chambers, the upper portion of said baffle containing perforations, a horizontally disposed shroud within said outer shell having a cylindrical end extending through one end of said outer shell and having the other end butting against said baffle within said first chamber, said shroud having two side walls and a rounded bottom portion extending between said side walls close to the bottom of said outer shell, said bottom portion containing at least one longitudinal slot, the total slot area of said bottom portion being less than 25 percent of the area between said side walls, a horizontally disposed bundle of heating coils within said shroud, an outlet pipe open at the bottom and extending from below the perforated upper portion of said baffle within said second chamber, a condenser shell extending horizontally from the upper portion of said outlet pipe parallel to said shroud, a transverse swash plate disposed across the bottom of said condenser shell near said outlet pipe, a horizontally disposed bundle of cooling coils within said condenser

shell, a wire mesh water separator within said outlet pipe, and an inlet tube for water to be treated entering said cylindrical end of said shroud outside said outer shell.

9. In a sea water distillation plant, a first horizontal shell, a second horizontal shell parallel to and spaced from said first shell, a transverse bulkhead in said first shell defining first and second chambers, sea water evaporating means comprising heating means in the lower portion of said first chamber, said bulkhead being perforated in its upper portion to provide steam passage between said first and second chambers, and a steam passage from said second chamber to said second shell, said second shell containing a steam condenser cooling means.

10. The combination according to claim 9, in which the second shell containing the condenser means is enclosed within the walls of the upper portion of the first shell.

11. The combination according to claim 10, in which one end of the second shell containing the condenser means extends through the perforated portion of the bulkhead.

12. The combination according to claim 9, in which the inlet of the steam passage is disposed below the lowermost perforations of the bulkhead.

13. The combination according to claim 12, including a moisture mist separator in said steam passage.

References Cited

UNITED STATES PATENTS

2,180,050	11/1939	Hickman	202—205
2,776,938	1/1957	White et al.	202—173
2,880,146	3/1959	West	202—180
3,192,131	6/1965	Loebel et al.	202—173
3,197,387	7/1965	Lawrance	202—197 X

FOREIGN PATENTS

1,025,805	3/1958	Germany.	

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