

April 26, 1960

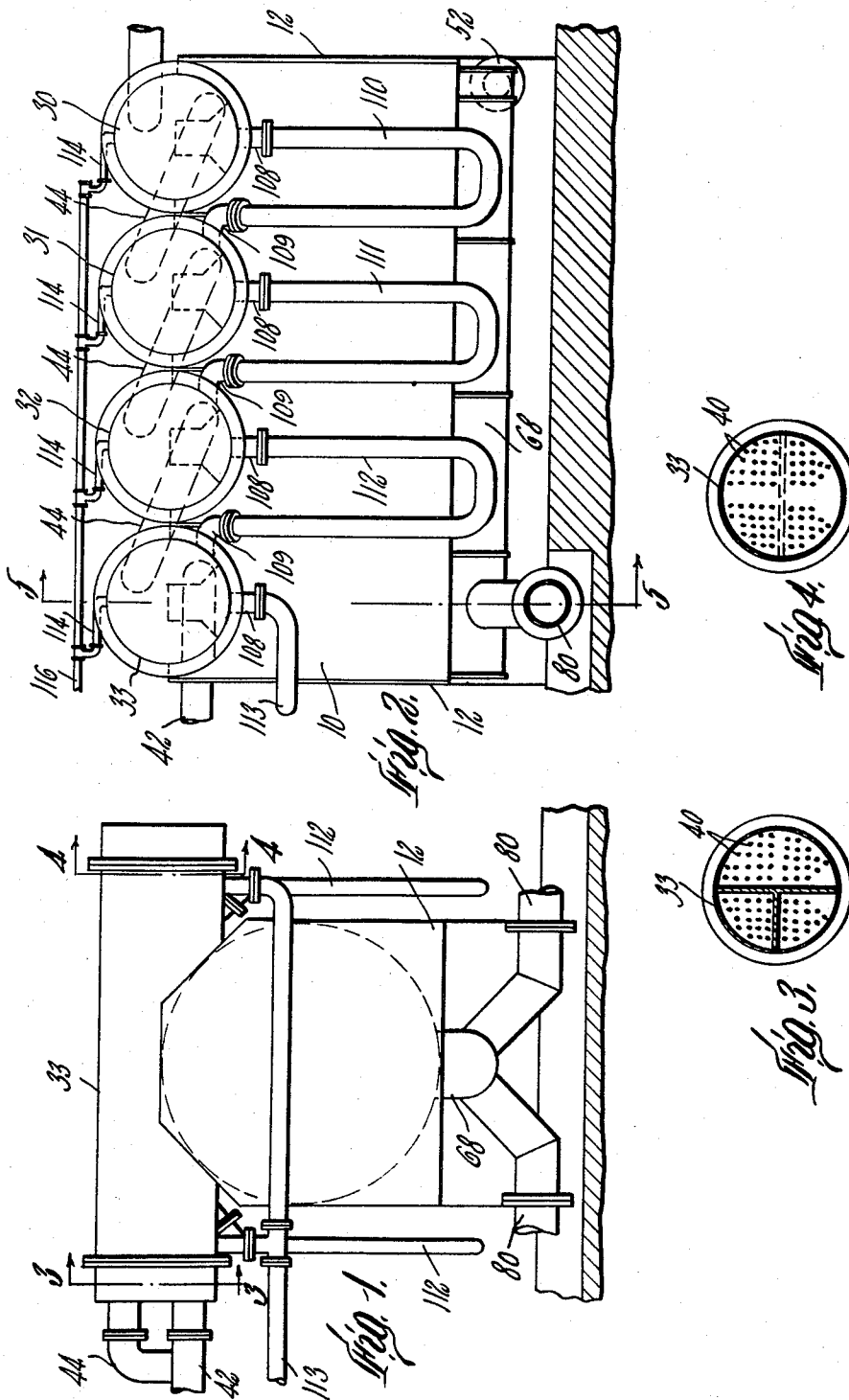
R. E. SIEGFRIED

2,934,477

FLASH-TYPE DISTILLATION SYSTEM

Filed Aug. 9, 1956

4 Sheets-Sheet 1



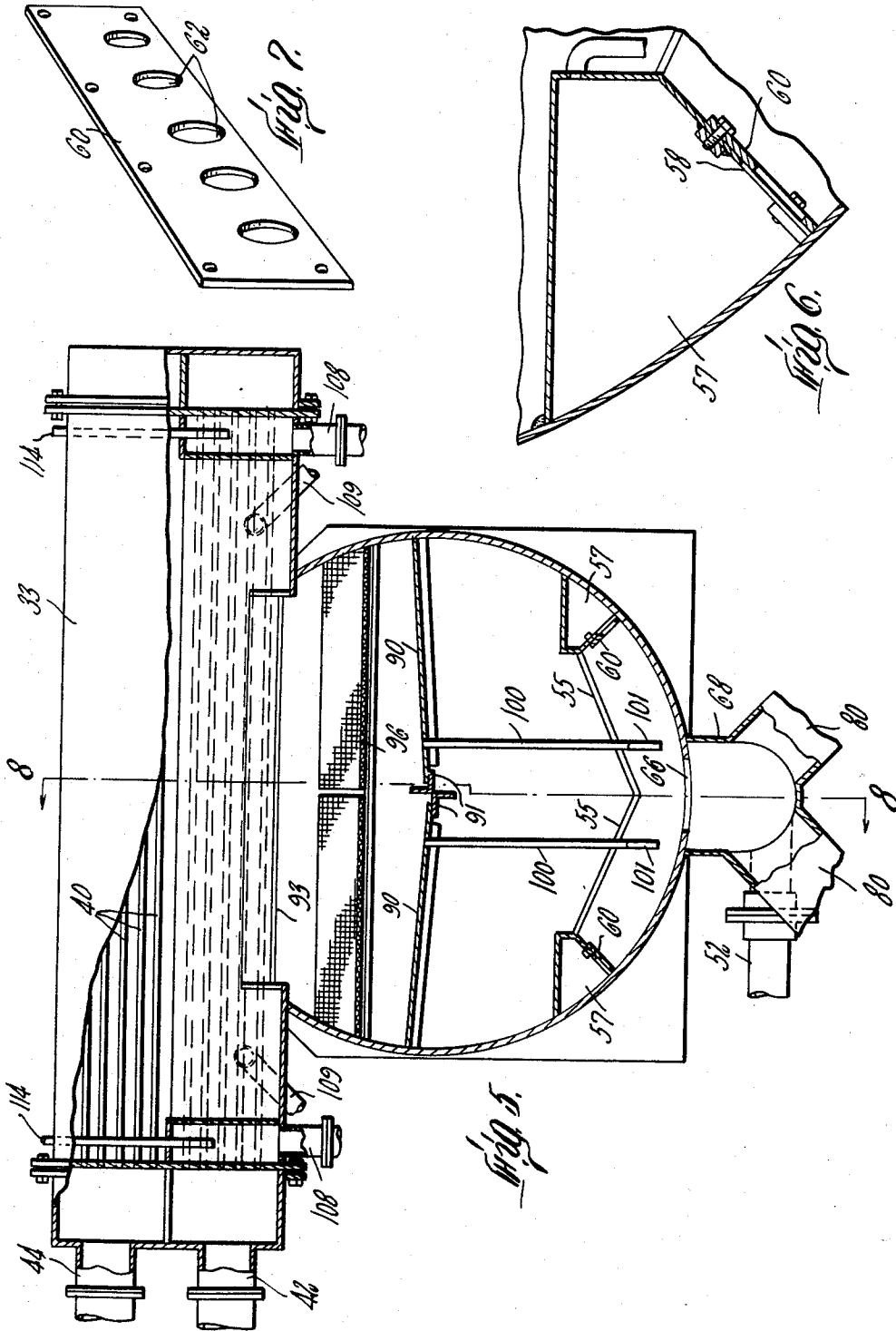
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FLASH-TYPE DISTILLATION SYSTEM

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Filed Aug. 9, 1956

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April 26, 1960

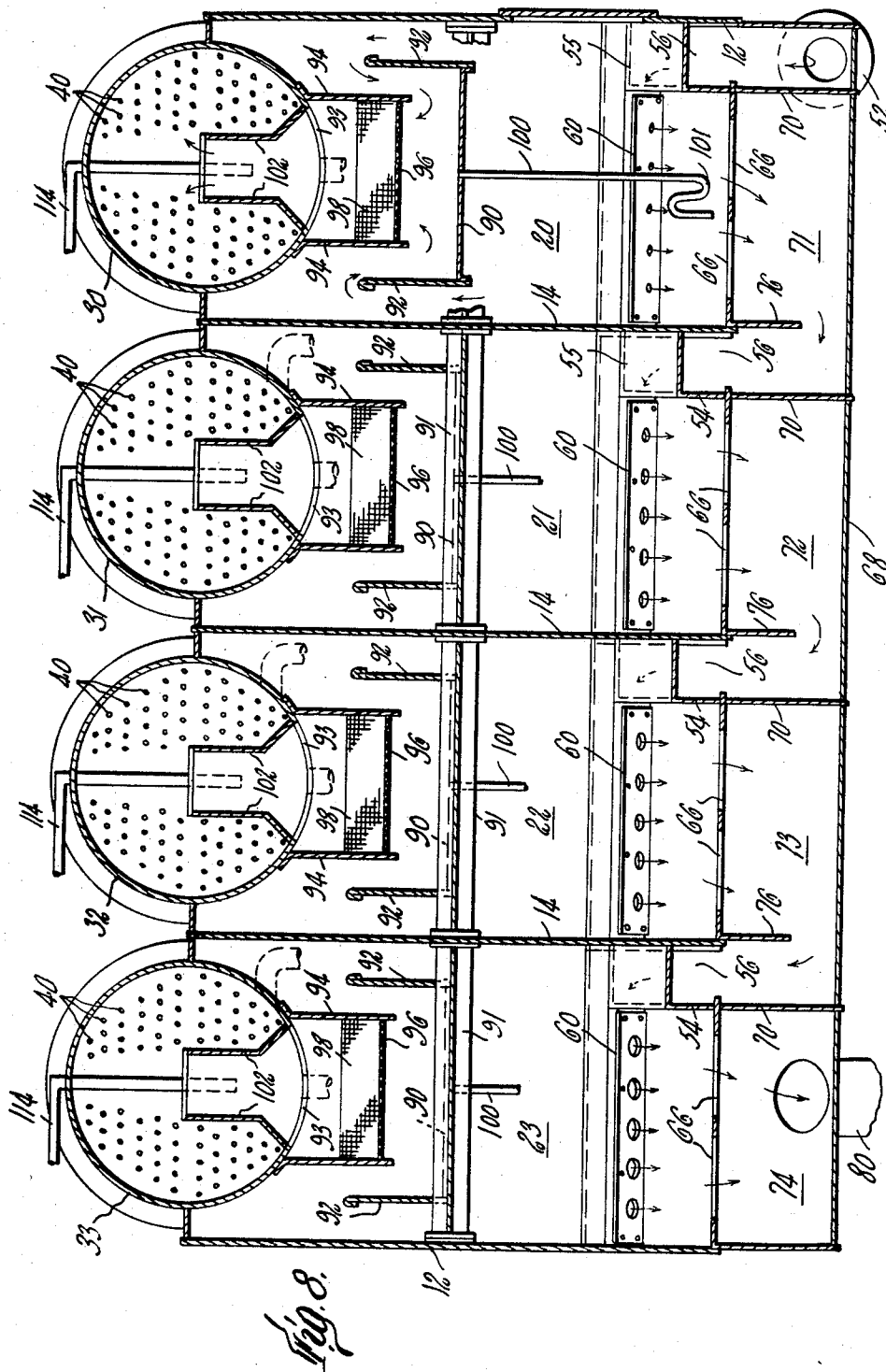
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2,934,477

FLASH-TYPE DISTILLATION SYSTEM

Filed Aug. 9, 1956

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April 26, 1960

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FLASH-TYPE DISTILLATION SYSTEM

2,934,477

Filed Aug. 9, 1956

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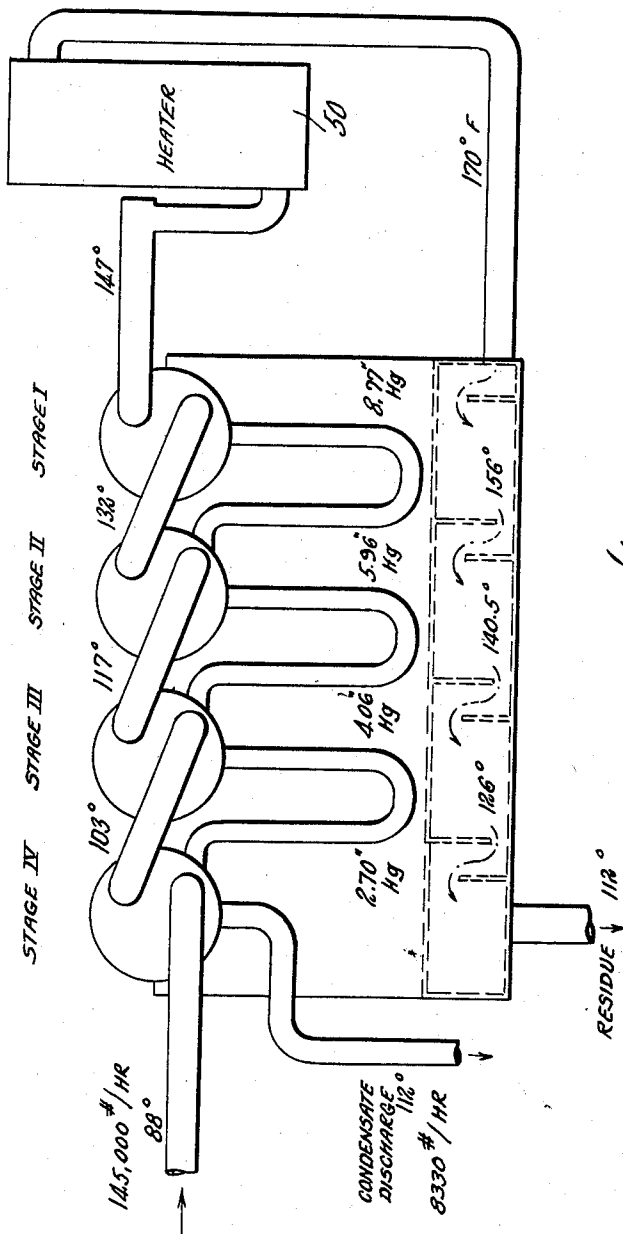


Fig. 9.

1

2,934,477

FLASH-TYPE DISTILLATION SYSTEM

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Application August 9, 1956, Serial No. 602,962

1 Claim. (Cl. 202—174)

This invention relates to a flash evaporator and pertains more specifically to apparatus for purifying sea water.

One object of the invention is to provide a flash evaporator of simplified, compact and inexpensive construction.

Another object is to provide a flash evaporator in which the liquid to be evaporated is employed for condensing vapor which has previously been evaporated and as a consequence receives a portion of the heat required to raise it to evaporating temperature.

Still another object is to provide a multi-stage flash evaporator in which the liquid input is in countercurrent, heat-exchange relationship with the vapor in the several stages of the evaporator.

Other and further objects will be apparent from the drawings and from the description which follows.

In the drawings:

Fig. 1 is a view in end elevation of one embodiment of the present invention;

Fig. 2 is a view in side elevation of the embodiment shown in Fig. 1;

Fig. 3 is a view in section taken along line 3—3 of Fig. 1;

Fig. 4 is a view in section taken along line 4—4 of Fig. 1;

Fig. 5 is a view in section on an enlarged scale taken along line 5—5 of Fig. 2;

Fig. 6 is a detail view on an enlarged scale showing the means for introducing the stream of heated liquid to be evaporated along one side of the evaporating chamber;

Fig. 7 is an isometric view of an orifice plate through which the stream of heated liquid is introduced into the evaporating chamber;

Fig. 8 is a view in section taken along line 8—8 of Fig. 5; and

Fig. 9 is a schematic view showing the path of the liquid through the evaporator and the conditions prevailing at each of the several stages in the evaporator.

With reference to Figs. 1, 2 and 8, the evaporator comprises a main cylindrical vessel 10 provided with end walls 12, 12 and divided by means of three internal partitions 14, 14, 14 into four separate cylindrical evaporating chambers or units 20, 21, 22, 23. End walls 12, 12 and partitions 14 all have a polygonal shape and extend outwardly beyond cylindrical wall 10 as best appears in Fig. 1 in order to provide optimum reinforcement for wall 10.

Associated with each of the evaporating chambers is a cylindrical condenser 30, 31, 32, 33, each condenser intersecting its corresponding evaporating chamber transversely thereof with the top of the chamber opening into the bottom of the condenser at their intersection. Each condenser is provided with a nest of tubes 40, 40 through which cooling water flows. An inlet 42 is provided for introducing cooling water into the tubes of condenser 33 whence it passes through outlet 44 into the tubes of condenser 32, thence into condensers 31 and 30 in sequence,

2

the temperature of the cooling water being increased as it passes through each condenser.

In the preferred embodiment of the invention the liquid, for example sea water, which is to be evaporated is employed as the cooling liquid in the condensers. However, the temperature of this cooling liquid as it leaves condenser 30 is not sufficiently high for the desired evaporation to take place, and so a supplemental heater 50 (Fig. 9) is preferably provided which raises the temperature to the desired level. The supplemental heater 50 may take any convenient form such as a boiler heated with any desired fuel, the cooling system of a diesel engine or a gasoline engine, or any other suitable or convenient source of heat.

Each evaporating unit 20—23 is provided with a partition 54 spaced from partition 14 which together with imperforate cover 55 forms a manifold or distributor 56 communicating at opposite ends with a pair of headboxes 57, 57 extending along the inner wall of each chamber 20—23 on opposite sides thereof (Fig. 5). Each headbox 57 is provided with an aperture or opening 58 in its lower wall, over which an orifice plate 60 may be secured as by bolting. Each orifice plate is provided with a plurality of orifices 62, 62 through which the liquid to be evaporated may flow onto the wall of each chamber 20—23. Orifices 62, 62 will vary in size in each chamber 20—23, as best seen in Fig. 8, in order to provide the desired flow rate through each unit of the multi-stage evaporator under the varying conditions existing in each stage.

Outlet or drain openings 66, 66 are provided in the bottom of each unit 20—23 through which any excess unevaporated liquid may flow. Extending axially along the bottom of units 20—23 is a unitary sump passage 68 into which apertures 66 open. Imperforate partitions 70, 70 (Fig. 8) aligned with partitions 54 are provided to divide sump 68 into separate chambers 71, 72, 73, 74, each of which communicates with a separate evaporating chamber 20—23 through apertures 66, 66. In addition, sump chamber 71 communicates with inlet manifold 56 of evaporating chamber 21, sump chamber 72 communicates with the inlet manifold of evaporating chamber 22, and sump chamber 73 communicates with the inlet manifold of evaporating chamber 23. Baffles 76, 76 are provided in each of sump chambers 71, 72, 73 and serve to provide a liquid seal between successive evaporating chambers. The last sump chamber 74 is provided with a pair of outlets 80, 80 through which any residual unevaporated liquid may pass to waste.

It will be clear from the foregoing that the heated liquid entering the multistage evaporator through inlet 52 passes successively through each evaporating unit 20—23, a portion of the liquid evaporating or vaporizing in each unit as it flows from orifices 62, 62 downwardly over the wall of the evaporating chamber to outlet openings 66, 66.

In order to prevent any liquid droplets which may be entrained in the vapor in each evaporating unit from passing into the corresponding condenser and thus contaminating the distillate or condensate, there is provided in each evaporating chamber a pair of generally horizontal imperforate baffles 90, 90 (Fig. 5) extending completely across the full width of the chamber above the level of headboxes 57, 57 and supported by angle irons 91, 91 or in any other suitable manner. Each baffle 90 has a length somewhat less than that of its evaporating chamber (Fig. 8) terminating short of partition 14 or end wall 12 as the case may be and provided with side walls 92, 92, thus providing passageways through which the liquid vapor rising from the heated liquid flowing through the lower portion of the evaporating chamber can pass upwardly.

Each condenser 30-33 is provided with an aperture 93 in its bottom communicating with its corresponding evaporating chamber above baffle 90. Extending downwardly from opposite sides of each aperture 93 along the full length thereof is a side wall 94 which is spaced inwardly from side wall 92, the lower margin of wall 94 extending below the upper margin of wall 92 to provide a vapor passageway therebetween. A perforate supporting plate 96 is secured between each pair of side walls 94, 94 and serves to support a mass 98 of wire mesh, steel wool, or similar vapor pervious material. Drain pipes 100, 100 extending downwardly from each baffle 90 serve to carry off any liquid which accumulates thereon, each pipe 100 being provided with a conventional liquid S-seal 101 at its lower end to prevent passage of vapor upwardly therethrough.

Within each condenser 30-33 a baffle 102, 102 extends upwardly from the margins of aperture 93, serving to direct the rising vapor to the upper part of each condenser. Outlets 108, 108 are provided at opposite ends of each condenser (Fig. 5) for removal of the condensate. The condensate from condenser 30 passes through a U-shaped liquid seal 110 into condenser 31 through inlet 190 where it is combined with the condensate accumulating in condenser 31, the combined condensate leaving through outlets 108, 108 and passing through U-seal 111 to inlet 109 of condenser 32. Similarly the combined condensate from condenser 32 passes through U-seal 112 to condenser 33, while the total combined condensate from condenser 33 passes through main outlet 113 to storage or use.

In order to remove non-condensable gases from within each evaporating chamber and its corresponding condenser, vacuum pipes 114, 114 are provided at each end of each condenser and connected by means of header 116 to a suitable conventional vacuum pump such as a steam jet (not shown).

A typical set of evaporating conditions for the multi-stage evaporator of the present invention is shown in schematic Fig. 9. The sea water or other liquid feed is introduced first into the cooling tubes of condenser 33 through inlet 42, the temperature of the water feed being assumed for the purpose of this example to be 88° F. As the water emerges successively from condensers 33, 32, 31 and 30, its temperature will be 103°, 117°, 132° and 147° F. respectively. Upon emerging from supplemental heater 50 it will be at 170° F., at which temperature it is introduced into evaporating chamber 20 which is maintained at a pressure of 8.77 inches of mercury by means of vacuum pipes 114, 114. As the water emerges from orifices 62, 62 at opposite sides of chamber 20 and flows down its sides toward outlet apertures 66, 66 a portion of it evaporates, reducing the temperature of the remainder to approximately 156° F., at which temperature the residual unevaporated water is passed to the second-stage evaporating chamber 21 in which the pressure is maintained at 5.96 inches mercury. In this evaporating chamber an additional portion of the water feed is evaporated and the temperature still further reduced as shown in Fig. 9. This operation is continued at each of the successive stages until the residual water leaving the stage-four evaporating chamber 23 is at a temperature of approximately 112° F. passing to waste.

The vapor generated in each evaporating chamber 20-23 passes upwardly on each side of baffles 90 (Fig.

8), then downwardly between walls 92 and 94, then upwardly again through perforate supporting plate 96 and vapor pervious mass 98. The serpentine path followed by the vapor causes most of the entrained liquid particles or droplets to be removed by impinging on one or more of the baffles or walls; any remaining entrained liquid is removed upon passing through mass 98, whence it drips onto baffle 90 and is returned to the evaporating chamber through drain pipe 100.

The vapor, upon reaching its respective condenser free from entrained liquid, is condensed, flowing to the bottom of the condenser and out through outlets 108, 108. The condensate from condenser 30 is introduced into the bottom of condenser 31 to mix with the additional condensate therefrom resulting in a combined condensate of uniform temperature. Similarly, the condensates from each stage continue to be successively combined, resulting in a total combined condensate at a temperature of 112° F.

Under the foregoing conditions a sea-water feed of 145,000 pounds per hour containing about 32,000 p.p.m. total solids will produce a pure water condensate amounting to 8,330 pounds per hour having no more than 4 p.p.m. total solids.

Although specific embodiments of the invention have been described herein, it is not intended to limit the invention solely thereto, but to include all of the obvious variations and modifications within the spirit and scope of the appended claim.

I claim:

A flash evaporator comprising a plurality of generally horizontally disposed cylindrical evaporating chambers arranged end-to-end, a headbox for introducing a stream of heated feed water to be evaporated along both sides of each of said chambers positioned intermediate the top and bottom thereof and allowing the feed water to flow down the inner wall thereof, a sump at the bottom of each of said chambers for collecting any unevaporated liquid and conveying it to the next successive chamber, said headboxes having apertures therein through which the feed water flows down the inner wall of its evaporating chamber to the sump, the size of the apertures in each of said headboxes being progressively larger to control the rate of flow of feed water between each pair of adjacent evaporating chambers, a generally cylindrical condenser intersecting each of said evaporating chambers transversely thereof with the top of the chamber opening into the bottom of the condenser at their intersection, and means for reducing the pressure within each of said chambers and condensers and for removing noncondensable gases from each of said condensers, said means communicating with each of said condensers independently of the remaining condensers.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,934,477

April 26, 1960

Robert E. Siegfried

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 38, for "evaporating" read -- operating --;
column 4, line 38, for "collecting my" read -- collecting
any --.

Signed and sealed this 11th day of October 1960.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON

Commissioner of Patents