

July 27, 1948.

H. C. DAVIS ET AL

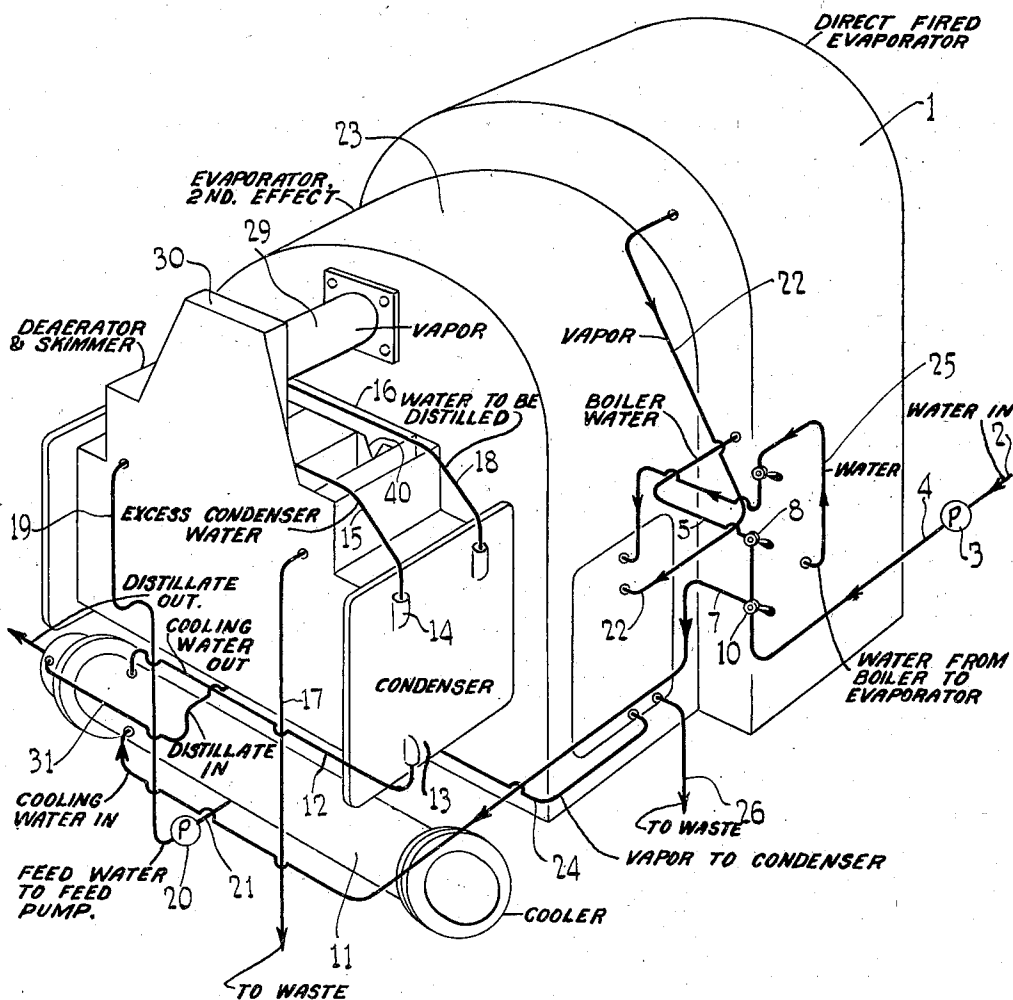
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WATER STILL WITH DEAERATOR

Filed Feb. 27, 1942

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Fig. 1.



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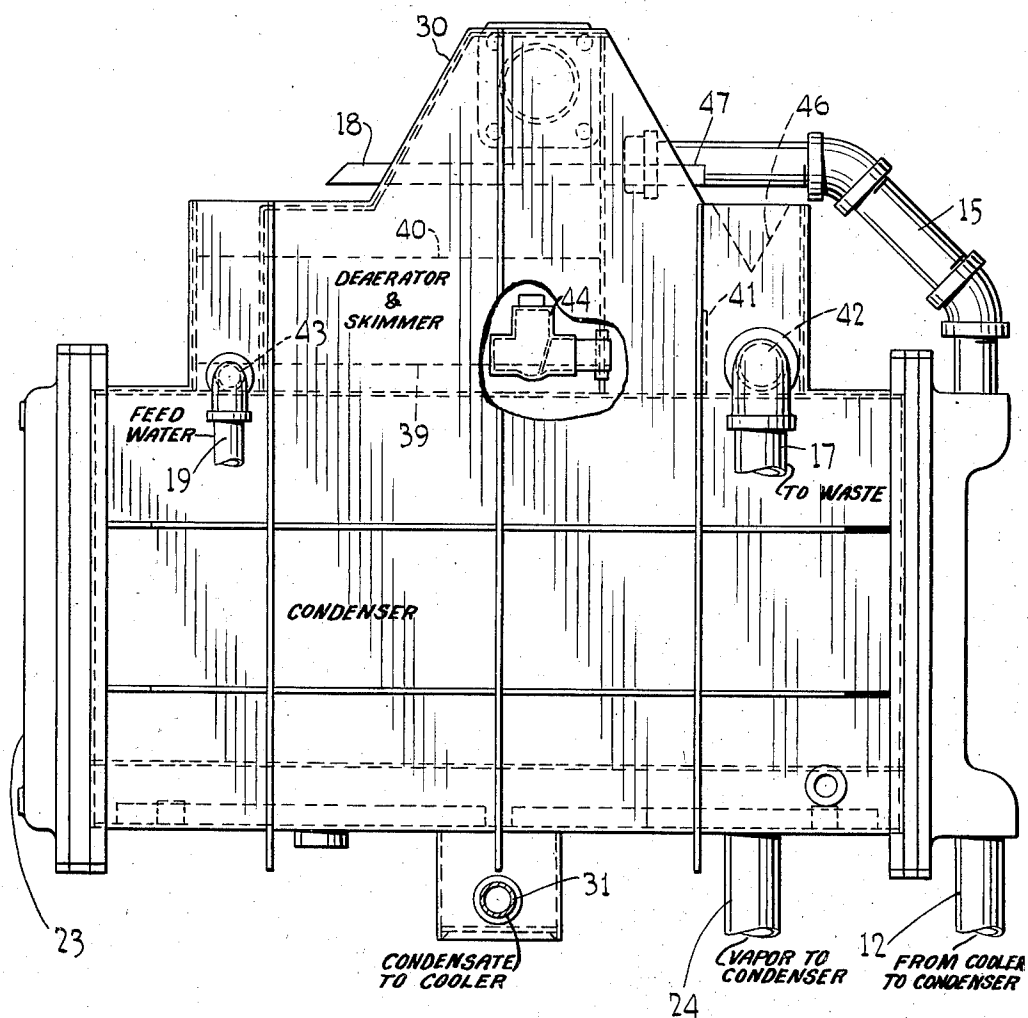
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Fig. 2.



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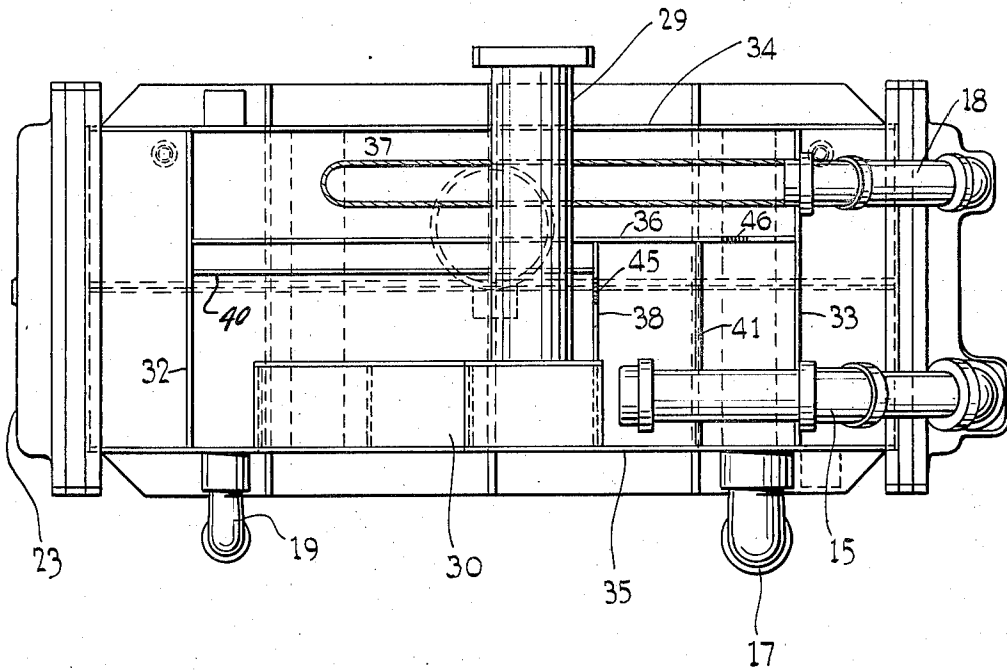
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Fig. 3.



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2,445,907

WATER STILL WITH DEAERATOR

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Application February 27, 1942, Serial No. 432,612

5 Claims. (Cl. 202-177)

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The invention herein disclosed relates to a distillation system that is especially suitable for distilling water and comprehends a combined condenser, deaerator skimmer, reboiler and separator adapted for use in the system.

There are many situations, industrially and otherwise, where a more or less continuous supply of distilled water is required. A severe requirement is that of producing drinking water from various and different sources of water normally unfit for human consumption. The requirement becomes more severe when it becomes necessary to produce the distilled water so that it is suitable for use in storage batteries. Coupled with these there has now been added to the problem to make it most severe the necessity of having a portable unit suitable for Army and Navy movements and operable with a minimum fuel consumption.

By the invention herein disclosed there is provided a distillation system that may be compactly arranged; that is suitable for continuous operation; that is comparatively simple in construction and arrangement; that is suitable for the distillation of water irrespective of the source from which it is obtained; that treats the water before distillation so that it is less injurious to the materials in the evaporation chambers; that conditions the water so as to reduce the amount of oil or other floating matter that might retard evaporation; that treats the water so as to remove air and other gases that affect evaporation and the quality of the distillate; and that permits of a continuous blow down so as to minimize the concentration in the evaporating chamber without increasing fuel consumption.

A distillation system constituting one specific embodiment of the invention and the units that form part of the invention are illustrated in the accompanying drawings and described in detail below.

The drawings include:

Fig. 1 which is an isometric, diagrammatic representation of the system;

Fig. 2 which is a side elevation of the combined condenser, aerator and skimmer; and

Fig. 3 which is a plan of the same.

The distillation system illustrated diagrammatically in Fig. 1 includes a direct fired vapor or steam generating boiler 1, which may be heated or fired in any well known manner, and which is utilized directly and in the first instance for the vaporization of the water. Through the intake 2, water is drawn from a source by a pump 3. The water is delivered through a pipe 4 to two branch pipe lines 5 and 7 through manually op-

erated valves 8, 9 and 10 controlling the flow to the branch lines 5, 6 and 7 respectively. The branch 5 is connected to the boiler 1 and is provided for filling the boiler on starting up. The branch 7 is connected to the shell of a cooler 11 in which there is a coil out of communication with the interior of the shell and forming a closed, open ended passage. Another pipe 12 connects the shell of the cooler to a condenser 13 to which the water, that has passed through the shell of the cooler, and in contact with the coil therein, flows.

The condenser is a multipass condenser and may be of any well known construction with one exception. At least one pass, the first, and preferably the first several passes of the condenser are such as to accommodate a much larger amount of water than the last or last several passes. Much more water is required to condense the vapors and cool the distillate than is required for distillation. In consequence, a large volume of water per unit of time from the source is caused to flow through the cooler and part of the condenser, the first few passes, in order to condense the vapors and cool the distillate to approximately the temperature of the source. The condenser is, therefore, provided with a connection 14 through which the excess water is withdrawn at the end of the first several passes, that is the passes capable of accommodating the total volume, and just prior to the last few passes, that is the passes which are arranged to accommodate the lesser quantity that is required for distillation. In a system such as that illustrated, which constitutes a portable unit, a four pass condenser has been found satisfactory, the excess water being bled from the condenser after the third pass. In this arrangement a pass is considered as a flow through the condenser and back.

A pipe 15 is connected to the connection 14 and extends above a deaerator and skimmer 16 formed on top of the condenser. Into a chamber of the deaerator, through the pipe 15, the excess water is delivered. This chamber of the deaerator is connected to waste through a pipe 17. Another pipe 18 is connected to the condenser and delivers the water to be distilled to the deaerator and skimmer 16. This water is drawn from the deaerator through a pipe 19 and delivered by a pump 20 through a pipe 21 to the boiler. This constitutes the feed to the boiler during operation.

The steam or vapors formed in the boiler 1 are delivered through a pipe 22 to the coil of the evaporator 23. After passing through the coil

of the evaporator, the vapor is delivered by a pipe 24 to the shell of the condenser.

The plant constitutes a multi-effect evaporation system. The first effect evaporation takes place in the direct fired boiler and the second effect in the evaporator. To this end, the shell of the evaporator is connected by a pipe 25 to receive water from the boiler, the blow down from the boiler. In operation the boiler is continuously blown down, the blow down being the feed to the evaporator shell. The other end of the evaporator shell is connected by a pipe 26 to waste. Thus the blow down from the boiler passes to the evaporator and through the evaporator shell to waste continuously. There is, therefore, a continuous blow down of the boiler and evaporator which prevents the accumulation or concentration of solid matter thereby greatly increasing the duration of operation before affecting capacity output.

In the evaporator, the heat from the vapors passing through the coil is transferred to the water in the shell which is vaporized. Thus, in the evaporator the second effect evaporation is obtained. The vapors from the evaporator pass through a large pipe 29 to a conduit 30 that is connected to the shell of the condenser. Thus, in the shell of the condenser, the condensed vapors from the first effect, the boiler 1, and the vapor from the second effect, the evaporator 23, are brought together in the condenser.

The condensate is collected in a well at the bottom of the condenser and delivered through a pipe 31 to one end of the coil of the cooler. The other end of the coil of the cooler is connected to the container to receive the distilled water.

The construction and assembly of the deaerator and skimmer and the condenser are shown in Figs. 2 and 3. The deaerator and skimmer is formed on the condenser. To this end there is provided end walls 32 and 33 and side walls 34 and 35. Extending longitudinally of the compartment or pan formed by the side walls, there is provided a baffle 36 which forms a compartment 37 between it and the side wall 34. This baffle 36 engages the bottom of the deaerator to a point where a weir 38, extending transversely from the side wall 35, is connected to it. From this point, the lower edge 39 of the baffle is raised from the bottom of the deaerator forming a passage thereunder. Extending between the weir 38 and the end wall 32, and parallel to the baffle 36, there is a weir 40. The weir 40 is substantially lower than the baffle 36. A transverse weir 41 is also provided that extends between the side wall 35 and the baffle 36. This weir is between the weir 38 and the end wall 33. The pipe 17 connected to waste is connected through an opening 42 through the side wall 35 and communicating with the compartment between the weir 41 and the end wall 33. The pipe 19 is connected to an opening 43 in the side wall 35 and adjacent the end wall 32. Adjacent the lower end of the weir 38, there is an opening which is connected to a check valve 44. In the weir 38 and the baffle 36 there are deep V-shaped notches 45 and 46. These notches extend to a point somewhat below the level of the weir 40, which determines the level to which the water must rise in the deaerator. These notches are provided for skimming off the top of the water and thus carrying the greater portion of oils, greases and other foreign matter that rise to the surface, into the discharge compartment between the weir 38 and the end wall 33.

The pipe 15 extends over this discharge compartment between the end wall 33 and the weir 38. It is open at 47 to discharge into this compartment to the left of the weir 41. The pipe 18 extends over the receiving compartment 37 and is open at bottom, i. e., the section over the compartment is a semi-section cut away at the bottom, to discharge into the compartment 37. The pipes 15 and 18 rise to the same elevation to equalize the head or back pressure on the two branches of the water and so effect a proportionate distribution of the water in accordance with the arrangement of the passes in the condenser.

The water to be distilled, i. e., that delivered through the pipe 18 enters the chamber 37 and rises therein to the elevation of the weir 40. Any floating matter is skimmed through the V-notch 46 into the waste compartment. The water then passes under the baffle 36 and over the weir 40 into the boiler feed compartment in a thin sheet form. As the water must pass down under the baffle 36, floating matter remains on the top and is skimmed into the discharge compartment. The top of the water in the other discharge or feed compartment, is skimmed through the V-notch 45 into the waste compartment to further remove floating foreign matter. In its passage in the compartment 37, under the baffle 36 and over the weir 40, gases are liberated and pass off to the atmosphere.

The weir 41 is provided in the waste compartment so that during operation, there will be in the waste compartment, to the left of the weir, a head equal to the height of the weir. If the level of the water in the boiler feed compartment goes below the level of the weir 41, the check valve 44 opens to permit water to flow from the waste compartment to the boiler feed compartment. This arrangement assures the supply of boiler feed water.

It is to be noted that the conduit 30 through which the vapors from the evaporator pass to the condenser shell constitutes a large heat transfer surface within the boiler feed compartment of the deaerator. This further heats the water in this compartment and in consequence, effects a further liberation of gases as well as additionally preheating the boiler feed water.

While the system illustrated in the drawings and described above includes a multiple effect evaporation, it will be obvious that the invention is likewise applicable to a single effect evaporation system that is normally supplied with steam from a direct fired boiler or from any other source of steam supply where the steam that is used as the heating agent is returned in the form of condensate to the source from whence it came. Also, the invention permits the operation of a direct fired boiler for the direct evaporation of raw treated water, the resultant steam or vapor being condensed as the distilled water. In addition, it provides an arrangement permitting multiple effect evaporation wherein the first effect evaporator may be a direct fired boiler and the vapor from which is used as the heating medium to the heating surface of the second effect evaporator and wherein the condensate of such vapor forms a part of the distilled water supply instead of being returned to the boiler. There is, with this system, no necessity for maintaining in storage previously treated water for starting up the system.

It will be apparent to those skilled in the art that the system of the invention is capable of

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continuous operation and provides for a continuous flow of liquid through each and every evaporator regardless of whether a single effect evaporator be direct fired. The blowing down in a two or more effect plant follows consecutively from the first effect to the last effect. In this manner there is a continuous blowing down of boiler or every effect and the concentration of solid matter or sludge is kept low and does not accumulate to a point where shut down is necessary.

It will be obvious that various changes may be made by those skilled in the art in the arrangement of the system and the units thereof within the principle and scope of the invention as expressed in the appended claims.

We claim:

1. For a distillation system of the kind described, a combined deaerator and skimmer comprising an open liquid container, a series of baffles and weirs within the container forming a liquid receiving and two discharge compartments, means for delivering liquid to the liquid receiving and one of the discharge compartments, means for discharging liquid from the discharge compartments, a weir within the discharge compartment having the liquid receiving means associated therewith arranged to maintain a head of liquid within the compartment, and a check valve controlling communication between the two discharge compartments.

2. For a distillation system of the kind described, a deaerator comprising an open liquid container, a series of baffles and weirs within the container forming a liquid receiving and two discharge compartments, means for delivering liquid to the receiving compartment and means for discharging the liquid from the discharge compartments, one of said weirs being arranged to skim the upper part of the liquid from the liquid receiving compartment into one of the discharge compartments, and a pair of said baffles being arranged to cause the flow of liquid from the bottom of said liquid receiving compartment into the other of said discharge compartments, and another of said weirs being arranged between the two discharge compartments.

3. For a distillation system of the kind described, a combined deaerator and skimmer comprising an open liquid container, a series of baffles and weirs within the container forming a liquid receiving and two discharge compartments, means for delivering liquid to the liquid receiving and one of the discharge compartments, means for withdrawing liquid from one of the discharge compartments, means for discharging liquid from the other discharge compartment, a weir within the discharge compartment having the liquid receiving means associated therewith arranged to maintain a head of liquid therein, and means operative upon a difference in the head between the discharge compartments for delivering liquid from the discharge compartment having the liquid receiving means associated therewith to the other discharge compartment.

4. In a distillation system of the kind described, the combination comprising a condenser, means for delivering water to the condenser, two discharge outlets for the water delivered to the condenser, a combined deaerator and skimmer mounted on the condenser, and discharge conduits connecting said discharge outlets and extending to the same elevation above the deaerator and open to discharge therein.

5. A distillation unit comprising, in combina-

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tion, evaporating means, a water cooled condenser to which vapor from the evaporating means is conducted to be condensed into distillate, a water-operated cooler connected to said condenser to receive the distillate therefrom, and means for supplying deaerated and heated water to said evaporating means including a pump operable to draw water from a source and discharge the same to said cooler at a rate greatly in excess of the feed water requirements of said evaporating means, a conduit leading from said cooler to said condenser for conducting the partially heated water to said condenser for further absorption of heat while reducing the vapor in the condenser to distillate, a deaerator having a first, a second and a third compartment, with the second and third compartments operable to maintain a reserve of liquid, a conduit tapped into the coolant water circuit of said condenser at a point in advance of the end thereof and discharging to the second compartment of said deaerator and designed to take off the major part of the coolant flowing through said condenser, a conduit tapped into the coolant water circuit of said condenser at the end thereof and discharging to the third compartment of said deaerator, the rate of discharge being in excess of the feed water requirements of said evaporating means, said third compartment overflowing into the first compartment, and said second compartment providing a reserve operable to flow into said first compartment if the overflow from said second compartment is insufficient to maintain the water in the first compartment at a predetermined level, a feed water conduit leading from the bottom of said first compartment to said evaporating means, a pump in said conduit continuously supplying feed water to said evaporating means at a rate in excess of the evaporation thereof, and means for permitting a continuous blow down from said evaporating means.

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