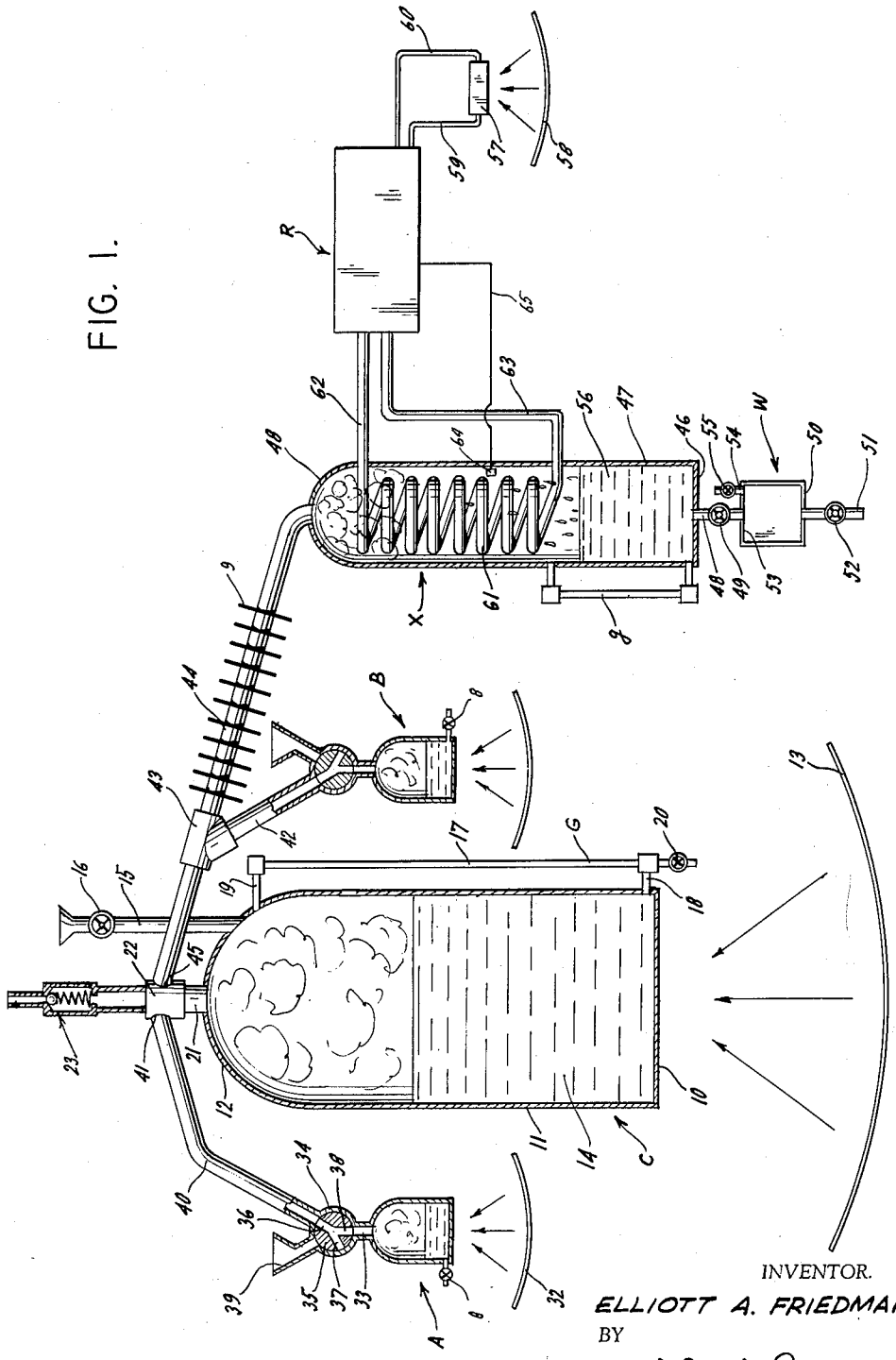
March 14, 1961 E. A. FRIEDMAN 2,975,107

DISTILLATION APPARATUS

Filed Dec. 6, 1957 2 Sheets-Sheet 1

FIG. 1.



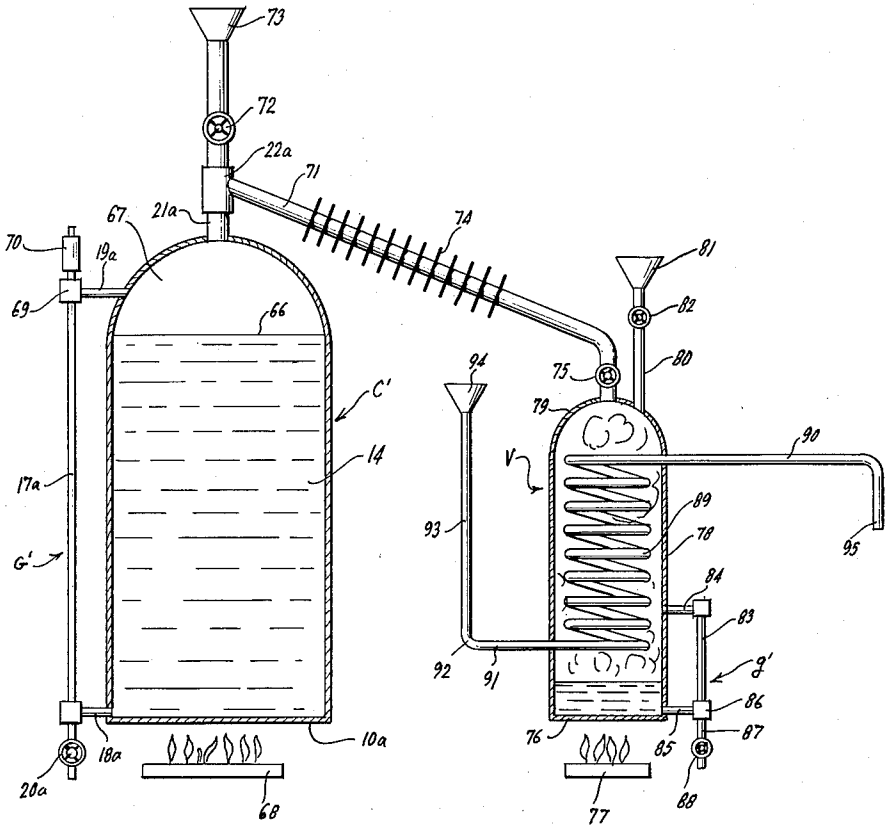
INVENTOR.
ELLIOTT A. FRIEDMAN
BY
Mock & Blum
ATTORNEYS

March 14, 1961 E. A. FRIEDMAN 2,975,107

DISTILLATION APPARATUS

Filed Dec. 6, 1957 2 Sheets-Sheet 2

FIG. 2.



INVENTOR.
ELLIOTT A. FRIEDMAN
BY
Mocker & Blum
ATTORNEYS

United States Patent Office 2,975,107
Patented Mar. 14, 1961

2,975,107

DISTILLATION APPARATUS

Elliott A. Friedman, 3077 Hull Ave., New York, N.Y.

Filed Dec. 6, 1957, Ser. No. 701,242

5 Claims. (Cl. 202—52)

The present invention relates to a still that is designed primarily for the distillation of sea water to obtain water and a concentrated salt-water solution and is principally concerned with a still having novel features that result in increased efficiency. The invention also involves a novel process for distilling sea water. The still is designed for the purpose of obtaining water for general use such as drinking, irrigation, and industrial purposes. It also provides a concentrated salt solution that is adapted for use in various chemical and industrial processes.

At the present time, it is a well-accepted fact that solar energy may be employed for the distillation of sea water. However, when solar energy is employed, it is of the utmost importance that the process and apparatus function with maximum efficiency. Because of this, it has been recognized as desirable to achieve a partial vacuum or attenuation of the air over the sea water in the main distillation chamber because such partial vacuum will lower the boiling point of sea water and make it possible to carry out the distillation process at a lower temperature.

With the foregoing conditions in mind, the present invention has in view as its foremost objective the provision of a process for distilling sea water; and which process is characterized by the fact that auxiliary steam is initially produced in auxiliary distillation chambers which originally are in communication with the atmosphere to exhaust substantially all the air therefrom; whereupon the auxiliary distillation chambers are placed in communication with a main distillation chamber to evacuate the air content thereof; and whereupon refrigerating apparatus is employed to condense this steam and thus achieve the partial vacuum in the main distillation chamber.

Still another object of the invention is to provide a method of the character indicated in which solar heat or fuel-generated heat is employed to energize the refrigerating operation.

Another object of the invention is to provide a method of the character aforesaid in which the auxiliary steam may be cut off from the main distillation chamber at the time the refrigerating apparatus is brought into operation or continued in use to reduce the pressure in the main distillation chamber while the refrigerating system is in operation.

Another object in view is to provide distillation apparatus of the character aforesaid which consists essentially of a main distillation chamber and a plurality of auxiliary vacuum distillation chambers that are adapted to be initially placed in communication with the atmosphere, to exhaust all the air therefrom, then placed in communication with the main distillation chamber to convey the steam or vapor which is quickly generated in the auxiliary chambers to the main chamber and exhaust air from the latter.

Another object in view is to provide, in apparatus of the character noted, means for interrupting the communication between the auxiliary chambers and the main distillation chamber.

Another object in view is to provide, in distillation apparatus of the type noted, a refrigerating unit that is heat energized and which has associated therewith a condensation chamber that is adapted to be placed in communication with the main distillation chamber. After the auxiliary distillation elements have been operated to substantially replace the air in the main distillation chamber with steam, the refrigerating unit is brought into operation to condense the steam and thus attenuate the gaseous content of the space above the sea water in the main distillation chamber to lower the effective boiling point.

While it is possible to employ just about any source of heat to operate the subject still, the invention has particularly in mind the use of solar energy as the heating medium; and the various components of this still are particularly designed to be operated by the heat of the sun, although the invention has, as another important object, the provision of a still of the character aforesaid in which the auxiliary vacuum chambers are heated by the combustion of a fuel.

After the still has been brought into production by use of the refrigerating unit as above outlined, salt-free water will be condensed in the condensing chamber of the refrigerator. In drawing off this salt-free water, it is highly important that little or no air be admitted to the system. Thus, another object of the invention is to provide, in distillation apparatus of the type indicated, a condensation chamber having an auxiliary withdrawal chamber in communication therewith. As salt-free water is produced in the condensation chamber, it will flow into this auxiliary withdrawal chamber; and the latter is provided with an air vent. When water is withdrawn from the latter, the air vent may be opened, at which time communication between the withdrawal chamber and the condensation chamber is cut off. Thus, definite assurance is had that a minimum of air is admitted into the distillation system; and which air, if admitted, would have the effect of raising the boiling point.

Various other more detailed objects and advantages of the invention, such as arise in connection with carrying out the above-noted ideas in a practical embodiment, will in part become apparent and in part be hereinafter stated as the description of the invention proceeds.

The invention therefore comprises a process and apparatus for distilling sea water by using solar or fueled heat energy; and which apparatus is characterized by the presence of a main distillation chamber, a plurality of vacuum distillation chambers adapted to be brought into communication with said main distillation chamber, a refrigerating unit energized by solar heat, and a condensation chamber associated with said refrigerating unit and having an auxiliary withdrawal chamber.

For a full and more complete understanding of the invention, reference may be had to the following description and accompanying drawing, wherein:

Figure 1 is a side view, partly in section and partly in elevation, which diagrammatically depicts the apparatus of this invention; and

Figure 2 is a similar view of a modification.

Referring now to the drawing, a main distillation chamber is referred to in its entirety by the reference character C and is defined by a casing having a bottom wall **10**, a cylindrical wall **11**, and a dome-shaped top **12**.

In accordance with one of the main objectives of this invention, it is intended that the main distillation chamber be heated by solar energy. Thus a solar heating device is represented at **13** as being disposed beneath the bottom **10** so as to reflect the heat of the sun onto this

bottom. Obviously, the solar heating device 13 could be located to reflect heat onto any part of the chamber C where it will be most effective.

The chamber C is almost completely filled with sea water as represented at 14; and for this purpose a filling tube 15 is provided; and it will be noted that this tube 15 communicates with the dome 12. A valve, represented at 16, is included in tube 15 to cut off communication with the atmosphere after the chamber C has been filled to the proper level with the sea water 14. With the chamber C almost completely filled, there remains but little air to be evacuated to achieve the required vacuum.

In order to enable an operator to determine the level of sea water within the chamber C, a level gauge is provided and referred to in its entirety by the reference character G. The gauge G includes a vertical transparent tube 17 that is connected at the bottom by a tube 18 to the lower portion of the chamber C and another tube 19 which communicates with the upper portion of the chamber C. A valve shown at 20 may be included in a continuation of the tube 17 and may be employed when occasion demands to drain the chamber C so as to remove the concentrated salt solution therefrom.

Extending upwardly substantially from the mid and uppermost point of the dome-shaped top 12 is a tube 21 to which is connected a manifold coupling 22. Above this coupling 22 the tube 21 is provided with a one-way, inlet safety valve 23 of the spring biased ball-type which protects the chamber C from any damage due to the possibility of pressure therein reaching an excessively low level.

In the position of the valve member 35 depicted in the drawing, communication between the auxiliary chamber A and main chamber C is established, as through connecting valve passageways 36 and 38 and conduit 40 connected to coupling 42 at 41. Obviously, this valve member 35 may be rotated to establish communication between the filling spout 39 and auxiliary chamber A through connecting passageways 36 and 37, as when it is required to supply the chamber A with water or to exhaust vapor from the chamber A to the atmosphere. When so operated, the valve member 35 cuts off communication between the auxiliary chamber A and main chamber C. Both the auxiliary chamber A and B are provided with drains 8 that may be employed to drain off the concentrated salt solution left in the chambers after distillation. Associated with the chamber A, as beneath the latter, is a heating element 32, such as a mirror to effect solar heating of the chamber.

The auxiliary chamber B is substantially the same as chamber A with the exception that the conduit 42 which communicates with the valve casing 34 has its upper end connected to a coupling member 43 that is included in a conduit 44, one end of which is connected to the manifold coupling 22 as indicated at 45. The other end of this conduit 44 is connected to the condensation chamber, which is now to be described. The conduit 44 is provided with cooling fins 9 which aid in the condensation operation.

The condensation chamber is referred to in its entirety by the reference character X. It comprises a flat bottom 46, a cylindrical wall 47, and a dome-shaped top 48 to the midpoint of which is connected one end of the conduit 44.

The condensation chamber is provided with a level gauge, represented at *g*, which is generally similar to the level gauge G of the distillation chamber C.

Connected to the bottom 46 and depending therefrom is a tube 48 the lower end of which is connected to a withdrawal chamber W. Included in the tube 48 is a valve 49. The withdrawal chamber W includes a bottom at 50 with which communicates a withdrawal tube 51 including a valve 52. The withdrawal chamber W also has a top wall 53 that is provided with an air-vent tube 54 having a valve 55.

It is evident that, with the valve 49 open, salt-free water, such as represented at 56 in the condensation chamber X, will flow through the tube 48 into withdrawal chamber W. However, when it is desired to withdraw water from the latter, this valve 49 is closed while valves 52 and 55 are opened. Thus water is withdrawn from the tube 51 while air is admitted to the withdrawal chamber W through the tube 54.

A refrigerating unit of the type that is energized by heat is represented at R. This unit R includes an element at 57 that is heated by the solar reflector shown at 58, or by fueled heat. Tubes 59 and 60 extend from the element 57 to the unit R. A heat-transfer coil is represented at 61 and is shown as being disposed within the upper portion of the condensation chamber X. The upper end of the coil 61 is connected to the refrigerating unit R by a tube 62; while the lower end of the coil 61 is connected to the unit R by a tube 63. A thermostat 64 is shown as being located within the condensation chamber X and is connected by a line 65 with the refrigerating unit R to automatically control the latter.

Operation

While the mode of operating the apparatus above described to achieve the process of this invention is believed to be obvious from the illustration of the drawing and description of parts given, it may be briefly outlined as follows.

The main distillation chamber C is first filled to a proper level with sea water 14 utilizing the tube 15 for this purpose, whereupon the valve 16 is closed. The auxiliary distillation chambers A and B are also filled to a proper level employing the filling spouts 39 for this purpose with the valve members 35 in position establishing communication between the auxiliary chambers A and B and the atmosphere. At the beginning of the operation, the refrigerating unit R is rendered ineffective; and no action of any consequence takes place in the condensation chamber X.

As the several distillation chambers are heated by fuel or other energy, and particularly the auxiliary distillation chambers A and B, steam is generated; and the steam from these auxiliary chambers is exhausted to the atmosphere. When substantially all the air has been exhausted from these chambers, the valves 35 are adjusted to establish communication between the auxiliary chambers A and B on the one hand, and the main distillation chamber C, on the other. Heating is now discontinued in chambers A and B, causing condensation and vacuum in chambers A, B and C. This may be repeated until sufficient vacuum is created in chamber C to start boiling. Valves 35 are then closed to chamber C and steam from the latter passes through the conduit 44 into the condensation chamber X.

After a substantial amount of steam has been so generated and delivered to condensation chamber X, the refrigerating unit R is automatically brought into operation by thermostat 64; or it may be started into operation manually; and the valve members 35 are closed so as to cut off communication between the auxiliary chambers and the main distillation chamber. In this position the three-way valves 34 effect communication between the atmosphere and chambers A and B, while keeping chamber C closed to the atmosphere. The primary purpose of the thermostat is to prevent chamber X from becoming too cold and filling with ice to damage the apparatus and prevent its proper functioning.

With the refrigerating unit R effective, the cooling coil 61 will cause a condensation of the steam within the condensation chamber X; and, as this steam is so condensed, additional steam vapor will be withdrawn from the main distillation chamber C. Thus the gaseous con-

tent of the latter chamber above the sea water 14 is helped to be attenuated; and a condition of partial vacuum is achieved so as to lower the effective boiling point of this sea water 14. With this boiling point so lowered, the solar-heat element 13 is effective to transform the sea water 14 in the main distillation chamber C into steam or vapor that is conducted through the conduit 44 to the condensation chamber X and there condensed into pure water 56.

Once the process is brought into operation, the only solar-heating elements which are effective are those at 13 and 58—the first for the main distillation chamber and the second for the refrigerating unit.

It is believed that the process of this invention is rendered particularly efficient and easily brought into operation by the refrigerating unit, which quickly lowers the boiling point of the sea water.

The modification

In Figure 2 there is illustrated a modified form of the claimed invention in which fueled energy is preferably employed, although solar heat might be used, and the apparatus greatly simplified by utilizing the condensation chamber to perform the function of the auxiliary distillation chambers A and B in the form of Figure 1.

The main distillation chamber is shown at C′ and is filled with the water to be distilled, such as sea water 14, to the level 66. With the chamber C filled to this height, the air space represented at 67 is quite small, thus leaving but little air to be evacuated in getting the process started. The main distillation chamber C′ has the usual bottom 10*a*, which may be heated by an appropriate source of fueled energy such as represented at 68. A level gauge is shown at G′, and comprises the vertical tube 17*a* that is connected to the bottom of the chamber C′ by tube 18*a*, with the manually controlled valve 20*a* providing a drain for removing a concentrated salt solution that is left after distillation. The upper end of the vertical tube 17*a* is connected to the upper portion of the chamber C′ by horizontal tube 19*a*; and above the joinder of the latter with the vertical tube 17*a*, which is represented by a coupling 69, there is provided a safety valve 70 of a well-known type. This safety valve 70 is indicated as desirable when fueled energy is employed.

Upstanding from the top of the chamber C′ is the usual vertical riser tube 21*a* having a coupling at 22*a* for connecting conduit 71 with tube 21*a*. This tube 21*a* may include a valve corresponding to the valve 23 of Figure 1, which is manually controlled as indicated at 72; and its upper end may be provided with a filling spout 73.

The conduit 71 is provided with a plurality of cooling fins 74; and its lower end is connected to the upper end of a combined vacuum and distillation chamber, referred to in its entirety by the reference character V. A manually operated valve is included in the conduit 71 just above the chamber V as represented at 75.

The chamber V has a flat bottom 76 to which heat is applied by the fueled heating device represented at 77. The chamber V also includes a cylindrical wall 78 and a dome-shaped top 79, with the conduit 71 communicating with the upper central portion thereof. At one side of this point of communication, the top 79 is provided with a filling tube 80 having a funnel 81 at the top and including a manually controlled valve 82. At the bottom of the cylindrical wall 78 there is a level gauge referred to in its entirety by the reference character *g*′, which comprises a vertical tube 83, horizontal tubes 84 and 85, with the vertical tube 83 being continued down beyond a lower coupling member 86 to provide a discharge spout 87 that includes a manually controlled valve 88. A heat-exchange coil is shown at 89 as included in the chamber V. This coil 89 has one end portion 90 that passes through an opening in the lower part of the wall 78. The end portion 91 includes a bend at 92 from which upstands a vertically upstanding part 93 having a spout 94 at its upper free end. The portion 90 is turned down at its end as indicated at 95.

In the operation of this form of the still, the chamber V performs two functions. In the first instance, it constitutes a vacuum chamber which aids in initially removing air from the upper portion of the main distillation chamber C′ and quickly achieving a generation of vapor within this chamber. After this vapor is generated and delivered to the chamber V through the conduit 71, the chamber V then begins to function as a condensation chamber when a cooling medium is passed through the coil 89.

The operation briefly is this:

Water to be distilled is first charged into the main distillation chamber C′ to a proper level as indicated at 66. This filling action takes place through filling spout 73 and conduit 21*a*. At the beginning of the operation, the valve 72 remains open. Chamber C′ may be colored black to attract solar rays.

Water is also filled to a required level in the chamber V through tube 80, after which the valve 82 is closed. The valve 75 is opened and the valve 72 is also opened. Heat is now applied to the bottoms of both chambers through the medium of the fueled heating sources 68 and 77. Vapor from the chamber V is now exhausted to the atmosphere, which eliminates air from the chambers V and C′. Valve 72 is first closed, and then heat source 77 is cut off.

As soon as the chamber V has cooled to a sufficient degree as by using the coil 89, a vacuum is formed in the chambers C′ and V. The distilling operation is now begun during which steam passes through conduit 21*a* and coupling 22*a* to conduit 71 and aids in exhausting air from the space 67. A cooling medium is then passed through the coil 89. This results in a condensation of the vapor within the chamber V; and this action is continued. To increase the vacuum, valve 75 is closed, valve 82 opened, and heat source 77 is rekindled. Valve 82 is then closed, heating source 77 is cut off, valve 75 is opened, and coil 89 is brought into operation.

In the modification of Figure 2, the pipe 90 is shown at a level higher than that of pipe 91. However, this position may be reversed and the pipe 90 placed on the lower level and the pipe 91 on the higher level.

While preferred specific embodiments of the invention are hereinbefore set forth, it is to be clearly understood that the invention is not to be limited to the exact steps, mechanisms, and arrangements illustrated and described, because various modifications of these details may be provided in putting the invention into practice within the purview of the appended claims.

What is claimed is:

1. In distillation apparatus, a relatively large main distillation chamber, a heating element operatively associated with said main distillation chamber, a plurality of relatively small auxiliary distillation chambers, a heating element operatively associated with each of said auxiliary chambers, whereby the contents of said auxiliary chambers are more quickly raised to vaporization temperature by a limited quantity of heat, conduits communicating directly between the upper regions of said auxiliary chambers and said main chamber, an outlet connected to each of said conduits in communication therewith, a three-way control valve in each of said conduits in communication with the respective outlet for selectively venting heated vapor from said auxiliary chambers, passing heated vapor from said auxiliary chambers to said main chamber for accelerating temperature rise in the latter, and closing said auxiliary chambers, a condensation chamber out of heat-exchanging relation with said main distllation chamber, a heat-energized refrigerating unit having a heat-exchange coil within said condensation chamber, a heating element for said refrigerating unit,

and a conduit communicating between the upper regions of said condensation chamber and said main distillation chamber, for passing vapor from said main chamber to said condensation chamber for condensation thereof to lower pressure in said main chamber and lower the boiling point of the contents thereof.

2. In the distillation of sea water, the method comprising the steps of: partially filling a main distillation chamber with water, partially filling an auxiliary distillation chamber with water, applying heat to both of said chambers to generate water vapor in the upper chamber regions and at the same time exhausting said vapor to the atmosphere, establishing communication between the upper regions of said auxiliary chamber and said main chamber with said auxiliary and main chambers closed to the atmosphere, establishing communication between the upper regions of said main chamber and a condensation chamber to pass vapor from said main chamber to said condensation chamber, and refrigerating vapor in said condensation chamber to condense the same and create a partial vacuum in said main chamber at the same time interrupting communication between said auxiliary and main chambers.

3. In the distillation of sea water, the method comprising the steps of: simultaneously heating main and auxiliary distillation chambers having their upper regions in communication to generate water vapor that partially replaces air in said main distillation chamber, closing said main distillation chamber to the atmosphere, refrigerating vapor from said main distillation chamber to condense the same to creat a partial vacuum in said main distillation chamber at the same time interrupting communication between said main and auxiliary chambers, and withdrawing condensed vapor as purified water.

4. In the distillation of sea water, the method comprising the steps of: applying solar heat to a main distillation chamber with a plurality of auxiliary distillation chambers having their upper regions in communication with the main chamber to generate water vapor that partially replaces air in said main distillation chamber, closing said main and auxiliary chambers to atmosphere, passing vapor from said main chamber to a condensation chamber while maintaining said main chamber closed to the atmosphere, refrigerating vapor in said condensation chamber to condense the same to create a partial vacuum in said main distillation chamber, interrupting communication between said auxiliary distillation chambers and said main chamber, continuing the heating of said main distillation chamber and said condensing of vapor therefrom, and withdrawing purified water from said condensation chamber.

5. In distillation apparatus, a main distillation chamber, a heating element operatively associated with said main distillation chamber, a plurality of auxiliary distillation chambers, a heating element operatively associated with each of said auxiliary chambers, conduits directly communicating between the upper regions of said auxiliary chambers and said main chamber, an outlet connected to each of said conduits in communication therewith, a three-way control valve in each of said conduits and communicating with a respective outlet for selectively venting heated vapor from said auxiliary chambers, passing heated vapor from said auxiliary chambers to said main chamber for accelerating temperature rise in the latter, and closing said auxiliary chambers, a condensation chamber out of heat-exchanging relation with said main distillation chamber, a heat-energized refrigerating unit having a heat-exchange coil within said condensation chamber, a heating element for said refrigerating unit, a thermostat in said condensation chamber and connected to said refrigerating unit to automatically control operation of the latter, and a conduit communicating between the upper region of said condensation chamber and said main distillation chamber for passing vapor from said main chamber to said condensation chamber for condensation therein to lower pressure in said main chamber and lower the boiling point of the contents thereof.

References Cited in the file of this patent

UNITED STATES PATENTS

415,133	Wood	Nov. 12, 1889
1,076,410	Dunnam	Oct. 21, 1913
1,087,907	Publicker	Feb. 17, 1914
1,109,794	Sellers	Sept. 8, 1914
1,268,233	Furman	June 4, 1918
1,496,392	Todd	June 3, 1924
2,487,884	Lunt	Nov. 15, 1949