Sept. 19, 1944. E. S. CLEMENS 2,358,559

WATER RECLAIMER MOBILE TYPE

Filed Oct. 9, 1941 2 Sheets-Sheet 1

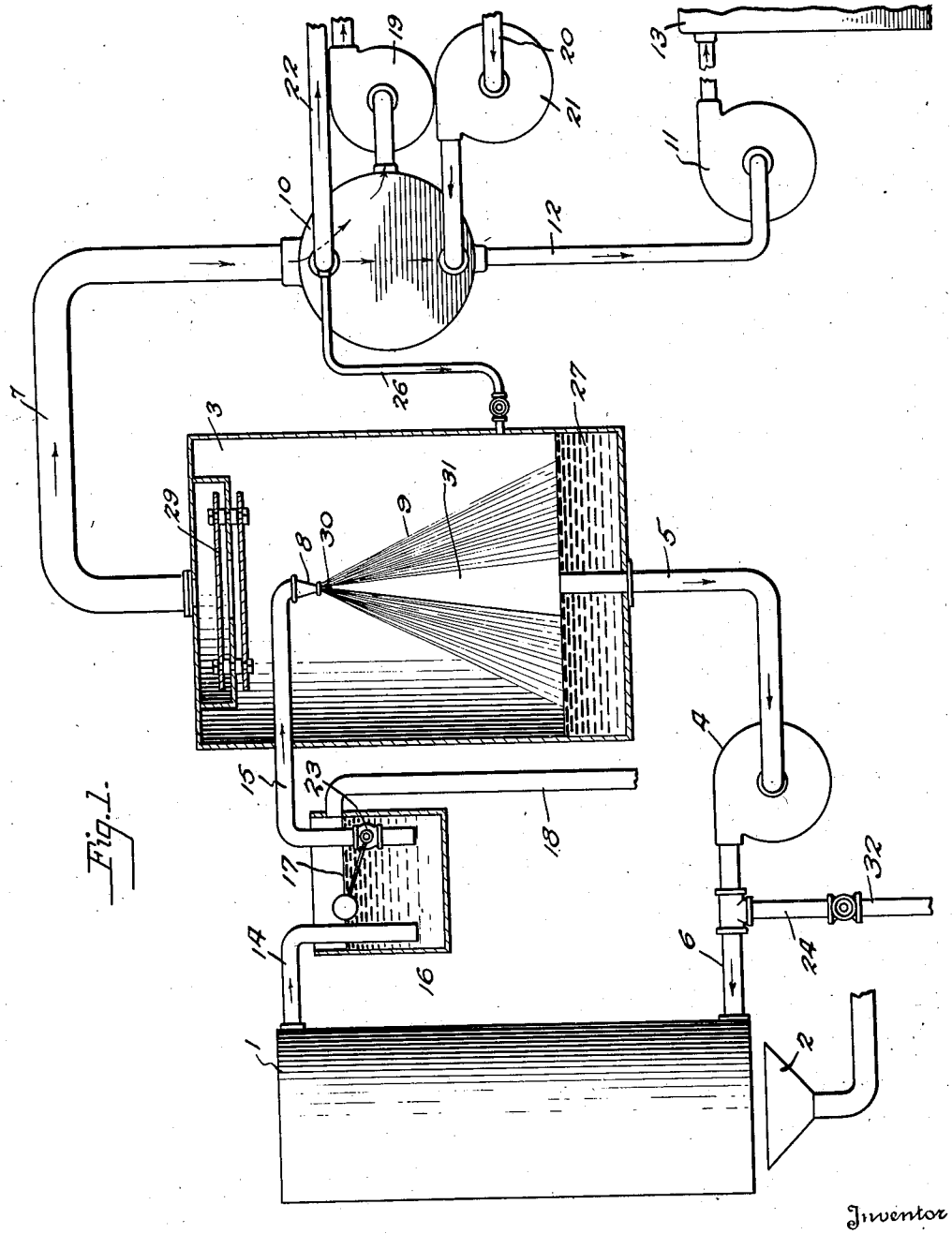


Fig. 1.

Inventor

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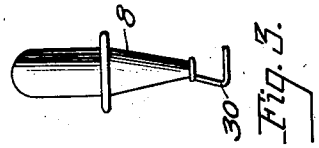


Fig. 3.

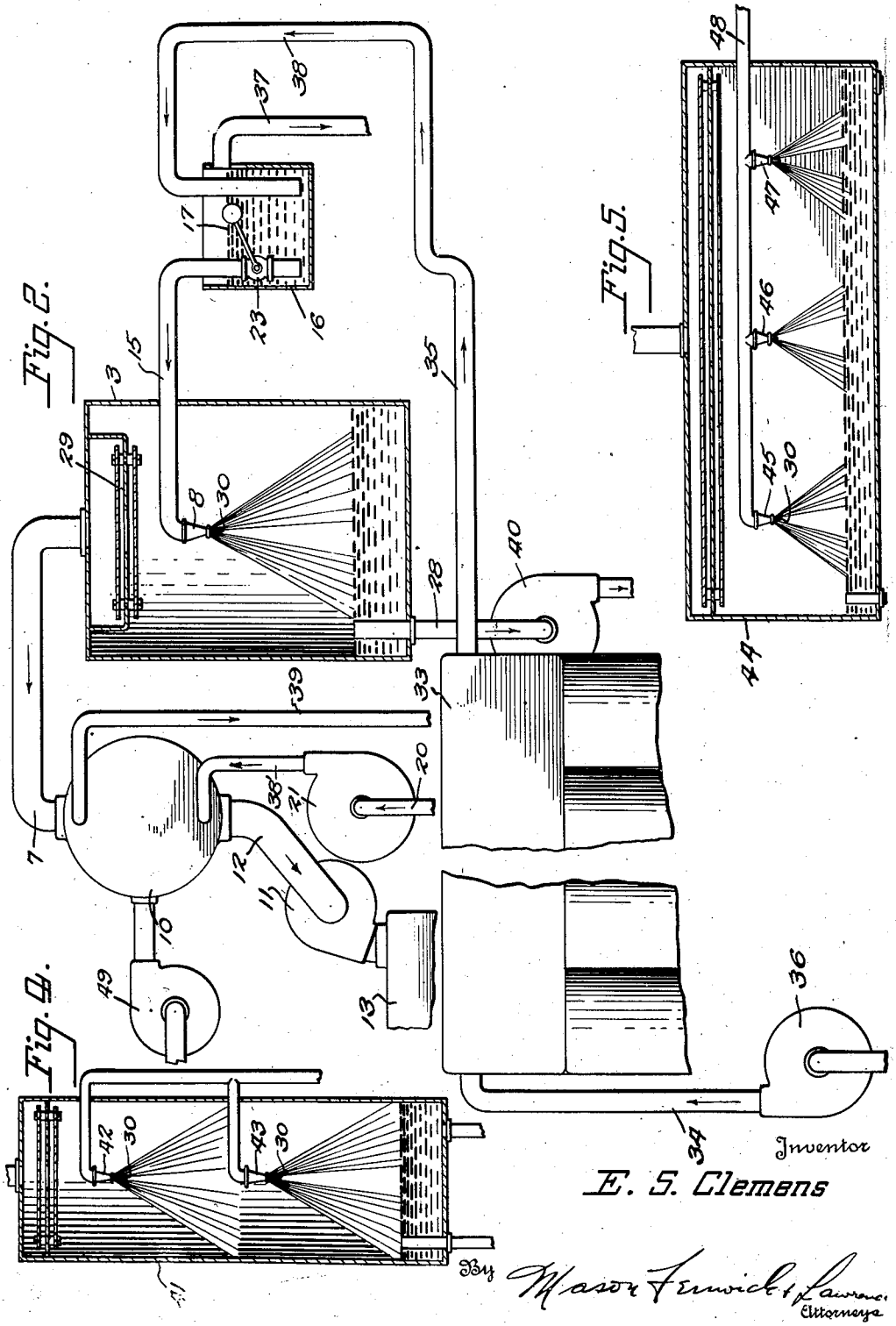
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Attys.

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Filed Oct. 9, 1941 2 Sheets-Sheet 2



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2,358,559

UNITED STATES PATENT OFFICE

2,358,559

WATER RECLAIMER MOBILE TYPE

Edwin S. Clemens, New Orleans, La., assignor to Water Reclaimer Corporation, Mobile, Ala., a corporation of Alabama

Application October 9, 1941, Serial No. 414,369

7 Claims. (Cl. 202—236)

This invention relates to water reclaiming apparatus and has for its object the provision of means for obtaining potable water from an impure water supply, stressing the larger proportionate quantity of water reclaimed and the maximum economy in the utilization of heat in the reclamation of the water.

The function of the subject apparatus involves the evaporation in vacuo of water heated to a lower than boiling point temperature which ordinarily would necessitate, for the pump recirculation of the raw water from heater to vacuum chamber, that the latter be elevated to at least the vacuum seal height above the surface level of the body of raw water. Otherwise, the water will flash into vapor in the circulating system, making the pump ineffective. This has limited the practical employment of vacuum water reclaimers to boats or buildings wherein the presence of a tower-like structure from twenty to thirty feet or more in height is unobjectionable.

One of the objects of the present invention is to provide access of atmospheric pressure to the circulating water column between the heating chamber and the vacuum chamber, relieving the vacuum tension of the circulating column, averting the tendency of the water to "flash" in the circulating line, and permitting the pump to properly function with the apparatus at any desired low level. This adapts the apparatus of the present invention to be mounted on a truck as well as to be used in boats or in buildings, which is the most important consideration in providing mobile water reclaiming units for armies, etc.

Another object of the invention is to introduce the heated water to the vacuum chamber in the form of a hollow conical curtain whereby maximum surface, both the inside and outside of said curtain, is exposed to the evacuated atmosphere of the vacuum chamber.

Still another object of the invention is the provision of a "cone splitter" to open one side of the conical spray particularly near the apex where the water curtain is continuous, thereby to allow the water vapor from the inside of the apical portion of the hollow cone to escape.

A further object of the invention is to provide a sediment and solute collecting body of water with level determining overflow, at the bottom of the vacuum chamber, which is continuously agitated by the impingement of the water spray against the surface thereof, so that the high density of water is kept in a condition of uniform concentration continuously discharging all solids therein contained, into said overflow.

Other objects of the invention will appear as the following description of a preferred and practical embodiment thereof proceeds.

In the drawings which accompany and form a part of the following specification and throughout the several figures of which the same characters of reference have been employed to designate identical parts:

Figure 1 is a view in elevation, partly in section, showing an embodiment of the invention adapted to be mounted upon a truck;

Figure 2 is a similar view showing a modified form of the invention adapted for use on a boat;

Figure 3 is an elevational view of a spray nozzle featuring the "cone splitter";

Figure 4 is a vertical section through a modified form of vacuum chamber showing a plurality of sprays in vertical axial alignment; and

Figure 5 is a similar view through a modified form of vacuum chamber in which a plurality of sprays are horizontally arranged.

Referring now in detail to the several figures, and first adverting to that form of the invention shown in Figure 1, this being the installation designed particularly for a mobile unit and in which it is contemplated that a capacity of reclaimed water is required greater than can be obtained from the mere waste heat of the truck power plant, the numeral 1 represents a water heater, which may be heated if desired, in part by waste heat from the internal combustion engine, not shown, which normally operates the truck, but which is shown as being served by a suitable burner 2. The water heater 1 is one of the elements of a circulatory system which includes also the vacuum chamber 3 and the pump 4, which pumps water from the lower part of the vacuum chamber by way of the conduit 5 and returns it to the water heater through the conduit 6. The atmosphere of the vacuum chamber is continuously evacuated through the conduit 7 at the top of said chamber.

Heated water from the upper part of the heater 1 is drawn into the vacuum chamber through a downwardly directed spray nozzle 8 which delivers the water to the vacuum chamber in the form of a hollow inverted cone 9, or other suitable spray. A portion of the heated water spray is evaporated in the vacuum chamber, the water vapor being carried through the conduit 7 to a condenser 10. A pump 11 connected to the lower part of the condenser by a conduit 12, delivers the condensate water from the condenser to a storage chamber 13. The water vapor from the chamber 3 is drawn into the condenser through

the conduit 7 by a suitable pump 19 which after the condensation of the water, discharges the vehicle air into the atmosphere.

It is obvious that if the conduits 14 and 15 which lead from the heater to the spray nozzle 8 were a continuous unbroken circuit, the circulatory path from the vacuum chamber through the pump 4, heater 1, and back to the vacuum chamber, would have both ends subject to the pull of vacuum in opposite directions, so that, the water being heated to a temperature below its atmospheric boiling point but higher than the boiling point under the degree of vacuum maintained in the vacuum chamber, might flash into a vapor, creating a void in the pump 4 which would interrupt its pumping function and bring the circulation of water to an end and the vapor would condense back into the water in the recirculating line itself. Also, if the entire circulatory system were closed, more heat would be required if the whole recirculation line were under vacuum, as the vacuum would have a tendency to reduce the temperature of the water to the vacuum temperature. For instance, steam leaving the exhaust of an engine or turbine at 300° F. and discharged into a vacuum of 27 inches, as referred to 30 inches barometer, would instantly be reduced to approximately 115° F., or into a 28 inch vacuum to approximately 105° F. So, by discharging the water from the heater into atmospheric pressure and allowing the vacuum to pull this water into the reclaimer tank, the total heat of the water is then put through the spray head for vaporization in the reclaimer tank.

In order to avoid this, I have provided a break in the circulatory conduit at which break atmospheric pressure is imposed upon the column of circulating water, relieving the vacuous tension of the circulatory water column and preventing the tendency of the water to flash into a vapor in the pump, or for that matter, at any other point than the vacuum chamber itself.

This break is effected by the provision of an open topped vessel 16 which is filled with water up to a constant minimum level 17, determined by the position of a float valve 23 in the conduit 15 which leads to the spray nozzle. The maximum level is determined by the overflow pipe 18. The adjacent ends of the conduits 14 and 15 dip into the vessel 16 below the water level 17. Thus, the function of the pump 4 is to pump into the vessel 17 which is under atmospheric pressure, and the function of the vacuum in the vacuum chamber 3 is to draw liquid from the body of liquid in the vessel 16.

The condenser 10 is cooled by raw water drawn from the source of supply through the conduit 20 and pumped to the condenser by the pump 21 and discharged by way of the pipe 22. The cooling water, of course, becomes heated in the condenser, and as it is desired to conserve as much as possible of the heat of this water, as much as may be needed to make up the loss due to the volume of water reclaimed, plus high density water thrown away through pipe 32 in Fig. 1, is fed into the chamber 3 through the branch pipe 26.

That part of the water of the conical spray 9 which does not evaporate in the vacuum chamber 3 accumulates in a body 27 in the bottom of said vacuum chamber to a level determined and maintained by the upper end of the conduit 5 which extends an appreciable distance above the bottom of the vacuum chamber. This water is necessarily of relatively high density, containing solutes resulting from the evaporation of part of the spray and also sediment in suspension. A part of this high density water is bled off from the system through the valved pipe 24 connecting into the conduit 6, either continuously or periodically, as may be desired. This prevents progressive increase in the density of the water circulating through the system and avoids the deposit of scale, etc., in the various parts of said system. As the spray 9 impinges forcibly against the surface of the high density water body 27, it keeps this water body in a state of agitation whereby a uniform proportion of the solids which it contains are continuously carried to the pipe 24. This purge of the high density water does away with the necessity of having to clean scale and salt accumulations from the various parts of the system as it required with ordinary coil types of evaporators. In other words, the subject water reclaimer is self cleaning.

A baffle 29 requires the water vapor to traverse a circuitous path before reaching the conduit 7, and prevents any splash of impure water from being entrained with the outgoing water vapor and contaminating the reclaimed water.

A hollow cone spray has been selected as affording the maximum surface exposed to the vacuum within the vacuum chamber 3. The water constituting this cone spray is in the form of a thin curtain, both the inner and outer surfaces of which are exposed to the vacuous atmosphere within the vacuum chamber. Such a curtain has the form of a continuous sheet of water toward the apical portion of the cone, but in the lower or wider portion the sheet of water breaks into cascades of drops more or less separated and affording innumerable passages from the inside to the outside of the cone for the exit of the water vapor. Ordinarily, a certain volume of water vapor would be trapped within the apical portion of the hollow cone by the continuous sheet of water forming the upper part of said cone. This would decrease the evaporative surface of the inside of the cone. In order to prevent this loss in evaporative efficiency, I have provided the cone splitter 30 which has the form of a blade or wire attached to the rim of the spray nozzle and extending inwardly so as to intersect the surface of the cone closely adjacent the apex thereof. Such a splitter diverts the water issuing from the spray nozzle 8, forming a cleft 31 from apex to base and providing an avenue for the continuous discharge of all of the water vapor generated on the inside of the cone.

By the provision of the atmospheric break represented by the open vessel 16, into which the adjacent ends of the conduits 14 and 15 dip below the water level, I am enabled to maintain circulation of water between the heater and vacuum chamber without resorting to the elevation of the vacuum chamber to a height equal in or exceeding the vacuum seal height above the level of the body of raw water being reclaimed. Without this break, it would be impractical to install this system in a mobile unit such as a truck or other places where height is limited.

Referring now to that adaptation of the invention shown in Figure 2, this represents a boat or other installation in which a relatively large amount of waste heat is available and in which the volume of water required to be reclaimed is generally not so large as to require any supplemental heating agency.

The heater in this form of the invention is represented by the water jacket 33 of the internal combustion engine which operates the boat, and which is applied with cooling water drawn through the conduit 34 from the sea. The cooling water heated by the engine is pumped from the engine jacket by way of the conduit 34 by the pump 36 and delivered to the open topped vessel 16 through the conduit 38. The spray nozzle 8 and the splitter 30 are the same as described in connection with that form of the invention illustrated in Figure 1. The adjacent ends of the conduit 38 and the conduit 15 which supplies the spray nozzle dip into the vessel 16 below the water level 17, which is maintained by the float valve 23 and by the overflow pipe 37, the latter discharging into the sea. Vacuum in the vacuum chamber 3 is maintained by the pump 11, the induction end of which communicates through the conduit 12 and condenser 10 with the water vapor conduit 7. A separate vacuum pump, such as that shown at 49 in Figure 2 may be used, if desired. Cooling water for the condenser is pumped from the sea through the conduit 20, pump 21 and conduit 38', and returns to the sea by way of the conduit 39. The baffle 29 is the same as in the first described form of my invention and performs the same function. A body of water is maintained in the bottom of the vacuum chamber 3 to a level determined by the height at which the upper end of the pipe stands above the bottom of the vacuum chamber. A proportion of the high concentration water is withdrawn by the pump 40 and discharged into the sea.

This form of the invention differs from that illustrated in Figure 1, solely in that waste heat from an internal combustion engine is employed as the heating agent for the water being treated, and that no attempt is made to obtain maximum heat conservation.

Referring now to Figures 4 and 5, these show forms of vacuum chamber and arrangements of spray nozzle which can be alternatively employed for the vacuum chambers and spray nozzles shown in either Figures 1 or 2. In Figure 4 the vacuum chamber 41 is vertically elongated and a plurality of spray nozzles 42 and 43 are arranged in vertical axial alignment, each being equipped with a cone splitter 30. Evaporative efficiency is gained through the increased surface resulting from the use of the multiple nozzles. Figure 5 shows a horizontally enlarged vacuum chamber 44, in which the spray nozzles 45, 46 and 47 are in horizontal alignment emanating from a common manifold 48. Each of these nozzles is equipped with the cone splitter 30.

While I have in the above description disclosed what I believe to be a preferred and practical embodiment of the invention, it will be understood to those skilled in the art that the specific details as shown and described are by way of illustration and not to be construed as limiting the scope of the invention which is expressed in the appended claims.

What I claim as my invention is:

1. Water reclaiming apparatus comprising means forming a vacuum chamber, a condenser, a conduit connecting the upper part of said vacuum chamber with said condenser and a pump for drawing water vapor into said condenser from said vacuum chamber and maintaining vacuum in said chamber and a water circulation system including a water heater and conduits communicating therewith and with the upper and lower parts of said vacuum chamber, and means for relieving vacuum tension on the water column in said circulation system comprising a vessel open to atmosphere intercalated in said upper conduit and forming part thereof, means for maintaining a water body in said vessel at constant level, said water body forming part of the circulating water column, the ends of said upper conduit adjacent said vessel being submerged below the level of said water body, a spray head terminating said upper conduit within said vacuum chamber, drawing water from said vessel, and a pump in said lower conduit pumping from said vacuum chamber through said heater to said vessel.

2. Water reclaiming apparatus comprising means forming a vacuum chamber, a condenser, a conduit connecting the upper part of said vacuum chamber with said condenser, and a pump for drawing water vapor through said condenser from said vacuum chamber and maintaining vacuum in said chamber, a water circulation system including a water heater and conduits communicating therewith and with the upper and lower parts of said vacuum chamber, a spray head terminating in said upper conduit within said vacuum chamber, said upper conduit including pipe sections communicating respectively with said heater and said spray head, and an intermediate vessel open to atmosphere having an overflow determining a constant water level, said pipe sections communicating with said vessel below said level, a pump in said lower conduit drawing water from said vacuum chamber, and delivering to said vessel and said spray head drawing from said vessel.

3. Water reclaiming apparatus comprising means forming a vacuum chamber, a condenser, a conduit connecting the upper part of said vacuum chamber with said condenser, and a pump for drawing water vapor through said condenser from said vacuum chamber and maintaining vacuum in said chamber, a water circulation system including a water heater and conduits communicating therewith and with the upper and lower parts of said vacuum chamber, a spray head terminating said upper conduit within said vacuum chamber, said upper conduit including pipe sections communicating respectively with said heater and said spray head, and an intermediate vessel open to atmosphere having means determining a constant minimum water level, and having an overflow above said minimum level, said pipe sections at their adjacent ends dipping within said vessel below said level, a pipe extending within said vacuum chamber to a certain height above the bottom thereof determining the retention of a body of water at constant level within said vacuum chamber replenished by the spray from said spray head, a pump in said lower conduit pumping water from the body in said vacuum chamber through said heater into said vessel, said spray head drawing water from said vessel.

4. Water reclaiming apparatus as claimed in claim 3, including a pipe connecting into the water conduit from said vacuum chamber to said heater for purging a portion of the high concentration of water passing through said conduit.

5. Water reclaiming apparatus as claimed in claim 3, including a suction conduit communicating with said vacuum chamber above said spray head and with a condenser, a pump con-

nected to said suction conduit through said condenser for drawing water vapor from said vacuum chamber into said condenser and discharging the vehicle air from said condenser, means for circulating cooling water through said condenser and means for returning a part of the heated discharged cooling water to said circulation system.

6. Water reclaiming apparatus comprising means forming a vacuum chamber, a condenser, a conduit connecting the upper part of said vacuum chamber with said condenser, and a pump for drawing water vapor through said condenser from said vacuum chamber and maintaining vacuum in said chamber, a water circulation system including a water heater and conduits communicating therewith and with the upper and lower parts of said vacuum chamber, a downwardly directed spray head terminating said upper conduit within said vacuum chamber, said upper conduit including pipe sections communicating respectively with said heater and said spray head, and an intermediate vessel open to atmosphere having a constant minimum water level, said pipe sections at their adjacent ends dipping within said vessel below said level, a float controlled valve in said upper conduit determining the minimum level in said vessel, said lower conduit extending within said vacuum chamber to a certain height above the bottom thereof determining the retention of a body of water at constant level within said vacuum chamber replenished by the spray from said spray head and against the surface of which said spray impinges, and a pump in said lower conduit pumping water from the body in said vacuum chamber through said heater into said vessel, said spray head drawing water from said vessel.

7. A spray head for use in vacuum chamber evaporating apparatus comprising a nozzle having discharge orifices angularly arranged to deliver a spray in the form of a hollow cone and a cone splitter carried by said nozzle comprising a blade extending transversely across the path of the spray to form a cleft in the spray to provide an avenue of escape for vapor from within the conical spray.

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