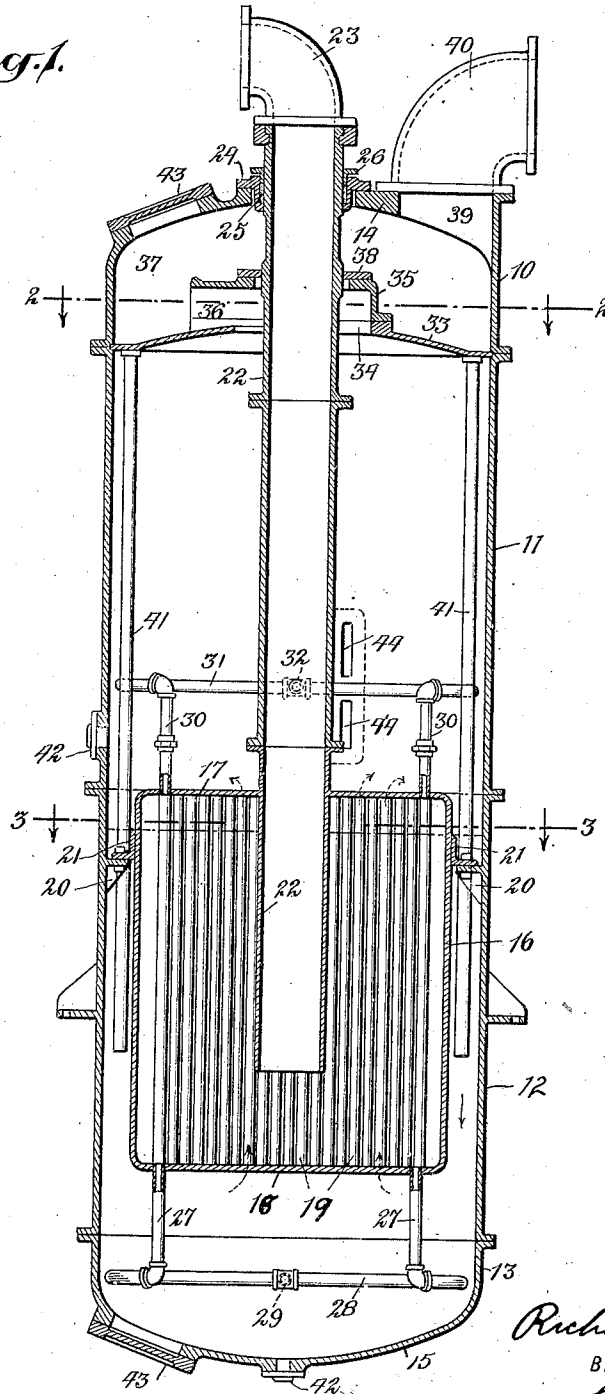


R. D. KEHOE.
EVAPORATOR.
APPLICATION FILED AUG. 13, 1919.

1,363,323.

Patented Dec. 28, 1920.
2 SHEETS—SHEET 1.

Fig. 1.



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Fig. 2.

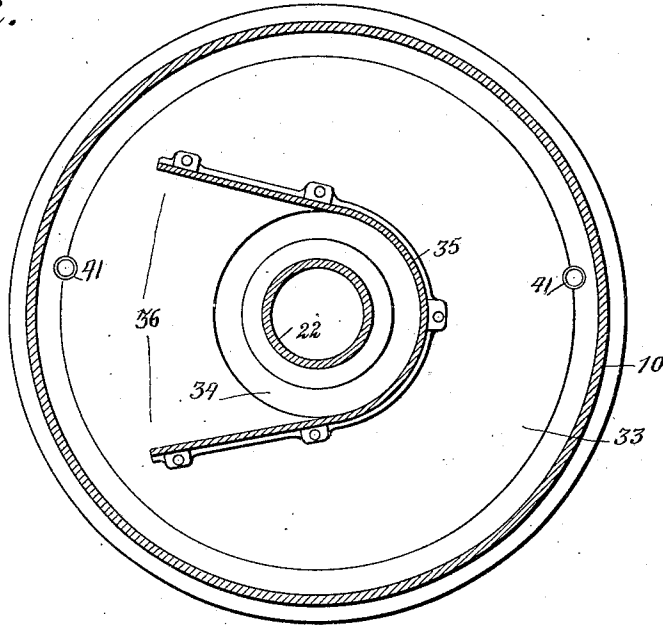
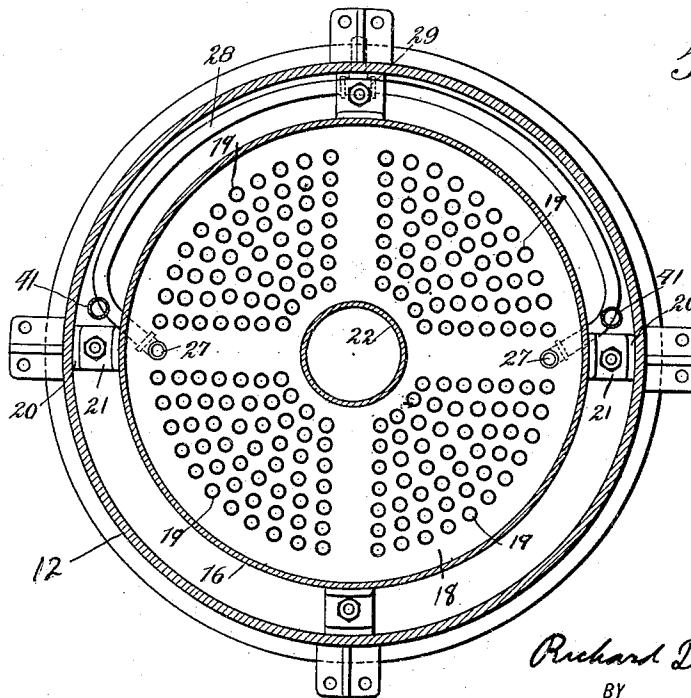


Fig. 3.



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UNITED STATES PATENT OFFICE.

RICHARD D. KEHOE, OF PELHAM MANOR, NEW YORK.

EVAPORATOR.

1,363,323.

Specification of Letters Patent.

Patented Dec. 28, 1920.

Application filed August 13, 1919. Serial No. 317,122.

To all whom it may concern:

Be it known that I, RICHARD D. KEHOE, a citizen of the United States, and a resident of Pelham Manor, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Evaporators, of which the following is a specification.

This invention relates to certain improvements in fluid heat interchange apparatus, particularly adapted for use as an evaporator for the treatment of liquids to remove to a greater or less extent volatile constituents thereof. One important object of my invention is to effect a highly efficient application of the steam or other heating medium and an automatic circulation of the liquid to be heated so that a very high rate of evaporation may be secured. A further important object of my invention is to effect a substantially complete separation from the vapor of the liquid particles carried bodily along by the vapor and the return of such condensed or separated liquid to the main body being evaporated. Various other important objects are secured by means of my improved apparatus, one embodiment of which has been selected for illustration in the accompanying drawings.

In these drawings:

Figure 1 is a central vertical section, and Figs. 2 and 3 are transverse sections on the lines 2—2 and 3—3 respectively of Fig. 1.

In the specific form illustrated, I employ a vertically disposed substantially cylindrical shell which may be made up of any suitable material, dependent upon the character of the liquid to be treated. I have shown this shell as formed of a plurality of cylindrical sections 10, 11, 12, and 13, flanged and rigidly connected but separable if desired, for cleaning, repair, or replacement. Any desired number of such sections may be employed. As illustrated, the top section 10 is formed integral with a top wall 14 while the lower section 13 is formed integral with a bottom wall 15. This latter may vary in shape or character dependent upon the character of the material to be treated and whether or not such material is to be evaporated to dryness or high viscosity or is merely to be concentrated or reduced in volume.

Within the lower portion of the shell is a calandria into which the heating medium is

to be delivered. This is illustrated as a cylindrical drum 16 of somewhat smaller diameter than the shell and having the upper and lower heads or tube sheets 17 and 18 welded or otherwise rigidly and tightly secured thereto. A large number of tubes 19 are connected to and supported by the heads or tube sheets 17 and 18, and are open at both ends into the body of the shell. The calandria may be supported in any suitable manner and held substantially co-axial with the main shell of the evaporator. The supporting means are illustrated as a plurality of lugs 20 formed integral with the shell wall section 12 and supporting and secured to lugs 21 carried by the peripheral wall of the calandria.

The tubes 19 are preferably arranged in groups leaving radially extending passages between adjacent groups and from a central free space. Rigidly secured to the upper head 17 of the calandria is a steam inlet pipe 22 of comparatively large cross sectional area and terminating approximately two-thirds of the way down from the top wall. Steam is delivered to this pipe from a supply conduit projecting through the wall of the shell. This supply conduit 23 is preferably co-axial with the evaporator and projects through the top wall 14 of the latter. It is illustrated as formed of sections flanged and bolted together and provided with an elbow 23 at its upper external end. It is important that the joint between this pipe and the wall 14 be tightly packed so that the desired degree of pressure or vacuum may be maintained in the evaporator. As shown, the top wall 14 has a collar 24 rigidly and tightly secured thereto and encircling the steam conduit 22 and having an annular gasket space 25 in which a gasket may be compressed by a gland 26 outside of the evaporator and threaded into the outer end of the collar 24. By means of this construction the packing may be easily tightened, replaced, or repaired from the exterior of the evaporator.

The lower head or tube sheet of the calandria is provided with one or more drain pipes 27 for the water of condensation and these may lead to a manifold 28 in the lower part of the evaporator, which latter has an outlet 29 through the wall of the latter. For permitting the escape of air from the calandria a somewhat similar arrangement of outlet pipes 30 lead from the upper head or

tube sheet of the calandria, to the manifold 31 and thence to an outlet 32 through the wall of the evaporator.

As an important feature, I provide an entrainment separator in the upper part of the evaporator. This is illustrated as including a transverse wall 33 which may be supported in any suitable manner by the peripheral wall of the evaporator, as for instance, by being clamped in a groove between the abutting ends of the wall sections 10 and 11. This transverse wall 33 has a central opening 34 receiving the steam conduit 22 and somewhat larger than the latter so as to provide an annular passage for the steam or other vapor rising from the liquid being evaporated. Extending over this passage 34 is a hood 35 provided with a lateral outlet 36 to the compartment or chamber 37 between the partition wall 33 and the top wall 14 of the evaporator. A fairly tight joint is formed between the top wall of this hood and the steam conduit, although it is not necessarily steam tight and may be formed by a simple annular collar or plate 38. The vapor may escape from the chamber 37 through an outlet 39 in the top wall 14 which is illustrated as being provided with an elbow 40.

The partition wall 33 is preferably higher at its center than at the periphery so that any liquid collecting upon the upper surface will drain toward the outer edge. This outer edge portion is illustrated as being provided with a plurality of drain pipes 41 leading downwardly along the walls of the evaporator and terminating adjacent to the lower end of the calandria and below the normal liquid level in the evaporator. This liquid level may be maintained at any desired point but for efficiency, it is preferably adjacent to but slightly below the upper end of the calandria.

The wall of the evaporator may be provided with any suitable number or arrangement of filling and emptying conduit connections, manholes, and the like, and with any desired arrangement or number of sight glasses, gages, level indicators, or other appurtenances of the ordinary evaporator. I have shown openings 42 for pipe connections which may be used in filling and emptying, and have shown manholes 43 in the top and bottom and sight glasses 44, in the peripheral wall above the normal liquid level.

In the operation of my improved evaporator, the liquid to be evaporated is admitted to the shell, as for instance, through the inlet 42 in the wall section 11 and the evaporator is filled to the desired level. This is preferably slightly below the upper tube sheet 17 of the steam drum. Steam is admitted through the conduit 22 to the lower portion of the drum and flows through the

radial passages between the tubes 19 so as to highly heat the latter. The liquid standing within the tubes becomes very highly heated and will ordinarily spurt up from the upper ends thereof and fall back on to the drum or down along the walls of the shell. As the drum is spaced from the shell there may be a continuous circulation of the liquid up through the tubes and down along the outside of the drum. The vapors together with any particles of liquid carried up thereby will pass at high speed through the restricted passage 34 and impact against the upper wall of the hood 35. The speed of flow will be materially reduced in the outlet 36, which is spaced from the outer wall of the chamber 37. The flow will increase as it passes between the end of the hood and the wall and will again reduce in the comparatively large chamber 37. This alternate increasing and reduction in the speed of flow of the vapor and liquid, together with the repeated change of direction of flow and the impact against the walls will effect a substantially complete separation of the entrained liquid which will flow back into the main body of the liquid through the pipes 41 while the vapor escapes from the outlet 40.

It will be noted that the steam inlet and vapor outlets are arranged adjacent to each other at the top of the evaporator so that two, three or more evaporators can conveniently be combined together to form double, triple or quadruple, etc., effects. The units may be close together and conveniently arranged and supported on steel structures with the minimum of piping connections. All connecting pipes, elbows, etc., may be of standard construction and therefore made at low cost without the necessity of special patterns. It will be noted that the steam inlet to the calandria enters the top center and continues down through the entrainment separator so that there is the minimum surface of connections exposed with the minimum radiation and heat losses. The entrainment separator is so designed that the vapors arising pass through a narrow constriction and strike with great force against the wall, thus breaking up the foam into liquid and vapor which latter will pass from the evaporator while the liquid returns. The combining of the entrainment separator within the body of the evaporator saves in floor space and adds but little to the height of the evaporator. The expansion joint and stuffing box through which the steam pipe passes permits of an expansion or contraction of the steam pipe and provides the minimum surface to be packed against leaks to the atmosphere. It will be noted that the steam enters the body of the calandria at a point about three quarters of the way down to the bottom so that

it tends to force upwardly any air within the latter and permits of the rapid and free escape of the latter and the withdrawal of the water of condensation. The calandria is so supported that there is the minimum mechanical strain and the pipes thereof are free at the upper and lower end so that they may be readily cleaned without breaking any pipe connections.

It will of course be obvious that the specific form illustrated forms only one embodiment of my invention, and that various changes may be made within the scope of my invention as defined in the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An evaporator, including a chamber for the liquid to be treated, having a vapor outlet at the top, a heater in the lower part thereof, a steam supply pipe extending vertically through the top of said chamber to said heater, and an entrainment separator in the upper part of said chamber below said vapor outlet and encircling said steam pipe but spaced therefrom to leave a passage for the upward movement of the vapor in close proximity to the steam pipe.

2. An evaporator, including a chamber for the liquid to be treated, having a vapor outlet at the top, a heater in the lower part thereof, a steam supply pipe leading through the top of said chamber and connected to said heater, and a transversely extending annular partition wall in the upper part of said chamber and encircling said steam pipe and spaced therefrom to leave a vapor passage in close proximity to said steam pipe.

3. An evaporator, including a chamber for the liquid to be treated, having a vapor outlet at the top, a heater in the lower part thereof, a steam supply pipe leading through the top of said chamber and connected to said heater, a transversely extending annular partition wall in the upper part of said chamber and encircling said steam pipe and spaced therefrom to leave a vapor passage in close proximity to said steam pipe, and a hood above said partition plate and encircling said steam pipe, and having a laterally disposed outlet adjacent to the inner wall of said chamber and spaced from said first mentioned outlet.

4. An evaporator, having a shell, a steam drum disposed within the lower portion

thereof, and spaced from the walls thereof, a steam pipe extending through the top wall of said shell to said drum, a vapor outlet at the upper part of said shell, a transverse partition within said shell below said vapor outlet and encircling and spaced from said steam pipe, and a hood supported by said partition for receiving vapors rising through the latter and deflecting them against the wall of the shell.

5. An evaporator, having a shell, a steam chamber in the lower portion thereof, and spaced from the side walls thereof, a vapor outlet at the upper part of said shell, and an entrainment separator within the upper portion of said shell below said outlet, and including a transverse partition having an annular vapor passage therethrough, and a hood over said passage and having an outlet adjacent to the side wall of said shell opposite to said first-mentioned outlet.

6. An evaporator having a shell, a steam chamber in the lower portion thereof spaced from the side walls of said shell and having open ended vertical pipes through said steam chamber whereby liquid in said shell may circulate up through said pipes and down the exterior of the steam chamber, means for rigidly securing said steam chamber to the walls of said shell and a steam inlet pipe having sliding connections through the top wall of said shell and rigid connections with the top of said steam chamber, said steam pipe projecting downwardly within said chamber to a point adjacent to the bottom of the latter.

7. An evaporator having a shell, a steam chamber in the lower portion thereof and spaced from the side walls thereof, a vapor outlet at one side of the upper part of said shell, a centrally disposed steam pipe extending through the top of said shell and connected to said steam chamber, a transverse partition in the upper portion of said shell and spaced from said steam pipe to leave an annular vapor passage in close proximity to and encircling said steam pipe and a hood encircling said steam pipe above said annular vapor passage, said hood having an outlet at one side thereof directed against the side wall of said shell opposite to said first mentioned outlet.

Signed at New York, in the county of New York and State of New York, this 5th day of August, A. D. 1919.

RICHARD D. KEHOE.