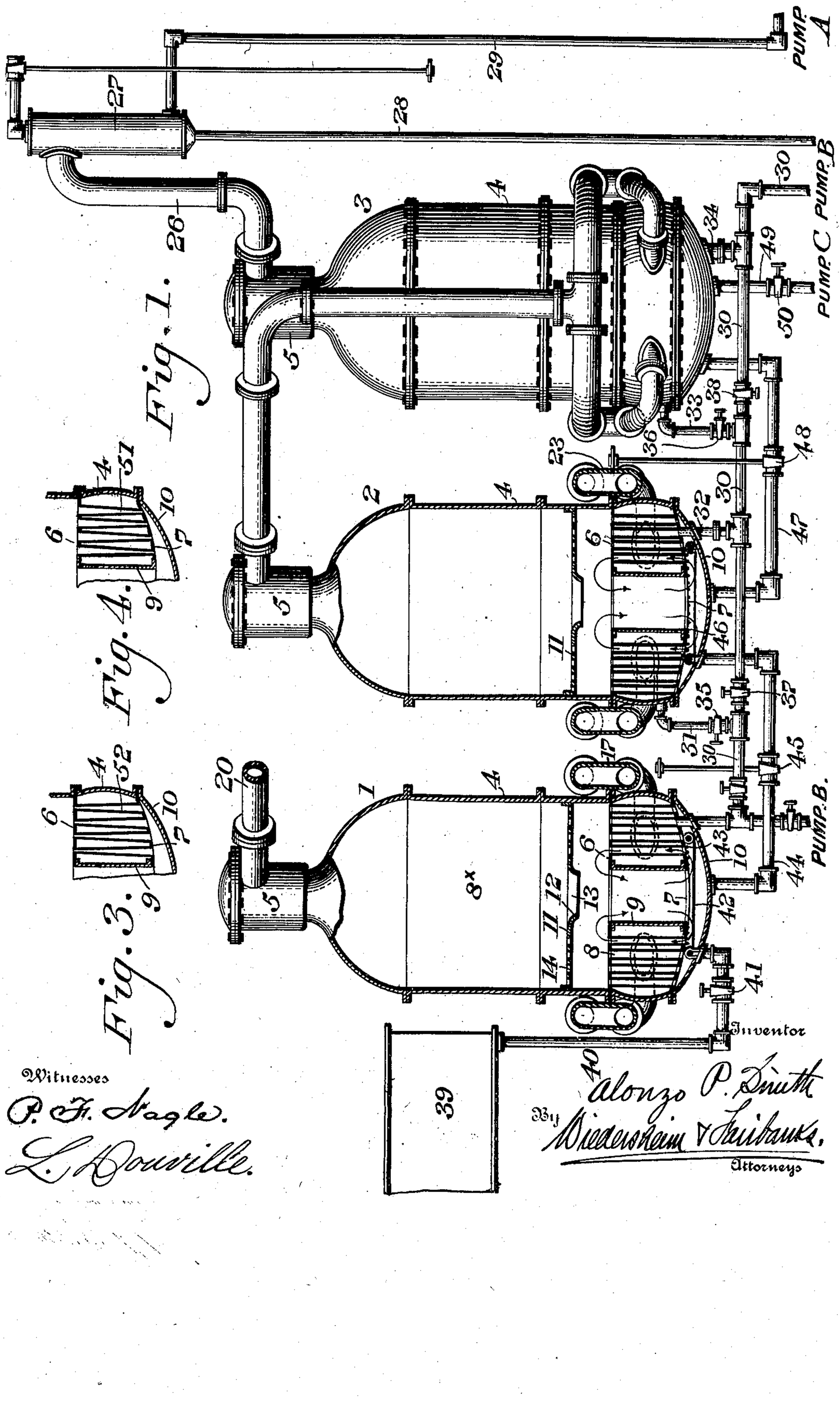
No. 881,351. PATENTED MAR. 10, 1908.

A. P. SMITH.

VACUUM PAN.

APPLICATION FILED JUNE 2, 1904.

2 SHEETS—SHEET 1.



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2 SHEETS—SHEET 2.

Fig. 2.

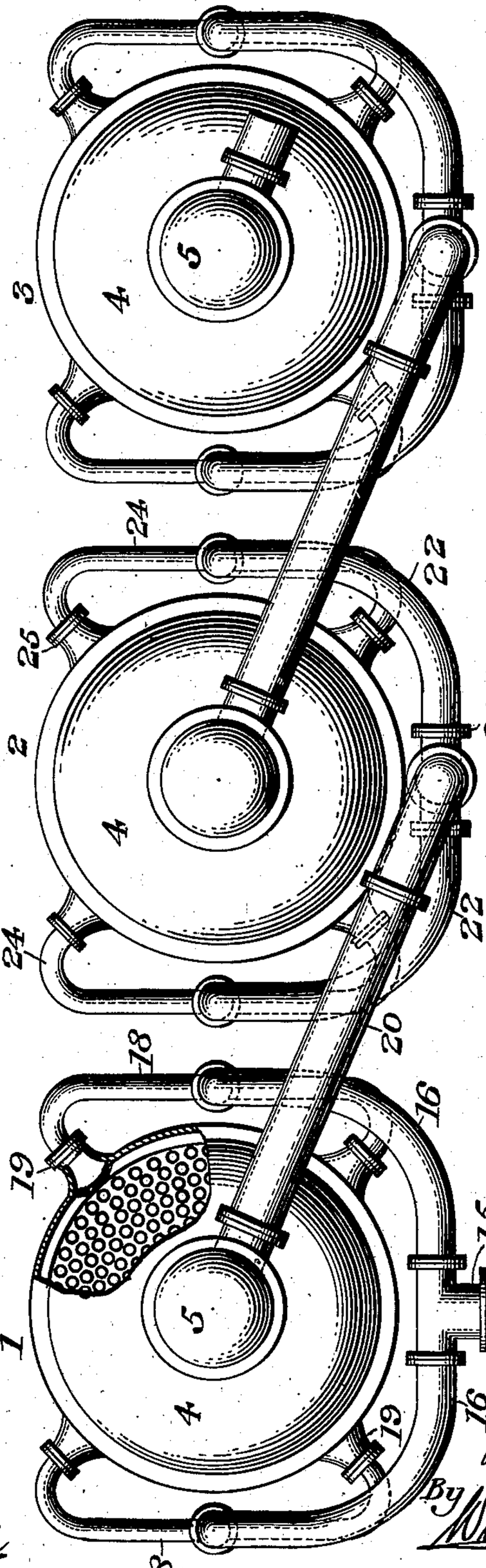
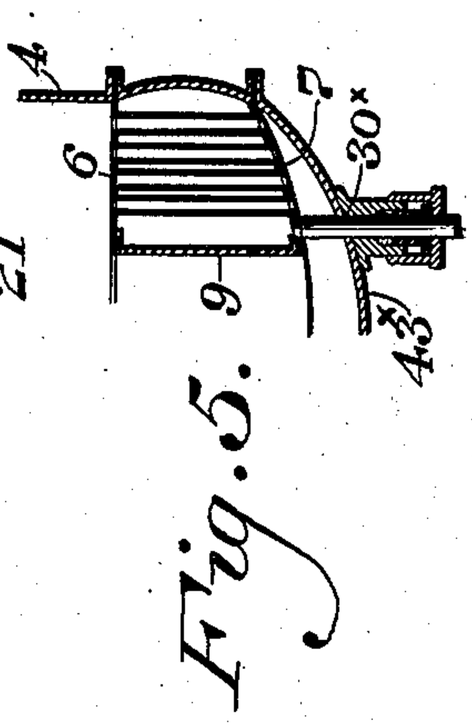


Fig. 5.



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VACUUM-PAN.

No. 881,351. Specification of Letters Patent. Patented March 10, 1908.

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To all whom it may concern:

Be it known that I, ALONZO P. SMITH, a citizen of the United States, residing in the city and county of Philadelphia, State of Pennsylvania, have invented a new and useful Improvement in Concentrators, of which the following is a specification.

My invention relates to evaporators particularly such as are used for the concentration of liquids.

It consists in providing a multiple effect device with improved means for the distribution of steam and of vapor, for leading the water of condensation to the secondary stills or effects and for alternatively leading this water of condensation to the stills or to the boilers.

It further consists in providing a baffle plate for preventing the carrying over of liquid with the vapor.

It further consists in the use of taper tubes in the circulating device.

It further consists of novel features of construction, all as will be hereinafter fully set forth.

Figure 1 represents partly in elevation and partly in vertical section, a triple effect evaporator embodying my invention. Fig. 2 is a top plan view of the same partly broken away, parts being removed for clearness of illustration. Figs. 3 and 4 are fragmentary vertical sections showing modified forms of the circulating portion of the device. Fig. 5 is a similar section showing a modified pipe connection.

Similar numerals of reference indicate corresponding parts in the figures.

Referring to the drawings, 1, 2 and 3 designate connected evaporator stills or effects in which a liquid is evaporated or concentrated. Each of these consists of a body 4 and dome 5. In each is provided upper and lower crown sheets 6 and 7 respectively, which are connected by a plurality of tubes 8 swaged or secured in the sheets in the usual manner. An annular wall 9 located axially of the crown sheets 6 and 7 forms a relatively large passage from the vapor space $8^{\times}$ above the upper crown sheet 6 to the liquid space between the lower crown sheet 7 and the convex bottom 10 of the still. Within each of the stills is a baffle plate 11 having a central depending flange 12 apertured at 13 and a plurality of other apertures 14 surrounding the flange 12.

15 designates a fitting adapted to be connected with a steam pipe leading from a boiler, not shown. From the fitting 15 branch pipes 16 lead to points on diametrically opposite sides of the still 1. Depending pipes 17 connect the pipes 16 with branches 18 curved as shown in Fig. 2 and connected with fittings 19 located quadrantly around the periphery of the still 1 within the space between the crown sheets 6 and 7, which I shall hereafter designate as the steam space. From the dome 5 of the still 1 a pipe 20 leads laterally and downwardly to a fitting 21 which is connected by branches 22 to downwardly extending branches 23, thence by lateral curved branches 24 to fittings 25 connecting with the steam space between the crown sheets 6 and 7 of the still 2, it being understood that the fittings 21, 23 and 25 and branches 22 and 24 are similar to the fittings 15, 17 and 19 and to the branches 16 and 18 respectively. It will also be understood that the dome 5 of still 2 is connected with the steam space between the crown sheets of still 3 by a similar system of pipes and fittings. I have shown the device as consisting of three stills or effects connected in tandem, but it is obvious that two, four or any other number of stills may be so connected. From the dome 5 of still 3 a pipe 26 leads to a condenser 27 provided with a suitable tail pipe 28, the condenser 27 being also connected by means of a pipe 29 to a vacuum pump, indicated by the words "pump A" in Fig. 1 of the drawings. The steam space between the crown sheets 6 and 7 in still 1 is tapped by a pipe 30, which leads beneath all the stills and is connected at each of its ends to a pump, indicated as pump B in Fig. 1 of the drawings. A branch 31 rising from the pipe 30 enters the steam space in still 2. A branch 32 swaged into the lower crown sheet 7 of still 2 and passing through the still bottom 10 also connects with the pipe 30. In the same way the steam space of still 3 is connected by branches 33, 34 with the pipe 30. Suitable valves 35 and 36 are placed in the riser or inlet pipes 31 and 33 respectively, while other valves 37, 38 are placed in the pipe 30 on the pump side of the risers 31 and 33.

39 designates a liquid tank connected by a pipe 40, in which is a valve 41, to an annular fitting 42 located within the liquid space between the crown sheet 7 and the bottom 10 of the still 1. The ring or annular fitting 42

is provided with a series of perforations 43, as shown in Fig. 1 of the drawings. A pipe 44 having a valve 45 leads from the bottom 10 of still 1 to a perforated annular fitting 46 within the still 2, the ring being similar in form and position to the ring 42 above described. In like manner a pipe 47 having a valve 48 communicates with a similarly formed and located ring, not shown, in the bottom of still 3. A pipe 49 in which is a valve 50 leads to a pump, not shown, but marked as pump C in Fig. 1.

In Figs. 3 and 4 of the drawings, I have shown portions of crown sheets 6 and 7 in which are tubes 51 and 52 respectively. The tubes 51 as shown in Fig. 3 taper downwardly while the tubes 52 shown in Fig. 4 have their largest diameter at the lower ends and taper upwardly.

The operation is as follows:—The valves 41, 45 and 48 being open, weak liquid, which it is desired to concentrate, is permitted to flow from a suitable receptacle, as the tank 39, into all of the stills or effects until their upper crown sheets 6 are covered. Pump A is then started to reduce the atmospheric pressure, a vacuum of about 28½ inches being ordinarily carried in the third still or effect. Steam is then admitted to still 1 through the tee 15 and connecting branches and through the four fittings 19 to the space between the crown sheets 6 and 7 which incloses the tube 8. It will be noted that the effect of the distribution of the steam to the four quadrantal points of the steam space will be to very evenly distribute the steam so that practically none of the tubes 8 are more heated than the others. Owing to the heating surface of the tubes being relatively greater than that of the wall 9, a circulation of the liquid will be set up as shown by the arrows in Fig. 1 of the drawings. The steam being introduced under pressure of say five pounds and a vacuum of about five inches being obtained, it is obvious that a violent ebullition of the liquid will occur. The resulting vapor will be carried off through the pipe 20 and branches 22 and 24 and be distributed very equally through the space between the crown sheets in still 2 where it will set up a boiling of the liquid therein, the vacuum being about sixteen inches. In the same way the vapor from the still 2 is carried over, distributed and used in still 3, with of course a similar effect. From the still 3 the vapor passes through the pipe 26 to the condenser 27 in which vacuum is produced by means of a pump A. It is obvious that the baffle plates 11 will act to prevent the raising and carrying over of molecules of the liquid with the vapor.

To assist in the evaporation of the liquid in the secondary stills, the water of condensation produced in the steam space of still 1 is carried by means of pipe 30 and admitted through branch 31 to the steam space of still 2, the valve 35 being open and the valve 37 closed for this purpose. In like manner the opening of valve 33 and the closing of valve 38 permits the water of condensation to pass from still 2 to still 3. From the last still, which in this case is still 3, this water is drawn off by branch 34 into pipe 30, which as already explained, is connected with pump B, which leads to the hot well or the like.

By passing the liquid from tank 39 through a series of perforations 43, in the annular fitting 42 it is fed into the still in a finely divided state which still further conduces to that uniformity of distribution and of heating which it is the object of my invention to secure. This advantage is continued by the use of the like perforated rings in each of the secondary stills or effects. It is obvious that heat units may be conserved by jacketing all the connecting pipes and fittings in any well known manner.

For most purposes the ordinary straight tubes 8, shown in Figs. 1 and 2 of the drawings, give satisfactory results and are preferable on account of their relatively low cost. For concentrating a salt solution, however, the tubes shown in Fig. 3, having their largest diameters at the lower ends are preferable as tending considerably to prevent loss of conductivity by incrustation, while the reversely tapered tubes, shown in Fig. 4, are advantageous in the case of very light solutions in preventing carrying over of the liquid.

In Fig. 5, I have shown a mode of securing the branches which connect the steam space with the pipe 30. Where acids are being concentrated these pipes are quite rapidly destroyed. By taper threading the upper end of the riser $30^{\times}$ where it enters the crown sheet 7 and passing it through a suitable stuffing box in the bottom $43^{\times}$ of the still, it may be readily removed and replaced without injury to the other parts and at little trouble or expense.

By means of the various devices shown for securing a uniform distribution of the heat and of the liquid to all parts of each of the stills, which devices may be used together or separately as desired, I am able to secure much more economical results than have heretofore been attained.

It is evident that various changes may be made by those skilled in the art, which may come within the scope of my invention and I do not therefore desire to be limited in every instance to the exact construction herein shown and described.

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

1. An evaporator having a steam space, means for admitting a heating agent at

quadrantal points from the periphery toward the center of said steam space for uniformly distributing the heating agent within said steam space, vertical tubes in said steam space, and a perforated ring beneath said tubes.

2. An evaporator, a pipe connected with said evaporator for supplying a heating agent thereto, a plurality of branches from said pipe, a plurality of branches connecting each of said first-named branches directly with the steam space of the evaporator, tubes in said steam space, and a perforated ring beneath said tubes.

3. An evaporator, a pipe connected therewith for supplying a heating agent thereto, a plurality of branches from said pipe, a plurality of branches connecting each of the first-named branches with the steam space of the evaporator, tubes in said steam space, a perforated ring beneath said tubes, and a pipe leading from the space below said tubes for connection with the perforated ring of an adjacent evaporator.

4. An evaporator, means in the lower portion thereof for heating and circulating a liquid, embodying vertical tubes in the lower portion of said evaporator with a relatively large central passage therethrough, a perforated ring near the bottom of the evaporator beneath the inlets for the heating agent, and a perforated baffle plate above and in proximity to the heating means.

5. An evaporator having in its lower portion means for heating and circulating a liquid, embodying vertical tubes in the lower portion of the evaporator with a relatively large central passage therethrough in combination with a substantially annular perforated ring below the same, means for supplying liquid to said ring, and a perforated baffle plate above and in proximity to the heating means.

6. An evaporator, means in the lower portion thereof for heating and circulating a liquid, a perforated ring near the bottom of the evaporator beneath the inlets for the heating agent, a perforated baffle plate above and in proximity to the heating means, and a plurality of tapered tubes between said ring and baffle plate.

ALONZO P. SMITH.

Witnesses:
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