

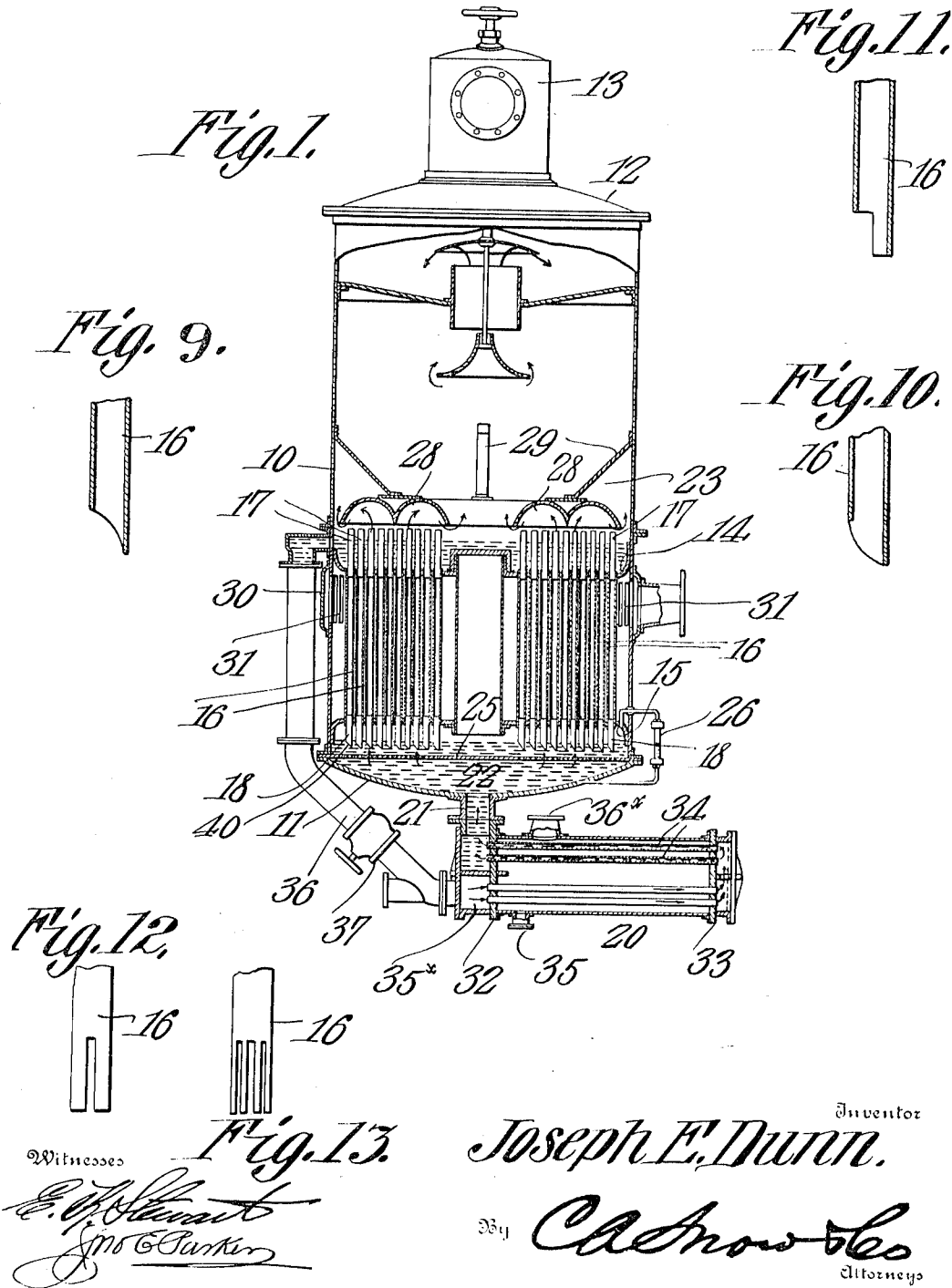
J. E. DUNN.
EVAPORATOR.

APPLICATION FILED MAY 26, 1909.

1,067,010.

Patented July 8, 1913.

4 SHEETS—SHEET 1.



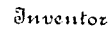
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Fig. 2.



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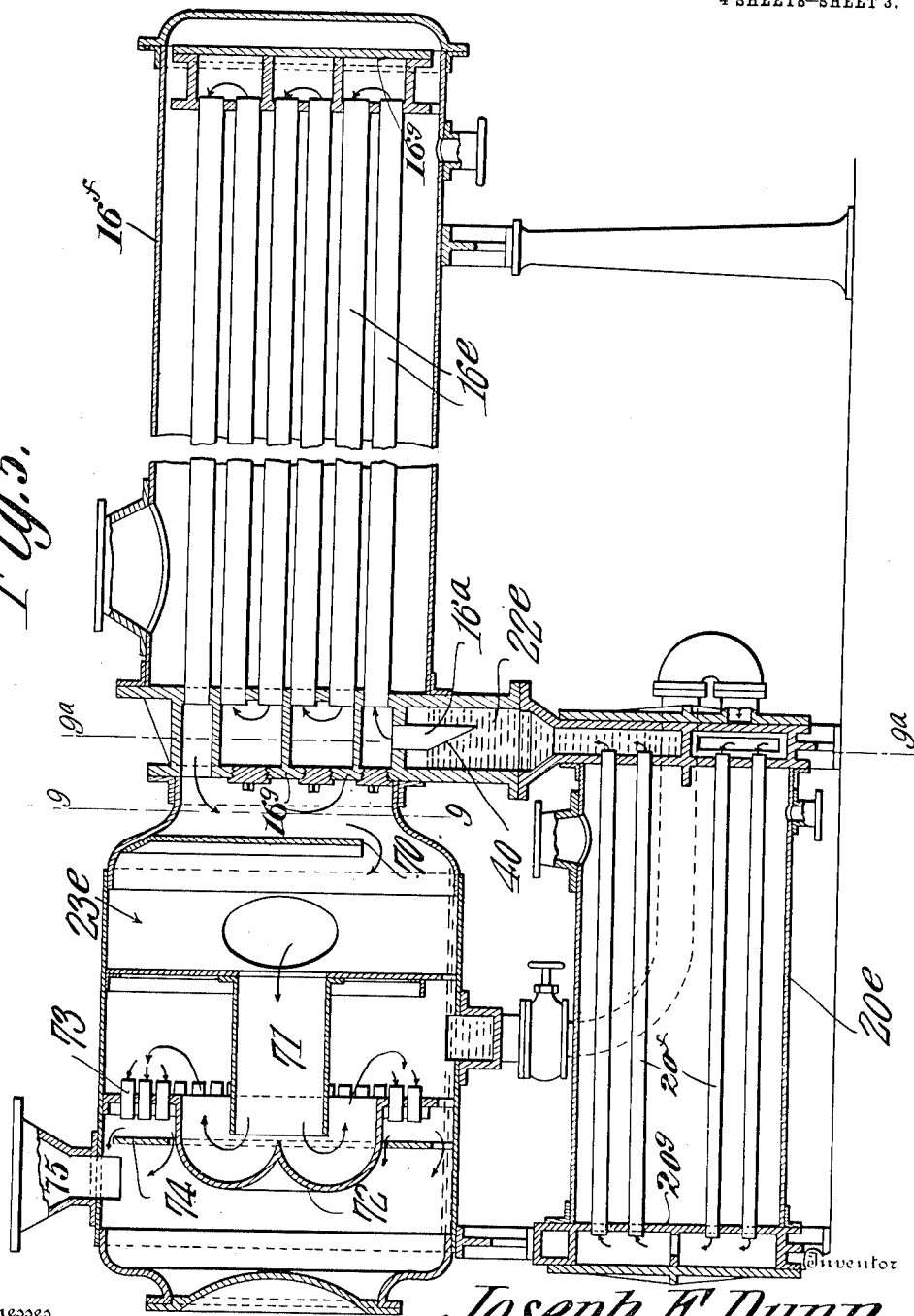
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4 SHEETS—SHEET 3.

Fig. 5.



Witnesses

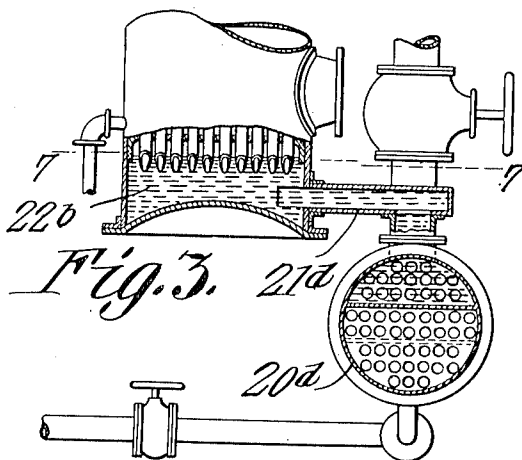
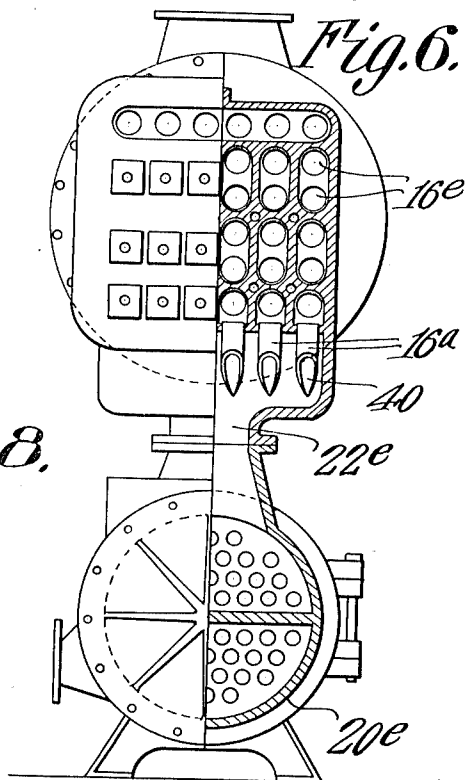
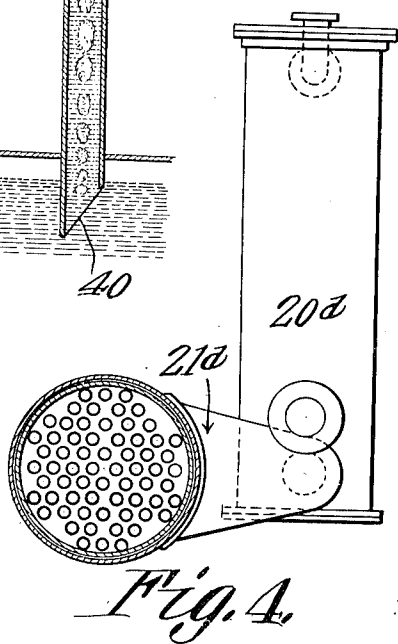
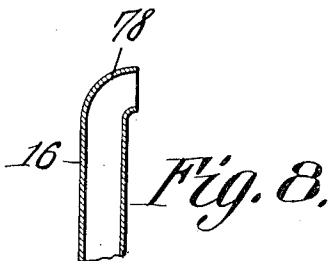
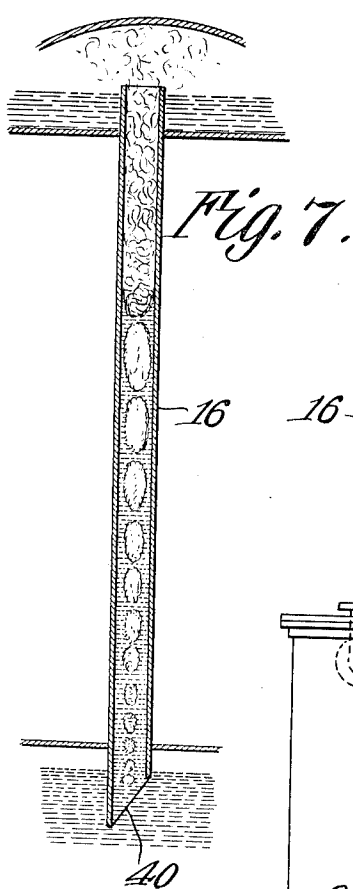
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4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

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EVAPORATOR.

1,067,010.

Specification of Letters Patent.

Patented July 8, 1913.

Application filed May 26, 1909. Serial No. 498,398.

To all whom it may concern:

Be it known that I, JOSEPH E. DUNN, a British subject, residing at Santiago, Island of Cuba, have invented a new and useful Evaporator, of which the following is a specification.

This invention relates to apparatus for evaporating liquids, and it is applicable to the concentration of saccharine and other liquids, the generation of steam and other purposes where it is desirable to secure rapid evaporation at minimum expense.

In practically all boilers or concentrating pans, bubbles of steam form at those surfaces exposed to the greatest heat, and until driven off through the body of the liquid, act as non-conductors and prevent the liquid from coming into contact with the heat radiating surfaces. This is obviated to some extent by more or less rapid circulation of the liquid, but where large quantities of liquid are treated, there is considerable loss in heating due to the insulating action of such bubbles and the comparatively small percentage of the liquid making contact with the heating surfaces.

Leading objects of the present invention are to effect the separation, even distribution and rapid circulation of previously heated and partially vaporized liquid and steam or vapor therein, and to utilize the bubbles of steam or vapor in carrying the liquid along heating surfaces in the form of films, which are quickly converted into steam and the bubbles thus formed utilized in carrying further liquid in the form of films along the heating surfaces, whereby rapid and efficient evaporation is effected.

My improvements comprise, in their preferred form, a generator for heating the liquids, in combination with an evaporator having a supply and pressure chamber to which the liquid and steam or vapor are delivered from the generator, evaporating tubes having ends extending into the supply chamber, and means for effecting the separation of the liquid and vapor and securing an even distribution thereof to the tubes. The steam or vapor collected in the chamber above the inlets to the tubes effect a pressure serving to maintain the liquid at the desired level with relation to the inlets and to secure the desired flow of liquid and vapor through the tubes.

The further features of my improvements

are fully disclosed in the following description and the accompanying drawings in illustration thereof.

In the drawings, Figure 1 is a sectional elevation of apparatus embodying the invention; Fig. 2 is a sectional elevation of a double effect evaporator embodying modifications of the construction shown in Fig. 1; Fig. 3 is a sectional view of a further modification comprising the lower part of a single vacuum pan in combination with a generator; Fig. 4 is a sectional view taken on the line 7-7 of Fig. 3; Fig. 5 represents a further modification comprising a sectional elevation of a horizontal single effect vacuum pan in combination with a generator; Fig. 6 is a sectional view taken partly in the plane of the line 9-9 and partly in the plane of the line 9^a-9^a of Fig. 5; Fig. 7 is a sectional view of an evaporating tube and its connections, with illustration of vapor and liquid supplied thereto and passing therethrough; and Figs. 8, 9, 10, 11, 12 and 13 illustrate forms of vaporizing tubes that may be used.

In Fig. 1 of the drawing, which represents a simple embodiment of the invention, the vaporizer has an upright cylindrical casing 10 provided with a lower head 11, and an upper head 12, the latter carrying a steam dome 13, from which steam may be taken off for power or other purposes.

Extending across the casing are upper and lower tube sheets 14 and 15, to which are secured the ends of a plurality of vertical vaporizing tubes 16. These tubes are shown in the present instance as provided with upper extensions 17 and lower extensions 18, although for all practical purposes the three parts 16, 17 and 18 may be and preferably are integral.

The chamber 22 between the lower flue sheet 15 and the lower head 11 receives steam or vapor and water from a generator 20, through the connecting passage 21, the liquid being subsequently forced from this chamber upward through the vaporizing tubes 16 and discharged into the chamber 23 above the upper flue sheet 14. As the liquid and steam enter the chamber 22 under high pressure, it is desirable to effect even distribution of the liquid and prevent its rushing upward immediately through the nearest vaporizing tubes, and for this purpose a perforated distributing plate 25 is extended

across the chamber 22 at a point below the inlets of the vaporizing tubes, the plate being suitably secured in place between the bolting flanges of the lower head and bottom of the casing. The central portion of the plate 25 is imperforate, whereby the incoming fluid is deflected and its force broken, hence it will rise evenly through the perforations into the upper portion of the chamber. This plate serves further to separate the steam from the liquid, the steam rising to the top of the chamber and forming a cushion above the level of the liquid.

At one side of the lower portion of the casing is a gage glass 26, which is connected to both the steam and liquid spaces of the chamber 22, in order to indicate changes in the level of liquid in said chamber.

Arranged above the tops of the vaporizing tubes are baffle plates 28 which may be supported by suitable straps 29 riveted or otherwise secured to the inner wall of the casing. The steam discharging from the vaporizing tubes will strike against these baffle plates and any liquid which may have been entrained or carried up therewith will be deflected and fall to the bottom of the chamber 23, while the steam will pass upward to the main steam space or dome.

The vaporizing tubes are heated in any suitable manner, and, in the present instance, the casing is shown as provided with an annular flue 30 that encircles the casing wall, said wall being provided with numerous openings 31 that communicate with the flue, and at one side of the flue is a coupling nipple to which may be connected any suitable heat supply means.

It is to be understood that the heating devices may be of any type, and their nature will depend on the available fuel, the character of work, and the degree of heat to be maintained; thus, in some cases the vaporizing tubes may be located in an ordinary furnace, such as a steam boiler furnace, using coal or hydro-carbon for fuel, or waste products of combustion from a furnace or furnaces may be utilized, or the tubes may be heated by gas jets, or, in some instances, high pressure steam may be employed as the heating means where the liquid to be vaporized does not require high temperature.

The primary generator 20 is in the form of a horizontally disposed cylindrical casing having tube sheets 32 and 33 and circulating tubes 34 arranged in upper and lower banks, the casing having an entrance port 35 for a heating fluid and a discharge port 36 therefor.

The inlets of the lower bank of the tubes 34 communicate with a chamber 35* that is placed in communication with the upper separating chamber 23 by means of a pipe 36, which is provided with a controlling valve 37.

In the operation of this apparatus, the liquid in the generator is heated until steam is formed, and this fluid passes upward into the chamber 22, where it is distributed by the perforated plate 25 and gradually rises therethrough, the liquid level being maintained in proximity to the inlets to the tubes 16 as shown in the drawings. Steam or vapor will be separated from the liquid and collect above the inlets to the tubes 16, forming a cushion in the upper part of the chamber 22, maintaining the liquid at the desired level, and, by pressure and gradual admission to the tubes, acting to force and siphon the liquid therethrough in thin, uniformly distributed and rapidly moving films in contact with the heating surfaces. The steam bubbles which enter the lower ends of the tubes, together with the liquid and the steam bubbles which are formed within the tubes, are expanded by the heat and rush upward through the central portions, while the liquid films are forced into rapidly moving frictional contact with the surfaces of the tubes. As the stream of fluid strikes against the baffle plate, the entrained liquid is separated, falls to the bottom of the separator chamber below the tops of the tubes, and is returned to the generator.

Fig. 2 illustrates a modified construction comprising similar pans arranged in multiple effect, wherein the vapor formed in one of them is used for heating the other, and the liquid partly concentrated in one is passed to the other for further concentration according to the ordinary principle of multiple effect pans.

The generator tubes 34° and the evaporating tubes 16° of each pan are located in a casing 10° which contains the tube sheets 14°, 15°, 50 and 51, the space between the sheets 15° and 50 forming the supply and pressure chamber 22° into which extend the vaporizing tubes 16° and into which the generator tubes 34° discharge.

The generator tubes 34° are secured to the tube sheets 50 and 51 and have their lower or feed ends in communication with a feed chamber 52 having a perforated spreader plate 53 therein.

The flue sheet 14° forms the bottom of the separator chamber 23° into which the vaporizing tubes extend and discharge. In this case mingled steam and liquid from the generators pass into the respective pressure and supply chambers 22° of the vaporizers, where separation is effected, liquid being forced upward through the tubes 16° by the steam in the chambers and by that formed in these tubes. The entrained liquid, discharged with the steam from the tubes into the separator chambers, is collected in the bottoms thereof, the steam being baffled to effect the separation of the liquid by baffles 28° and returned to the generators by con-

duits 36°, to be recirculated. In this construction the lower end of the pipe 36° is coupled to two valved branches 55 and 56, so that the liquid from one pan may be returned to the generator at the lower portion of the same pan or may pass in whole or in part to the generator of the next succeeding pan.

In the upper portion of each pan a division plate 57 separates the chamber 23° from the upper steam space, and the central portion of this division plate carries a large vertical tube 58 containing a slidable guide 59 for the lower end of a valve stem 60, and on this stem is secured a valve 61 which may be turned down to close the upper end of the tube when necessary. The valve 61 will operate also to separate any water which may pass upward through the tube 58, this water being returned to the lower space 23° through a drain tube 63.

In the construction shown in Figs. 3 and 4, which illustrate a single effect pan, the generator 20° is external, and is connected to the pressure space 22° by means of a pipe 21°. This construction facilitates access to the main vaporizing coils.

In Figs. 5 and 6 is illustrated a single effect vacuum pan in which the vaporizing tubes 16° are horizontally disposed in a casing 16', being connected by suitable headers 16° in continuous series, and the generator casing 20° contains the horizontal tubes 20' having their ends connected by the headers 20°, the heated liquid and steam passing therefrom to the supply and pressure chamber 22° and thence through the oblique openings 40 of the tubes 16° to the vaporizing tubes under the influence of the steam cushion that forms at the top of the chamber 22°, as previously described.

The vapor with the entrained liquid which is discharged from the uppermost vaporizing tubes 16° strikes against a baffle plate 70, and a portion of the liquid will fall to the bottom of the separating chamber 23°, the vapor passing through a central tube 71 and striking against a second baffle 72, whereby it is deflected back, passed through a series of tubes 73, and directed against another baffle plate or ring 74, so that all of the liquid will fall to the bottom of the chamber 23°, while the steam is free to pass off through an escape passage 75 at the top of said chamber. It will be noted that in this case the level of liquid in the chamber 23° is below the normal liquid level in the pressure chamber 22° and in this case a pump may be employed to effect the return of the liquid to the generator, although a pump will not in all cases be necessary for the reason that the discharge from the chamber 22° will so reduce the pressure in said chamber that the liquid in the chamber 23° will tend to flow by gravity into the tubes of the generator.

Instead of employing the baffle plates, or in addition thereto, the upper ends of the vaporizing tubes may be turned at an angle, as indicated at 78 in Fig. 8, so that the course of the fluid issuing from the tubes will be changed to such an extent as to allow the liquid to separate from the steam by gravity.

While the openings at the lower ends of the vaporizing tubes have been described as oblique or diagonal, as illustrated at 40 in Fig. 7, it is to be understood that the tubes may be cut in many different ways for the purpose of accomplishing the same result, that is to say, to permit the passage of steam for the purpose of reducing the pressure before the body of the liquid lowers to a point below the extreme end of the tubes. Thus in Fig. 9, the tube 16 is cut on a slightly concaved line; in Fig. 10 on a convex line; in Fig. 11 one side is cut away; in Fig. 12 the wall of the tube is slotted; and in Fig. 13 a number of slots are used.

Having described my invention, I claim:

1. In a device of the class described, a casing having upper and lower flue sheets, the space below the lower flue sheet constituting a pressure chamber, and the space above the upper flue sheet constituting a separating chamber; a plurality of tubes extending terminally beyond both sheets; a generator; a connection between the generator and the pressure chamber effective to maintain a steam cushion in the pressure chamber whereby the liquid will be forced to travel through all of the tubes from the pressure chamber to the separating chamber only; means for heating the tubes between the flue sheets; and means for maintaining the liquid level in the separating chamber below the tops of all of the tubes.

2. In a device of the class described, a casing having upper and lower flue sheets, the space below the lower flue sheet constituting a pressure chamber and the space above the upper flue sheet constituting a separating chamber; a plurality of tubes extended terminally beyond both sheets, the tubes being of equal length and having their ends disposed in parallel planes; a perforated distributing plate mounted in the pressure chamber below the ends of the tubes; a generator; a connection uniting the generator with the pressure chamber below the distributing plate effective to form a steam cushion in the pressure chamber whereby the liquid will be forced to travel in one direction only through all of the tubes from the pressure chamber to the separating chamber, means for heating the tubes between the flue sheets; and means for maintaining the liquid level in the separating chamber below the tops of all of the tubes.

3. In a device of the class described, a

casing having upper and lower flue sheets, the space below the lower flue sheet constituting a pressure chamber and the space above the upper flue sheet constituting a separating chamber; a plurality of tubes extended terminally beyond both sheets; a generator; a connection between the generator and the separator chamber operative to maintain the liquid level in the separating chamber below the tops of all of the tubes, the said connection being located without the casing; a connection between the generator and the pressure chamber effective to maintain a steam cushion in the pressure chamber whereby the liquid will be forced to travel through all of the tubes from the pressure chamber to the separating chamber only; and means for heating the tubes between the flue sheets.

4. In a device of the class described, a casing having upper and lower flue sheets, the space below the lower flue sheet constituting a pressure chamber and the space above the upper flue sheet constituting a separating chamber; a plurality of tubes extended terminally beyond both sheets, the

tubes being of equal length and having their ends disposed in parallel planes; a perforated distributing plate mounted in the pressure chamber below the ends of the tubes; a generator; a connection uniting the generator with the pressure chamber below the distributing plate effective to form a steam cushion in the pressure chamber whereby the liquid will be forced to travel in one direction only through all of the tubes from the pressure chamber to the separating chamber; a connection between the generator and the separating chamber operative to maintain the liquid level in the separating chamber below the tops of all of the tubes, the said connection being located without the casing; and means for heating the tubes between the flue sheets.

In testimony that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

JOSEPH E. DUNN.

Witnesses:

WM. T. STEEL,
ETHEL G. YEAGER.