P. KESTNER.

PROCESS FOR CONCENTRATING LIQUIDS.

APPLICATION FILED AUG. 16, 1911.

1,022,321. Patented Apr. 2, 1912.

Fig. 1.

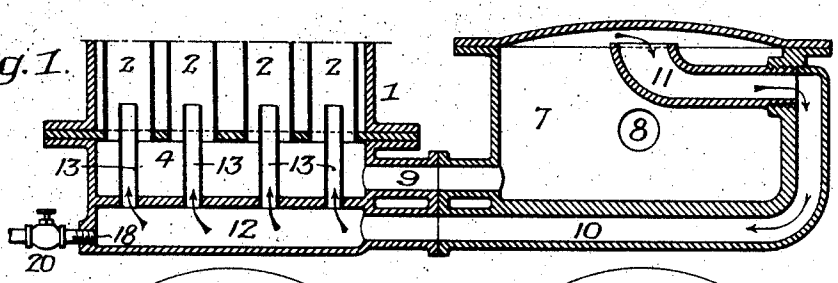


Fig. 2.

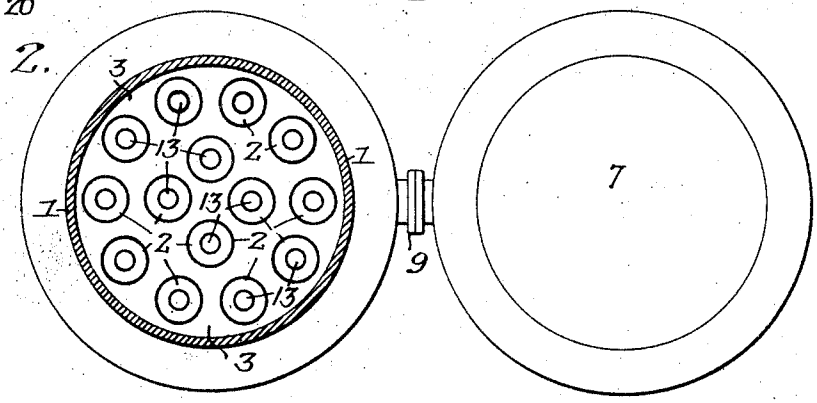


Fig. 3.

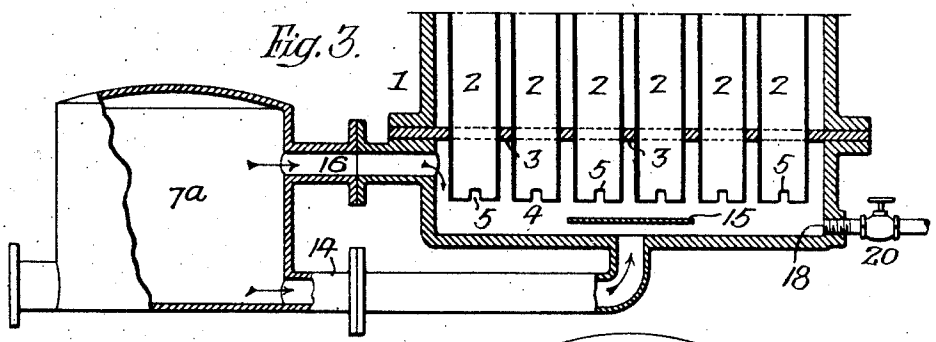
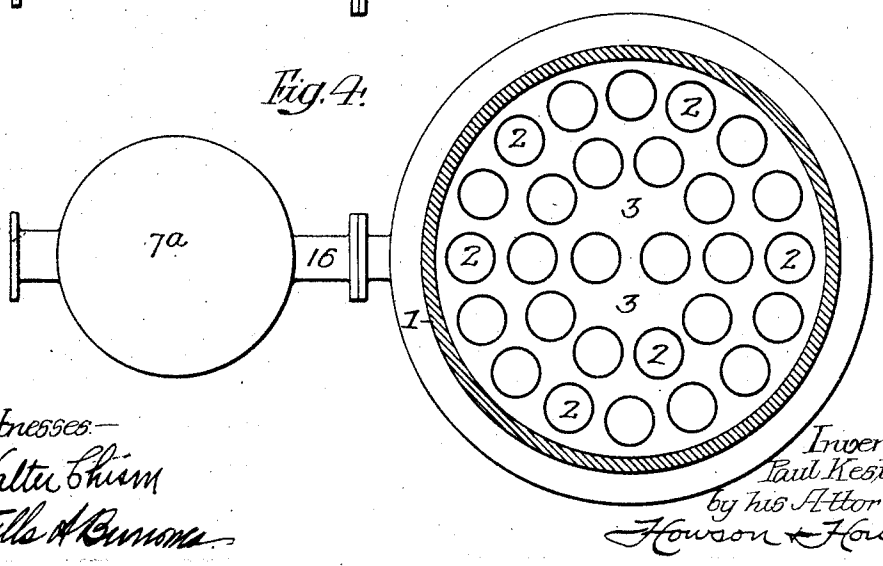


Fig. 4.



Witnesses:—
Walter Chism
Willis A. Simmons

Inventor:—
Paul Kestner.
by his Attorneys—
Howson & Howson

UNITED STATES PATENT OFFICE.

PAUL KESTNER, OF LILLE, FRANCE, ASSIGNOR TO KESTNER EVAPORATOR COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

PROCESS FOR CONCENTRATING LIQUIDS.

1,022,321. Specification of Letters Patent. Patented Apr. 2, 1912.

Original application filed July 20, 1910, Serial No. 572,855. Divided and this application filed August 16, 1911. Serial No. 644,405.

To all whom it may concern:

Be it known that I, PAUL KESTNER, a citizen of the Republic of France, and a resident of Lille, Department Nord, France, have invented certain Improvements in Processes for Concentrating Liquids, (being a division of my application for patent filed July 20, 1910, under Serial No. 572,855, which is a division of my application filed November 1, 1909, Serial No. 525,710,) of which the following is a specification.

My invention relates to a process of evaporating liquid or liquid bodies; and the object of my invention is to provide improved means for feeding such liquid or liquid bodies to the base of vertical tube evaporators in which concentration or evaporation is effected by the climbing of the liquid within elongated tubes externally heated that will insure an even and simultaneous feed of the liquid or liquid bodies thereto.

In modern types of evaporators, the liquid to be evaporated is usually conducted as a film or layer traveling over or through heated tubes, as the case may be. In traveling through a heated tube, it is necessary to provide special means for an even annular distribution of the liquid upon the inner walls of the tube, and since most of these evaporators use a plurality of parallel tubes heated by a common steam jacket and having a common feed, it is necessary to provide special means whereby the distribution of the liquid to the several tubes shall be made uniform, so that each such tube shall receive substantially the same amount of liquid as every other tube.

In one of the modern types of evaporator known as the climbing film or "Kestner" type, the liquid is caused to travel upward as an annular film through a heated tube or series of tubes. It is caused to travel upward in this manner by the presence of a central body or core of steam or vapor passing upward in contact with it and with considerable velocity. As actually manufactured, in this Kestner type of apparatus, there is a plurality of parallel vertical tubes surrounded by a common steam jacket. At their lower ends, these tubes pass through a horizontal tube sheet into a feed chamber, the ends of the tubes depending into this feed chamber for some distance, say several inches. Into this chamber is led liquid. This liquid when coming from a previous effect and therefore relatively hot, or when coming from a special preheater, on entering the feed chamber, undergoes self-evaporation, some or much of its water flashing into vapor. The vapor and liquid pass upward through the heated tubes, the liquid traveling upon the inner wall of the tube as an annular layer, while the vapor passes through the center of this annulus.

In order to secure an even distribution of the liquid and vapor among the several tubes and to insure each tube securing the same relative amounts of liquid and of vapor, the depending ends of the tubes are provided with laterally presented orifices; the lower ends being slotted or beveled as the case may be. The hot liquid entering the feed chamber separates into vapor and liquid, the vapor layer overlying the liquid layer. The laterally presented orifice at the base of the tube prolongations taps both the liquid and the vapor layers, insuring that some of each shall enter each tube. Without some such arrangement as this, the tubes are apt to receive liquid and vapor alternately, or some of the tubes may receive more liquid than others; some of the tubes may indeed be dry, taking nothing but vapor, while other tubes may be entirely filled with liquid. This is undesirable. It is, however, somewhat difficult to produce a uniform level of the liquid to such a feed chamber as described. Since the multiple effect is working under differential pressure and the entering liquid comes into the effect under relatively high pressure, it enters the feed chamber with considerable velocity and tends to bank up more or less at one point or another within such chamber. It may, for instance, if the inlet be somewhat tangential, pass around to the opposite side of the chamber and there bank up, giving a height of liquid higher than that next the inlet. Or the liquid may bank up near the inlet when coming in under less force.

In the present invention, I have devised a process of securing the desired even feed of both liquid and vapor to the several tubes and for insuring that each such tube shall receive the same relative amounts of liquid and vapor as each other tube. For this purpose, I produce a preliminary separation of vapor and of liquid in a special preliminary

chamber and then feed the vapor separated and the liquid separated individually into the feed chamber proper of the apparatus. And in the modification of my invention at present preferred, I further introduce the steam or vapor into each tube as a positive jet, drawing in the liquid after it by what may be termed an injector action. Where this is done, the prolongation of the tubes into portions depending into the feed chamber may be omitted, as may the laterally presented orifice. Where the separation of liquid and vapor is effected in a preliminary chamber, it is of course, practically immaterial whether the liquid banks up more at one point in such a chamber than at another, while the liquid separated may be fed uniformly from such chamber into the feed chamber proper.

While this invention in some of its aspects is applicable to any type of evaporator wherein an annular traveling layer of liquid is produced on the interior of a heated tube, in its present specific embodiment I regard it as more particularly applicable to evaporators of the stated "Kestner" or climbing film type.

In the accompanying drawing, I have shown more or less diagrammatically certain organizations of apparatus elements within the limits of the present invention and useful in the performance of the stated process.

In this drawing: Figure 1, is a sectional elevation of one form of apparatus embodying my invention; Fig. 2, is a sectional plan view of the same; Fig. 3, is a view similar to Fig. 1, of a modified construction embodying my invention, and Fig. 4, is a sectional plan view of the structure shown in Fig. 3.

In the operation of the elongated vertical tube evaporators of the said Kestner type in which evaporation is effected by film climbing of the liquid or liquid body under treatment, the essential result to be obtained is, as stated, the feeding of said liquid or liquid body to all of the tubes simultaneously and uniformly. The liquid coming from a previous evaporator is superheated; that is, it is higher in temperature than the boiling point of the evaporator in which it is introduced, and the result is that the instant the liquid passes the feed valve, the pressure being reduced, the boiling point is reduced also and some of the liquid flashes into steam, causing the liquid to be filled with bubbles.

In multiple effect evaporators, whether working under vacuo or under pressure, the relative pressure in each succeeding effect is always lower than in the next preceding effect and, concomitantly, the boiling point of the liquid passing successively through the several effects is also lowered so that the vapors from the preceding effect shall a ways be hot enough to boil the liquid in tl next succeeding effect. The liquid in pas ing from one effect into the lower pressu of the next becomes partly vaporized and full of bubbles of released steam. It is ve desirable that these bubbles of steam shou be separated and separately introduced in the tubes for ascent and evaporation therei One reason for this is that it is desirable have a uniform liquid level near the en of the tubes so that the feed in each tu will be uniform; the steam entering tl tube independently of the liquid, at the t of a laterally presented orifice or slot wh such arrangement is provided, and the li uid entering the slot therebelow and passi up the tube adjacent the walls of the sam If this level is not made uniform, or if the is a disturbance caused by the liquid ente ing at one side of the feed chamber, it w be readily understood that some of the tub are apt to receive more liquid than others; condition that would interfere with the ef ciency of the apparatus. Owing to the pre ence of the large amount of vapor, due a fall in temperature and pressure when t liquid is passed from one effect to the fe chamber of the next effect, there is alwa an opportunity for some of the tubes to r ceive a greater amount of liquid th others; and the essential object of my i vention is to provide a process whereby t liquid and its accompanying vapor may so controlled that the entrance of the sa to the several tubes will take place simu taneously and with a substantially unifor body of liquid and vapor.

In the present embodiment of my inve tion, provision is made for definitely sep rating the liquid or liquid body from t steam or vapor which accompanies it pri to entering the feed chamber. To accor plish this, a separate chamber is provid disposed adjacent the feed chamber which in direct communication with the tubes, a provision is made for independent transf of the liquid and the steam or vapor to sa feed chamber and the tubes in communic tion therewith.

The forms of feeding device shown a described herein are designed to overcor difficulties heretofore met with in feedi liquid or liquid bodies undergoing treatme to the base of evaporating tubes.

In Figs. 1 and 2, of the drawings he with, 1 represents the lower portion of t heating shell or casing shown as of t "climbing film" type and containing eva orating tubes 2 to which the liquid or liqu body to be concentrated is to be fed for c cent therein. Carried by the shell or casi 1 is a tube sheet 3 to which the tubes a connected, while in the structure shown Figs. 3 and 4, the tubes pass through sa

tube sheet into a feed chamber 4, and in such instance the tubes may be beveled or provided with laterally presented orifices or slots 5, in the manner indicated in my prior Patent No. 882,322.

Referring again to Figs. 1 and 2, 7 represents a chamber disposed adjacent the casing 1, and into which the heated liquid to be concentrated is fed from a suitable inlet 8, and in which chamber more or less perfect separation of the steam or vapor from the liquid may be effected; such steam or vapor being passed directly to the evaporating tubes 2. For this purpose the chamber 7 has a passage 9 for delivering the liquid to the chamber 4 below the tubes and in direct communication therewith, and a passage 10 with an inlet conduit 11 at the top of the chamber 7, which passage communicates with a chamber 12 below said chamber 4, and from this chamber 12 the steam or vapor may enter the evaporating tubes 2 through short sections of tubing indicated at 13. In this form of the structure, no provision is made for extending the tubes 2 into the feed chamber, but such arrangement is not thought to be necessary with this particular structure in view of the direct means used for transferring the steam or vapor to the evaporating tubes.

In the structure shown in Figs. 3 and 4, the liquid enters an auxiliary chamber 7^a and flows through a passage 14 to the feed chamber 4 into which the evaporating tubes 2 project and strikes a deflector or baffle 15 therein which serves to spread the liquid to all parts of said chamber. The steam or vapor accompanying the liquid or developed within said chamber 7^a rises to the top of the same and enters the feed chamber 4 through a passage 16 which leads from a point near the top of said chamber 7^a and circulates around the upper portion of the feed chamber 4 simultaneously with the entry of the liquid therebelow and with the latter wetting the inner walls of the tubes 2 uniformly and simultaneously; it facilitates the flow of liquid therein, and the operation in the subsequent concentration of the same.

With the projecting tubes, the laterally presented orifices 5 will tap both steam and liquid layers, allowing a simultaneous entry of both into each tube, but with the structure of Fig. 1, positive means are provided for the delivery of liquid and of vapor into each evaporating tube and the beveling or slotting of the tube ends and their prolongation becomes unnecessary.

The structures shown herein as auxiliary to the evaporator may be of sheet metal or cast metal, or parts may be of sheet metal and parts of cast metal. The tubes 2 may be projected into the feed chamber 4 as indicated in the structure shown in Figs. 3 and 4, to any desired extent; the desirability of such extension depending in some measure upon the size and capacity of the evaporating element. The several feed chambers are provided with suitable drainage outlets 18 closed by plugs—or other suitable devices, or they may be provided with valves 20. In addition, the feed chamber in each instance is so constructed and arranged and of such size with respect to the shell containing the evaporating tubes that all of said tubes are accessible when said feed chamber or the lower portion of the same is removed.

The feature of the present invention is the provision of a process employing auxiliary means exterior of the main feed chamber and in communication with the evaporating tubes for the separation of the steam or vapor from the liquid, and the separate feeding of said steam or vapor and of said liquid to the tubes.

An evaporator with the auxiliary devices shown comprising means for effecting an even feed and distribution of the liquid may be used as a single evaporating effect or as any effect of a multiple effect system and it may be operated under a pressure greater or less than that of the atmosphere. Any number of similar effects of this type may be arranged in a multiple effect system or one such effect may be arranged in combination with effects of a different type. It should, however, in whatever arrangement it be used, be so arranged as to receive a supply of liquid at a temperature greater than the boiling point at the pressure prevailing in the effect so as to permit self evaporation to take place in the preliminary chamber. When used as a single effect or as the first effect of a multiple, is should therefore be coupled with a source of preheated liquid.

I claim;—

1. The process of evaporating liquids, which comprises transmitting liquid into and through a heated tube as an annular traveling film by means of a jet of steam directed axially of said annular film.

2. The process of evaporating liquids, which comprises transmitting liquid into and through a vertical heated tube as an annular traveling film by means of a jet of steam directed axially of said annular film.

3. In the evaporation of liquids, the process which comprises releasing the pressure upon a heated liquid in a suitable chamber to permit self-evaporation and formation of vapor, separately conducting the vapor so formed and the residual liquid into different points of the feed chamber of an evaporator having heated tubes, and simultaneously feeding portions of such liquid and of such vapor to each of said tubes.

4. In the evaporation of liquids, the process which comprises releasing the pressure upon a heated liquid in a suitable chamber

to permit self-evaporation and formation of vapor, separately conducting the vapor so formed and the residual liquid into different points of the feed chamber of an evaporator having vertical heated tubes, and simultaneously feeding portions of such liquid and of such vapor to each of said tubes.

5. In the evaporation of liquids, the process which comprises releasing the pressure upon a heated liquid in a suitable chamber to permit self-evaporation and formation of vapor, separately conducting the vapor so formed and the residual liquid into different points of the feed chamber of an evaporator having heated tubes, and simultaneously feeding portions of such liquid and of such vapor to each of said tubes, the vapor being fed into the tubes in such manner as to draw in liquid by an injector action.

6. In the evaporation of liquids, the process which comprises releasing the pressure upon a heated liquid in a suitable chamber to permit self-evaporation and formation of vapor, separately conducting the vapor so formed and the residual liquid into different points of the feed chamber of an evaporator having vertical heated tubes, and simultaneously feeding portions of such liquid and of such vapor to each of said tubes, the vapor being fed into the tubes in such manner as to draw in liquid by an injector action.

7. The process, which consists in separating a body of heated liquid into liquid and vapor; thereafter delivering the residual liquid to the feed chamber of a film evaporator; and facilitating the passage of the liquid to and through the tubes of the evaporator by means of vapor directed axially of the tubes.

8. The process, which consists in relieving the pressure on a body of heated liquid to form separate bodies of vapor and liquid, and causing the residual liquid to start flowing upwardly through vertical heated tubes by means of steam jets.

9. The process which consists in relieving the pressure on a body of heated liquid to form separate bodies of liquid and vapor, and starting the residual liquid to flow upwardly upon the walls of vertical heated tubes by means of axially directed jets of vapor.

10. The process, which consists in releasing the pressure on a heated liquid to permit of self-evaporation and formation of vapor; separately conducting away the vapor so formed; delivering the residual liquid to the feed chamber of a vertical tube evaporator; and delivering portions of such liquid simultaneously to each of the tubes by means of vapor jets directed axially thereinto.

11. In the evaporation of liquids, the process which consists in releasing the pressure upon a heated liquid in a suitable chamber to permit of self-evaporation and formation of vapor; separately conducting away vapor so formed and delivering the residual liquid into the feed chamber of an evaporator having vertical heated tubes; and simultaneously feeding portions of such liquid to each of said tubes together with a jet of steam or vapor directed axially of the tubes to cause them to draw in liquid by an injector action.

12. The process which involves leading heated liquid into a pressure releasing chamber to permit self-evaporation and formation of vapor; conducting away said vapor; and transmitting the liquid so treated to the evaporating element of an evaporator whose prevailing temperature is less than that of said liquid.

13. In the evaporation of liquids, the process which involves releasing the pressure upon a heated liquid in a suitable chamber to permit of self-evaporation and formation of vapor therefrom; separately conducting away the vapor so formed; and delivering the residual liquid into the feed chamber of an evaporator having vertical heated tubes and operating at a temperature less than that of said liquid.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

PAUL KESTNER.

Witnesses:
HENRI CHARRIER,
LÉON PECKEL.