(No Model.)

2 Sheets—Sheet 1.

S. M. LILLIE.

VACUUM EVAPORATING APPARATUS.

No. 466,862. Patented Jan. 12, 1892.

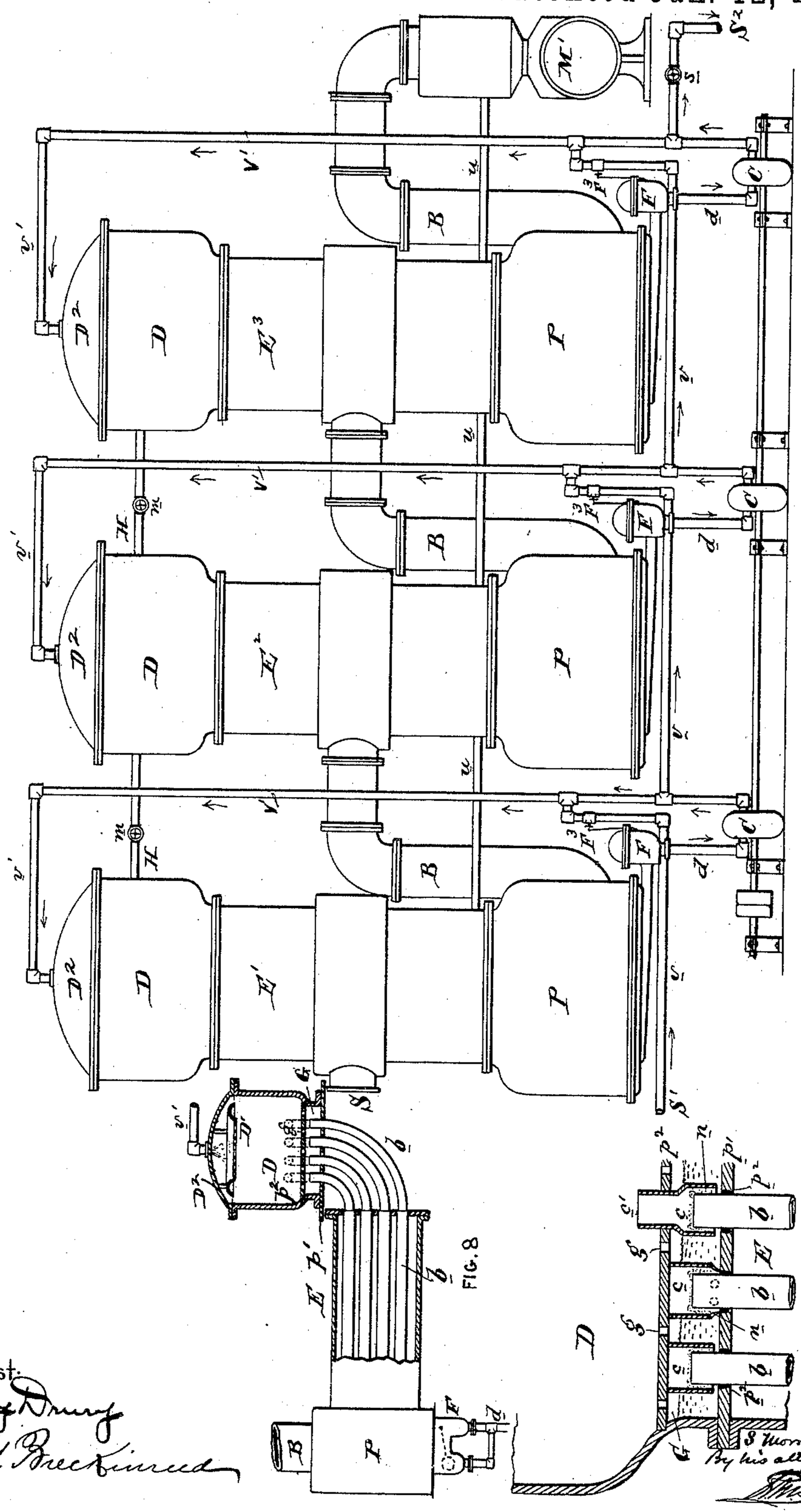

FIG. 1

FIG. 8

FIG. 7

Attest:
Henry Drury
E. W. Breckinridge

Inventor:
S. Morris Lillie
By his atty
[illegible]

(No Model.) 2 Sheets—Sheet 2.

S. M. LILLIE.

VACUUM EVAPORATING APPARATUS.

No. 466,862. Patented Jan. 12, 1892.

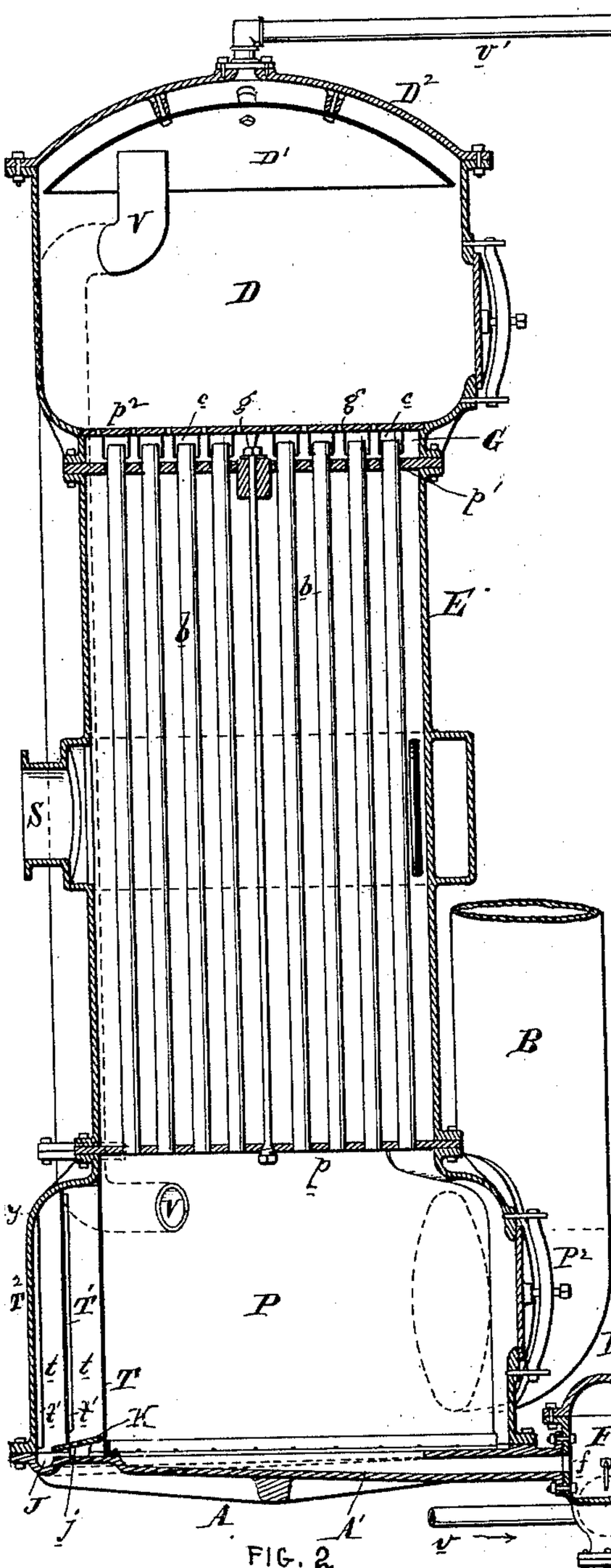

FIG. 2

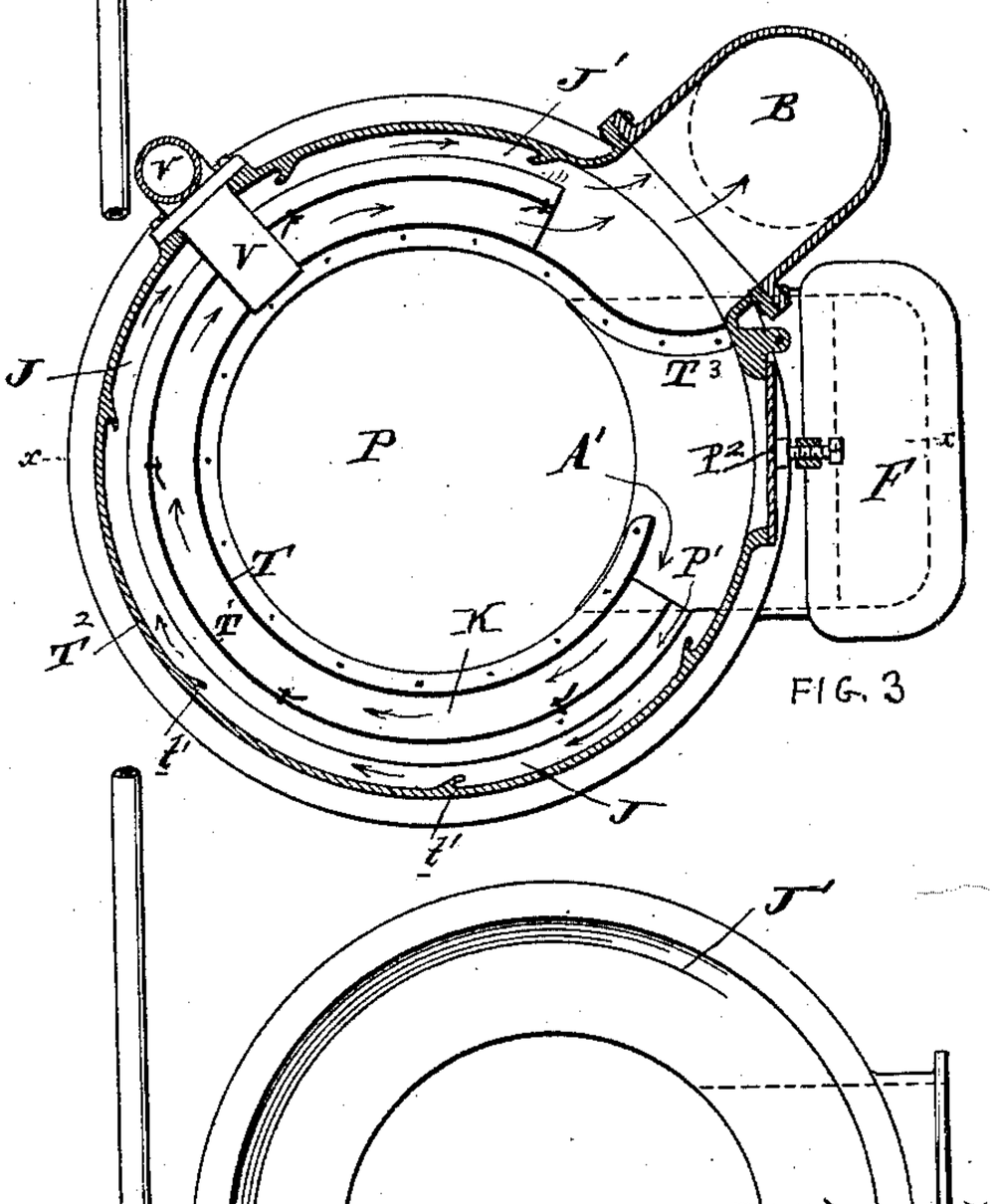

FIG. 3

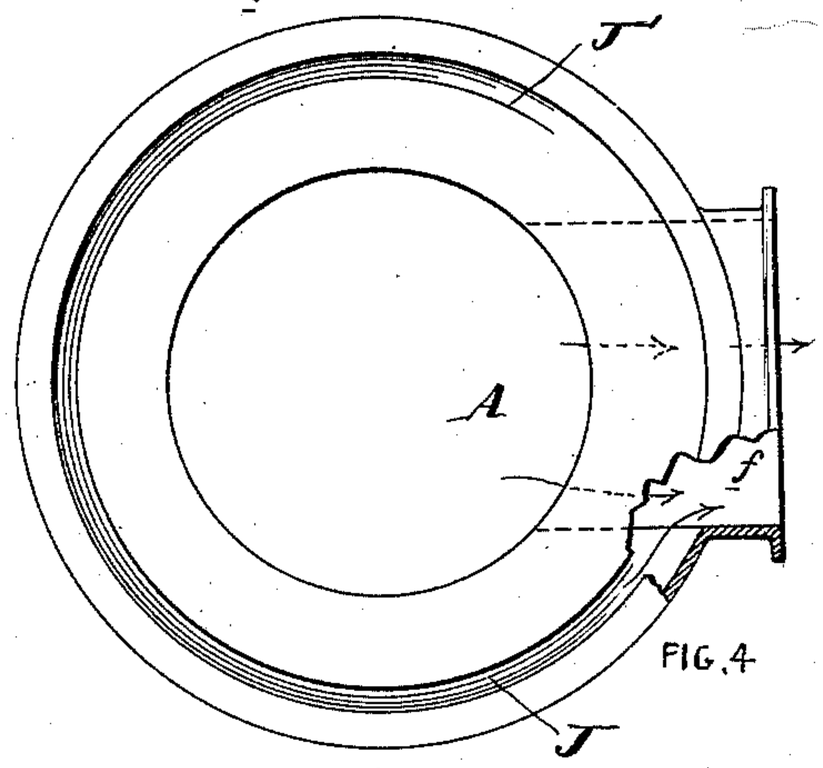

FIG. 4

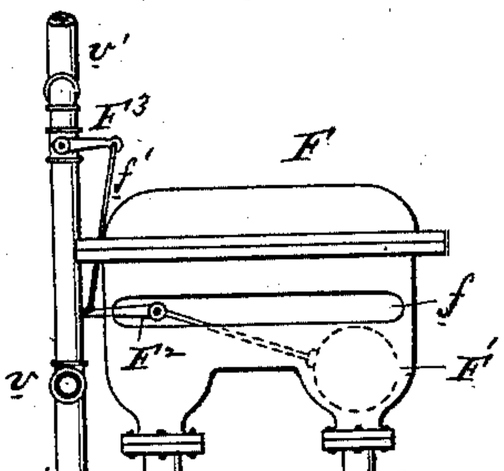

FIG. 5

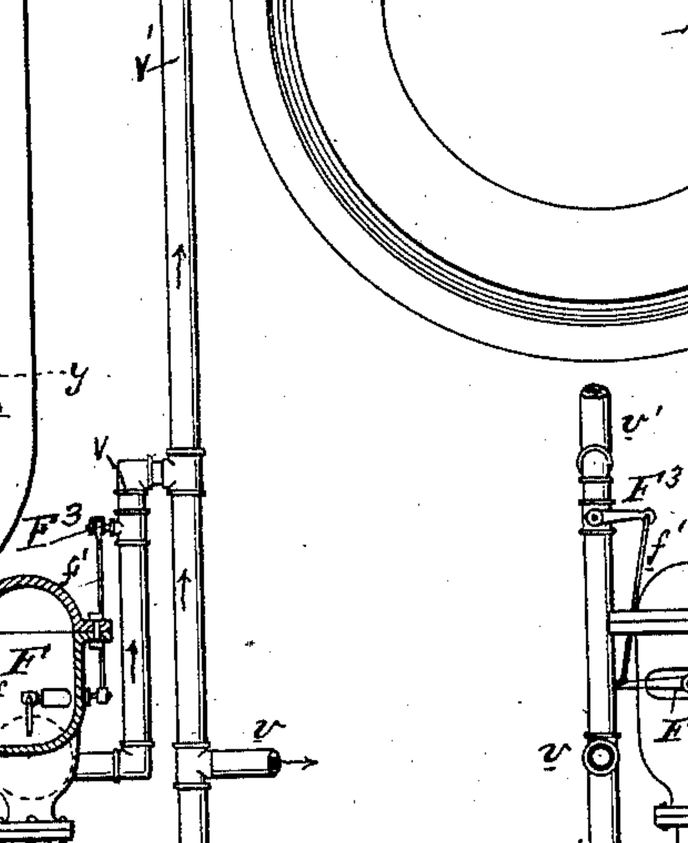

FIG. 6

Attest:
Henry Drury
E. W. Breckinridge

Inventor:
S. Morris Lillie
By his Atty
Thos. S. Sprague

UNITED STATES PATENT OFFICE.

SAMUEL MORRIS LILLIE, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO THE SUGAR APPARATUS MANUFACTURING COMPANY, OF SAME PLACE.

VACUUM EVAPORATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 466,862, dated January 12, 1892.

Application filed April 19, 1888. Serial No. 271,128. (No model.) Patented in England August 28, 1888, No. 12,391; in France August 31, 1888, No. 192,707; in Belgium September 1, 1888, No. 83,105; in Germany September 13, 1888, No. 50,387; in Spain September 26, 1888, No. 8,676, and in Austria-Hungary June 5, 1889, No. 1,290 and No. 1,337.

To all whom it may concern:

Be it known that I, SAMUEL MORRIS LILLIE, of Philadelphia, Pennsylvania, have invented new and useful Improvements in Evaporating Apparatus, (for which I have obtained patents in foreign countries, to wit: Great Britain, No. 12,391, dated August 28, 1888; Belgium, No. 83,105, dated September 1, 1888; France, No. 192,707, dated August 31, 1888; Spain, No. 8,676, dated September 26, 1888; Austria-Hungary, No. 1,290 and No. 1,337, dated June 5, 1889, and Germany, No. 50,387, dated September 13, 1888,) of which the following is a specification.

My invention relates to intransit evaporating apparatus, examples of which are shown in United States Letters Patent, numbered and issued to me as follows, viz: No 341,669, dated May 11, 1886; No. 344,586, dated June 29, 1886; No. 378,843, dated February 28, 1888, and No. 422,235, dated February 25, 1890—that is, to evaporating apparatus in which the liquid is evaporated while flowing over the heating-surface in comparatively thin films or layers from a device or devices by which the liquid is distributed over the said surfaces into a collecting chamber or receptacle into which the thickened liquid flows from the surfaces; and it consists, first, in improved means for separating suspended particles of liquid from the vapors resulting from the evaporation and escaping from the pan, and, secondly, in new means for supplying and automatically controlling the supply of the liquid to be evaporated to the pans, and for regulating the flow of said liquid into the first pan of a series joined to form a multiple effect (and consequently also for regulating the density of the concentrated liquid) automatically by the rate of discharge of the concentrated liquid from the last pan of the series. The first consists of an annular passage, which may have one or more concentric diaphragms in it, through which passages the vapors flow in their escape from the pan, and in which the particles of suspended liquid are thrown against the surfaces of the diaphragm and outer wall of the passage by centrifugal force, and thereby separated from the vapors. The second consists in leading the liquid to be evaporated in a pan into the return-pipe, which conducts liquid from the circulating-pump back into the pan, so that it may become thoroughly mixed with the returning and more concentrated liquid before passing into the feeding-chamber for the evaporating tubes or surfaces.

In the construction shown in my former patents above mentioned—viz., Nos. 341,669, 344,586, and 378,843, the return liquid and the thinner feed liquid entered the feeding-chamber G from opposite or different sides, and consequently they could not become thoroughly mixed, and different tubes would be fed with liquids of different densities, objections which are overcome by this my improved method of feeding—viz., into the return-pipe—which is claimed by me and applicable both for pans in which the evaporation is from the internal surfaces of the tubes, as in my patent, No. 341,669, and for those in which the evaporation is from the external surfaces of the tubes, as in my patent, No. 344,586, and the second consists, further, of means for automatically regulating the flow of liquid into an evaporator of this class by means of the liquid in a detached chamber connected to the pan, through which detached chamber the return liquid flows in passing from the collecting-chamber of the pan to the distributing devices of the same, and the second consists, again, of a hand-valve in the discharge-pipe or of equivalent means for regulating the flow of the concentrated liquid from the last pan of a multiple effect and of intermediate mechanism connecting the last pan with the valve in the supply-pipe to the first pan and automatically operated by the rate of discharge of the concentrated liquid from the last pan to open or close the said valve to varying degrees, depending upon the said rate of discharge of the concentrated liquid.

In the drawings, Figure 1 is an elevation showing a multiple-effect evaporating apparatus embodying my invention. Fig. 2 is a sectional elevation of one of my improved evaporators or pans with its adjuncts. Fig. 3 is a cross-section of same on line *y y* of Fig. 2. Fig. 4 is a plan view of the lower head removed from the evaporator or pan.

Fig. 5 is an elevation of the regulator for controlling the supply of thin liquor to the pan. Fig. 6 is a sectional plan view similar to Fig. 3, showing a modified arrangement. Fig. 7 is a cross-section showing an enlarged view of the construction for feeding the evaporating-tubes, and Fig. 8 is an elevation, with part in section, of a modified form of my evaporator or pan.

Referring to the drawings, E is a heating or steam chamber containing a battery of vertical evaporating-tubes *b*, which open below through the tube-plate *p* into the collecting-chamber P, and above through the tube-plate P′ into the feed chamber G, into which they extend for a short distance and have their upper edges all lying in the same horizontal plane as nearly as may be. A little above the upper ends of the tube *b* is a plate p^2, having perforations *g* in it and above which is the dome D. Extending through or supported in or by the plate p^2 are tubes *c*, one for each evaporating-tube *b*. Each tube *c* is of larger diameter than its evaporating-tube, surrounds the latter, and is concentric with it, thus forming between the two the annular passages *n*, which communicates below with the surrounding space in G. The purpose of the feeding-tubes *c* and their annular passages *n* is to insure an equal supply of liquid to be evaporated to the several evaporating-tubes *b*, irrespective of slight differences in the level of the liquid in the feed-chamber G above the evaporating-tubes, which is caused by the contracted passages *n* requiring a head of liquid above the tops of the tubes *b* to force the liquor through said passages. The section of each tube *c* above the evaporating-tube and by which it extends through the plate if made as shown in Fig. 7, is preferably of a reduced diameter, as shown at *c*′. The dome D has approximately vertical side walls provided with a man-hole or door, and is closed above by the cap D^2, bolted to flanges on the side wall of the dome. The cap D^2 has a liquid-conducting pipe *v*′ opening through it near the center and top, and it supports directly below the mouth of the said feed-pipe a distributing plate or diaphragm D′, which may be perforated, as shown in Fig. 8, or not perforated, as indicated in Fig. 2. When perforated, as shown in Fig. 8, a portion of the liquid falling from the pipe *v*′ may pass through the perforations and the remainder overflow the edges of the diaphragm onto and down the side walls of the dome. Any vapors which may be formed in the dome or which may escape into it from the evaporating-tubes *b* may pass by a passage or pipe V, communicating with the interior of the dome below the diaphragm D′ to the collecting-chamber.

The collecting-chamber P is divided by the vertical cylindrical partition T, which bends outward at T^3 to meet the outer wall T, forming the curved, circular, or annular surrounding chamber, which connects at one end with the compartment P at P′ and at the other end with the vapor-outlet main B. In the outer wall opposite the passage between the inner compartment and the annular chamber is a man-hole P^2, closed by a door, by opening which access may be had to the compartment into which the lower ends of the evaporating-tubes open.

In the annular compartment *t* may be placed one or more concentric partitions T′, which may rest on the false bottom K with which the annular chamber is provided. The inner face of the outer wall T^2, and also of each of the concentric partitions T′, has on its face the ribs or ledges *t*′ inclining from the face of the wall toward the passage from the annular chamber to the inner or collecting-chamber P. At the lower end of each ledge there is a perforation *j* through the false bottom into the gutter J below it, which gutter J leads into a passage *f*, which delivers from the collecting-chamber P into the float-chamber F by the inclined floor A′ of the lower head A of the evaporator. A pipe *d* leads from the float-chamber F to the pump C, which latter delivers through the return-pipe *v*′ into the dome D of the pan, and through the discharge-branch *v* away from the pan, the discharge-branch *v* being in the case of a multiple effect the liquid-supply pipe *v* of the next cooler pan of the series. The supply-pipe *v* of a pan delivers into the return-pipe *v*′ of the same so that the liquid to be evaporated supplied through it becomes thoroughly mixed with the thicker return liquid before entering the dome D and the evaporating-tubes. The discharge-pipe *v*, branches from the return-pipe *v*′, preferably at a point between the pump C and the supply-pipe *v*, in order that the thickened liquid leaving the pan by it may not be diluted by the thin liquid entering from the supply-pipe. A float F′ in the float-chamber F rises and falls with the level of the liquid in the chamber, and through the lever F^2 and connecting mechanism *f*′ a butterfly-valve F^3 in the pipe *v*, which brings the liquid to be evaporated to the pan, is operated in such manner that as the float rises the valve closes, and as it falls the valve opens in proportion. The pump C is continually running, and is consequently continually circulating the liquid, and such liquid as is not conveyed off by the discharge-pipe *v* away from the pan, passes up through the return-pipe *v*′ and is again caused to pass through the same pan in which it was previously treated, but now it is mixed with some fresh or thin liquid from the supply-pipe *v* to this pan.

The discharge of concentrated liquid from the pump to the next pan by pipe *v* is controlled by the discharge from the last pan of the apparatus, which is controlled by valve *s* in the discharge-pipe S^2 of the said last pan. If this valve were fully opened, then little or no liquid would be returned to the pan from which it was first drawn, while, on the other hand, if the valve *s* is not fully open

much of the liquid is caused to pass through the same pan two or more times, but each time being diluted with other liquid not before treated in that pan. The operation of this pan in evaporating or concentrating a liquid is as follows: The liquid to be concentrated flows by the supply-pipe *v* and the pipe *v'* mixed with the circulating liquid through the cap D^2 of the dome D upon the distributing plate or diaphragm D', thence onto and down the side walls of the dome upon and over the perforated plate p^2, through whose perforations it flows into the feed-chamber G, whence it overflows the upper edges of the evaporating-tubes *b*, which edges lie all in the same horizontal plane. The liquid then flows in thin films down the inner surfaces of the tubes, suffering evaporation in its course, due to a heating agent, as steam, supplied to the heating-chamber E by the main S. The unevaporated concentrated liquid falls from the bottom of the tubes, together with vapor formed by the evaporation into the interior chamber of the separating-chamber P, and flows by the passage *f* into the float-chamber, whence it is drawn by the pump C and is delivered away in part from the pan (see arrows, Fig. 2) by the discharge-pipe *v*, which is the supply-pipe of the next cooler-pan in the case of a multiple effect, and in part is returned by the pipe *v'* to the heating-surfaces again.

The rate of feed of the thin liquid from the supply-pipe *v* to the pan is governed by the flow of concentrated liquid from the pan by the discharge-pipe and the automatic action of the float. If the discharge is increased by opening wide the valve *s*, (see right-hand side of Fig. 1) the level of the liquid in the float-chamber, and consequently the float itself, will fall until the butterfly-valve in the supply-pipe *v* is opened sufficiently to correspondingly increase the feed of the thin liquid in the pan. If the flow from the discharge is diminished by partially closing its valve *s*, the level of the liquid in the float-chamber and also the float rises, and the feed from the supply-pipe is correspondingly diminished.

Other things remaining equal the density of the finished product is diminished in proportion as the valve *s* in the final discharge-pipe S^2 is opened and increased in proportion as it is closed, and to regulate its density it is only necessary to open or close the valve, as the case may be, until the thickened material leaves the final discharge-pipe at the desired density. The function of the pump in addition to that of supplying liquid to the next evaporating-pan is to return a portion of the liquid to the dome of its pan, which will assist the fresh liquid in keeping the surface of the tubes well covered. The vapors resulting from the evaporation pass from the tubes into the chamber P and thence through the annular chamber *t* and away from the pan by the vapor-main B. During its rapid passage along this annular chamber any drops or particles of liquid that may be carried along by it are projected by centrifugal force against the inner surface of the walls T' T^2, to which they adhere, while the vapor passes on and away from the pan, perfectly freed of all particles of liquid, which would otherwise be held in suspension. The separated liquid adhering to the surfaces of the walls flow down the same to the gutter J, along which it flows into the passage *f* and float-chamber. The ledges *t'* on the inner faces of the walls T' T^2 serve to prevent liquid being drawn along the said surfaces and out of the vapor-discharge by the rushing vapors. The concentric partitions or diaphragms T' are placed in the annular chamber to lessen the radial distance through which the particles of liquid held in the escaping vapors will have to be moved before coming in contact with a surface to which they can adhere. This combination of collecting-chamber and annular vapor-passages may be used with pans operating on the principle common to the apparatus described in this application and in my hereinbefore-mentioned Letters Patent, whatever may be the construction of the feeding devices for the evaporating-tubes. This separator, consisting of a central chamber and concentric vapor-passages, may be arranged exteriorly to evaporators of any construction with a vapor-conduit leading from the evaporator to the separator. In my pending application, Serial No. 299,218, separators are shown thus arranged with respect to evaporators, the vapors however being led into the sides of the separators and escaping by the central chambers—that is, taking the reverse course through the annular separating-passages to that by the vapors in the apparatus described herein.

In Fig. 8 is shown a modification of this overflow system of feeding the evaporating-tubes with liquid. In this arrangement the upper edges of the evaporating-tubes all lie approximately in the same horizontal plane, a short distance above the tube-plate *p'*, as in Fig. 2, the feeding-tubes *c* are dispensed with, and the liquid having fallen through the perforations in the perforated plate p^2 at once overflows the edges of the evaporating-tubes.

Another feature of the modification shown in Fig. 8 is that the evaporating-tubes, heating-chamber E, and collecting-chamber are arranged horizontally, while the dome and feeding device are vertical, as before.

Other modifications of this overflow feeding system for the evaporating-tubes of pans operating substantially as set forth will readily present themselves to those skilled in the art. For example, in the modification shown in Fig. 8, the evaporating-tubes, or, more strictly speaking, the curved tubes leading to the same, might open horizontally through the side walls of the feeding-chamber, as shown in dotted lines, but all at the same level, in which case, also, the rising liquid in the feed-

chamber would overflow into the several tubes at approximately the same rate, and I do not wish to limit myself to any particular form or arrangement of the devices for practicing this overflow system of feeding limited quantities of liquid to the evaporating-tubes of apparatus operating on the principle of that described in this and my former patents.

In the modification shown in Fig. 6 we have the curved or annular passages *t* formed with two inlets P′ and one outlet, requiring the vapors to travel only half the distance. A pipe *d′*, with a valve d^2, may be used to drain the float-tank F, when desired. (See Fig. 5.) The evaporating-pans E′, E^2, and E^3 may be combined to form a multiple effect in the manner shown in Fig. 1, in which the vapor-main B of one evaporator connects with the heating-chamber E of the next pan or evaporator, and the main B of the last pan or evaporator connects with the vacuum-pump M′. The domes of the several pans may be connected by pipes H, having valves *m*, which would be used in starting the plant to exhaust the air from the pans. Drain-pipes *u* may connect the bottom of each of the heating-chambers E, so that the condensed liquid may pass from chamber to chamber and finally be discharged into the condenser of the vacuum-pump. The supply-pipes *v* for pans E^2 and E^3 connect with the discharge side of the pump C of the preceding pan by pipe *v′*. The fresh or thin liquid enters the first pipe *v* at S′, and the concentrated liquid passes out by the final discharge-pipe S^2 of the third pan, and its flow is regulated by valve *s*. In a multiple effect like this the valve *s* controls the operation of the floats and their valves F^3, and hence the supply-liquid by pipes *v* to the various pans, and it is also evident that the float and its valve for pan E^3 control the supply of liquid to pan E^2, and likewise the float and its valve to pan E^2 control the supply and height of liquid in the pan E′, and the float and its valve to pan E′ control the flow of this liquid from S′, and consequently that the valve in the liquid-discharge pipe for the last pan, operating through the liquid in the said pan and intermediate mechanism automatically actuated thereby connecting with the valve in the supply-pipe to the first pan, automatically controls the flow of liquid into the first pan, increasing or diminishing the latter as itself is increased or diminished. In the apparatus herein shown and described, the above-mentioned intermediate mechanism consists of the liquids in the several pans, the floats resting in the same, and the valves operated by the latter back to the valves in the supply-pipe to the first pan.

Other arrangements of the intermediate mechanism will readily suggest themselves to those skilled in the art. For example, the valve in the supply-pipe to the first pan might be controlled and operated directly by the float in the last pan acting through metal connecting devices, the flow of liquid from pan to pan being regulated as shown in my patent, No. 378,843—viz., by the level of the liquid in the pan from which the liquid flows—without departing from this feature of my invention, which is that the flow of the thin liquid into the first pan is automatically regulated by the rate of flow of the thickened liquid from the last pan, which in turn is controlled by an attendant by means of a hand-valve or other suitable contrivance in the discharge-pipe for the thickened liquid.

Any number of pans may be combined to form a multiple effect, and the details may be modified in various ways without departing from my invention. The details here shown are those preferred, but other equivalents may be substituted in lieu thereof without changing the principles involved or the operation of the apparatus in carrying out my invention.

The devices for feeding the tubes of an intransit evaporating apparatus by overflow and other features described, but not claimed herein, are shown, described, and claimed in my pending application, Serial No. 305,984.

Having thus described my invention, what I claim is—

1. In an evaporating-pan, the combination of the evaporating-tubes and inclosing heating-chamber, liquid-feeding devices for the tubes at one end of the same, a collecting-chamber, into which the tubes open at their other ends, and one or more annular vapor-passages approximately concentric with the collecting-chamber, leading from the said collecting-chamber to a vapor-escape from the pans, substantially as described.

2. In an evaporating-pan, the combination of the evaporating-tubes and inclosing heating-chamber, a dome at one end of the tubes and heating-chamber having liquid-supply openings leading to the tubes, an inlet for the liquid to be evaporated opening into said dome, a collecting-chamber at the other end of the tubes and heating-chamber, a vapor-passage opening from the dome above the liquid-level and communicating with the collecting-chamber, and a vapor-escape conduit leading from the collecting-chamber, substantially as described.

3. In an evaporating-pan, the combination of the evaporating-tubes and inclosing heating-chamber, feeding devices for the tubes at one end of the same, a collecting-chamber at the other end of the tubes and heating-chamber, one or more annular vapor-passages approximately concentric with the collecting-chamber, opening from said collecting-chamber and leading to a vapor-outlet pipe, and drainage-passages leading from the bottom of the collecting-chamber and from the circular passages to the outside of the pan, substantially as described.

4. In an intransit evaporating-pan consisting of evaporating-tubes heated by steam or otherwise, feeding devices for distributing the liquid to be evaporated over the surfaces

of the tubes, a collecting-chamber for receiving the unevaporated liquid as it falls from the tubes, with a return-pipe and circulating-pump leading and delivering from the collecting-chamber to the feeding devices, substantially as described, the combination, with said return-pipe, of a supply-pipe for the thin material to be concentrated opening into it between the circulating-pump and the feeding devices for the tubes, the combination operating to mix the said thin material with the thicker return liquid before it passes upon the evaporating-tubes, substantially as described.

5. In an evaporating-pan consisting of evaporating-tubes heated by steam or otherwise, feeding devices and a collecting-chamber for the tubes, with a return-pipe and circulating-pump leading and delivering from the collecting-chamber to the feeding devices, substantially as described, the combination, with the said return-pipe, of a supply-pipe for the thin material to be evaporated opening into it between the circulating-pump and the feeding devices for the tubes, and a discharge-pipe for the thickened material leading from it at a point between the said supply-pipe and the pump, substantially as described.

6. In an evaporating-pan consisting of evaporating-tubes contained in a heating-chamber, feeding devices and a collecting-chamber for the tubes, respectively, at opposite ends of the same and operating substantially as described, the combination of a supply-pipe for the thin material with connections leading into the pan, a discharge-pipe for the thickened material leading from the collecting-chamber, a valve in the supply-pipe, mechanism connected with the said valve and with the collecting-chamber and automatically operated by the rising and falling of the level of the liquid in the collecting-chamber to close and open the valve, respectively, and a valve in the said discharge-pipe for the collecting-chamber by which the flow of liquid from the chamber and thereby the level of the liquid in it and also the valve in the supply-pipe are regulated, substantially as specified.

7. In an evaporator, the combination of the evaporating-tubes, the collecting-chamber P, having curved partitions or walls T T′ T², inclined floor A′ for the chamber P, and inclined gutter J for the curved passage-ways formed by the walls or partitions, substantially as described.

8. In an evaporator, the combination, with the evaporating-tubes, of the collecting-chamber into which the tubes discharge, a vapor-escape passage surrounding the collecting-chamber and approximately concentric partitions in the said vapor-escape passage subdividing it into a number of narrower passages, substantially as specified.

9. In an evaporator, the combination of the evaporating-tubes, the collecting-chamber, with an annular vapor-escape passage encircling and leading from the chamber, and a false bottom K in the annular vapor-passage, having passages or perforations through it leading into the space below the same, substantially as described.

10. In an evaporator, the combination of the evaporating-tubes, a collecting-chamber P, having curved partitions or walls T T′ T², inclined floor A′ for the chamber P, inclined gutter J for the curved passage-way formed by the walls or partitions, and the curved inclined floor K, having communicating passages for liquid from the compartment between walls T T′ T² and the gutter, substantially as described.

11. In an evaporator, the combination of the evaporating-tubes, the collecting-chambers, into which the evaporating-tubes open, a liquid-discharge conduit for the unevaporated liquid leading from the collecting-chamber, a vapor-escape passage encircling the collecting-chamber, and the gutter J at the bottom of the vapor-passage and leading to the said liquid-discharge conduit of the collecting-chamber, substantially as specified.

12. In a separator for separating suspended particles from vapor or gases, constructed, substantially as described, with an annular separating and discharge passage having an inlet and outlet for the vapor, respectively, at opposite ends of the same, the combination, with the annular separating-passage, of concentric partitions or diaphragms located in the same, substantially as specified.

13. In a separator for separating the suspended particles from vapor or gases, the combination of a central chamber, an annular separating-passage approximately concentric with the said chamber communicating at one end with the chamber and at the other end terminating in a suitable port, a conduit or conduits for the vapors connecting to the said port, and a vapor conduit or conduits connecting to the central chamber, substantially as specified.

14. In a separator for separating suspended particles from vapors and gases, constructed with annular vapor-passages and operating substantially as described, the combination, with the concave surfaces against which the suspended particles are thrown by centrifugal force, of transverse ledges formed on the same, substantially as and for the purpose specified.

15. The combination of two or more evaporating-pans arranged to form a multiple effect, with liquid-conduits between the collecting-chamber of the first pan and the feeding devices for the tubes of both pans, means for positively circulating the liquid through the said conduits, a liquid-supply pipe with connections leading to the feeding devices of the first pan, an automatic valve in the said supply-pipe or connections operated by the level of the liquid in the first pan to control the supply of liquid to the same, a valve

in the liquid-conduit leading from the first pan to the second, automatically operated by the level of the liquid in the second pan to control the flow of liquid from the first pan into the second, a liquid-conduit connecting the collecting-chamber of the second pan with the feeding devices for its tubes, means in the said conduit for circulating the liquid, and a valve in the discharge-pipe for the liquid from the second pan, substantially as specified.

16. In a combination of two evaporating-pans to form a multiple effect, a liquid-supply pipe with connections leading into the first pan, a valve in the said supply-pipe automatically operated by the level of the liquid in the first pan to control the supply of liquid to the same, a liquid-discharge pipe with connections leading from the collecting-chamber of the first pan into the second pan, a valve automatically operated by the level of the liquid in the second pan to regulate the flow of liquid from the first pan to the second, and a valve in the liquid-discharge pipe for the collecting-chamber of the second pan, substantially as described.

17. The combination of two pans operated substantially as described to form a multiple effect, with a liquid-conducting pipe and connections leading from the collecting-chamber of the first pan to the second pan, a valve automatically operated by the level of the liquid in the second pan to regulate the flow of liquid from the first pan into the second, and a liquid-discharge pipe for the collecting-chamber of the second pan, substantially as described.

18. In the multiple-effect evaporating apparatus, the combination of two or more evaporating-pans through which the liquid being evaporated flows in succession, a valve in the supply-pipe for the said liquid to the first pan of the series, a discharge-pipe for thickened material for the last pan of the series, a valve in the said discharge-pipe for regulating the flow of the thickened material from the last pan, and intermediate pipes and operating devices connecting the valve in the said discharge-pipe with the valve in the supply-pipe to the first pan, the valve in the discharge-pipe operating through the liquid in the intermediate pipes and through the operating devices to open and close the valve in the said supply-pipe to the first pan as it is itself opened and closed, substantially as specified.

19. In a combination of two or more pans operating substantially as described to form a multiple effect, a liquid-discharge pipe with connections for each pan, excepting the last pan leading from the said pan to the next cooler pan of the series and containing a valve automatically operated to regulate the flow of liquid through the pipe by the level of the liquid in the next pan, a liquid-discharge pipe for the last pan, and a hand-valve in the same to control the flow of liquid through all the pans, substantially as described.

20. In an intransit evaporator, the combination of an evaporating-surface adapted to be heated by steam or other heating agent, distributing devices for delivering the liquid to be evaporated in thin films over the evaporating-surface, a collecting-receptacle into which the unevaporated liquid falls from the evaporating-surface, liquid-return conduits leading from the collecting-receptacle of the evaporator to the distributing devices for its evaporating-surface, means—as a pump, for example—for effecting a flow of the liquid continuously through the said return-conduits from the collecting-chamber to and through the distributing devices onto the evaporating-surface, and so cause a continuous circulation of liquid over the evaporating-surface and back through the return-conduits, a detached chamber located in and forming a part of the said return-conduits through which detached chamber the return liquid flows in its passage from the collecting-receptacle to the distributing devices, a fresh liquid-feed pipe with connections leading into the evaporator, a valve in the feed-pipe, and a regulator for said valve automatically operated by the liquid in the detached chamber to regulate the feed of fresh liquid to the evaporator, substantially as and for the purpose specified.

In testimony whereof I hereunto set my hand.

S. MORRIS LILLIE.

Witnesses:
R. M. HUNTER,
ERNEST HOWARD HUNTER.