No. 828,524. PATENTED AUG. 14, 1906.

J. A. WARREN.

EVAPORATING APPARATUS.

APPLICATION FILED APR. 19, 1905.

2 SHEETS—SHEET 1.

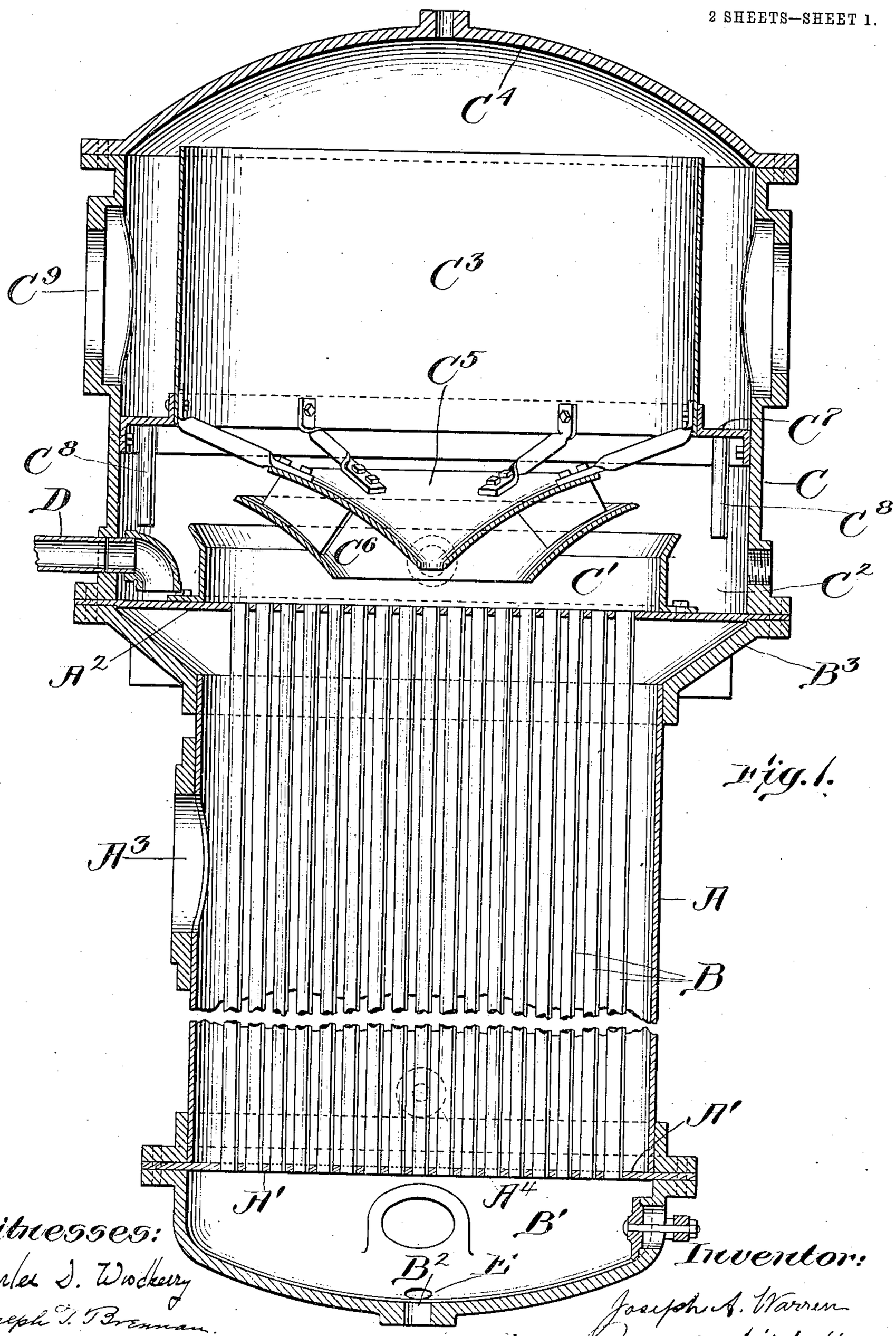

Fig. 1.

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2 SHEETS—SHEET 2.

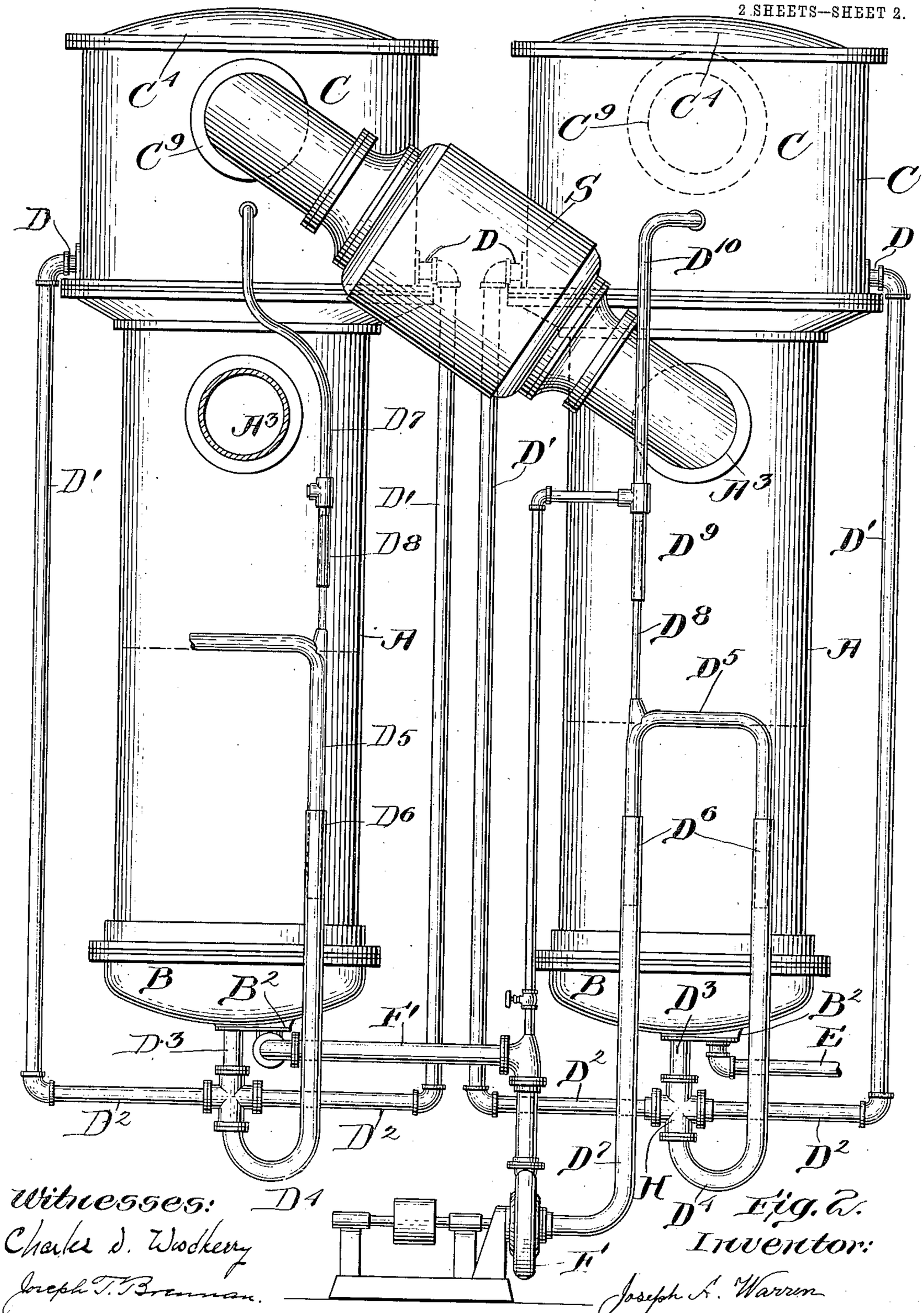

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Fig. 2.

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UNITED STATES PATENT OFFICE.

JOSEPH A. WARREN, OF WESTBROOK, MAINE, ASSIGNOR TO SAMUEL D. WARREN, MORTIMER B. MASON, AND FISKE WARREN, OF BOSTON, MASSACHUSETTS.

EVAPORATING APPARATUS.

No. 828,524. Specification of Letters Patent. Patented Aug. 14, 1906.

Application filed April 19, 1905. Serial No. 256,408.

To all whom it may concern:

Be it known that I, JOSEPH A. WARREN, a citizen of the United States, and a resident of Westbrook, in the county of Cumberland and State of Maine, have invented new and useful Improvements in Evaporating Apparatus, of which the following is a specification.

My invention relates to evaporating apparatus, such as used to evaporate spent liquor from pulp-digesters; and it consists in sundry improved structural arrangements whereby the operation of such apparatus may be conveniently regulated and its efficiency and productive continuity improved.

My improvements are applicable to single evaporators or with appropriate modifications to an evaporating apparatus composed of several units operated in series, so as to utilize the well-known principle of multiple evaporation. However, whether these improvements be applied to a single or to a multiple apparatus the operation and regulation of units according to my invention will be in substance and effect the same.

The main object of my invention is so to construct and regulate the evaporator units that, on the one hand, the circulation of evaporating liquid may be maintained so as to cover adequately all the heating-surface, and so that, on the other hand, excessive, and therefore wasteful, foaming shall be avoided.

In the drawings hereto annexed, which illustrate an embodiment of my invention and improvements, whether applied to a single unit or to several units arranged in series, Figure 1 is a vertical cross-section of an evaporating unit; and Fig. 2 a vertical elevation of two such units in series, showing more in detail than Fig. 1 the arrangement of piping.

In Fig. 1, A is the cylindrical shell of a steam-chamber provided with tube-sheets A′ and A^2 and with vertical tubes B, which extend from tube-sheet A′ to tube-sheet A^2 and serve as channels of communication between the intake-chamber B′ and the vapor-chamber C. A lug B^2 is cast in the base of the chamber B′ and is provided with apertures for the coupling of circulation-pipes presently to be described. A flange-plate of suitable construction surrounds the opening A^3 in the shell A, the said opening adapted to communicate with a suitable steam-supply, which is the source of heat for the evaporation carried on in the apparatus. The condensed steam flows from a suitable aperture, as A^4, at or near the bottom of the steam-chamber and may be wasted or returned to the boiler from which the steam is originally supplied. The vapor-chamber C, as well as the upper tube-sheet A^2, is sustained by a flaring head B^3, which is properly secured to the upper rim of the shell A. The vapor-chamber C is covered by a dome C^4 and is provided with a lateral aperture C^9 for carrying off the vapors of evaporation. Within the vapor-chamber C there is secured a flange C^7, upon which is mounted the drum C^3, and from the drum C^3 there are suspended the conical or conoidal baffle-plates C^5 C^6. The annular space between the drum C^3 and the sides of the vapor-chamber C is drained by short pipes C^8, which are secured to the flange C^7. Upon the tube-sheet A^2 there is also secured a ring C′, between which and the lower part of the shell of the chamber C there is therefore an annular space or trough wherein the condensing vapors of evaporation and the unevaporated liquids are collected in the manner presently to be described. This trough (marked C^2 in Fig. 1) is drained by the pipes D, whereof one is shown in Fig. 1 and two in Fig. 2. Referring to Fig. 2, the drain-pipes D are continued in downward extensions D′ and lateral continuations D^2 to a coupling H, communicating with the pipe D^3. The coupling H has also secured to and communicating with it the pipe D^4, which is further connected with the discharge-elbow D^5 by means of sliding joints D^6. These sliding joints are provided so that the upper level of this discharge-pipe D^5 may be adjusted within convenient limits. In order to prevent siphon action, the siphon-breaker pipe D^8 is jointed by a sliding joint D^9 to the pipe D^{10}, which communicates with the interior of the vapor-chamber C. A pipe E enters the lug B^2 and serves as the entrance-conduit for the liquid to be evaporated.

Referring now to Figs. 1 and 2 in conjunction and leaving out of consideration for the present the series or multiple arrangement of the units shown in Fig. 2, the operation of the

apparatus considered as a unit is as follows: The liquid to be evaporated is run into the chamber B′ through the pipe E, Fig. 2, and thereupon rises in the tubes B to the level determined by the height of the elbow-pipe D^5. Steam is admitted to the shell A through the aperture A^3 and the liquid in the tubes B boils and rises by reason of the ebullition, blowing out at the tops of the tubes B into the chamber C against the baffle-plates C^5 C^6, which deflect the liquid portion into the trough C^2. The vapor of evaporation rises through the drum C^3, whereupon part of it is condensed and drips from the drum C^3 into the trough C^2, passes over into the annular space between the drum C^3 and the shell of the chamber C, passing out through the aperture C^9 into the atmosphere or to a condenser, where, if desired, a vacuum may be maintained. Condensation upon the sides of the chamber C or the outside of the drum C^3 collects on the flange C^7 and runs through the pipe C^8 into the trough C^2. As this trough is filled its contents run through the pipes D, D′, D^2, and D^3 back to the entrance-chamber B′ and pipes B, where the evaporation is repeated. The extent of evaporation and degree of concentration are regulated by the supply entering the apparatus at E and the liquor concentrated to the desired degree runs off through the pipes D^4, D^5, and D^7 and may be collected or disposed of at will, either by running it to storage-tanks of other apparatus, if only one evaporator unit is used, or by conducting it, as by a pump F, into another evaporator, from which it is finally conducted from the pipe D^5. (See left-hand evaporator of Fig. 2.)

In Fig. 2 a pair of evaporator units are shown arranged in series for multiple effect. In this arrangement of evaporators the steam-supply is admitted to the shell A through the aperture A^3 of the left-hand unit. The supply of liquor to be evaporated in the left-hand unit is derived from the discharge of partially-evaporated liquor from the right-hand unit, a pump F being provided which draws the liquid from pipe D^7, forcing it into the left-hand evaporator unit through the pipe F′. Thereupon this liquid is still further evaporated, circulating upward, as above described, and returned through the pipes D D′ D^2 D^3 to the base of the evaporator unit and when sufficiently concentrated passing off through the pipe D^4 to the inverted discharge-pipe D^5, which is connected to the pipe D^4 by a sliding joint D^6 and provided also with a siphon-breaking pipe D^7 telescopically connected to pipes D^5 and D^8. The final discharge of liquid after concentration is from the pipe D^5 of the last evaporator unit of the series.

The vapors of evaporation escape from the vapor-chamber C of the left-hand evaporating unit at the aperture C^9 and pass thence through a separator S, which may be of any known or desired construction, and thence into the aperture A^3 of the right-hand evaporator unit, as shown in Fig. 2. As will be recognized by those familiar with the construction and operation of evaporating apparatus, these units may be indefinitely multiplied to obtain the multiple evaporative effect through as many steps as required.

The economy and efficiency of each unit in such a system is properly conserved by the employment of the means such as above described for maintaining or regulating the hydrostatic level of the liquid to be evaporated, so that, according to the conditions existing, the heating-surfaces of each evaporator shall be adequately covered with liquid and so that, on the other hand, excessive foaming may be avoided. It may be that with an apparatus operating under substantially invariable conditions the determined level or levels of evaporating liquid will also be substantially invariable, in which case it might not be necessary to provide such devices as the telescoping joints above described; but I believe it to be desirable to furnish such apparatus with means not only for determining and maintaining the normal hydrostatic level of evaporating liquid, but also for adjusting this level to suit possible variations of condition.

When I speak of the "hydrostatic level," it will of course be understood that a clearly-defined level would only exist if the apparatus were cold and not operating, the ebullition in the operating apparatus being such that it would be quite difficult perhaps to ascertain exactly where the liquid was maintained; but, nevertheless, the hydrostatic condition exists as much in the operating as in the quiescent apparatus, and the determination of this level is of marked significance in the securement and regulation of economic working conditions.

The circulation through a unit or a series of units of the character described hereinabove may be maintained by means of a pump or pumps or by maintaining a vacuum at proper points. These, however, are or relate to expedients of operation which are thoroughly well understood by those skilled in the art to which this invention relates.

What I claim, and desire to secure by Letters Patent, is—

1. In an evaporating apparatus, a steam-chamber, vertical evaporating-tubes therein, means to supply fluid to said tubes from below, and a discharge-pipe provided with an overflow-bend, said bend vertically adjustable to regulate the hydrostatic level of liquid in the tubes.

2. In an evaporating apparatus, the steam-chamber, vertical evaporator-tubes therein, a supply-chamber below the tubes and communicating therewith, a vapor-chamber

above the tubes, return-pipe from the vapor-chamber to the supply-chamber, a discharge-pipe having an overflow-bend to determine the hydrostatic level of liquid in the evaporator-tubes, and a siphon-breaking pipe leading from the overflow to the vapor-chamber.

3. In an evaporating apparatus, the steam-chamber, vertical evaporator-tubes therein, a supply-chamber below the tubes and communicating therewith, a vapor-chamber above the tubes, return-pipe from the vapor-chamber to the supply-chamber, a discharge-pipe having an overflow-bend and telescopic joint to regulate and determine the hydrostatic level of liquid in the evaporator-tubes, and a siphon-breaking pipe leading from the overflow to the vapor-chamber and having a telescopic joint therein.

Signed by me at Boston, Suffolk county, Massachusetts, this 17th day of April, 1905.

JOSEPH A. WARREN.

Witnesses:

ODIN ROBERTS,

WALTER B. NYE.