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APPARATUS FOR EVAPORATING LIQUIDS.

No. 521,724. Patented June 19, 1894.

Fig. 2.

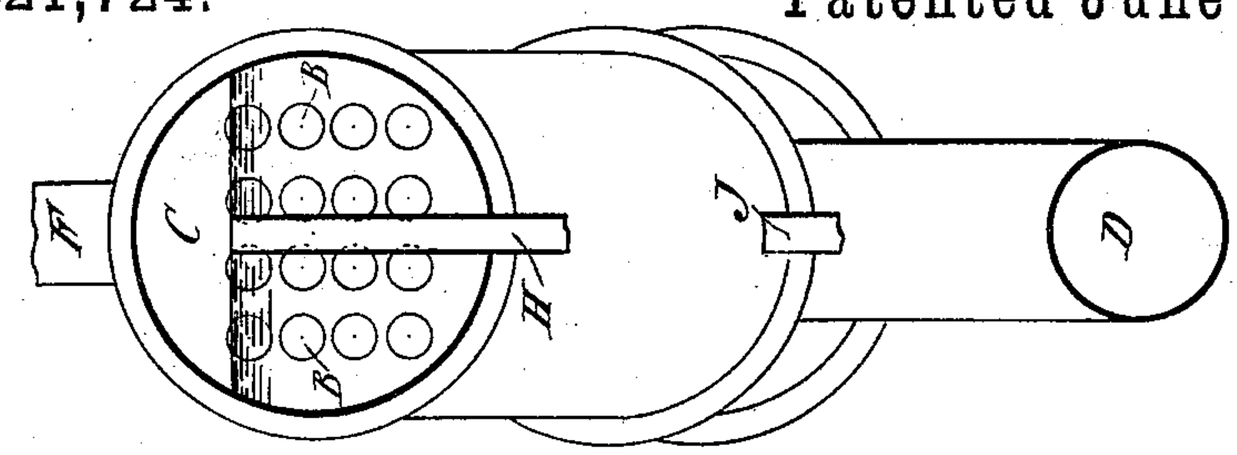

Fig. 1.

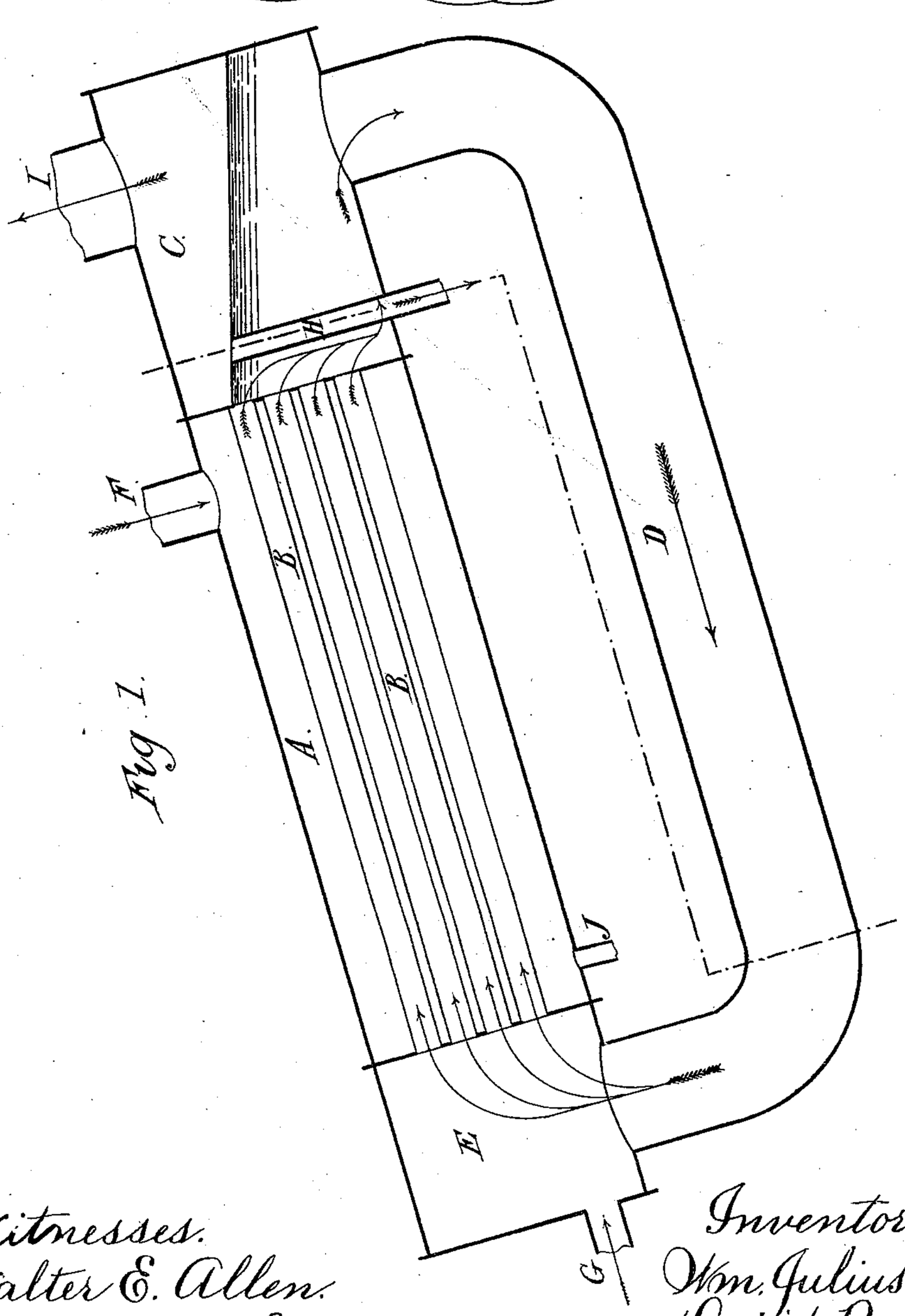

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Fig 4.

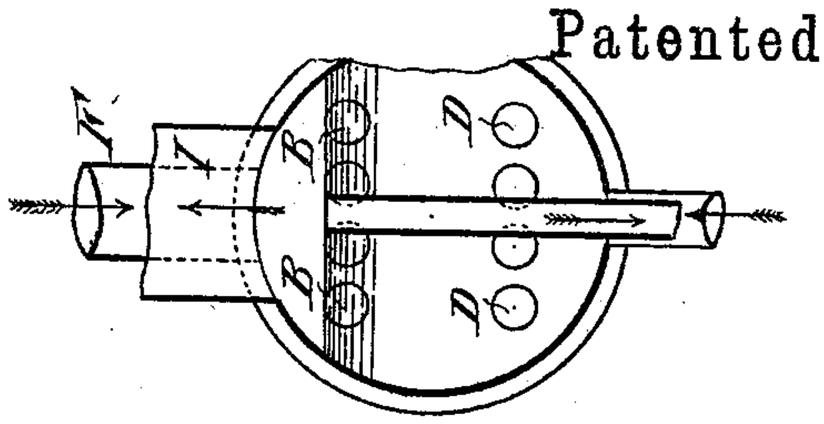
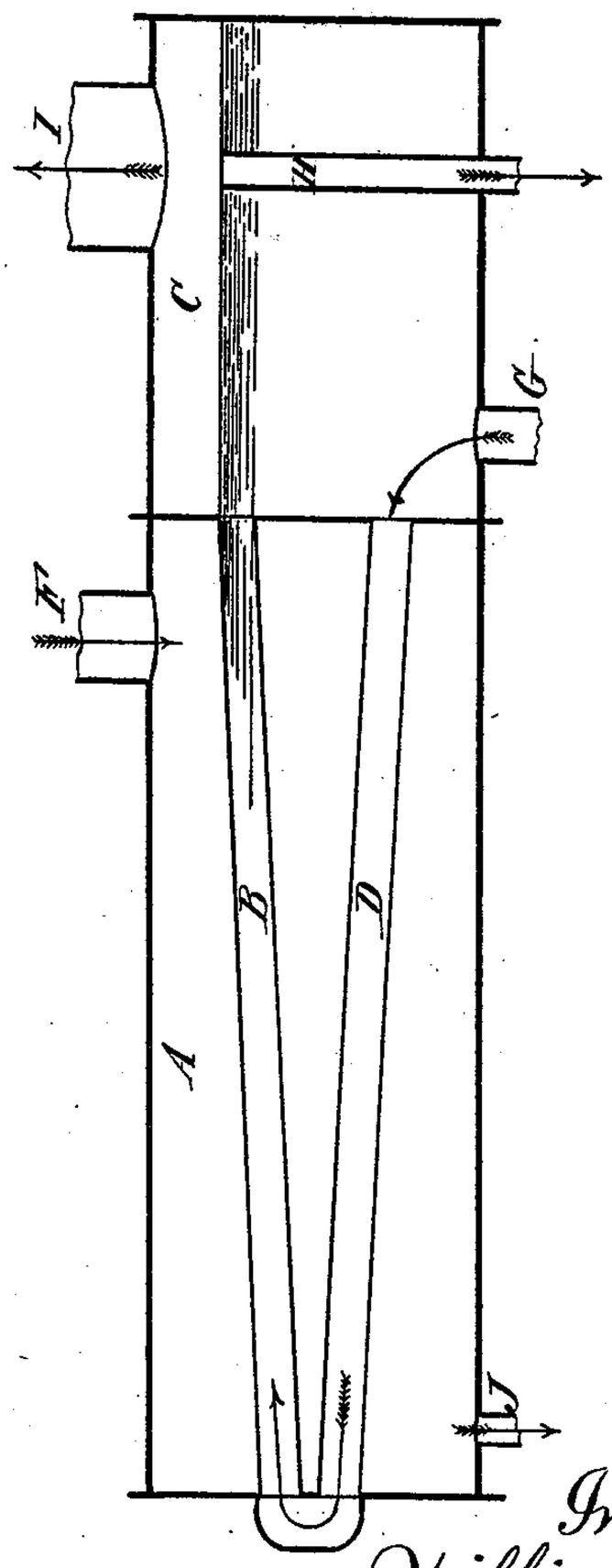


Fig. 3.



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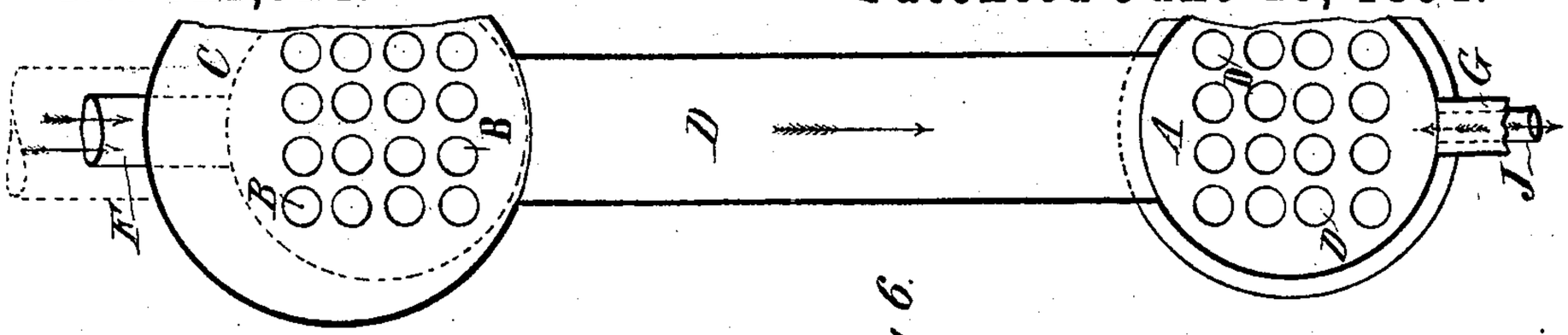

Fig. 6.

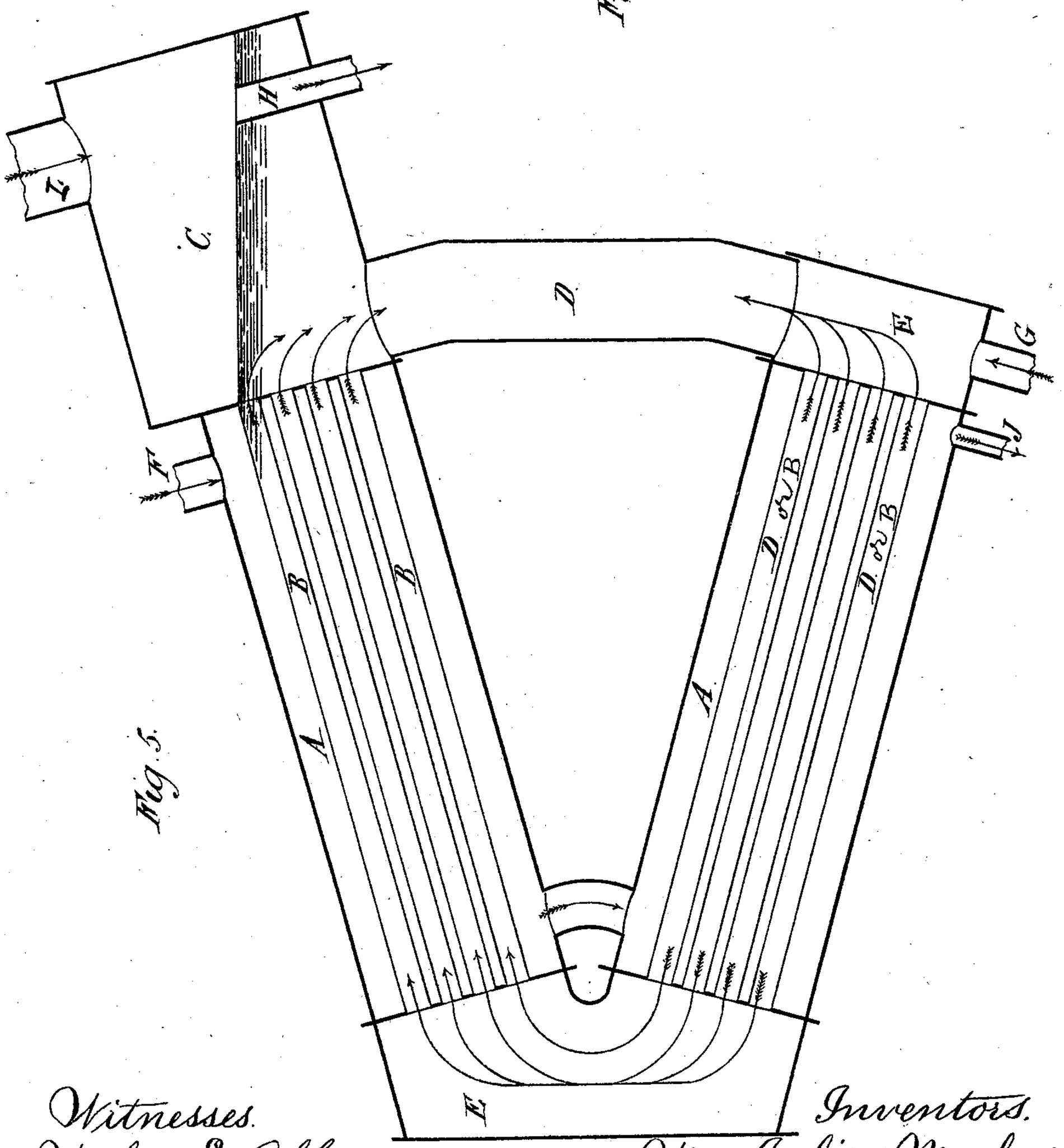

Fig. 5.

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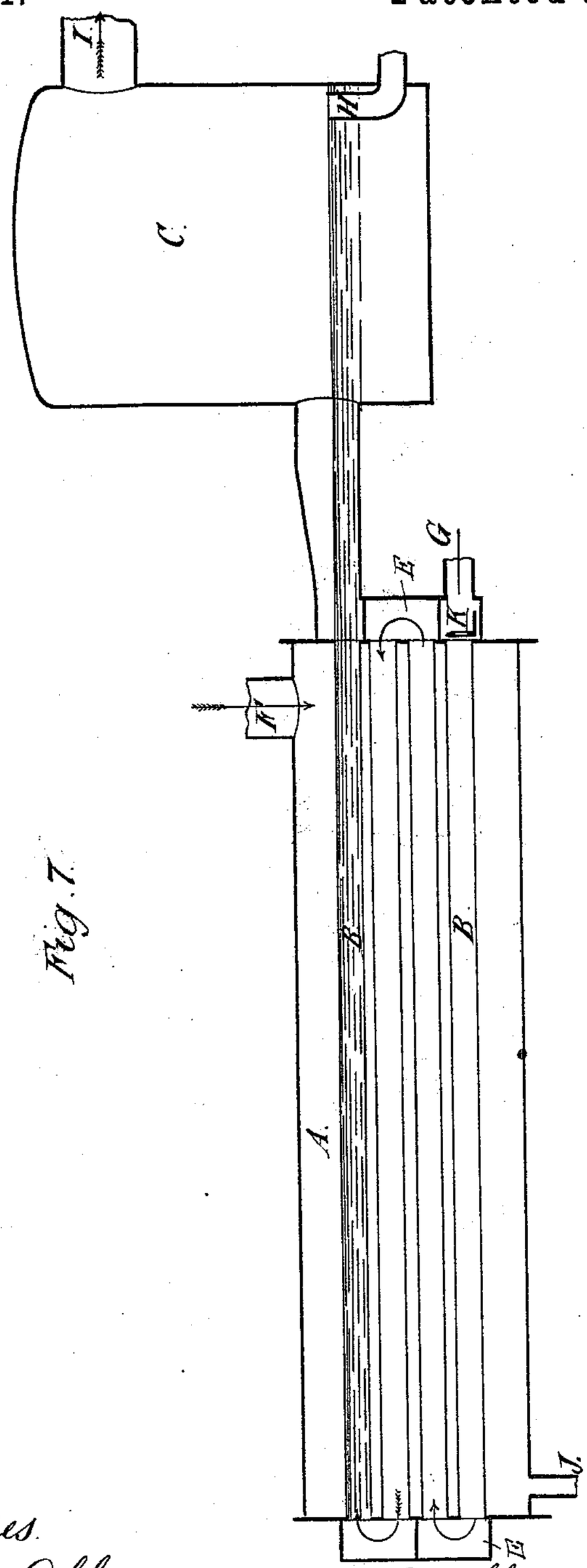

Fig. 7.

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Fig. 14.

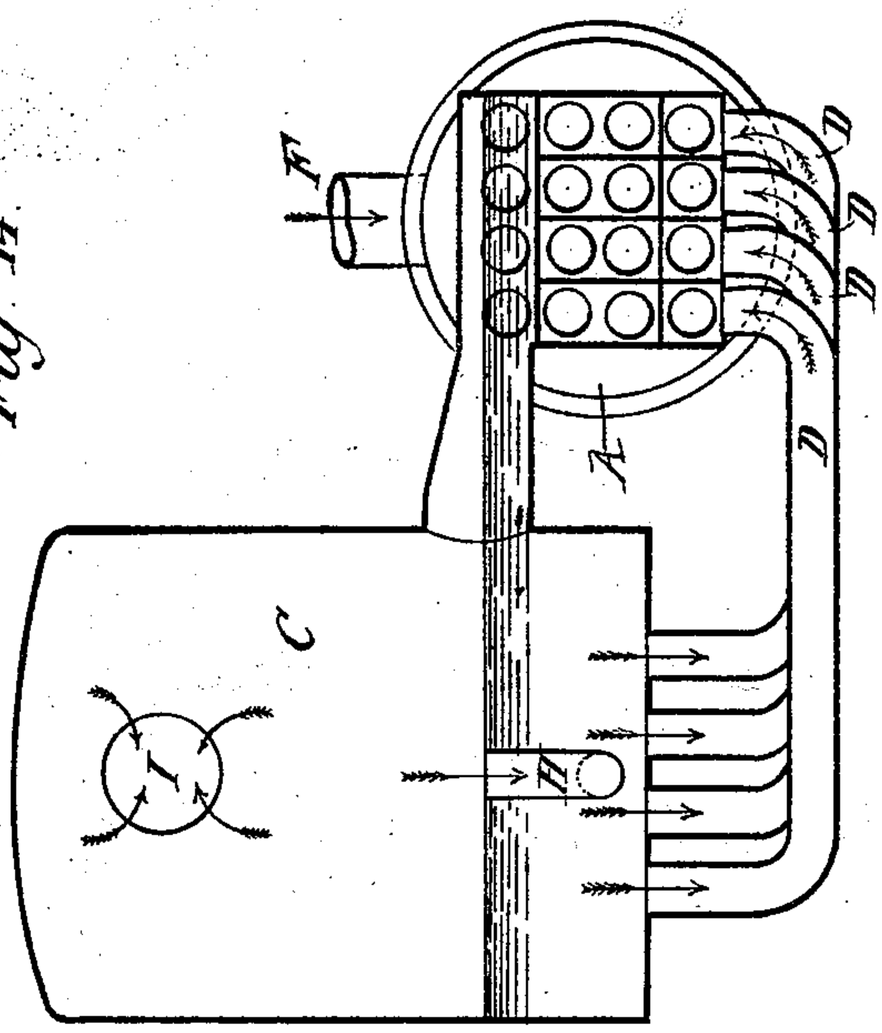

Fig. 8.

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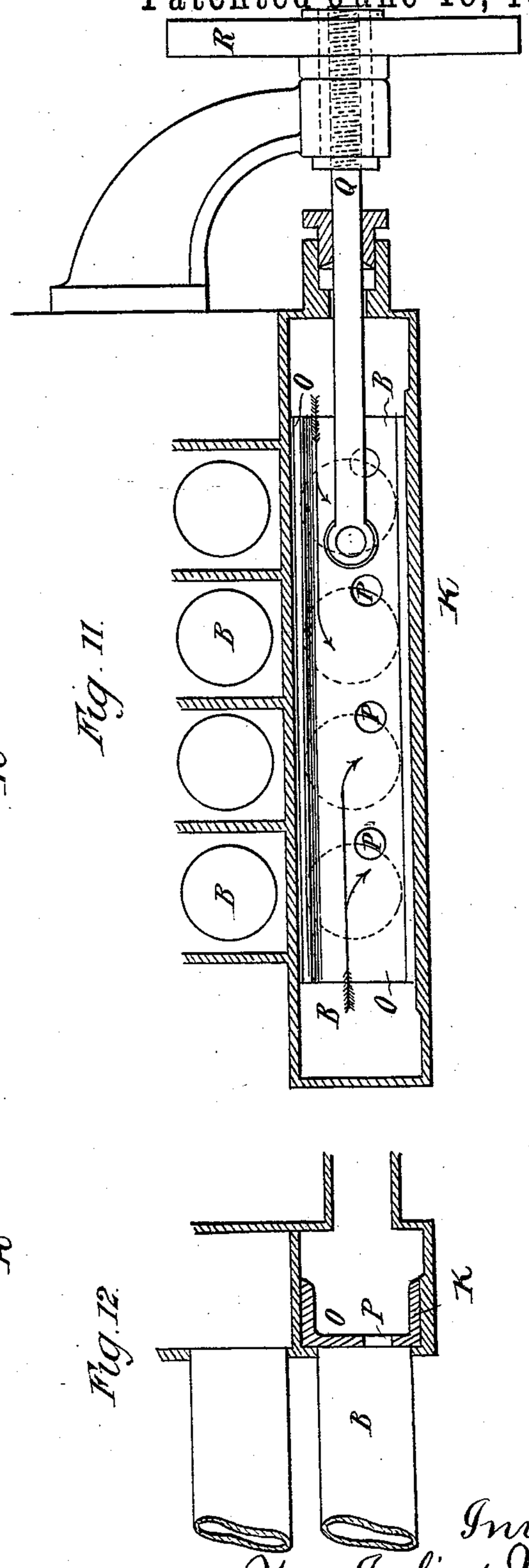

Fig. 9.

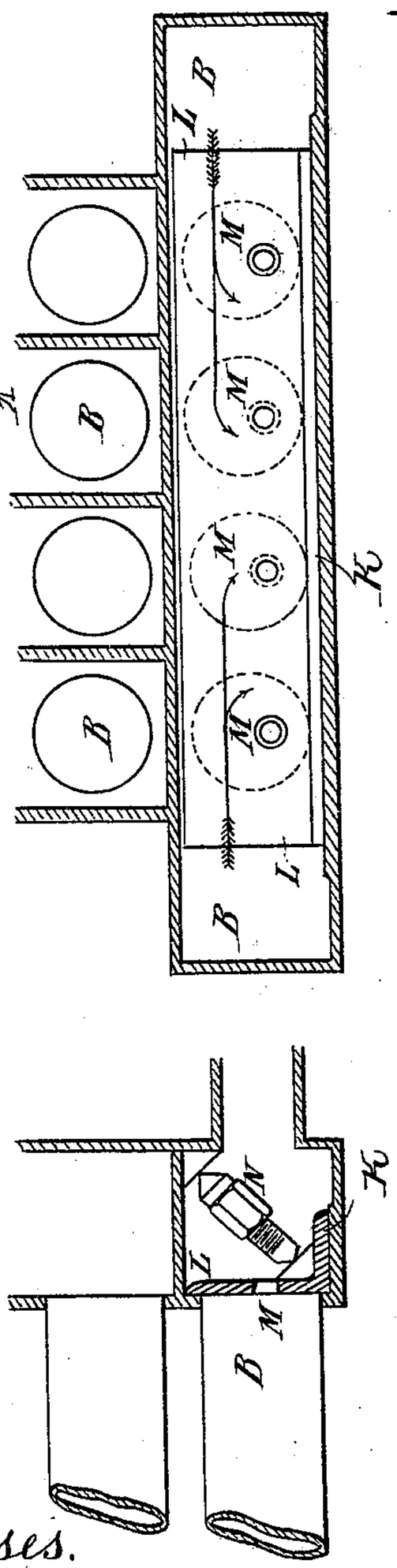

Fig. 10.

Fig. 11.

Fig. 12.

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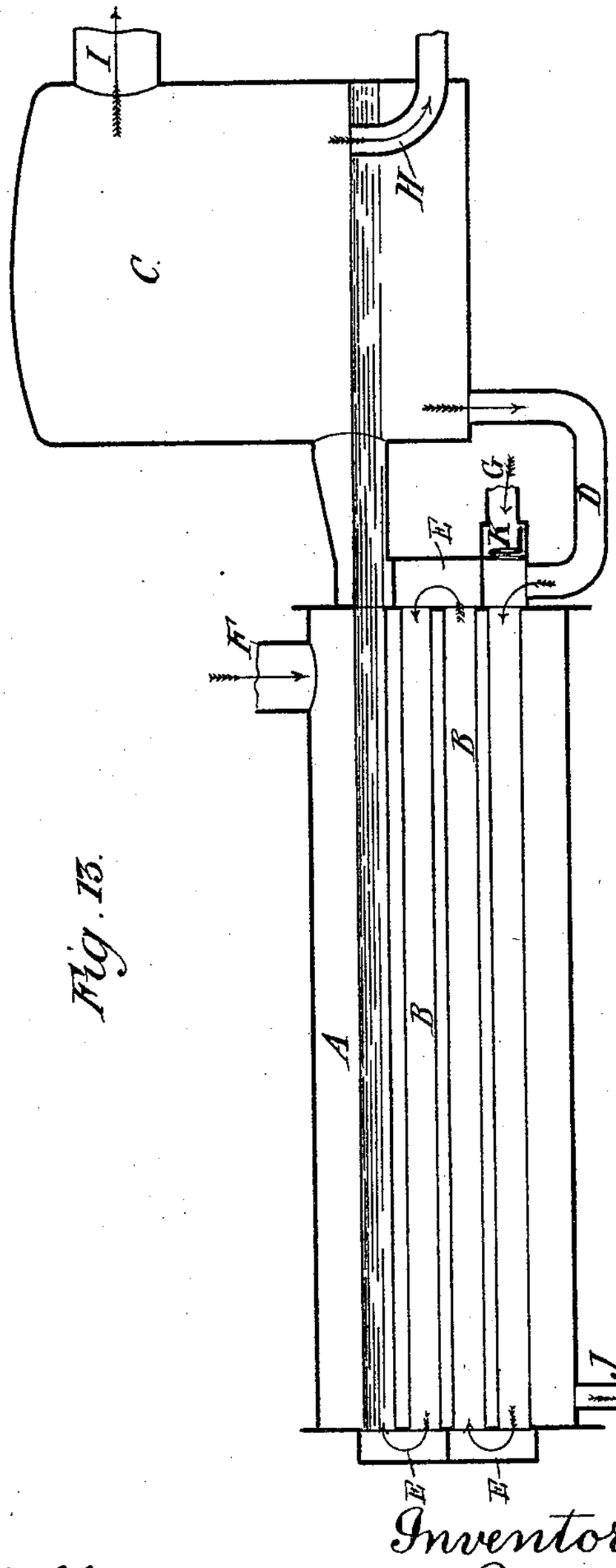

Fig. 15.

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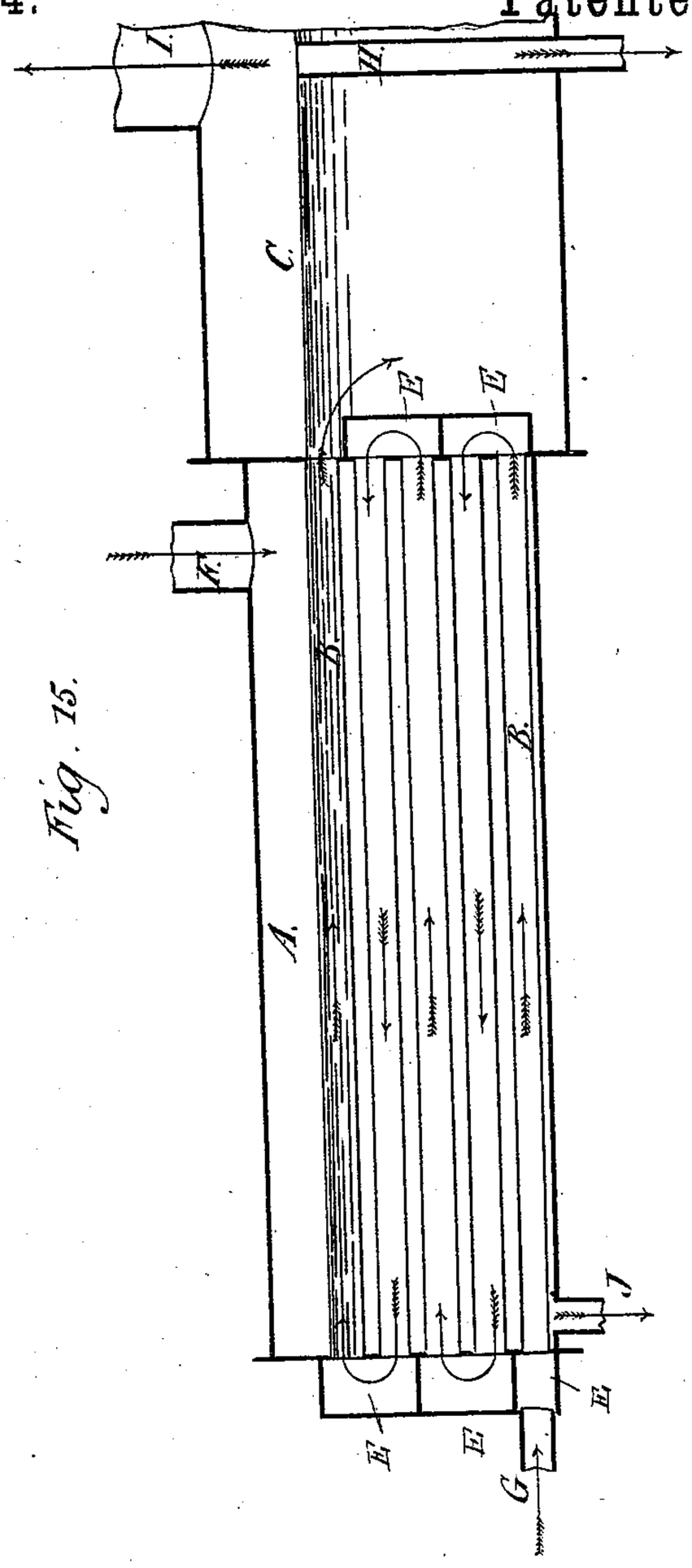

Fig. 15.

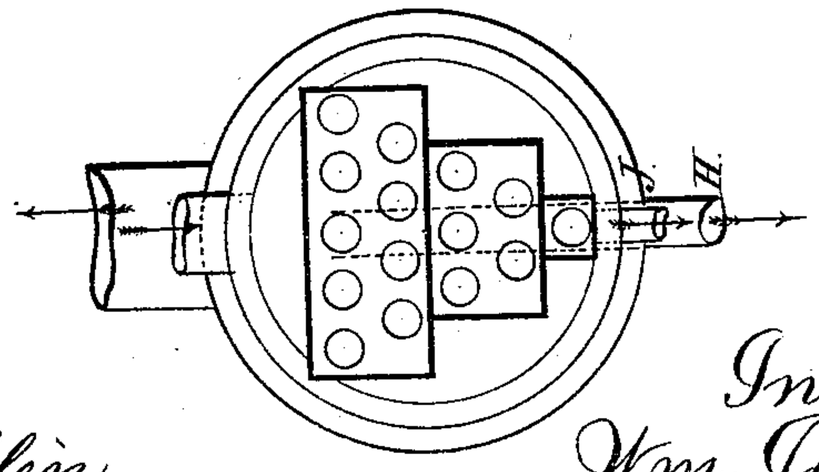

Fig. 16.

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UNITED STATES PATENT OFFICE.

WILLIAM JULIUS MIRRLEES AND DAVID BALLINGALL, OF GLASGOW, SCOTLAND.

APPARATUS FOR EVAPORATING LIQUIDS.

SPECIFICATION forming part of Letters Patent No. 521,724, dated June 19, 1894.

Application filed May 18, 1893. Serial No. 474,715. (No model.) Patented in England May 19, 1892, No. 9,499.

To all whom it may concern:

Be it known that we, WILLIAM JULIUS MIRRLEES, of the firm of The Mirrlees, Watson & Yaryan Co., Limited, engineers, and DAVID BALLINGALL, manager of said company, both of 45 Scotland Street, Glasgow, in the counties of Lanark and Renfrew, Scotland, subjects of the Queen of Great Britain and Ireland, have invented certain Improvements in Apparatus for Evaporating Liquids, (for which we have obtained a patent in Great Britain, No. 9,499, bearing date May 19, 1892,) of which the following is a specification.

Our invention relates to improvements in apparatus for evaporating, concentrating and distilling liquids such as sugar in single or multiple effect and has for its object the better utilization of the heating surface and simplification of the construction of this class of apparatus.

In carrying out this invention the liquid to be heated is circulated through tubes passing horizontally or up through tubes inclined to the horizon through a heating chamber, and the vapor is separated from the liquid in a compartment at one end of this chamber, from which chamber the whole or any portion of the liquid is returned to the inlet end of tubes or end of tubes farthest from the compartment by a tube or tubes at a lower level. When the tubes are inclined to the horizontal the best results will probably be obtained with tubes at an angle less than forty-five degrees. We do not contemplate arranging the tubes near the vertical. These return tube or tubes may pass through the heating chamber, or outside of it, and when passing through the heating chamber these also form part of the heating tubes. From the compartment any desired portion of the concentrated liquid is withdrawn or passed on to the next effect, should the apparatus be on the multiple effect principle. In another arrangement the liquid is fed into the lower series of tubes in the heating chamber, the liquid and vapor passing up from one series of tubes to the other, and discharged from the top series of tubes into a compartment where the vapor is separated from the liquid, the concentration of the liquid being regulated by the quantity of the feed liquid, or any desired portion of the liquid may be returned and fed into the lower tubes, as described in the previous class of apparatus; the distribution of the feed to the bottom series of tubes being regulated by small fixed openings or by means of a suitable adjustable valve or valves, or the natural flow of the liquid and vapor may be allowed to distribute the feed without the intervention of fixed openings or adjustable valves. The tubes in the heating vessel may be either horizontal or inclined to the horizon, rising in the direction of flow of the liquid. To facilitate circulation the heating tubes may be tapered, the area increasing in the direction of flow; also in apparatus where the liquid is fed into the lower series the numbers or size of the heating tubes in the upper series may be increased to allow for the increasing volume of the streams of mixed vapor and liquid.

In the drawings, Figure 1 is a sectional elevation showing the heating tubes inclined to the horizon with the return tube outside the heating chamber. Fig. 2 is a sectional end view of Fig. 1. Fig. 3 is a sectional elevation showing the return tubes inside the heating chamber and also acting as heating tubes. Fig. 4 is a sectional end view of Fig. 3. Fig. 5 is a sectional elevation showing the return tubes in separate heating chambers inclined to the horizon upward in the direction of flow. Fig. 6 is a sectional end view of Fig. 5. Fig. 7 is a sectional elevation showing the liquid fed into the lower series of tubes and discharged from the top series of tubes into the separating compartment. Fig. 8 is a sectional end view of Fig. 7. Fig. 9 is a detail of fixed regulating openings to be used in apparatus shown in Figs. 7 and 8. Fig. 10 is a sectional end view of Fig. 9. Fig. 11 is a detail of movable regulating valve to be used in apparatus shown in Figs. 7 and 8. Fig. 12 is a sectional end view of Fig. 11. Fig. 13 is a sectional elevation showing application of return tubes to apparatus shown in Figs. 7 and 8. Fig. 14 is a sectional end view of Fig. 13. Fig. 15 is a sectional elevation showing the liquid fed into a lower tube and the higher series of tubes increasing in number as the vol-

ume of vapor increases. Fig. 16 is a sectional end view of Fig. 15.

In the several forms of this invention shown on the accompanying drawings A is the heating chamber.

B B are the evaporating tubes passing through the heating chamber A.

C is the compartment where the liquid and vapor are separated from one another.

D is a return tube, or D D return tubes returning the liquid or part of the liquid from the separating compartment C to the inlet end E of the evaporating tubes B B.

F is the steam inlet from the boiler or the vapor inlet from a previous effect or any other heat generator to heat the liquid in the tubes B B.

G is the inlet for the liquid to be heated.

H is the concentrated liquid outlet.

I is the outlet for the vapor generated from the liquid.

J is the outlet for the water of condensation.

K in Figs. 7 and 13 is the regulating fixed opening or adjustable valve admitting the liquid into the lower series of tubes.

In Figs. 9 and 10 (showing detail of fixed regulating openings K in Figs. 7 and 13) L is an angled plate in which are drilled the openings M M opposite the bottom series of tubes B B, the plate L being held in position by a screw or screws N.

In Figs. 11 and 12 (showing detail of adjustable regulating valve K in Figs. 7 and 13) O is a sliding valve in which are drilled holes P P; the position of these regulating holes relative to the edges of the lower series of tubes B B and consequently the amount of their opening being regulated by means of the adjustable screwed spindle Q and hand wheel R.

In Figs. 1 and 2 the liquid to be concentrated is circulated through the evaporating tubes B B, and the whole or part returned to the inlet end E of the tubes B B by the pipe or tube D outside the heating chamber A. The vapor evaporated from the liquid is carried off by the outlet I and the concentrated liquid is withdrawn through the pipe H, the level of the liquid in the separating compartment being regulated by the height of the pipe H.

In Figs. 3, 4, 5 and 6 the return pipes or tubes D D are carried inside the heating chamber, and also act as heating tubes. Otherwise the apparatus are the same as shown in Figs. 1 and 2.

In the foregoing Figs. 1, 2, 3, 4, 5 and 6 the heating tubes are shown inclined to the horizon, rising in the direction of flow of the liquid, but they may be made horizontal. The inclination of the tubes may be varied in different machines for treating different liquids, but the best results will probably be obtained with an inclination less than forty-five degrees. The advantages of our invention would be lost by making the tubes nearly vertical.

In Figs. 7 and 8 the liquid to be concentrated is admitted into the lower series of tubes B B by the regulator K and passes up along with the vapor generated through the upper series of tubes as indicated by arrows until finally discharged into the compartment C from which the liquid and vapor are carried off as described for Fig. 1.

In Figs. 13 and 14 the liquid is passed through the tubes as in Figs. 7 and 8, but the apparatus has the addition of the return tubes D D by which any desired portion of the liquid is returned to the bottom series of tubes.

In Figs. 15 and 16 the liquid to be concentrated is fed into a lower tube B, the number of tubes gradually increasing to allow for the increased volume of the streams of liquid and vapor: otherwise the arrangement is the same as in Figs. 7 and 8. Although only one group of increasing number of tubes is shown, any number of groups may be employed in one heating chamber, and the distribution of the liquid arranged as in Figs. 7 and 8.

In Figs. 7, 9, 10, 11, 12, and 13 a distributer K is shown, but it may be dispensed with and the circulation in the tubes allowed to distribute the feed liquor. In all the illustrations parallel tubes of the same size have been shown, but they may be made tapered or increased in size or number as the volume of the vapor increases in passing to separating compartment.

Single effect apparatus have been illustrated, but any number of these apparatus may be combined to form multiple effect apparatus and the connections made as is usual in such apparatus.

The resultant concentrated liquor may be recovered or run to waste, or the vapor of distillation may be condensed and recovered or run to waste, or both may be recovered, depending upon the nature of the liquid and what is required to be recovered.

One or more apparatus constructed on the system now described may be combined with single or multiple effect apparatus of other construction and that in any order in the series of vessels forming the combination.

We claim—

1. An apparatus for evaporating liquids comprising a heating chamber A, having a steam or vapor inlet F at the top, and an outlet J at the bottom for the water of condensation, the evaporating tubes B, extending through the heating chamber and adapted to conduct the liquid in an upward direction, the chamber E at the inlet of the tubes, the separating compartment C at the outlet of the tubes, having an outlet I at the top for the vapor, and the pipe H extending upwardly through the separating compartment having its inlet on a level with the discharge ends of the upper evaporating tubes, substantially as described.

2. An apparatus for evaporating liquids

comprising a heating chamber A having an inlet F, and an outlet J, the evaporating tubes B, extending through the heating chamber and adapted to conduct the liquid upwardly, the chamber E in front of the tubes, having the inlet G, the separating compartment C, into which the upper ends of the tubes discharge, having the vapor outlet at the top, the liquid pipe H connected with the separating compartment, having its inlet on a level with the discharge ends of the upper evaporating tubes, and the return tube D connecting the bottom of the separating compartment with the chamber E; substantially as described.

3. An apparatus for evaporating liquids comprising a heating chamber A having a steam or vapor inlet F at the top, and an outlet J at the bottom for the water of condensation, the evaporating tubes B extending in series through the heating chamber, and adapted to conduct the liquid in an upward direction, the chambers E at the inlet of the tubes, the inlet G, the separating compartment C, into which the tubes discharge, having an outlet I at the top for the vapor, and the pipe H extending upwardly through the separating compartment having its inlet on a level with the discharge ends of the upper evaporating tubes, substantially as described.

4. An apparatus for evaporating liquids comprising a heating chamber A having a steam or vapor inlet F at the top, and an outlet J at the bottom for the water of condensation, the evaporating tubes B, extending in series through the heating chamber and increasing in number from the bottom to the top thereof, in each series, and adapted to conduct the liquid in an upward direction, the chambers E, at the inlet of the tubes, the separating compartment C, into which the tubes discharge, having an outlet I at the top for the vapor, and the pipe H extending upwardly through the separating compartment having its inlet on a level with the discharge ends of the upper evaporating tubes, substantially as described.

In witness whereof we have hereunto set our hands in presence of two witnesses.

WILLIAM JULIUS MIRRLEES.
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JNO. MIDDLEMASS,
Scotland Street, Glasgow, Cashier.