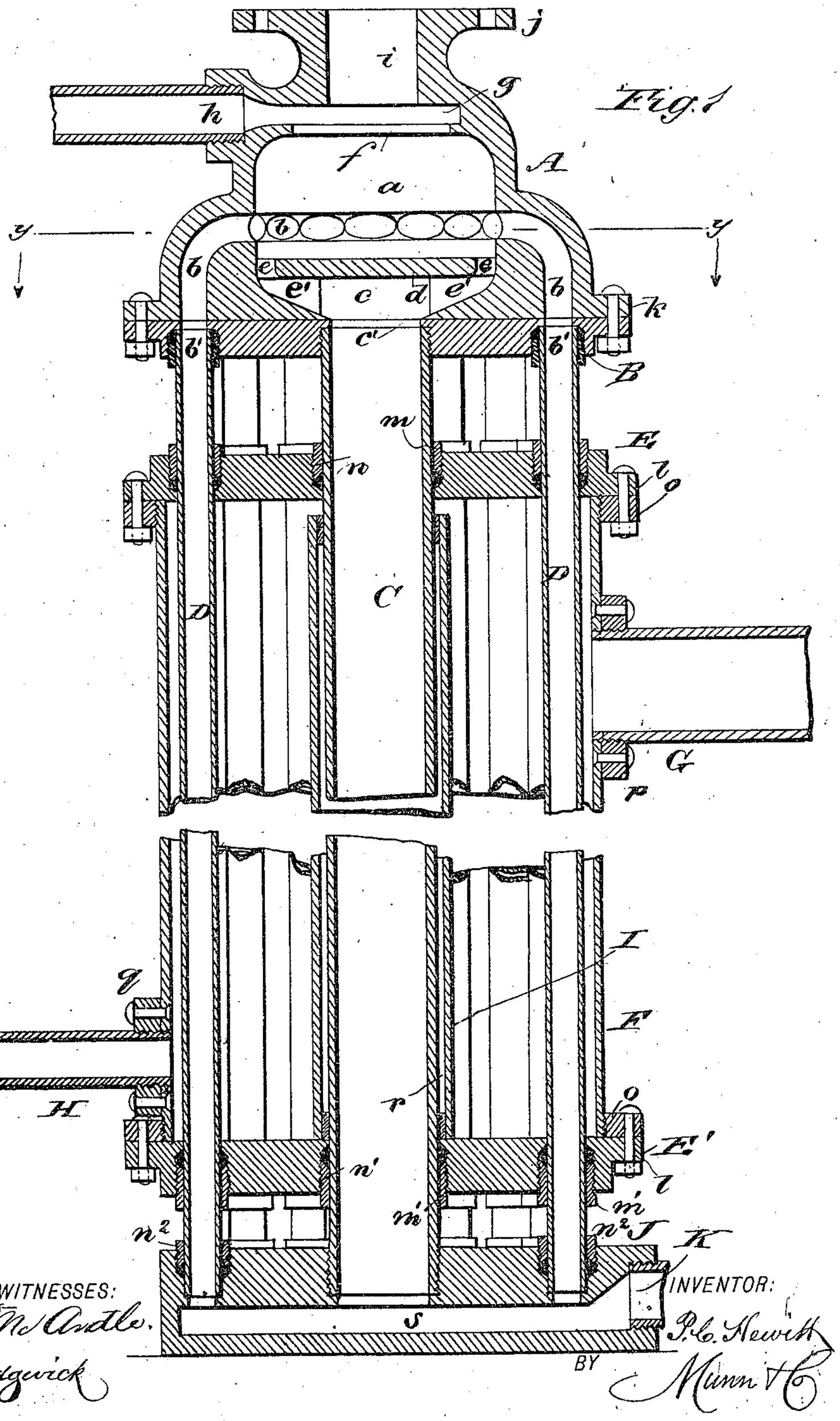
(No Model.) 3 Sheets—Sheet 1.

P. C. HEWITT.

EVAPORATOR.

No. 548,986. Patented Oct. 29, 1895.

Fig. 1



WITNESSES:

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C. Sedgwick

INVENTOR:

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(No Model.)

3 Sheets—Sheet 2.

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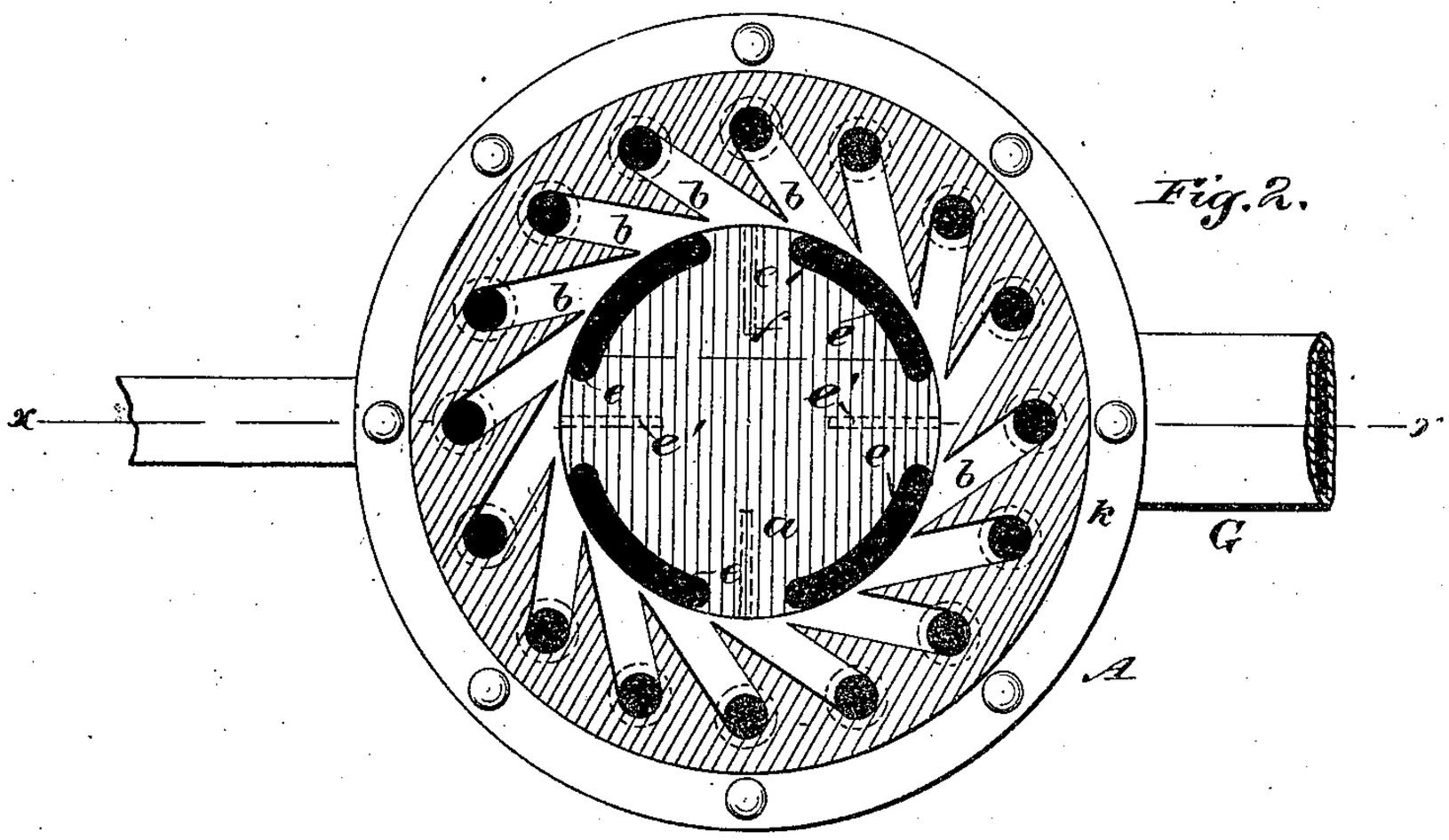
Fig. 2.



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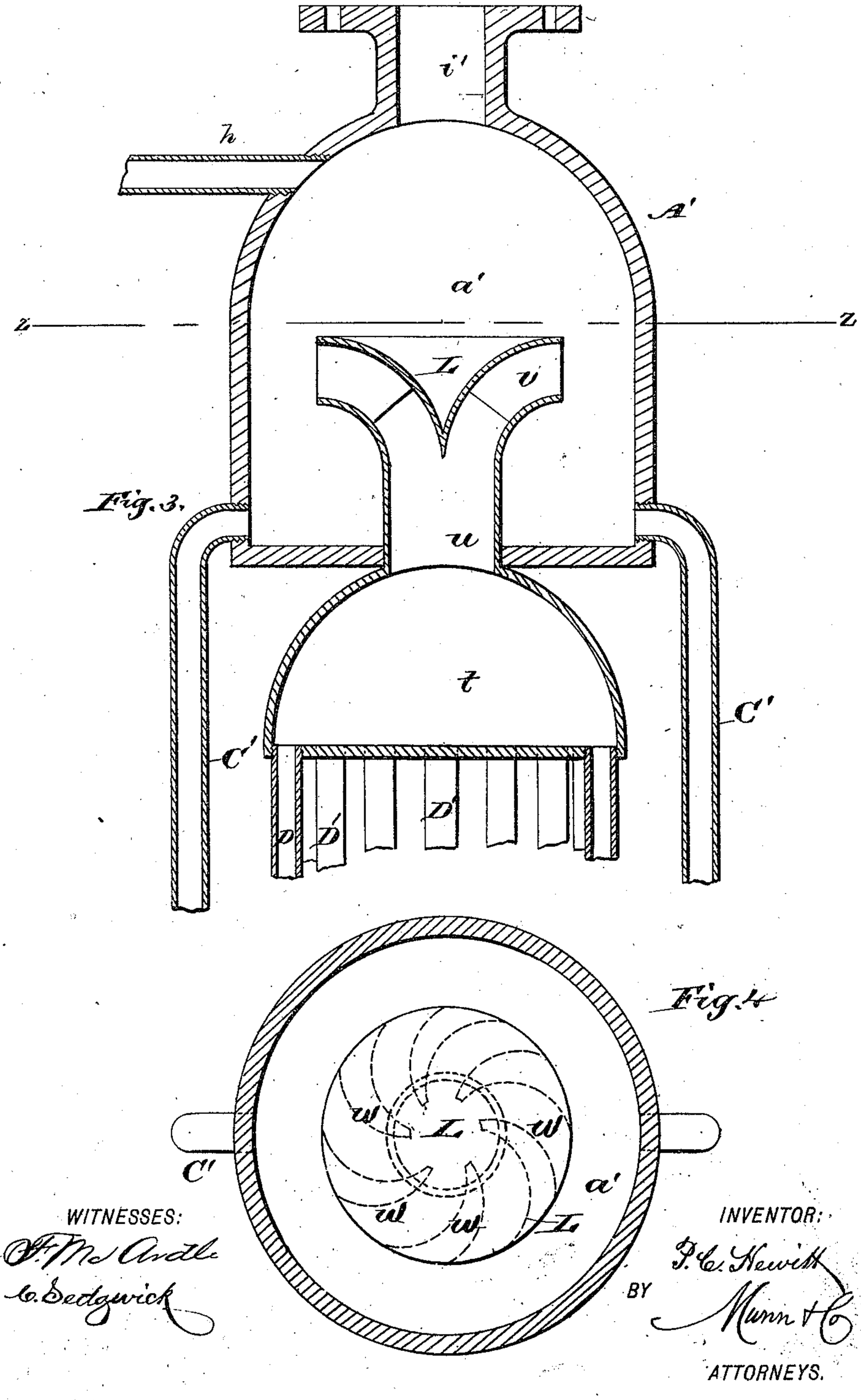

Fig. 3.

Fig. 4.

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UNITED STATES PATENT OFFICE.

PETER COOPER HEWITT, OF NEW YORK, N. Y.

EVAPORATOR.

SPECIFICATION forming part of Letters Patent No. 548,986, dated October 29, 1895.

Application filed July 2, 1892. Serial No. 438,762. (No model.)

To all whom it may concern:

Be it known that I, PETER COOPER HEWITT, of New York city, in the county and State of New York, have invented a new and Improved Evaporator, of which the following is a specification, reference being had to the annexed drawings, forming a part thereof, in which—

Figure 1 is a vertical section of my improved evaporator, taken on line *x x* in Fig. 2. Fig. 2 is a horizontal section taken on line *y y* in Fig. 1. Fig. 3 is a vertical transverse section of a modified form, and Fig. 4 is a horizontal section taken on line *z z* in Fig. 3.

Similar letters of reference indicate corresponding parts in all the views.

In the evaporation of liquids for the purpose of concentrating them or in the generation of steam for motive power or heat the circulation of the liquid is commonly secured by taking advantage of the difference in specific gravity due to different temperatures of different portions of the liquid. As the difference in density is slight, the circulation produced in this way is necessarily slow, permitting bubbles of vapor to adhere to the walls of the chamber or of the tube in which they are formed and to hinder the rapid transmission of heat from the said walls to the body of the liquid, and the liquid itself not being a good conductor of heat, except by convection, the amount of liquid evaporated in a given time by a given amount of surface is limited by the amount of heat the liquid will take up from the walls.

To facilitate the evaporation of liquids by accelerating their circulation and by securing a more effective contact of the liquid and heating-surface by bringing more liquid in contact with the heating-surface and also the rapid separation of the vapor formed from the liquid is the object of my invention.

My invention comprises an apparatus for rapidly evaporating liquids, as will be hereinafter fully described, and pointed out in the claims.

The separating-chamber A in the present case consists of a single casting furnished with a cylindrical cavity *a* and with passages *b*, which are tangential to the cylindrical cavity *a*. The said passages are curved inwardly in the casting, as shown in Fig. 2. The lower part of the cylindrical cavity *a* is conical, and in the casting is formed a central opening *c*, toward which the conical sides of the cavity incline. In the chamber A above the conical bottom thereof and a short distance below the openings of the passages *b* is arranged a horizontal partition *d*, and in the said partition adjoining the wall of the cavity are formed segmental ports *e*, and to the under side of the horizontal partition *d* are attached wings *e'*, which are located between the curved ports and project downwardly, the wings serving to check the rotary motion of the liquid passing through the ports. Above the openings of the passages *b* the chamber A is contracted and furnished with an inwardly-projecting flange *f*, forming an annular groove *g*, which communicates with and forms part of the liquid-discharge opening *h* at one side of the chamber. The inner edge of the inwardly-projecting flange *f* is arranged in a position intermediate between perpendicular lines drawn from the walls of the discharge-opening *i* and perpendicular lines drawn through the inner portions of the ports *e*, so that the inner wall of the revolving liquid will lie between the perpendicular lines passing through the inner portions of the ports *e*, and thus be withdrawn from the inner wall of the discharge-opening. The discharge-opening *i* is concentric with the chamber and is for the escape of vapor.

The chamber A is provided with a flange *j* at the top for receiving the vapor-pipe and with a perforated flange *k* at the bottom. To the said perforated flange *k* and in contact with the bottom of the chamber A is secured a plate B, provided with a central opening *c'*, coinciding with the opening *c* of the cavity *a*, and with openings *b'*, coinciding with the passages *b* of the chamber *a*. In the central opening *c'* of the plate B is screwed a pipe C, and in the openings *b'* of the said plate B are screwed the pipes D. To the pipes C D are fitted the perforated plates E E', which are each provided with a flange *l*. The said plates E E' are oppositely arranged with respect to each other and provided with glands *m n m' n'* on their outer surfaces, which permit of the movement of either or both of the plates E E' or of the pipes D C in the plates without causing leakage or straining the parts.

Surrounding the pipes C D and between

the plates E E′ is placed a cylindrical shell F, provided at its ends with flanges *o*, which are secured to the flanges *l* of the plates E E′ by means of bolts or otherwise. To one side of the shell F, preferably above the center thereof, is secured a collar *p*, into which is screwed a steam-supply pipe G, and to the opposite side of the shell, or in any convenient position, is secured a collar *q*, into which is screwed the discharge-pipe H, which passes through the shell F. A jacket I surrounds the portion of the pipe C inclosed by the shell F, leaving an intervening space *r*, which prevents the pipe C from being heated to the same degree as the pipes D. The pipe C is screwed into a hollow base J, communicating with the space *s* in the said base, and the pipes D enter the hollow base J and communicate with the space *s*, the said pipes D being surrounded by glands n^2. A supply-pipe K communicates with the interior *s* of the hollow base J.

The operation of my improved evaporator is as follows: The liquid to be evaporated is introduced into the apparatus through the pipe K, and in the present case the heat necessary to drive off the vapor is supplied by steam introduced into the shell F through the pipe G. The pipe C, being protected by the jacket I, is not heated to the same degree as the pipes D. The liquid contained in the pipes D gives off bubbles of vapor, thus rendering the columns contained by the pipes D non-homogeneous—that is to say, the said columns are composed partly of liquid, and partly of vapor—while vaporization is partly or wholly prevented in the central tube C. In consequence of the difference in density in the columns contained by the pipes C D the column contained in the pipe C descends, forcing upward the columns contained by the pipes D, causing the said pipes to discharge through the tangential passages *b* into the separating-chamber A. The jets which are thus made to enter the chamber impinge upon the walls of the chamber, and thus produce a rapid rotary motion in the liquid contained by the chamber, which carries the heavier portions of the liquid toward the wall of the chamber, while the vapor goes to the center of the chamber. As the capacity of the chamber is limited when liquid is supplied, one portion of the liquid is discharged over the inwardly-projecting flange *f*, the main portion being continuously discharged independently of the feed through the ports *e* into the lower part of the chamber *a*, thence into the pipe C, which returns it to the hollow base J, whence it again rises through the pipes D. This operation is made continuous, and the concentrated liquid which is discharged over the flange *f* and through the discharge-pipe *h* is replaced by fresh liquid introduced into the hollow base through the pipe K. The rapid upward movement of the liquid through the pipes D frees the walls of the pipes from all adhering bubbles of vapor, thereby maintaining a perfect contact of the constantly-changing liquid with the walls of the pipes, thus insuring the rapid transmission of heat and great rapidity of action. Moreover, the portion of liquid which is returned to the central tube C possesses a downward velocity due to the ascending velocity of the column in the pipes D D and its transformation into centrifugal force in the chamber *a*, and this downward velocity increases the effect of the weight of the liquid in the pipe C and adds to the rapidity of the circulation.

In the modification shown in Figs. 3 and 4 the pipes D′, in which the liquid is heated, communicate with a hollow base, as in the other case, and discharge into a receiver *t*, which is furnished with an outlet-pipe *u*, terminating in a multiple discharge-nozzle L, placed within the separating-chamber A′, the said multiple discharge-nozzle being provided with an enlarged annular opening *v*, in which are placed oblique wings *w*, which cause the jets of liquid to issue in a practically tangential direction, so as to produce a rotary motion of the liquid in the chamber A′. The separation of the liquid from the vapor is effected in the manner before described, and the vapor escapes through the opening *i*′, while the concentrated liquid escapes through the pipe *h*. The liquid is returned to the hollow base through the external return-pipes C′.

My method and apparatus can also be used for separating a mixed liquid or solution by the removal of one portion in the form of vapor, leaving another portion which is not vaporized. The absolute pressure, whether more or less than the atmospheric pressure under which my apparatus may be operated, does not affect the working of my invention, which is applicable to a wide range of pressures.

I wish to be understood as including in my invention under the term "evaporator," as used in the foregoing specification and the following claims, such apparatus as steam-generators, vacuum-pans, &c., used to vaporize liquids wholly or partly for any purpose whatever.

By the term "tangential jet or nozzle," as used in my specification and claims, I mean a nozzle arranged with reference to the separating-chamber, so that the jet discharged from the nozzle into the separating-chamber will strike the wall of the chamber at such an angle as to impart a rotary motion to the liquid discharged and to maintain rotary motion in the liquid in the separating-chamber.

My apparatus will work successfully whether the liquid is discharged into the separating-chamber from without inward, as would be the case in the form shown in Figs. 1 and 2, or from the central portion of the separator toward the walls thereof, as would be the case in the apparatus illustrated in Fig. 3, as either method will produce the required rotary motion in the separating-chamber. In the first instance the particles of vapor

would be forced inward toward the center of the chamber by the pressure of the liquid. In the second case the liquid would be projected through and beyond the vapor by virtue of its superior weight and density.

Having thus described my invention, I claim as new and useful and desire to secure by Letters Patent—

1. In an evaporator provided with heating tubes and one or more return tubes, a separating chamber provided with a series of stationary tangential nozzles communicating with the heating tubes, substantially as specified.

2. In an evaporator, wherein the separation of the vapor and the concentrated liquid is effected by the motion of the liquid, a separating chamber, the said separating chamber being furnished with a vapor outlet, one or more liquor outlets at the bottom thereof, and a liquor overflow arranged between lines passing through the vapor outlet and return liquor outlet, for the purpose of maintaining the inner or free surface of the body of liquor between the vapor outlet and the return liquor outlet, substantially as specified.

3. In an evaporator, the combination with the heating and return tubes, of a separating chamber provided with tangential nozzles, and having one or more discharge ports each, for vapor, liquor, and the return liquor, the said discharge ports being arranged in different planes, substantially as specified.

4. An evaporator, comprising a separating chamber, a series of heating tubes communicating with the separating chamber through tangential nozzles, a heating drum inclosing the tubes, and one or more protected return pipes insulated from the heat, for conveying the liquid from the separating chamber to the lower end of the heating tubes, substantially as specified.

5. In an evaporator, the combination with the heating and return tubes, of a separating chamber provided with tangential nozzles, and having one or more discharge ports each for vapor, for the liquid, and for the return liquid, substantially as specified.

6. In an evaporator, a series of evaporating tubes, and an inclosing shell provided with heads through which the tubes pass, the said heads being separated from the joints of the evaporating tubes with the separating chamber and hollow base, leaving portions of each tube exposed between the separating chamber and heating drum, and hollow base and heating drum, to avoid leakage of steam into the vacuum space, substantially as specified.

7. An evaporator, comprising a separating chamber, a series of heating tubes communicating with the separating chamber through tangential nozzles, a heating drum inclosing the tubes, and one or more return pipes for conveying the liquid from the separating chamber to the lower end of the heating tubes, substantially as specified.

PETER COOPER HEWITT.

Witnesses:
E. M. CLARK,
C. SEDGWICK.