

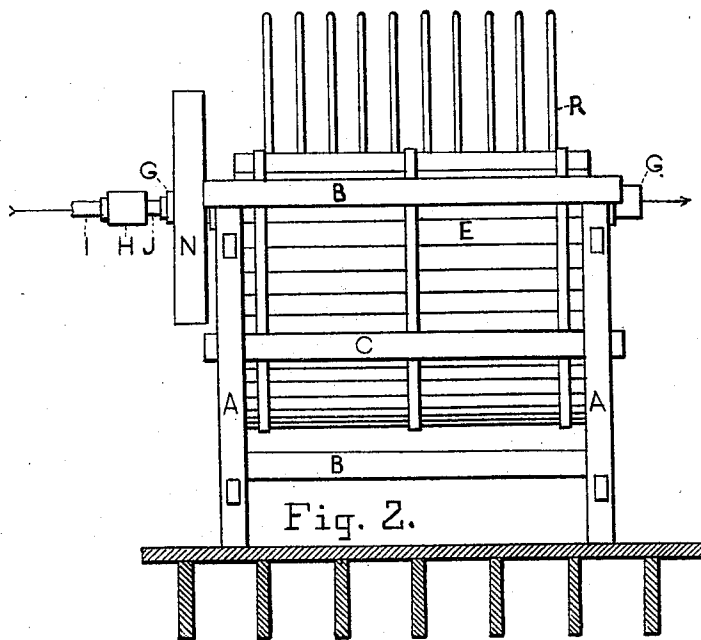
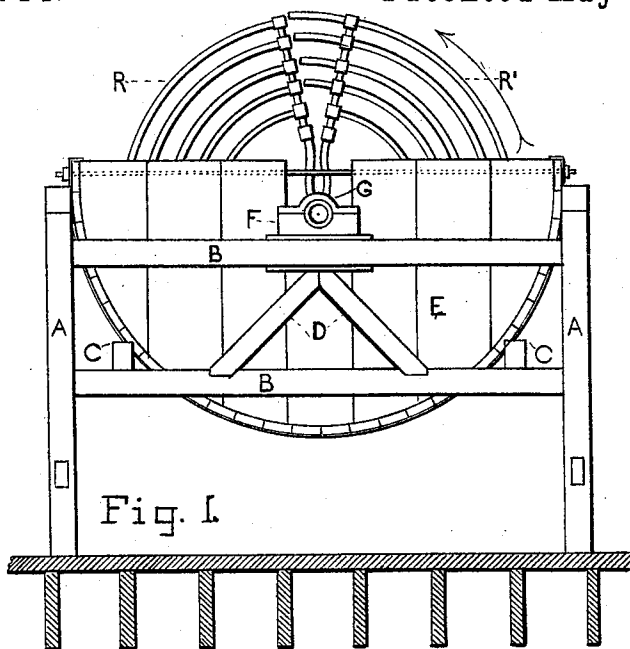
(No Model.)

3 Sheets—Sheet 1.

F. & R. C. SPRAGUE.
ROTARY EVAPORATOR.

No. 583,014.

Patented May 18, 1897.



WITNESSES:

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INVENTORS:

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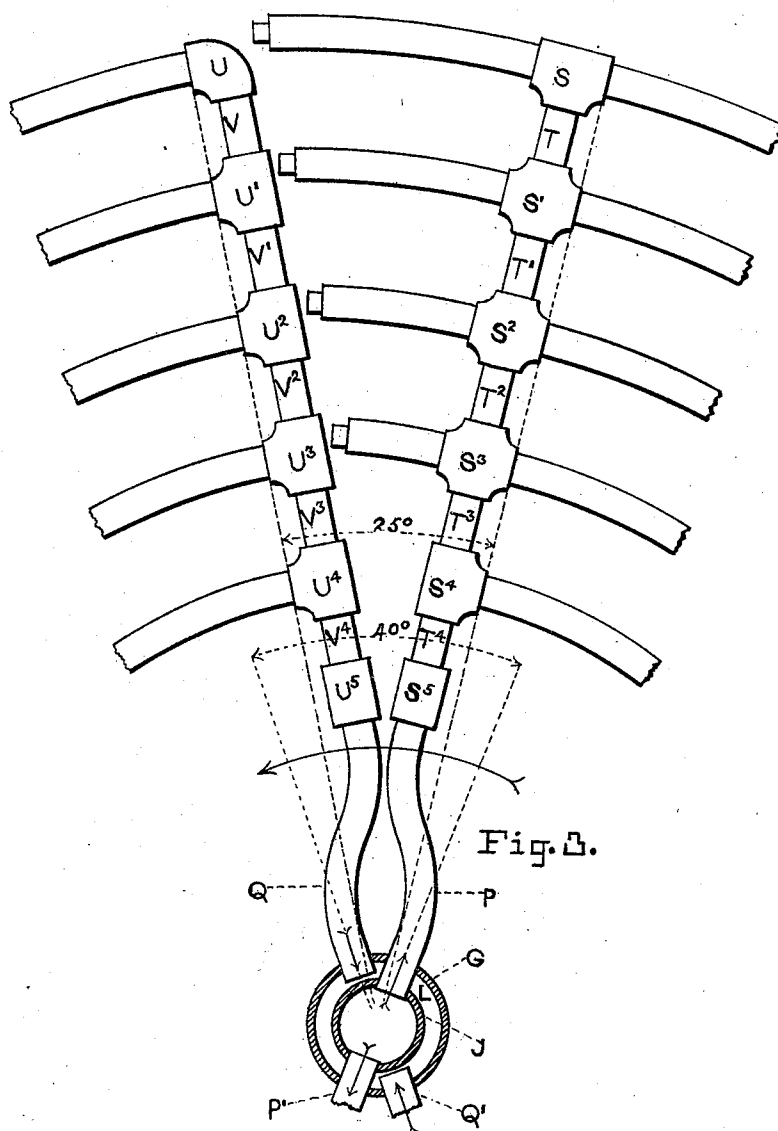
(No Model.)

F. & R. C. SPRAGUE.
ROTARY EVAPORATOR.

3 Sheets—Sheet 2.

No. 583,014.

Patented May 18, 1897.



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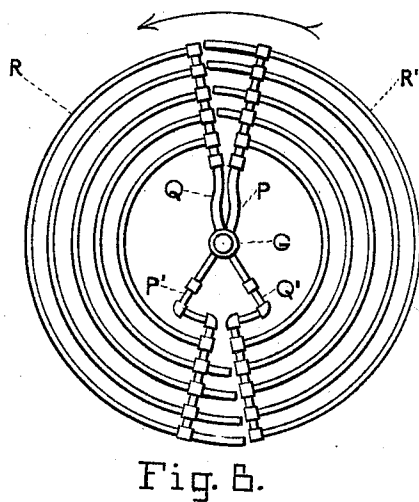
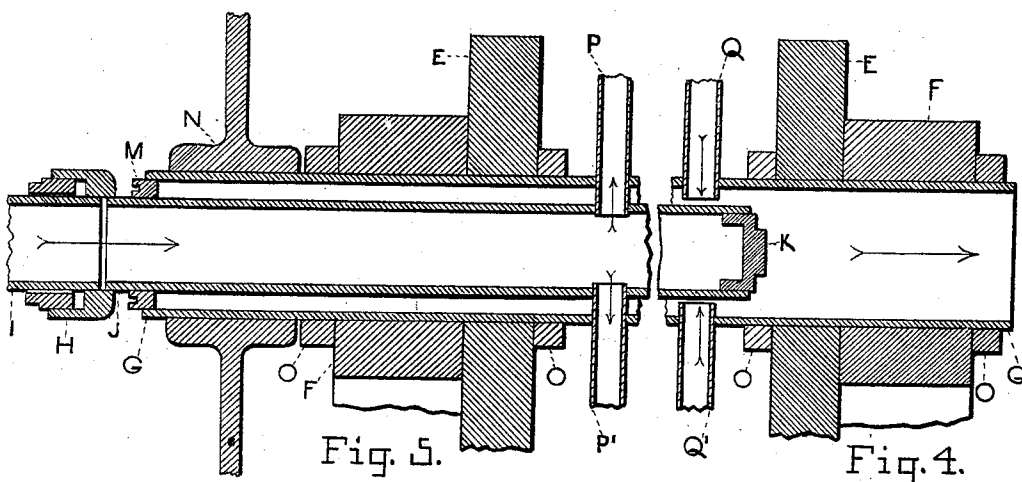
(No Model.)

F. & R. C. SPRAGUE.
ROTARY EVAPORATOR.

3 Sheets—Sheet 3.

No. 583,014.

Patented May 18, 1897.



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UNITED STATES PATENT OFFICE.

FINNEY SPRAGUE, OF ST. PAUL, MINNESOTA, AND RICHARD COBDEN
SPRAGUE, OF CEDAR RAPIDS, IOWA.

ROTARY EVAPORATOR.

SPECIFICATION forming part of Letters Patent No. 583,014, dated May 18, 1897.

Application filed March 29, 1895. Serial No. 543,739. (No model.)

To all whom it may concern:

Be it known that we, FINNEY SPRAGUE, residing at St. Paul, in the county of Ramsey and State of Minnesota, and RICHARD COBDEN SPRAGUE, residing at Cedar Rapids, in the county of Linn and State of Iowa, citizens of the United States, have invented a new and useful Rotary Evaporator, of which the following is a specification.

Our invention relates to improvements to that class of evaporators in which the heated evaporating-surfaces move by rotation in and out of and thereby effect the concentration of the fluid, solution, liquor, or substance acted upon, and in which the substance, when desired, may be kept at a suitable temperature otherwise than by the heat applied to the evaporating-surfaces moving therein. We use for such moving surfaces a novel construction of pipes arranged in concentric circles or parts of circles in planes perpendicular to and by composite hollow arms connected to a double hollow shaft, securing thereby the use of ordinary commercial forms of and sizes of steam pipes and fittings; the ability to use either steam or hot water as the medium of conveying heat to such evaporating-surfaces; the full and effectual escape of water; the ability, when desired, to cover separately each component part of such moving evaporating-surfaces with a protecting enamel or its equivalent, and to assemble such parts without strains dangerous to the protecting-covering.

Our invention is particularly adapted to the rapid evaporation and concentration under conditions of atmospheric pressure or in the open air of various liquids and solutions and to the preparation of jams and marmalades from fruits and of syrups and concentrated extracts from vegetable and fruit juices. By the use of our invention these operations can be performed without bringing the mass of the substance operated upon to or maintaining it at a high temperature, which is a desideratum in many instances and is accomplished simply by using only the heat derived through the medium of the coils rotating through the mass. Furthermore, it has been found in practice that if the mass be introduced to the apparatus at or near a

boiling temperature it will become reduced in temperature if no other heat be applied, or, in other words, if only the heat derived through the rotating coils be used. We attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is an end view of the evaporator from the right of Fig. 2. Fig. 2 is a side view. Fig. 3 is an enlarged view of two contiguous composite arms, showing their connection with the concentric circles or parts of circles of pipes and with the shaft, and a view of the shaft in cross-section at the points of connection of four composite arms. Fig. 4 is an enlarged sectional view of the outlet end of the shaft and the ends of two diametrically opposite composite outlet-arms and of the stopped end of inner pipe of shaft. Fig. 5 is an enlarged sectional view of the steam or hot-water inlet end of the shaft, of the ends of two diametrically opposite composite inlet-arms, of hub of driving-pulley, and of gland-connecting inner inlet-pipe of shaft with stationary steam or hot-water inlet pipe, Figs. 4 and 5 together illustrating the double hollow shaft. Fig. 6 is a plan view, on the scale of Figs. 1 and 2, of two sets of circles or parts of circles of concentric pipes and connected composite arms (hereinafter called "coils") and showing two methods of attachment of the arms to the shaft.

Similar letters refer to similar parts throughout the several views.

The posts A, ties B, rests C, and braces D constitute the framework for support of the semicylindrical tank E, pillow-blocks F, and of the shaft therein. The gland H is for connecting the stationary steam or hot-water inlet pipe I with pipe J, which lies within and, together with pipe G, forms the double hollow shaft. The inner pipe J is closed at K, a point near the same extremity of outer pipe G. The outer pipe G, which may have a protective covering of enamel or its equivalent within the limits of the tank, is turned and finished, where necessary, to receive the pulley N and collars O and for turning in the boxes of the pillow-blocks F. It may be of either wrought or cast iron and of any suitable diameter and thickness. Suitable pipe can ordinarily be

obtained as a commercial article, ready for the finishing operations thereon. One end thereof is left open, as an outlet, and the annular space L between the pipes G and J is closed at M, a point near the gland H, but the open and closed ends of G may be reversed.

N is the driving-pulley, and O the collars to prevent endwise movement of the shaft.

P P' are composite arms, combinations of pieces of pipe and fittings, as shown in Fig. 3. They extend outwardly from the inner circumference of pipe J through pipe G to connect with the concentric pipes of the coils R R', and their points of connection with pipes J and G are diametrically opposite, and they are the inlet-arms through which the heat-conveying medium is conducted to the coils. Q Q' are similar, though, as may be observed, not altogether so, composite arms. They extend outwardly from near the outer circumference of pipe J through pipe G, likewise to connect with the concentric pipes of the coils R R'. Their points of connection with pipe G are diametrically opposite, and they are the outlets for the spent-heat-conveying medium into the annular space L, thence through the open end of G, its return being prevented by reason of the specified relation of the arms Q Q' to the pipe J.

The portions of the arms P P' which are connected to pipes J G also extend therefrom radially, and then between G and the coupling S² are so bent as to bring the right-hand faces of the fittings S, S', S², S³, and S⁴ (see Fig. 3) to lie in a plane cutting the pipes J and G diametrically and lengthwise and divergent, by as small an angle as practicable, from a similar plane in which lie the left-hand faces of fittings U U' U² U³ U⁴ upon the arms Q Q'. The portions of arms Q Q' which are connected to pipe G extend therefrom also radially and are similarly bent as the similar portions of arms P P', so as to bring the left-hand faces of the fittings U U' U² U³ U⁴ to lie in a similar plane, divergent by as small an angle as practicable, from the plane in which lie the fittings upon arms P P'.

If the composite arms P P' Q Q' are constructed of so-called "three-quarter-inch wrought-iron steam-pipe" and appropriate fittings, the angle of divergence of the planes described will be about twenty-five degrees and the radial divergence of the arms P Q or P' Q' as they emerge from pipe G about forty degrees.

The object in constructing the composite arms P P' Q Q' so that the faces of the particularly-mentioned fittings shall lie, respectively, in the planes described is that the concentric pipes of the coils R R' may enter the described fittings tangentially and become connected without such strains as would otherwise endanger any protective covering of pipes and fittings, and also to economize by using commercial articles instead of specially-designed fittings, which would be required

for each concentric pipe to enable it to enter the fitting tangentially for the purpose specified. The space caused by the divergence of the arms P Q and P' Q' may be left open or may be usefully filled by short spurs of pipe closed at their outer ends, as shown in Figs. 1, 3, and 6.

Other important features of the construction of the composite arms P P' and Q Q' are that the short pieces of pipe T T' T² T³ T⁴ V V' V² V³ V⁴ have each on one end a right-handed and on the other end a left-handed screw-thread, and the cross-fittings S' S² S³, the T-fittings S⁴ U' U² U³ U⁴, and the couplings S⁵ U⁵ also have right and left handed screw-threads cut therein to receive the corresponding parts of the short pipes and that all parts may be assembled together economically and without additional or more expensive union-fittings, but we may substitute union-fittings for couplings S⁵ U⁵ and we may have the concentric pipes each in two parts connected by right and left threaded couplings and union-fittings.

When it is desired to increase the number of pipes in the coils by having them closer or as close together as is practicable, and they may be very much closer or more numerous than represented in the drawings, we modify the construction of that portion of the arms which serve to carry the fittings for connection with the concentric pipes. We can construct such portion of an arm by taking a single piece of pipe of the requisite length with necessary openings therein where the fittings will be located and either screw or press thereon accurately-fitted fittings in close proximity to each other.

The arms P P' and Q Q', constructed by either method substantially as and for the purpose set forth, are important features of our invention, but we do not confine ourselves to the particular form or method of connecting them to the shaft, as illustrated by P Q in Fig. 3. Another method is illustrated in Fig. 6 by P' Q', and there may be still other methods, but we prefer the method shown by P Q in Figs. 3 and 6 as giving the greatest degree of strength and rigidity to the coils.

The pipes I and J may be of the ordinary commercial article of wrought-iron steam-pipe of any suitable diameter, ready for the finishing operations thereon.

In Figs. 1 and 2 we represent the tank E, which is intended to contain the substance to be submitted to the operation of concentration by the evaporator, as made of wooden staves and heading, held together in a semi-cylindrical form by rods and semicircular bands. The rods, which may be located either above or below the shaft, tie the staves and heading together, while the bands, which should each be in two pieces joined by a turnbuckle, (not shown,) draw the staves together, thus making a firm and tight vessel resting within the framework heretofore described.

We do not show any method or appliance

for charging or discharging the tank E, as the charging may be done by any suitable means and the discharging through suitable openings and appliances either in the ends or bottom under conditions varying with the substance that may be operated upon.

We do not confine ourselves to a tank E made of wood, as described, but when it is preferable we substitute a metallic tank or a metallic tank lined with a protective enamel or its equivalent, or when it is desirable to submit the substance undergoing concentration to heat other than that which it may receive from coils rotating therein we substitute a metallic tank or a metallic tank lined with a protective enamel or its equivalent having a suitable portion of its cylindrical part double to admit the entrance of a heat-conveying medium for that purpose.

The water discharging from coils R R' through arms Q Q' into annular space L may be led away from the outlet end of G by any suitable means.

The pipe G of the double hollow shaft rests in bearings in the pillow-blocks F F'. The axis of the shaft is beneath and eccentric to the axis of the semicylindrical tank E, so that the periphery of the coils R R' may move close to the bottom and at a constantly increasing distance from the bottom point to the top of the sides of the tank.

The coils R R' are mounted upon the shaft as near to each other and as numerous as desirable or practicable. In Fig. 2 we illustrate ten sets of such coils, and in Figs. 1, 3, and 6 coils having five concentric pipes, which we construct of so-called "three-quarter-inch wrought-iron steam-pipe," but we do not limit ourselves to the exact number of coils, nor number of pipes in coils, nor size of pipes, nor to iron as the material of the pipe. The points of connection of the arms of one set of coils with the shaft in relation to those of adjoining sets may be located in continuous lines or in echelon.

In operating upon some substances, when the coils are constructed of iron pipes and fittings there arise reactions injurious to the coils or to the substance, or to both, which we prevent by covering the coils with a protective enamel or its equivalent, and by our method of constructing the coils any or all parts separately or a semicircular coil as a whole may be economically so protected, and with proper instruments and care afterward assembled and mounted upon the shaft without injury to such protective covering, and the joints, when necessary, protected by a suitable luting or cementing material.

The pipes J and G and coils R R' all combined are, by means of a moving belt applied to pulley N, caused to rotate at suitable speed in the direction shown by curved arrows in Figs. 1, 3, and 6, thereby continuously exposing films of the substance operated upon to the evaporative influences of air and the heat of steam or hot water circulating within

the coils and discharging water through outlet-arms Q Q'.

The vapors arising when the evaporator is in operation should be led away to the open air through a ventilating-hood.

We are aware of the construction shown in patent granted to Kimball and Sawyer April 19, 1859, No. 23,689, for a grain-drier. Our invention differs therefrom in both construction and purpose, and we do not, therefore, desire to claim as our invention any construction therein shown or claimed, but we do desire to claim only that which we believe to be novel and peculiar to our invention as shown herein.

We are also aware of the construction shown in Patent No. 364,908, granted June 14, 1887, to Geo. A. Dandt, for a coil for heating evaporating-pans, and also that shown in Patent No. 386,579, granted July 24, 1888, to G. Engsl, for improvements in heating-coils of vacuum-pans. In these instances the coils are stationary and arranged to be submerged beneath and designed to cause ebullition of the liquid operated upon, and the mechanical construction and arrangement of the coils are unlike that in our invention and we do not intend to claim as our invention any construction therein shown or claimed, but we do desire to claim that which we believe is novel and peculiar to our invention as set forth herein.

We are also aware of the construction shown in patent granted to P. J. Badoux June 9, 1868, No. 78,639, for a rotary evaporator, and we do not intend to claim as our invention any construction therein shown or claimed.

In our invention the construction, arrangement, and form of the pipes forming the evaporating-surfaces are essentially different and novel. In the Badoux evaporator the spirals arranged horizontally have a noisy, whipping, and beating action upon the substance operated upon, causing it to become objectionably filled with air-vesicles, and the spirals are never completely free from water of condensation, except when high-pressure steam is used. In our invention the pipes being arranged to rotate in vertical planes are completely discharged of water of condensation at every revolution, are adapted to the effective use of low-pressure steam or of the exhaust of a steam-engine, and operate smoothly and noiselessly. We desire to claim only that which we believe is novel and peculiar to our invention.

We are aware that prior to our invention it was not new to construct evaporators with surfaces rotating in and out of liquids placed in open vessels, and that such apparatus have been proposed and used wherein such surfaces, non-heated, have been subjected to currents of heated air. In other cases the moving surfaces have been heated from within. In some cases the contents of the open vessels have been heated by various methods; and we are aware that pipes have been used

for evaporating-surfaces in rotary evaporators, and we do not, therefore, broadly claim to evaporate substances by such means unless the apparatus be constructed and combined as herein described.

What we do claim as our invention, and desire to secure by Letters Patent, is—

1. In a rotary evaporator, the horizontal shaft consisting of an exterior pipe which has one end closed and is provided with any desirable number of diametrically opposite openings, points for attachment of and through which pass a like number of inlet-arms, and is provided also with a like number of diametrically opposite openings, points for attachment of and through which pass a like number of outlet-arms, in combination with an interior pipe which has one end closed and the other end connected by a gland to a stationary pipe and is provided with any desirable number of diametrically opposite openings coincident with like openings in the exterior pipe, points for attachment of the inlet-arms that have been passed through the coincident openings in the exterior pipe, substantially as described and for the purpose set forth.

2. In a rotary evaporator, the combination of the shaft consisting of pipes G and J provided with openings as described, the diametrically opposite inlet-arms and diametrically opposite outlet-arms extending from said shaft and the concentric pipes connecting said inlet with said outlet arms, substantially as described and for the purpose set forth.

3. In a rotary evaporator, the inlet-arm extending from pipe J, through pipe G to connect with a series of concentric pipes, said arm consisting of a combination of a reversed curved portion of pipe immediately attached to pipes J and G and an extended portion composed of pipe and suitable pipe-fittings, having the faces of the fittings at the points of connection with the concentric pipes, lying in a plane cutting said pipes J and G diametrically and lengthwise thereof substantially as described.

4. In a rotary evaporator, the outlet-arm extending from near the outer circumference of pipe J through pipe G to connect with a series of concentric pipes, said arm consisting of a combination of a reversed curved portion of pipe immediately attached to pipe G, and an extended portion composed of pipe and suitable pipe-fittings, having the faces of the fittings at the points of connection with the concentric pipes, lying in a plane cutting said pipes J and G diametrically and lengthwise thereof, substantially as described.

5. In a rotary evaporator, the combination of the inlet-arms P P' attached to and extending radially from the inner circumfer-

ence of pipe J through pipe G, the outlet-arms Q Q' attached to pipe G and extending radially from near the outer circumference of pipe J, and the connecting concentric pipes R R', said concentric pipes being arranged in a vertical plane in relation to the horizontal pipes J and G and designated to rotate in a vertical plane, substantially as described and for the purpose set forth.

6. In a rotary evaporator, the combination of the inlet-arm P attached to and extending radially from the inner circumference of pipe J through pipe G, and the outlet-arm Q attached to pipe G and extending radially from near the outer circumference of pipe J, the said arms P, Q, being caused to diverge as they emerge from pipe G by an angle of forty degrees, more or less, according to the size of pipe used, then bent toward each other until they nearly touch, then bent away from each other until they again diverge by an angle of twenty-five degrees more or less according to the size of pipe used, thus causing the faces of the fittings on arm P to which the concentric pipes R' are attached, and the faces of the fittings on arm Q to which the concentric pipes R are attached, to lie in planes cutting the pipes J and G diametrically and lengthwise thereof, substantially as described and set forth.

7. In a rotary evaporator provided with contiguous divergent inlet and outlet arms extending from a horizontal hollow shaft and connected to other contiguous divergent outlet and inlet arms by concentric pipes arranged in the same vertical plane, extending the concentric pipes across the space between said divergent arms by means of suitable pipe-fittings and short pieces of pipe, substantially as described and set forth.

8. In a rotary evaporator, the combination of the double hollow horizontal shaft consisting of pipes J and G, the evaporative coils mounted thereon in vertical planes consisting of inlet and outlet arms P Q' and inlet and outlet arms P' Q and connecting concentric pipes R' R, the semicylindrical tank with its supporting-frame, the bearings supported upon said frame and suitable for said shaft, and means for causing the rotation of said shaft and evaporative coils, whereby films of the substance operated upon may be exposed to the air and rapidly evaporated, substantially as described.

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