

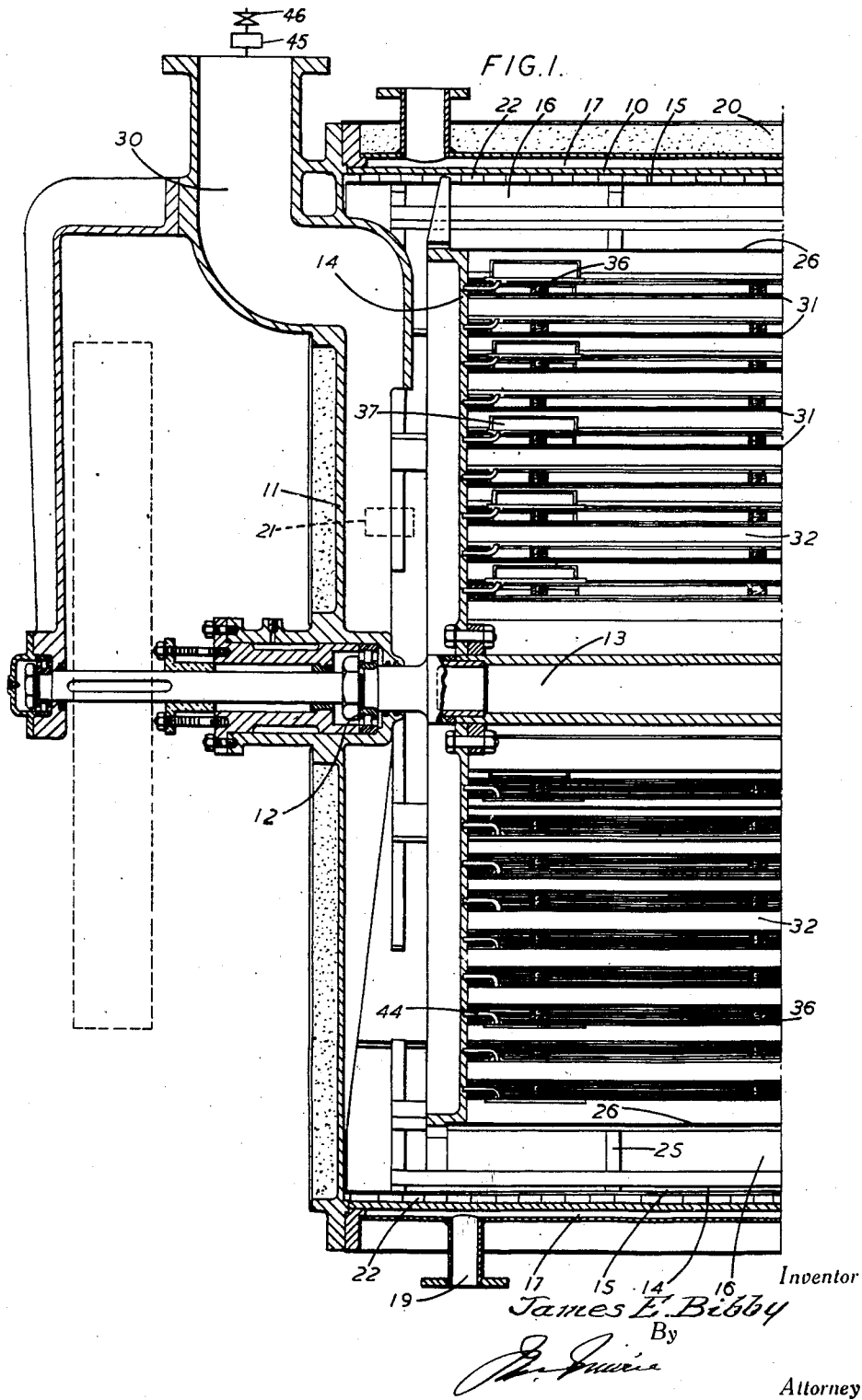
Jan. 3, 1950

J. E. BIBBY
ROTARY DRUM EVAPORATOR WITH CONCENTRIC
EVAPORATING CHAMBERS

2,493,220

Filed Aug. 15, 1946

4 Sheets-Sheet 1



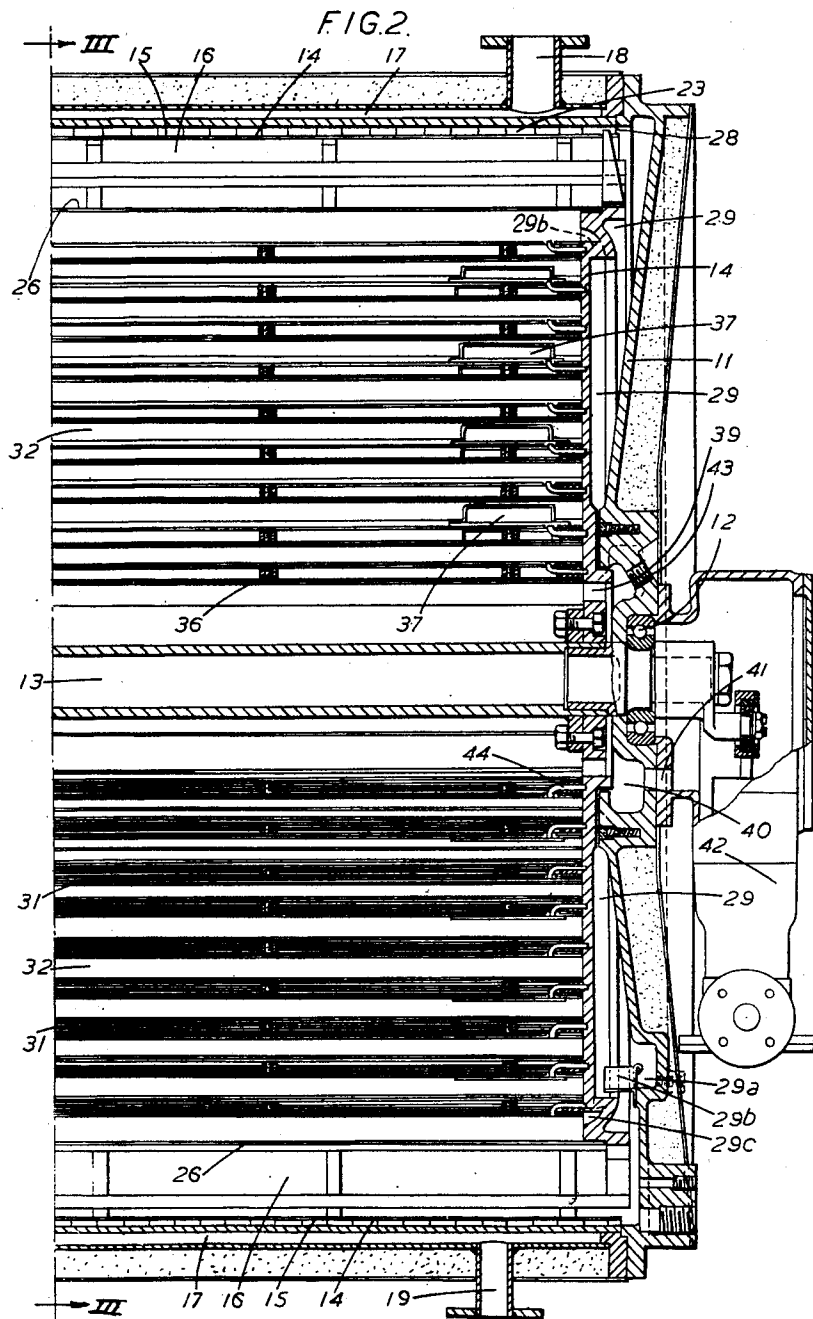
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James E. Bibby ^{Inventor}

By *[Signature]*

Attorney

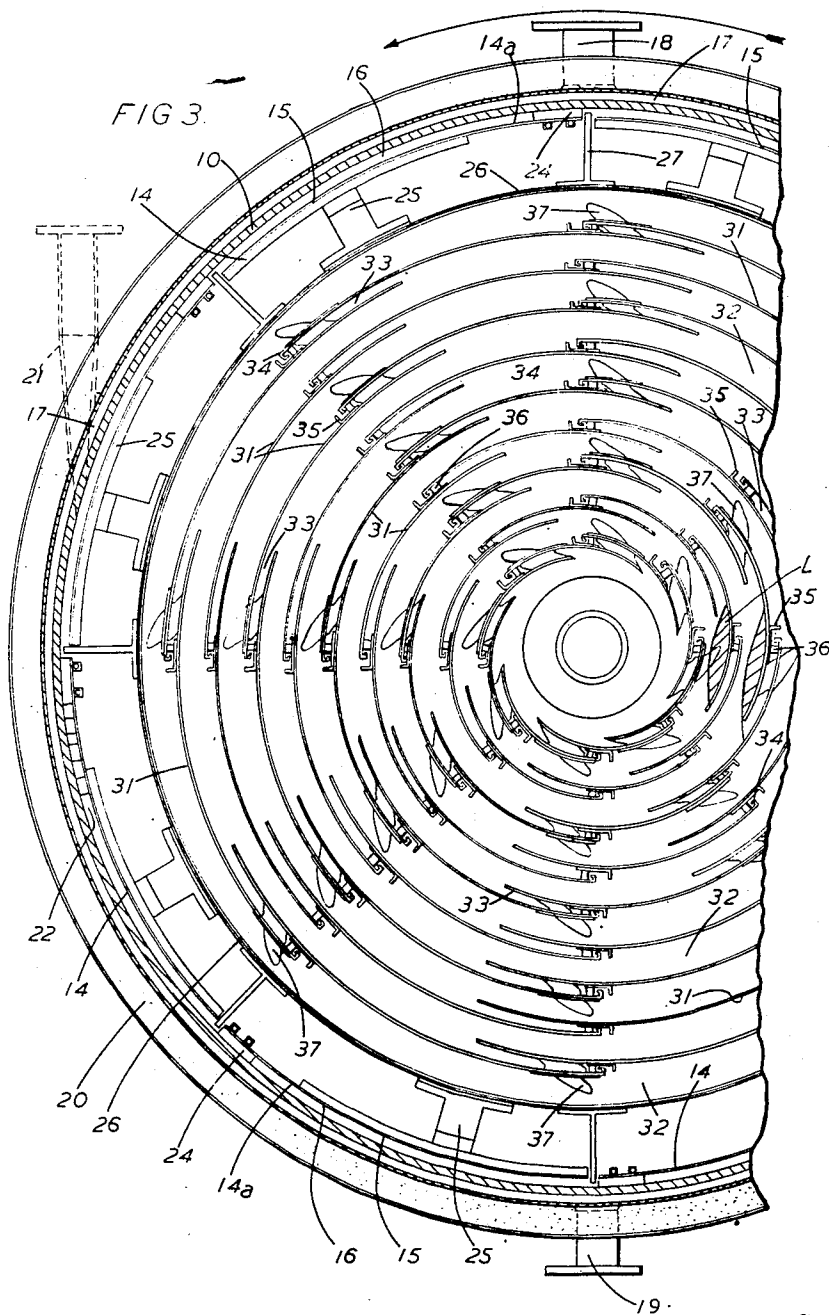
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James E. Bibby Inventor

By
J. E. Bibby

Attorney

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4 Sheets-Sheet 4

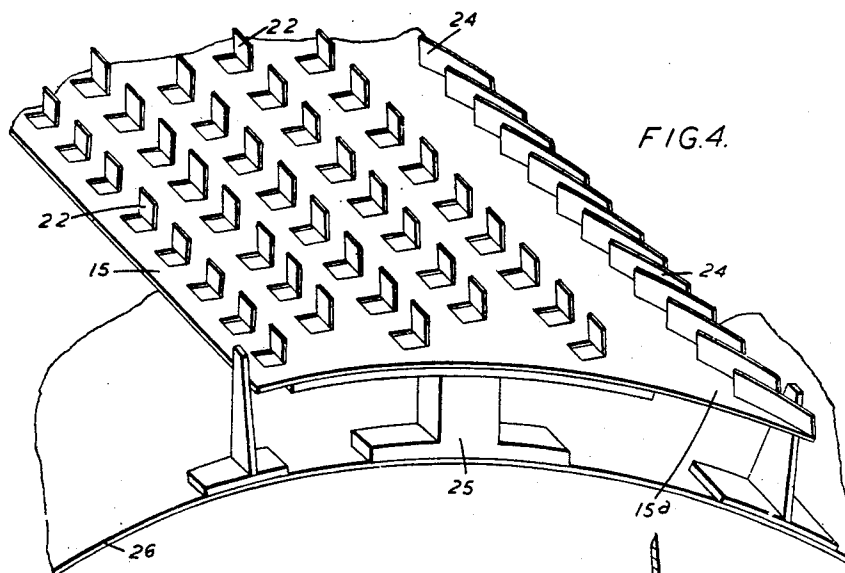


FIG. 4.

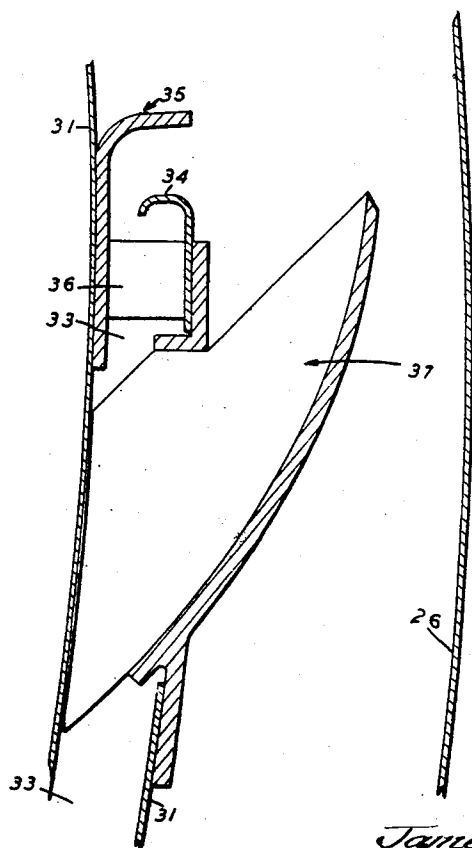


FIG. 5.

Inventor
James E. Bibby
By
J. E. Bibby
Attorney

UNITED STATES PATENT OFFICE

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ROTARY DRUM EVAPORATOR WITH CONCENTRIC EVAPORATING CHAMBERS

James Edward Bibby, Birkenhead, England, assignor to J. Bibby & Sons Limited, Liverpool, England, a British company

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In Great Britain September 5, 1945

7 Claims. (Cl. 202-236)

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This invention is for improvements in or relating to evaporators of the kind adapted to be used for the separation or extraction, by evaporation, of one liquid from another, and as also disclosed in applicant's co-pending application, Serial No. 690,765 filed concurrently herewith.

One object of the invention is to provide a machine which is especially suitable for use with liquids having a tendency to foam or froth during evaporation, or liquids containing small quantities of finely divided solids.

A highly successful application of the invention is to a machine for the treatment of oil which has been extracted by means of solvents, the machine being used after the extraction process has been completed to separate and recover the solvents from the oil. A further application of the invention is to a machine for the deodorization and like treatment of oils, e. g. palm oil, cotton seed oil, soya bean oil and the like.

According to the present invention there is provided an evaporator comprising a casing having a heating jacket, a drum or like member in said casing and having its peripheral surface spaced from the interior of the casing to form an evaporation chamber, either or both the casing and the drum being relatively rotatable, inlet means for introducing liquid to be treated (e. g. oil and solvent) into said evaporation chamber and an outlet for the evaporate (e. g. solvent).

In the preferred embodiment of the invention the casing is stationary and the drum is rotated. Due to the rotation of the drum, onto the surface of which the mixture of oil and solvent is fed, centrifugal force acts to maintain a skin or film of the liquid on the interior face of the casing or heating jacket so that said film is rapidly heated and the solvent evaporated. Preferably there are blades in the evaporation chamber which serve continuously to change the surface of the liquid in contact with the heating surface. This results in a rapid and highly efficient transfer of heat from the heating jacket to the liquid. The film of liquid may be traversed along the length of the casing, in contact with the heating jacket, by a series of angularly disposed plates or blades which work in the evaporation chamber. Conveniently some, at least, of the blades are arranged to scrape the interior face of the casing.

To provide a "second-stage" evaporator, the interior of the rotatable drum-like member may be divided by radially spaced circumferential partitions into a plurality of annular chambers. The innermost chamber has an inlet for steam or other gaseous media (hereinafter referred to as steam) and an outlet for residual liquid and the outermost chamber has an inlet for the liquid to be treated further (say, oil and solvent) and an outlet for the steam, or vice

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versa. Transfer means are provided in the partitions for the transfer of oil and solvent from one chamber to the next, said transfer means including a scoop-like member which receives, or gathers, the oil and solvent, from the body of cascading oil and solvent built up at one side of each chamber due to the rotation thereof, and transfers it to the next chamber. This process of transfer continues from annular chamber to annular chamber until the oil and solvent have passed from the outermost chamber to the innermost chamber (or vice versa) via a very long path and in contact with and, at least in part, counter-current to the steam. Due to this long path of flow in the form of a rapidly moving cascade the steam evaporates and carries off with it the solvent in an efficient and effective manner and leaves the oil substantially, if not completely, free of solvent. Preferably the transfer of oil and solvent from one annular chamber to another takes place alternately at opposite ends of the chambers so as further to increase the distance the oil and solvent have to flow counter-current to the steam.

Preferably each of the aforementioned partitions comprises at least two and preferably more arcuate elements or plates spaced apart or staggered radially to form apertures or passages in said partitions for the transfer of steam and evaporated solvent from one chamber to the next via a sinuous path and counter-current, at least in part, to the oil and solvent.

The combination of a primary evaporator having a steam jacket and rotating drum-like member, forming an evaporating chamber, and a secondary evaporator comprising a series of annular chambers as just described, provides a particularly compact and efficient machine.

One specific embodiment of the invention as applied to an evaporator for the evaporation and recovery of solvent from oil will now be described by way of example with reference to the accompanying drawings, the figures of which are semi-diagrammatic in character. On the drawings:

Figures 1 and 2 are complementary views showing the machine in sectional elevation, the section being taken vertically through the axis of the machine;

Figure 3 is a cross-section on the line III—III of Figure 2;

Figure 4 is a fragmentary detail perspective view of a part of the scraper construction for the primary evaporator part of the machine, and

Figure 5 is a fragmentary detail sectional view of the scoop construction which forms a part of the secondary evaporator part of the machine.

The machine comprises a cylindrical casing 10 closed at its ends by end plates 11 having centrally located bearings 12 for supporting a ro-

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tatable shaft 13. A drum 26 is located within the casing 10 and is spaced from the interior thereof to form an annular evaporation chamber 16. The drum 26 is supported by end plates 14 fixed on the shaft 13. The shaft 13 also carries, for rotation with it, a cylindrical drum-like bladed member comprising a sheet metal peripheral surface, built up from arcuate sections 15, supported by spaced brackets 25, from the drum 26. A steam or other heating jacket 17 (hereinafter called a steam packet) surrounds the casing, this steam jacket being provided with an inlet 18 for steam and with the necessary drainage means 19 and the like. The steam jacket is lagged, as indicated at 20, to prevent loss of heat. An inlet 21 for the mixture of oil and solvent is provided at one end of the casing 10 and enters the aforementioned evaporation chamber 16 tangentially with respect to the drum-like member 14, 15. Rows of radially projecting blades 22 are punched up out of the arcuate sections of the bladed structure 15 of the drum. There are also blades 24 or like members resiliently mounted on the arcuate sections 15 and pressed into contact with the interior surface of the casing 10 so as to scrape said surface. The blades 22 and 24 ensure changing of the liquid film on said interior surface continuously and this promotes rapid evaporation. The blades 24 are inclined with respect to the plane of rotation of the drum so that as the drum rotates the liquid is traversed along the evaporation chamber 16 towards the end 23 thereof remote from the inlet 21 for oil and solvent. It will be noted that the arcuate sections overhang their supporting brackets 25 as indicated at 15a to provide the required resilient support for the blades 24. The end of the evaporation chamber 16, remote from the inlet 21, is open as indicated at 28 and the oil and any remaining solvent therein pass from the primary or first-stage part of the machine via this opening into an annular cavity 29, between the end plates 11 and 14, from which it flows to the secondary evaporator part of the machine hereinafter described, by way of a transverse collecting tray 29a, a spout 29b, and an opening 29c in the right-hand end plate 14. Solvent evaporated off from the mixture of solvent and oil in the evaporation chamber 16 finds its way to, and passes from, the machine via an outlet duct 30 at the end thereof remote from that at which the oil is discharged.

The secondary evaporating part of the machine is housed within the drum 26 and comprises a series of radially spaced circumferential partitions 31 secured at their ends in the end plates 14 and located concentrically one within the other so as to divide the interior of the drum into a plurality of annular chambers 32.

Each of the annular partitions 31 comprises several arcuate-plate sections, the ends of which overlap, the sections being displaced or staggered radially with respect to one another so that where they overlap a passage-way 33 is formed for the flow of steam and evaporated liquid (e. g. solvent) from one chamber to the next. The axially extending edges 34 of the plates in the neighbourhood of said passages are turned inwardly whilst baffles 35 are located just ahead of the exit ends of said passages so that steam flowing from the passages issues in a radial direction. The arcuate sections of each partition 31 are maintained in their radially spaced relationship by spacing pieces 36. Each partition 31 carries several radial projecting scoop-like members 37 which open into the passage-ways 33 for the

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transfer of oil and solvent from one annular chamber 32 to the next. These scoop-like members are located alternately at opposite ends of the chambers.

The outermost of the annular chambers 32 communicates with the opening 29c by which the partially treated oil is discharged from the primary evaporator part of the machine above described. The innermost of the annular chambers 32 communicates with an opening 38 in the right-hand plate 14, which opening in turn communicates with a sump 40 for receiving the oil after final treatment, the oil passing from the sump, via a port 41, to a pump 42 by which it is discharged from the machine. An inlet 43 is provided for the injection of steam into the innermost of the chambers 32 via the port 39.

The operation of the machine above described is as follows:

The mixture of oil and solvent from which the solvent is to be extracted and recovered is introduced, via the inlet 21, into the primary evaporation chamber 16 and, due to the rotation of the drum member 14, 15 and centrifugal force and the blades 22 and 24, is caused to become a rapidly moving and changing film on the interior face of the casing 10 of the steam jacket 17. In its passage from one end of the evaporation chamber 16 to the other the liquid is heated and a part, at least, of the solvent is driven off and passes from the machine to a condenser via the aforementioned vapour outlet 30. The liquid oil passes from the primary evaporation chamber 16 to the outermost of the annular chambers 32 of the secondary evaporator and, due to the rotation of the inner drum and partitions 31, builds up as a segment-like body of cascading liquid to one side of the drum. When this body of liquid reaches a predetermined thickness some of it is gathered by, or cascades into, the scoops 37 on the neighbouring partition and is transferred into the next annular chamber 32 where it again builds up into a segment-like body of cascading liquid at one side of the chamber 32. This liquid in turn is gathered in the scoops 37 of the neighbouring partition and transferred to the next chamber 32. This procedure is carried on right through the several annular chambers and inasmuch as the scoops are arranged alternately at opposite ends of the drum the liquid flows sinuously through the several chambers from the outermost to the innermost. The manner in which the liquid builds up at one side of each chamber is indicated diagrammatically at L in Figure 3. Whilst this flow of oil and solvent is taking place in the one direction through the chambers 32, steam is flowing in the opposite direction through said chambers and is evaporating and taking up the remaining solvent from the oil and carrying it away via the aforementioned vapour outlet 30. It is appropriate to mention that the open mouths of the scoops 37 and the steam outlets 39 from the chambers 32 "lead" with respect to the direction of rotation of the chambers, the direction of rotation being indicated by the arrow in Figure 3. The segment-shaped body L of liquid at one side of each annular chamber 32 tends, of course, to remain stationary relatively to the rotating structure once it has been built up to a height and thickness consistent with the speed of rotation but in actual fact the liquid cascades, in the opposite direction to that in which the chambers 32 rotate, in the neighbourhood of the free surface of the liquid. The stage at which liquid is trans-

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ferred from one annular chamber 32 to the next depends, of course, on the position of the scoops 37, i. e. the spacing of the scoops from the neighbouring partition 31 from which they gather the liquid.

It is convenient, in order to facilitate assembly of the several elements forming a partition 31, to secure such elements to the end plates of the drum by means of bolt-like devices 44 which are slid into holes in the end plates 14 and are trapped against being removed therefrom, as each succeeding partition element or plate is located in position.

In some cases the secondary evaporation part of the machine may be dispensed with, whereas in other cases the secondary part may comprise a machine separate from (i. e. not within) the primary part. A machine of this character forms the subject-matter of our co-pending application for Patent No. 690,765 filed August 15, 1946 now Patent 2,484,445 granted October 11, 1949.

A condenser and suction apparatus are generally connected to the machine as indicated diagrammatically at 45 and 46 respectively in Figure 1. For certain purposes (e. g. for the deodorization of oils) it is desirable to maintain a high degree of vacuum in the machine.

In some cases the passage-ways 33 may be closed entirely, or be dispensed with, in the neighbourhood of the spacing pieces 36. In such an arrangement the steam flows counter-current to the oil by way of the scoops 37.

I claim:

1. An evaporator, comprising a casing, a cylindrical drum rotatably mounted in said casing with its axis of rotation horizontal and having its peripheral surface spaced from the interior surface of the casing to provide an evaporation chamber between said surfaces, a heating means for said chamber, inlet means for introducing liquid to be treated into said evaporation chamber, an outlet for vapor, discharge means for residual liquid and blades on the drum working on the interior surface of the casing, some at least of the blades extending in a slantwise direction around and along the peripheral surface of the drum, spaced apart apertured circumferential partitions within the drum dividing it into a series of annular chambers, means connecting the evaporation chamber to the outermost annular chamber for the passage of residual liquid thereto, at least one scoop on each partition and in register with an aperture therein for scooping up liquid from a body of liquid thrown by centrifugal force due to the speed of rotation of the drum against the outer peripheral surface of an annular chamber, said scoop transferring the liquid inwardly to the next inner chamber as the drum rotates, means for passing steam through the annular chambers, an outlet for vapor and an outlet in the innermost chamber for residual liquid.

2. An evaporator, comprising a casing, a cylindrical drum rotatably mounted in said casing with its axis of rotation horizontal and having its peripheral surface spaced from the interior surface of the casing to provide an evaporation chamber between said surfaces, heating means for said chamber, inlet means for introducing liquid to be treated into said evaporation chamber, an outlet for vapor, discharge means for residual liquid, blades projecting outwardly from arcuate plates mounted on the drum concentrically therewith, some at least of the arcuate plates having a resilient part which carries the scraper blades and maintains them operative to scrape the interior

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surface of the casing, some at least of the blades extending in a slant-wise direction around and along the peripheral surface of the drum to cause the liquid to move along the evaporation chamber, spaced-apart apertured circumferential partitions within the drum concentrically arranged and dividing the interior of the drum into several annular chambers, means connecting the evaporation chamber to the outermost annular chamber for the passage of residual liquid thereto, means for discharging the residual liquid from the innermost annular chamber, means for passing steam through each of the annular chambers in turn countercurrent to the liquid, an outlet means for vapor from the annular chambers and at least one scoop on each partition and in register with an aperture therein for scooping up liquid from a body of liquid thrown by centrifugal force due to the speed of rotation of the drum and lying against the outer peripheral surface of an annular chamber and transferring the liquid inwardly to the next inner chamber as the drum rotates.

3. An evaporator, comprising a casing, a cylindrical drum rotatably mounted in said casing with its axis of rotation horizontal and having its peripheral surface spaced from the interior surface of the casing to provide an evaporation chamber between said surfaces, heating means for said chamber, inlet means for introducing liquid to be treated into said evaporation chamber, an outlet for vapor, discharge means for residual liquid, blades projecting outwardly from arcuate plates mounted on the drum concentrically therewith, some at least of the arcuate plates having a resilient part which carries the scraper blades and maintains them operative to scrape the interior surface of the casing, some of the blades being arranged in several axially extending rows, the blades in one row being staggered with respect to the blades in a neighboring row, and other blades extending in a slant-wise direction around and along the peripheral surface of the arcuate plates, spaced-apart apertured partitions within the drum concentrically arranged and dividing the interior of the drum into several annular chambers, means connecting the residual liquid discharge means in the evaporation chamber to the outermost of the annular chambers, means for discharging the residual liquid from the innermost annular chamber, means for passing steam through each of the annular chambers in turn countercurrent to the liquid, an outlet means for the vapor from the annular chambers and at least one scoop on each partition and in register with an aperture therein for scooping up liquid from a body of liquid thrown by centrifugal force due to the speed of rotation of the drum against the outer peripheral surface of an annular chamber and transferring the liquid inwardly to the next inner chamber as the drum rotates.

4. An evaporator as claimed in claim 1, wherein the partitions forming the annular chambers each comprises several imperforate arcuate sections spaced apart radially and overlapped at their ends to form the apertures for the flow of vapor from one annular chamber to the next.

5. An evaporator as claimed in claim 2, wherein the partitions forming the annular chambers each comprises several imperforate arcuate sections spaced apart radially and overlapped at their ends to form the apertures for the flow of vapor from one annular chamber to the next, baffles being provided where one annular cham-

ber communicates with another for the passage of vapor.

6. An evaporator, comprising a casing, a cylindrical drum rotatably mounted in said casing with its axis of rotation horizontal and having its peripheral surface spaced from the interior surface of the casing to provide an evaporation chamber between said surfaces, a heating means for said chamber, inlet means for introducing liquid to be treated into said evaporation chamber, an outlet for vapor, discharge means for residual liquid, blades projecting outwardly from arcuate plates mounted on the drum concentrically therewith, some at least of the arcuate plates having a resilient part which carries the scraper blades and maintains them operative to scrape the interior surface of the casing, some of the blades being arranged in several axially extending rows, the blades in one row being staggered with respect to the blades in a neighboring row, other blades extending in a slant-wise direction around and along the peripheral surface of the arcuate plates to cause the liquid to move along the evaporation chamber from the liquid inlet means to the residual liquid discharge means, the latter being displaced along the chamber with regard to said liquid inlet means, spaced-apart partitions comprising several imperforate arcuate sections spaced apart radially and overlapped at their ends, said partitions being concentrically arranged and dividing the interior of the drum into several annular chambers and providing apertures for the flow of vapor from one annular chamber to the next, means connecting the residual liquid discharge means in the evap-

oration chamber to the outermost of the annular chambers, means for passing steam through each of the annular chambers in turn countercurrent to the liquid, outlet means for the vapor from the annular chambers and at least one scoop on each partition arranged alternatively at the right and left hand ends of the partitions and in register with apertures between overlapping arcuate plates for scooping up liquid from a body of liquid thrown by centrifugal force due to the speed of rotation of the drum against the outer peripheral surface of an annular chamber and transferring the liquid inwardly to the next inner chamber as the drum rotates.

7. An evaporator as claimed in claim 6, wherein baffles are provided where one annular chamber communicates with another for the passage of vapor.

JAMES EDWARD BIBBY.

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