

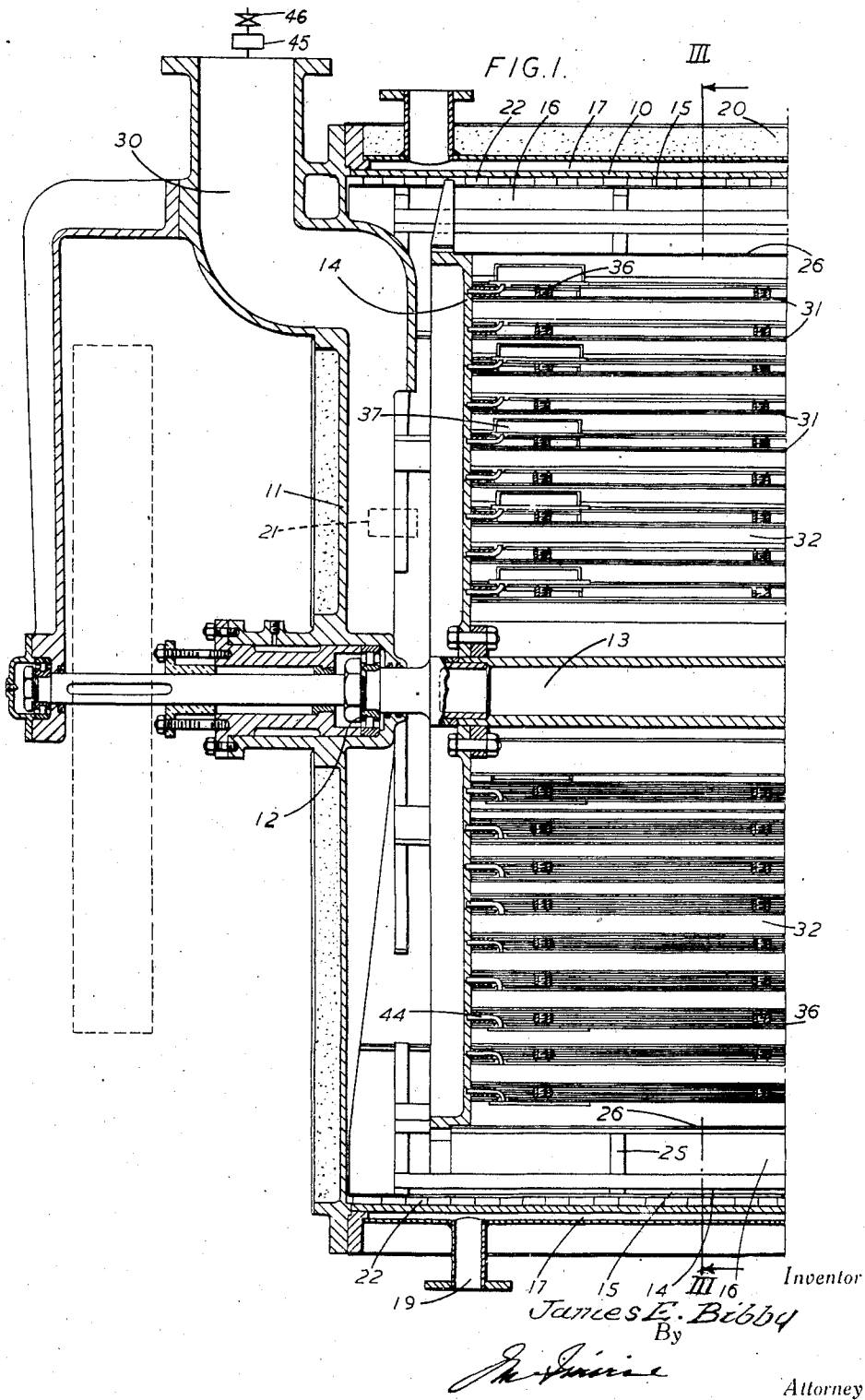
Oct. 11, 1949.

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

2,484,445

Filed Aug. 15, 1946

4 Sheets-Sheet 1



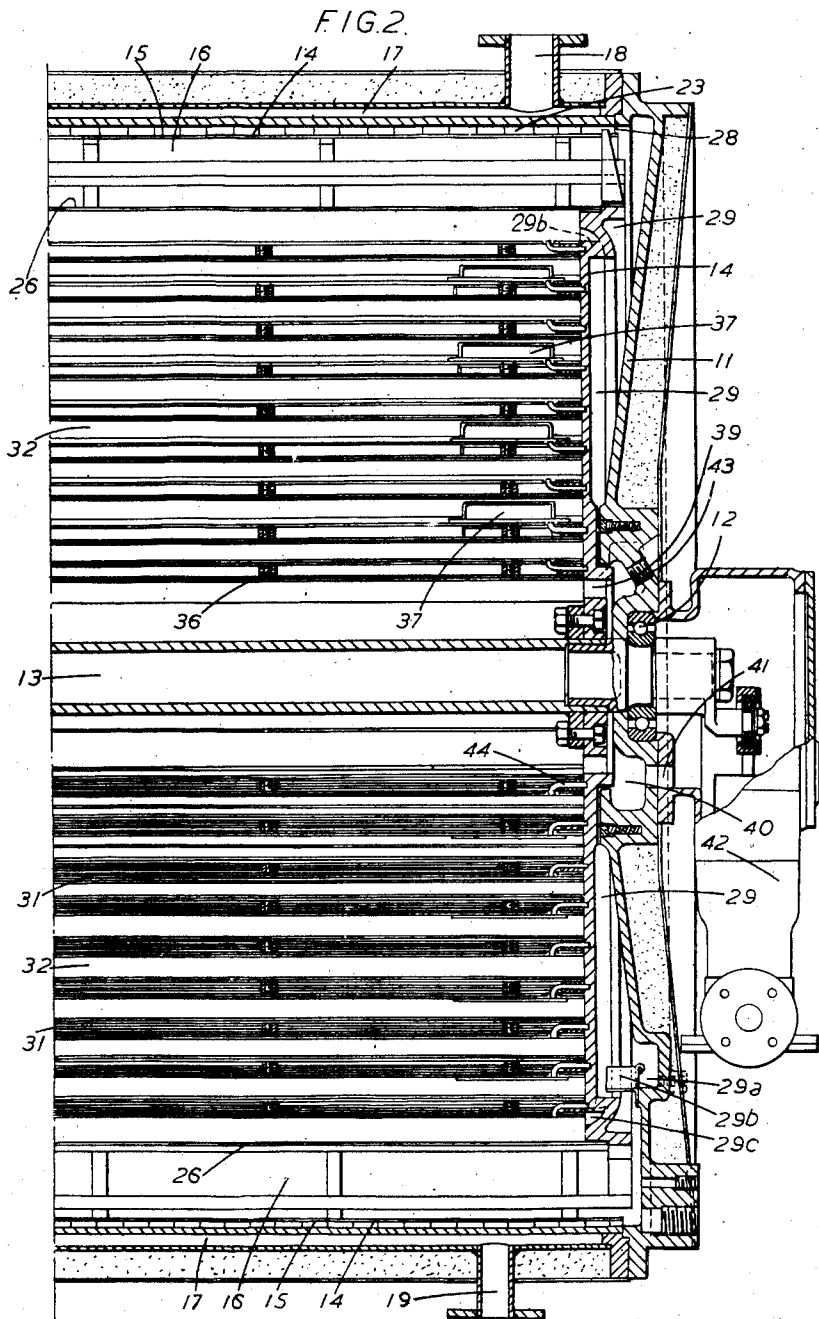
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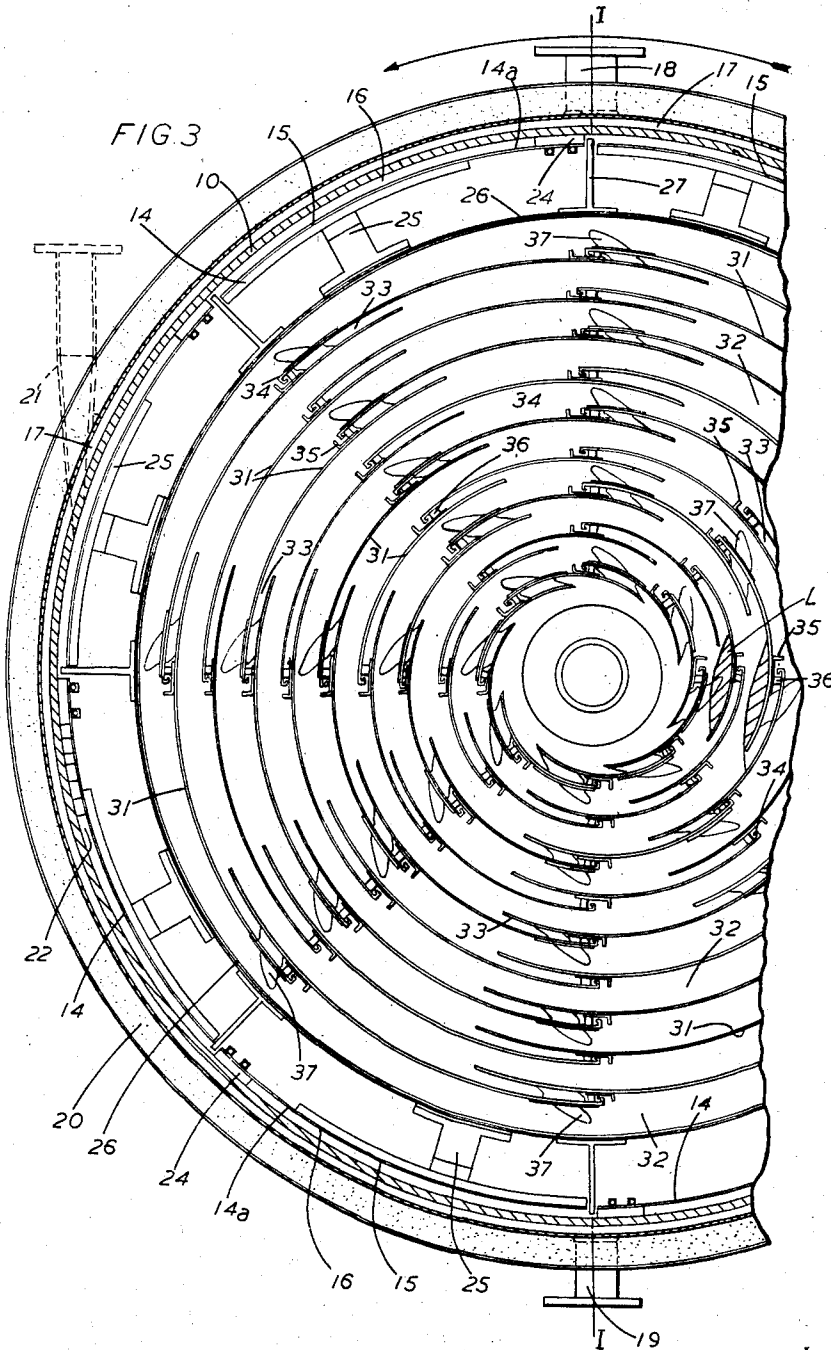
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4 Sheets-Sheet 4

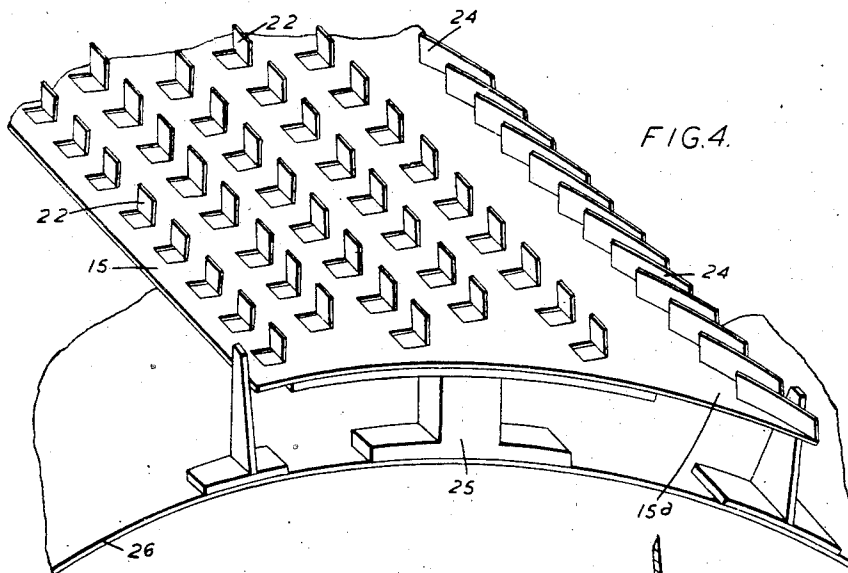


FIG. 4.

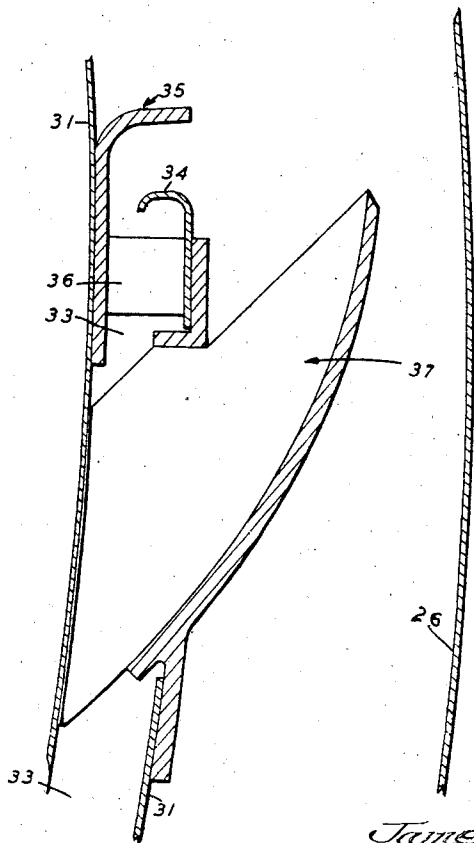


FIG. 5.

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UNITED STATES PATENT OFFICE

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ROTARY DRUM EVAPORATOR WITH CON-
CENTRIC EVAPORATING CHAMBERSJames Edward Bibby, Birkenhead, England, as-
signor to J. Bibby & Sons Limited, Liverpool,
England, a British companyApplication August 15, 1946, Serial No. 690,765
In Great Britain September 5, 1945

9 Claims. (Cl. 159—9)

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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. 690,764 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 rotatable drum, spaced-apart partitions within said drum and arranged one within the other so as to divide the interior of the drum into a plurality of annular chambers, an inlet for introducing liquid to be treated into at least one of said chambers, at least one transfer means or scoop on each partition for receiving or scooping-up liquid from one annular chamber and transferring it to the next as the drum rotates, means for passing steam or like evaporating medium through the annular chambers, an outlet for the steam and the evaporate and an outlet for the residual liquid.

According to a further feature of the present invention there is provided an evaporator comprising a rotatable drum, spaced-apart partitions within said drum and arranged one within the other so as to divide the interior of the drum into a plurality of annular chambers, an inlet in the outermost chamber for liquid to be treated and an outlet for the residual (i. e. treated) liquid in the innermost chamber, or vice versa, at least one transfer means or scoop on each partition for receiving or scooping-up liquid from one annular chamber and transferring it to the next as the drum rotates, an inlet for steam or like evaporating medium in the innermost chamber and an outlet in the outermost chamber for the steam and evaporate, or vice versa, and means in the partition for the flow of steam and evaporate through the chambers in turn.

The transfer means provided in the partitions receive or scoop-up liquid (e. g. oil and solvent)

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from the body of cascading oil and solvent built up at one side of each chamber, due to the rotation of the drum, 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.

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. On the drawings—

Figures 1 and 2 are complementary views showing the machine in sectional elevation, the section being taken on the line I—I of Figure 3,

Figure 3 is a cross-section on the line III—III of Figure 1,

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 rotatable 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 jacket) 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 23, 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-like 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 neighborhood 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 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 39 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 sinusously through the several chambers from the outermost to the innermost. The manner in which the liquid builds 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 33 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 neighborhood of the free surface of the liquid. The stage at which liquid is transferred 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.

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 neighborhood of the spacing pieces 36. In such an arrangement the steam flows counter-current to the oil by way of the scoops 37.

Whilst the invention has just been described more specifically and by way of example as applied to the combination of primary and secondary evaporator stages, it is to be understood that it is what has been called the secondary stage part of the apparatus with which the present invention is concerned. This part of the apparatus is capable of constituting a useful evaporator in itself. Furthermore, even as a second stage evaporator it need not be located within the primary stage part but may be a quite separate machine.

I claim:

1. An evaporator, comprising a drum rotatably mounted, spaced apart apertured partitions within said drum and arranged one within the other to divide the interior of the drum into a plurality of annular chambers, an inlet means on the outermost chamber for liquid to be treated, an outlet means for the residual liquid on the innermost chamber, means for passing steam through said annular chambers, an outlet means for vapor and at least one transfer scoop on each partition 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 chamber as the drum rotates.

2. An evaporator, comprising a drum rotatably mounted with its axis of rotation horizontal, spaced apart apertured partitions within said drum and arranged one within the other to divide the interior of the drum into a plurality of annular chambers, inlet means on the outermost chamber for liquid to be treated, an outlet means for residual liquid from the innermost chamber, means for passing steam through said annular chambers, an outlet means for vapor, and at least one transfer scoop on each partition and in register with an aperture therein, said scoops being located alternately on the right hand and left hand ends of each partition 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 to the next as the drum rotates.

3. An evaporator, comprising a drum rotatably mounted, spaced apart apertured partitions within said drum and arranged one within the other to divide the interior of the drum into a plurality of annular chambers, an inlet means in the outermost chamber for liquid to be treated and an outlet for the residual liquid in the innermost chamber, an inlet means for steam on the innermost chamber and an outlet means for vapor on the outermost chamber and at least one transfer scoop on each partition 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, comprising a drum rotatably mounted with its axis of rotation horizontal, spaced apart apertured partitions within said drum and arranged one within the other to divide the interior of the drum into a plurality of annular chambers, an inlet means in the outermost chamber for liquid to be treated and an outlet for the residual liquid in the innermost chamber, an inlet means for steam on the innermost chamber and an outlet means on the outermost chamber for vapor, transfer scoops located alternately at the left hand and right hand ends of each partition and in register with apertures 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.

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

6. An evaporator as claimed in claim 2, wherein the partitions forming the annular chambers each comprise several imperforate arcuate sections spaced apart radially and overlapped at their ends to form the apertures for the flow of liquid and vapor from one annular chamber to the next.

7. An evaporator as claimed in claim 1, wherein the partitions forming the annular chambers each comprise several imperforate arcuate sections spaced apart radially and overlapped at their ends to form the apertures for the flow of liquid and vapor from one annular chamber to the next and wherein baffles are located on the partitions slightly in front of the scoops thereon.

8. An evaporator as claimed in claim 4, wherein the partitions forming the annular chambers each comprise several imperforate arcuate sections spaced apart radially and overlapped at their ends to form the apertures for the flow of liquid and vapor from one annular chamber to the next and wherein baffles are located on the partitions slightly in front of the scoops thereon.

9. An evaporator as claimed in claim 1, and further comprising means for applying suction to the annular chambers.

JAMES EDWARD BIBBY.

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