March 27, 1951 G. G. ZAHM 2,546,381

APPARATUS FOR CONCENTRATING LIQUIDS

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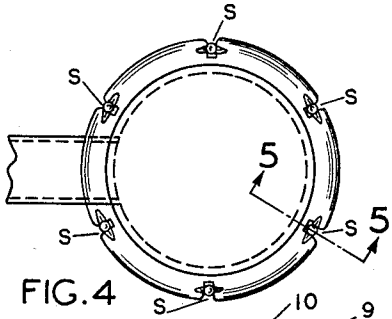


FIG. 4

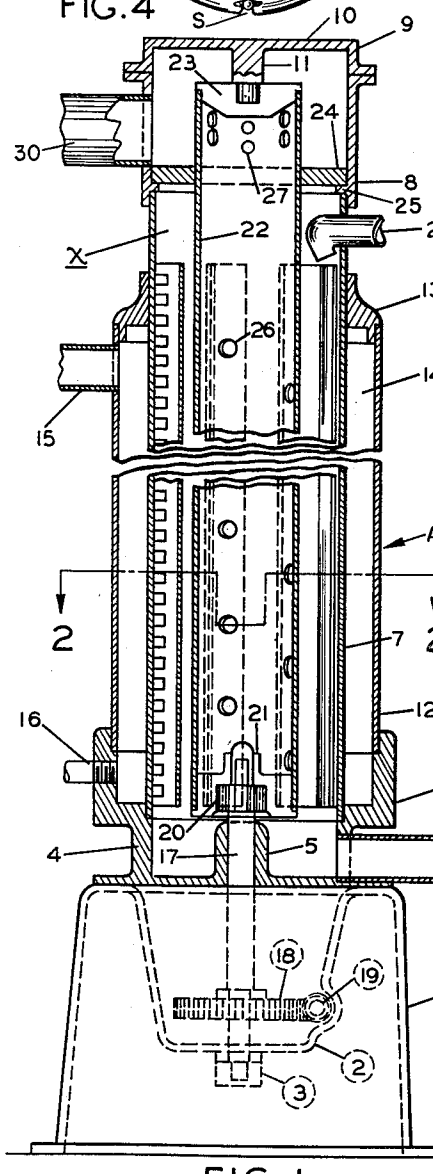


FIG. 1

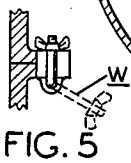


FIG. 5

FIG. 2

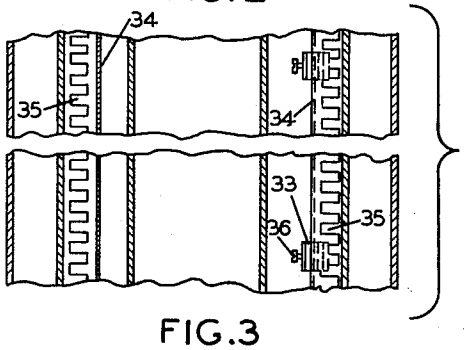


FIG. 3

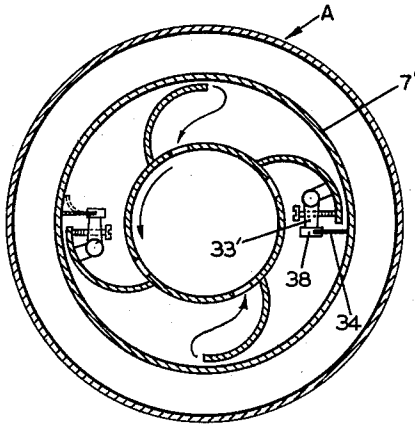


FIG. 6

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APPARATUS FOR CONCENTRATING LIQUIDS

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7 Claims. (Cl. 159—13)

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This invention relates to certain new and useful improvements in apparatus for concentrating liquids and, more particularly, liquids containing organic substances which would be impaired if the liquid were subjected to a high temperature for a considerable period of time.

It is the primary object of this invention to provide apparatus for treating organic solutions and colloidal liquids, whereby the liquid content in the same may be reduced quickly and economically and without impairing the chemical constituency, taste, or quality of the solutions or liquids.

It is a further object of the present invention to provide apparatus of the type and for the purposes stated in which entrainment is substantially eliminated.

It is a further object of this invention to provide means for causing liquids of the type stated to travel over a heat exchange surface under vacuum at high velocity, in a relatively thin film, and without building up a static coating on the heat exchange surface.

The above and other objects will become more fully apparent from the following specification which, by way of illustration rather than limitation, sets forth preferred processes and preferred forms of apparatus constituting embodiments of the present invention, the scope of which is defined in the appended claims.

In the accompanying drawing:

Figure 1 is a fragmentary vertical sectional view of a preferred form of apparatus for practicing my invention;

Figure 2 is a horizontal sectional view of the apparatus taken along line 2—2 of Figure 1;

Figure 3 is a fragmentary sectional view taken along line 3—3 of Figure 2;

Figure 4 is a top plan view of the apparatus;

Figure 5 is a detail sectional view taken along line 5—5 of Figure 4; and

Figure 6 is a horizontal sectional view of a modified form of apparatus constructed in accordance with and embodying the present invention.

In its general organization, A designates a preferred form of apparatus comprising a preferably cast iron base housing 1 having a central depressed gear box 2 provided in its bottom wall with a step-bearing 3. Welded or otherwise secured upon the upper face of the housing 1 in closure-forming disposition across the top of the gear box 2 is an upstanding base ring 4 having a vertical shaft-bearing 5 axially aligned with the

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step-bearing 3, and around its upper peripheral margin the base ring 4 is integrally provided with a diametrally enlarged, upwardly extending collar 6. Shrunk or otherwise suitably secured in the base ring 4, and extending upwardly therefrom in concentric relation to the shaft-bearing 5, is a cylindrical column 7 preferably constructed of copper, stainless steel, or other suitable material, and provided at its upper end with a peripheral flanged head ring 8 having a plurality of uniformly spaced swingable wing bolts *w* for retentive engagement in complementarily located peripheral slots *s* formed in a removable cap or dome 9 preferably of cylindrical form and including a horizontal top wall 10 which is, in turn, provided with a depending pintle or bearing-stud 11 aligned axially with the shaft-bearing 5.

Surrounding the column 7, and fixed at its lower end in the collar 6, is a cylindrical jacket or shell 12, and at its upper end the shell 12 is secured in a closure-collar 13 mounted around the column 7 somewhat below the head ring 8, thus forming an intervening jacket space 14 which is adapted to receive steam or other heating medium for heating the column 7. The steam or other heating agent is preferably supplied to this jacket space 14 by means of a steam supply pipe 15 fixed in and extending through the shell 12 adjacent its upper end, the excess steam and water of condensation being withdrawn from the lower end of the jacket space 14 by a discharge pipe 16 threaded through the collar 6.

Rotatably mounted at its lower end in the step-bearing 3, and projecting upwardly through the bearing 5, is a vertical shaft 17, provided, along the portion of its length within the gear box 2, with suitable driving gears 18, 19, which are conventionally connected to a prime-mover (not shown). At its upper end, the shaft 17 is connected by means of a spline-collar 20 to a hub 21 rigidly mounted in the lower end of a cylindrical impeller tube 22 of substantially smaller diametrical size than the column 7 and extending co-axially upwardly therethrough into the dome 9. At its upper end, the tube 22 is provided with an end plate 23 which rotatably engages the bearing-stud 11, and projecting inwardly at the lower end of the ring 8 is an annular horizontal partition plate 24 centrally bored and provided with a packing ring 25 for glandwise engaging the tube 22. Within the column 7, the tube 22 is provided with four equally spaced vertical lines of apertures 26, and above the partition plate 24, the tube 22 is further provided with a plurality of circumferentially spaced aper-

tures 27, so that the dome 9 communicates directly with the interior of the tube 22, but does not communicate directly with the annular vapor space between the outer face of the tube 22 and the inner face of column 7.

Welded to the outer face of the impeller tube 22 just ahead of each vertical line of apertures 26 (reference being had to the direction of rotation of the impeller tube 22 as shown by the inner arrow in Figure 2) are pairs of diametrally opposed impeller blades 28, 28', which curve outwardly and rearwardly in overlying relation to the associated line of apertures 26 terminating in almost tangential relation to the inner face of the column 7, but having a slight amount of clearance, for purposes presently more fully appearing. Said impeller blades 28, 28', have been more fully set forth in my copending application, Serial No. 575,512, filed January 31, 1945. It should be noted in this connection that the pair of blades 28 is located along a diametral plane at right angles to the diametral line along which the other pair of impeller blades 28' is located. Furthermore, the curvature of the blades 28 is not critical and, for that matter, the blades may have any desired cross-sectional contour, so long as the trailing edge comes into proximity with the inner face of the column 7 along a line substantially to the rear (with respect to the direction of revolution) of the radial line passing through the apertures 26 of such blade. Furthermore, the impeller blades 28 are somewhat shorter in vertical length than the column 7 so as to provide a head space x beneath the partition plate 24, and projecting through the column 7 into this head space x is a supply line 29 bent over at its inner end so as to discharge the stream of the incoming liquids against the inner face of the column 7. Finally, the column 7 is provided with a vacuum-line 30 which extends through the head 8 and a discharge line 31 which extends through the base-ring 4, both being connected, respectively, to conventional high vacuum pumping equipment and liquid storage or packaging equipment (not shown).

Formed integrally with, or otherwise fixed upon the inner faces of, the blades 28, is a vertically aligned series of inwardly projecting hinge posts 32 for swingably supporting scraper elements 33 longitudinally recessed along their outer vertical margins for retentively receiving relatively flexible scraper combs 34 having a plurality of uniformly spaced teeth 35. The teeth 35 of one scraper comb 34 are horizontally located in line with the spaces between the teeth 35 of the other scraper comb 34, so that the liquid material which flows between the teeth 35 of one scraper comb 34 will be picked up by the teeth 35 of the other scraper comb 34, with the result that the film of liquid being evaporated is kept very thin and maintained at high velocity. Furthermore, additional downward velocity is imparted thereto, and the formation of a static coating upon the heat exchange surface of column 7 is prevented. Finally, the scraper elements 33 are provided with a suitable number of set screws 36 which extend radially therethrough for stop-wise engagement against the blade faces, as at 37, thereby permitting the outward movement of the scraper elements under centrifugal force to be limited so that the mechanical pressure applied to the film of liquid may be controlled.

If desired, a modified form of scraper element 33' may be provided, as shown in Figure 6, having, along its outer vertical margin, a rigidly secured blade holder 38 disposed substantially at right angles to the scraper element 33' and provided with a scraper comb 34' substantially similar to the previously described scraper comb 34, except that it is somewhat shorter than the comb 34 and is presented more nearly radially to the inner surface of the column 7, so that somewhat greater scraping pressure may be applied.

In operation, a stream of liquid is admitted through the supply pipe 29 and permitted to flow down by gravity over the inner face of the column 7 while the latter is externally heated by admission of steam to the jacket space 14. As the liquid flows downwardly, a centrifugal motion is imparted to it by the impeller blades 28, 28', and the scraper combs 34, or 34', as the case may be, in the formation of a thin tubular film against the inner face of the column 7.

During its flow from the supply line 29 to the discharge line 31, the stream of liquid is subjected to high vacuum and a substantial portion will pass off as vapor through the apertures 26, as diagrammatically indicated by the outer arrows in Figure 2, the vapor flowing upwardly through the tube 22 and the apertures 27 into the dome 9 and thence into the vacuum line 30. The clearances between the outer edges of the blades 28 and the face of the column 7 permit portions of the liquid to escape from the influence of the blades and form the thin film extending from the rear side of each blade to the front of the next following blade 28. The liquid forming this thin annular layer is subjected to the rapid evaporating effect of the heated column 7 and the production of a static film or coating on the heat exchange surface of column 7 is prevented.

It should be understood that changes and modifications both in the methods, as well as in the form, construction, arrangement, and combination of the several parts, of the apparatus for evaporating or concentrating liquids may be made and substituted for those herein shown and described without departing from the nature and principle of the present invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. For use with a cylindrical concentrating column, the improvement comprising a tubular impeller to be rotatably mounted co-axially within the column, said impeller having a plurality of radially extending rearwardly curved blades, selected ones of said blades being provided with swingable scrapers having straight scraper combs.

2. For use in apparatus for concentrating liquids having impeller blades, the improvement comprising auxiliary scrapers comprising scraper elements hingedly mounted on selected impeller blades, scraper combs secured to the scraper elements, and adjustment means associated with the scraping elements for engagement with the blades for optionally determining the amount of outward swinging movement of the scraper combs during impelling action of the blades.

3. For use in apparatus for concentrating liquids having impeller blades, the improvement comprising auxiliary scrapers comprising scraper elements hingedly mounted on selected impeller blades, scraper combs secured to the scraper elements, and set screws associated with the scraper elements for engagement with the blades for optionally determining the amount of outward swinging movement of the scraper combs during impelling action of the blades.

4. For use in apparatus for concentrating

liquids having outwardly and rearwardly curved impeller blades, the improvement comprising auxiliary scrapers comprising scraper elements hingedly mounted on the inner face of selected blades, set screws extending radially through the scraper elements for stop-wise engagement against the inner face of the blades, said scraper elements being provided with longitudinal recesses along their outer vertical margins, and flexible scraper combs retentively engaged in said recesses.

5. For use in apparatus for concentrating liquids having outwardly and rearwardly curved impeller blades, the improvement comprising auxiliary scrapers comprising scraper elements hingedly mounted on the inner face of selected blades, set screws extending radially through the scraper elements for stop-wise engagement against the inner face of the blades, said scraper elements being provided with longitudinal recesses along their outer margins, and flexible scraper combs retentively engaged in said recesses, said scraper combs being so arranged so that the teeth of one scraper comb will track behind the spaces between the teeth of the other scraper comb immediately preceding it during rotation of the blades.

6. For use in apparatus for concentrating liquids having outwardly and rearwardly curved impeller blades, the improvement comprising auxiliary scrapers comprising scraper elements hingedly mounted on the inner face of selected blades, set screws extending radially through the scraper elements for stop-wise engagement against the inner face of the blades, blade holders rigidly secured along the outer vertical margin of the scraper elements and being disposed substantially at right angles to the scraper elements, and scraper combs secured to the blade holders.

7. For use in apparatus for concentrating liquids having outwardly and rearwardly curved impeller blades, the improvement comprising hinge posts integrally formed upon the inner faces of the blades, scraper elements swingably mounted upon the hinge posts and being recessed along their outer vertical margins, flexible scraper combs retentively engaged in the recesses of the scraper elements and having a plurality of uniformly spaced teeth, said scraper combs being of arcuate transverse cross-section and set screws extending radially through the scraper elements for stop-wise engagement against the inner face of the blades for regulating the amount of outward swinging movement of the scraper combs during impelling action of the blades.

GEORGE G. ZAHM.

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