Feb. 20, 1951 G. G. ZAHM 2,542,269

SCRAPER APPARATUS FOR CENTRIFUGAL EVAPORATORS

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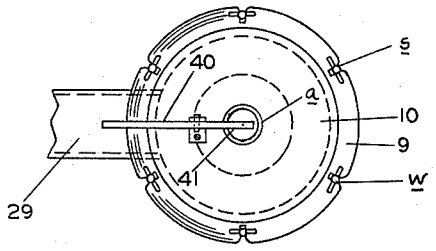

FIG. 4

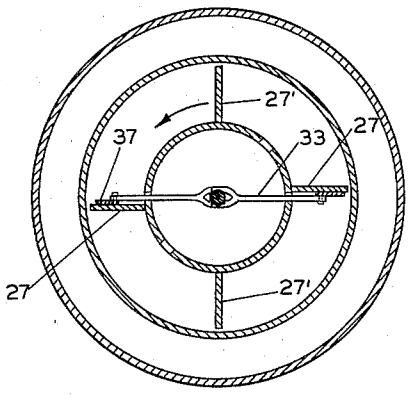

FIG. 2

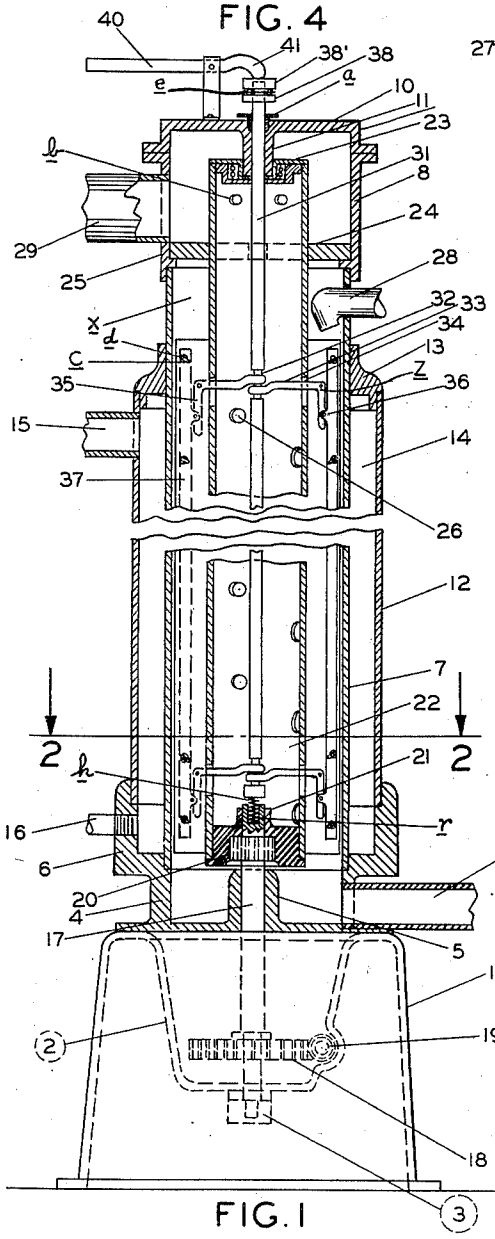

FIG. 1

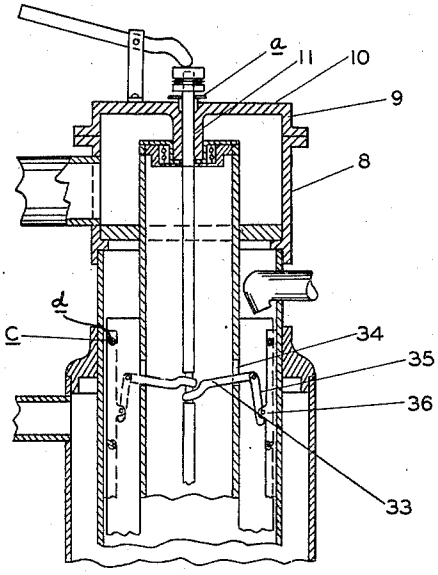

FIG. 3

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SCRAPER APPARATUS FOR CENTRIFUGAL EVAPORATORS

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4 Claims. (Cl. 159—6)

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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 purpose 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 practising my invention;

Figure 2 is a transverse sectional view along line 2—2 of Figure 1;

Figure 3 is a fragmentary sectional view showing the scraper blades in extended position; and

Figure 4 is a top view.

In its general organization, the preferred form of apparatus shown in the drawings comprises a preferably cast iron base housing 1 having a centrally depressed gear box 2 provided in its bottom wall with a step-bearing 3. Welded or otherwise secured upon the 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 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 or other suitable material, having a

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high co-efficient of heat conductivity, and provided at its upper end with a peripherically 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 shaft-bearing 11 aligned axially with the shaft-bearing 5. There is lodged in the upper part of the shaft-bearing 11 a packing-gland *a*.

Surrounding the column 7 and affixed at its lower end in the collar 6 is a cylindrical jacket or shell 12. 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 around the column 7 an annular 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 head 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 a radial double-race ball-bearing 23 concentric with the shaft-bearing 11. 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 gland-wise engaging the tube 22. Within the column 7, the tube 22 is provided with equally spaced vertical lines of apertures 26. Above the partition-plate 24, the tube 22 is further provided with a plurality of circumferentially spaced apertures *b*, so that the dome 9 connects 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 27, 27'. It should be noted in this connection that the pair of blades 27 is located along a diametrical line at right angles to the diametrical line along which the other pair of impeller blades is located. The impeller blades 27 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 28 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 29 which extends through the head ring 8, and a liquid discharge line 30 which extends through the base ring 4, the lines 29 and 30 connected, respectively, to conventional high vacuum equipment and liquid storage or pumping equipment (not shown).

Projecting downwardly through the packing-gland *a* and the shaft-bearing 11, concentrically within the impeller tube 22, is a shaft 31, its lower end terminating above the upper end of the shaft 17 and resting upon a compression spring *h* set axially into and projecting upwardly from a suitable spring-retaining recess *r* formed centrally in the upper end-face of the head 21. The shaft 31 is provided along its length within the impeller tube 22 with a plurality of diametrically reduced portions 32 for receiving the yoked ends *y* of pairs of oppositely extending radial pivot arms 33. Said arms 33 extend through aligned apertures 34 in the wall of the impeller tube 22 and are pivotally mounted, as at *z*, upon the blades 27 and integrally provided with downwardly extending short crank arms 35, the lower ends of which, in turn, are pivotally connected to ears 36 projecting from the inner vertical margin of elongated scraper blades 37. Said scraper blades 37 are positioned to abut surfacewise in a sliding manner against the rearward surfaces of said impeller blades 27 (reference being had to the direction of motion of said impeller blades as shown by the arrow in Figure 2) by means of support pins *d* which are mounted on the impeller blades 27 and extend through angular slots *c* formed in the scraper blades 37 and being so located that the scraper blades 37 will, in retracted position, have their outer vertical margin disposed inwardly of the outer vertical margin of the impeller blades 27.

The upper end of the shaft 31 is provided with a collar 38 provided upon its upper surface with a cap-like thrust-bearing 38' and containing therebetween a conventional ball and ball-retainer assembly *e*. Formed upon the surface 10 of the dome 9 is an upwardly extending radially slotted lug 39 offset from the aperture of the shaft-bearing 11 for rockably supporting a lever 40 provided at its outer extremity with a conventional handle. At its inner end, the lever 40 is provided with a yoke 41, which extends half around the shaft 31 and bears, at diametrally opposite points, under and against the under face of the bearing 38'.

In operation, a stream of liquid is admitted through the supply pipe 28 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 27 in the formation of a thin tubular film against the inner face of the column 7.

During its flow from the supply line 28 to the discharge line 30, the stream of liquid is subjected to high vacuum and a substantial portion will pass off as vapor through the apertures, as diagrammatically indicated by the outer arrows in Figure 2, the vapor flowing upwardly through the tube 22 and the apertures *b* into the dome 9, thence into the vacuum line 29. The clearance between the outer edges of the blades 27 and the walls of the column 7 permit portions of the liquid to escape from the influence of the blades 27 and form a thin film extending from the rear side of each blade to the front of the next following blade 27.

The shaft 31 is rotated by the rotation imparted to the scraper blades 37 from the impeller blades 27. During the operation of the apparatus, it is necessary periodically to remove the thin film which has formed on the walls of the column 7 to prevent said film from hardening thereon and thereby partially insulating the inner part of the column 7 from the heat in the jacket 12. To accomplish this purpose, the lever arm 40 is lowered, freeing the shaft 31 for downward movement, which is caused by the scraper blades 37 moving outwardly through centrifugal action. In moving outwardly, the scraper blades 37 also move upwardly as the support pins *d* are slid to the inner lower ends of the diagonal slots *c*, the length of the slots *c* thus controlling the amount of movement. This upward component of movement of the scraper blades 37 causes a depressing of the inner end of the pivot arms 33 through the action of the link 35, whereby the shaft 31 is pulled downwardly. Thereby extended, as may best be seen in Figure 3, the outer vertical margins of the scraper blades 37 project beyond the outer vertical margins of the impeller blades 27 into contact with the walls of the impeller tube 22, lightly scraping said walls as the impeller tube 22 rotates and thereby removing any film which tends to form thereon.

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. Apparatus for concentrating liquids comprising a steam-jacketed cylindrical column, a tubular member rotatably mounted co-axially within the column and having a plurality of apertures opening into its interior, a plurality of radially extending blades rigidly mounted on, and projecting outwardly from the tubular member, a shaft rotatably mounted co-axially within the tubular shaft, pivot arms extending radially outwardly from said shaft through apertures in the walls of said tubular member and rockably secured to selected ones of said blades, links integral with the outer ends of said pivot arms, and scraper blades operatively fixed to the outer ends of said links and means for reciprocating said shaft whereby the scraper blades are moved outwardly into scraping contact with the inner wall of the column.

2. Apparatus for concentrating liquids comprising a steam-jacketed cylindrical column, a

tubular impeller rotatably mounted co-axially within the column, said impeller having a plurality of apertures opening into its interior, a plurality of radially extending blades mounted on and projecting outwardly from the impeller, a shaft rotatably mounted co-axially within the impeller, said shaft being spacedly provided with diametrically decreased portions, pivot arms extending radially outwardly from said diametrically decreased portions of said shaft through apertures in the walls of said impeller and being rockably secured to selected ones of the blades, links integral the outer ends of said pivot arms, and scraper blades operatively affixed to the outer ends of said links, said scraper blades being parallel with and abutting surface-wise against said impeller blades and means for reciprocating said shaft whereby the scraper blades are moved outwardly into scraping contact with the inner wall of the column.

3. Apparatus for concentrating liquids comprising a steam-jacketed cylindrical column, a tubular impeller mounted coaxially within the column, a plurality of radially extending blades mounted rigidly on and projecting outwardly from the impeller, said blades having their outer vertical margins in spaced relation to the inner face of the column and being arranged in diametrically opposite pairs, said tubular impeller having a plurality of first apertures and second apertures opening into its interior, said second apertures being arranged in two vertically aligned rows which are substantially diametrically opposite to each other and are respectively adjacent to diametrically opposed blades, a shaft mounted coaxially within the impeller, means for permitting the impeller to rotate relatively to said shaft while the shaft remains substantially stationary, said shaft being provided with spaced diametrically reduced portions, pair of oppositely extending pivot arms operatively engaged at their inner ends within the diametrically reduced portions of said shaft and each projecting at its outer end through one of said second apertures and being pivoted upon the particular blade adjacent to such aperture, downwardly extending crank arms integral with said pivot arms, scraper blades pivotally connected to the crank arms, said scraper blades being parallel to and abutting surfacewise against said impeller blades, said scraper blades being provided with a plurality of spaced inwardly and downwardly extending slots, support pins projecting from said impeller blades for slidable cooperation with said slots, and mechanical means for imparting to said shaft a reciprocating motion while rotating whereby the outer vertical margin of the scraper blades may be moved outwardly beyond the outer vertical margins of the impeller blades into scraping contact with the walls of said column.

4. Apparatus for concentrating liquids comprising a steam-jacketed cylindrical column, a

tubular impeller mounted coaxially within the column, a plurality of radially extending blades mounted rigidly on and projecting outwardly from the impeller, said blades having their outer vertical margins in spaced relation to the inner face of the column and being arranged in diametrically opposite pairs, said tubular impeller having a plurality of first apertures and second apertures opening into its interior, said second apertures being arranged in two vertically aligned rows which are substantially diametrically opposite to each other and are respectively adjacent to diametrically opposed blades, a shaft mounted coaxially within the impeller, means for permitting the impeller to rotate relatively to said shaft while the shaft remains substantially stationary, said shaft being provided with spaced diametrically reduced portions, pairs of oppositely extending pivot arms operatively engaged at their inner ends within the diametrically reduced portions of said shaft and each projecting at its outer end through one of said second apertures and being pivoted upon the particular blade adjacent to such aperture, downwardly extending crank arms integral with said pivot arms, scraper blades pivotally connected to the crank arms, said scraper blades being parallel to, and abutting surfacewise against said impeller blades, said scraper blades being provided with a plurality of spaced inwardly and downwardly extending slots, support pins projecting from said impeller blades for slidable cooperation with said slots, mechanical means for lowering said shaft while rotating, causing the inner ends of said pivot arms to be moved to a point below the lower walls of said second apertures whereby the pivot arms are rocked upwardly by abutment thereagainst, to pivotally move the scraper blades outwardly beyond the outer vertical margins of the impeller blades into scraping contact with the walls of said column, and spring means bearing against the lower end of the shaft for normally biasing the shaft upwardly and thereby holding the scraper blades in retracted position.

GEORGE G. ZAHM.

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