

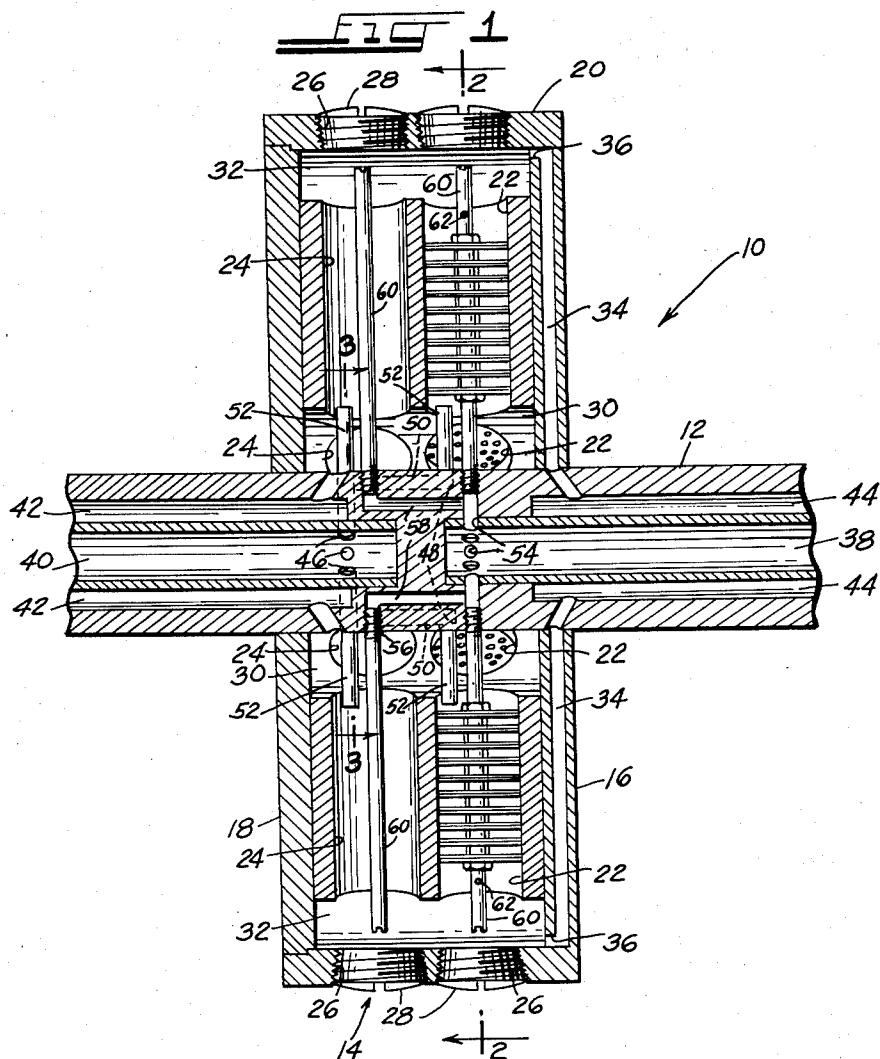
Dec. 31, 1963

W. G. PODBIELNIAK
CENTRIFUGAL MULTI-CHAMBER COUNTERCURRENT EXCHANGE DEVICE
WITH REMOVABLE DISC COLUMNS

3,116,246

Filed Dec. 8, 1961

3 Sheets-Sheet 1



INVENTOR.

WLADZIA G. PODBIELNIAK

BY

Silverman, Mullin & Cass

ATTY.

Dec. 31, 1963

W. G. PODBIELNIAK
CENTRIFUGAL MULTI-CHAMBER COUNTERCURRENT EXCHANGE DEVICE
WITH REMOVABLE DISC COLUMNS

3,116,246

Filed Dec. 8, 1961

3 Sheets-Sheet 2

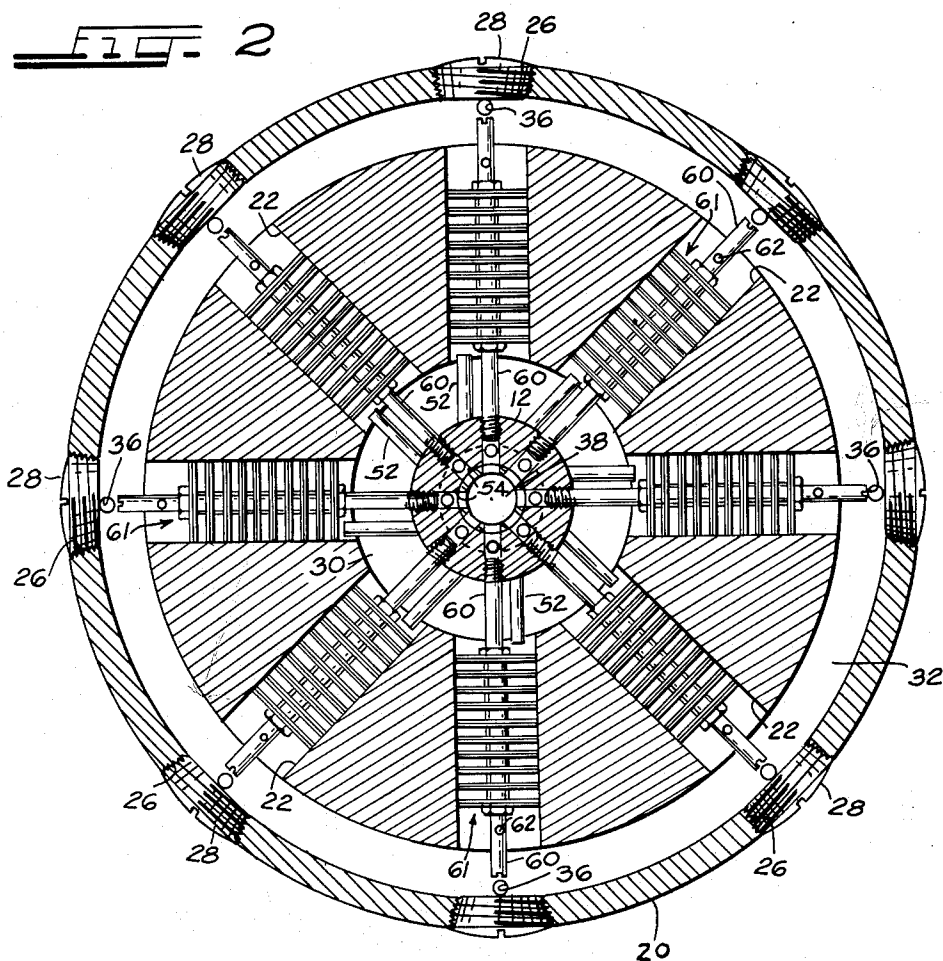
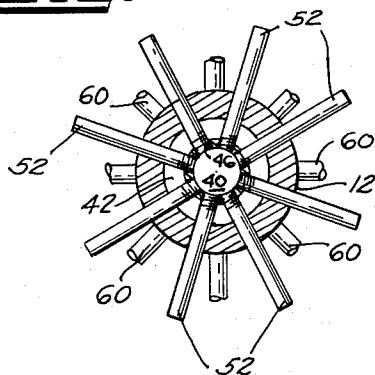


FIG. 3



INVENTOR.
WŁADZIA G. PODBIELNIAK
BY
Silverman, Mullin & Cass
ATTORNEYS.

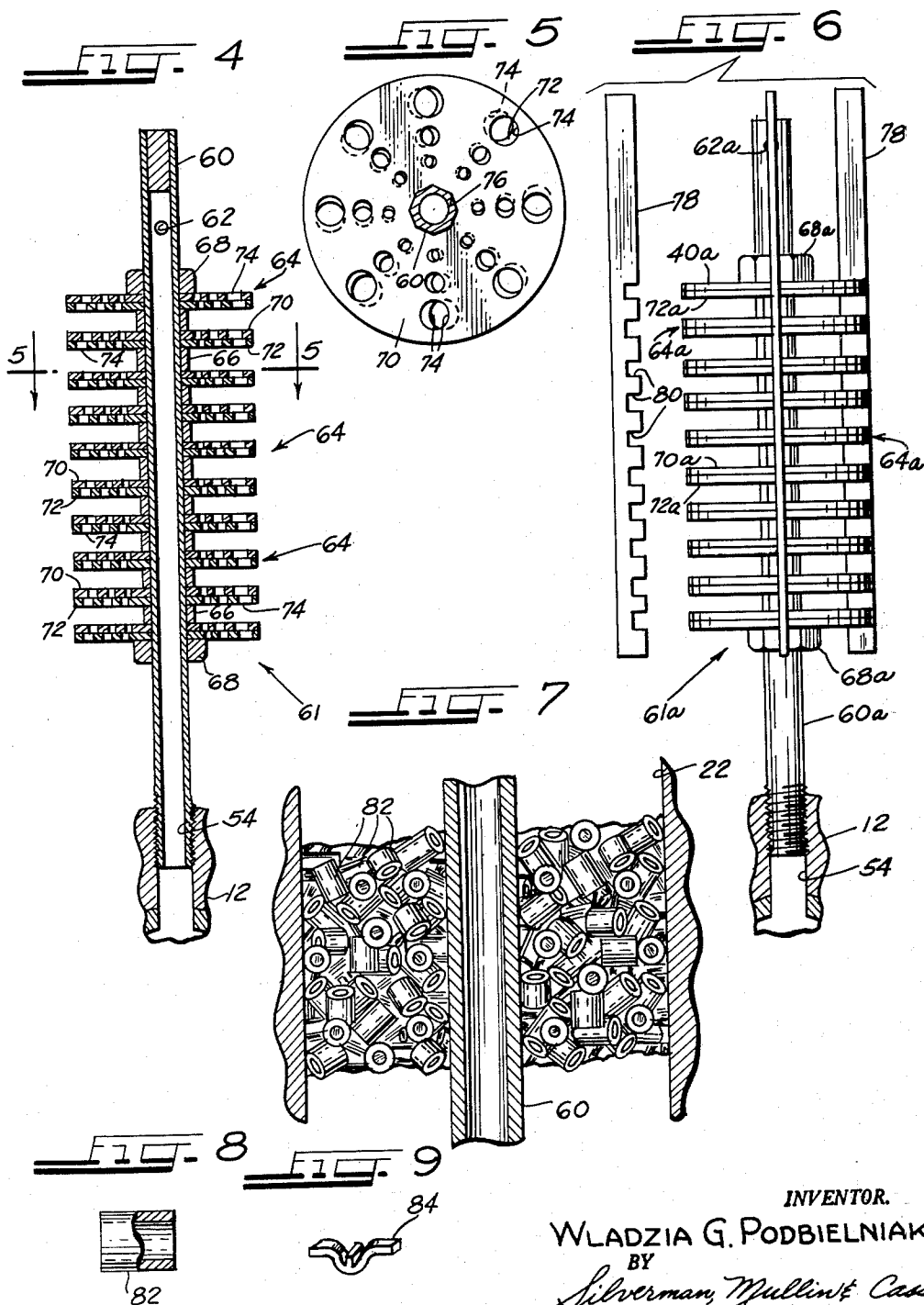
Dec. 31, 1963

W. G. PODBIELNIAK
CENTRIFUGAL MULTI-CHAMBER COUNTERCURRENT EXCHANGE DEVICE
WITH REMOVABLE DISC COLUMNS

3,116,246

Filed Dec. 8, 1961

3 Sheets-Sheet 3



INVENTOR.

WŁADZIA G. PODBIELNIAK
BY

Silverman, Mullin & Case

ATTORNEYS

1

3,116,246
CENTRIFUGAL MULTI-CHAMBER COUNTER-CURRENT EXCHANGE DEVICE WITH REMOVABLE DISC COLUMNS

Wladzia G. Podbielniak, 632 N. Dearborn St.,
Chicago 10, Ill.

Filed Dec. 8, 1961, Ser. No. 158,977
5 Claims. (Cl. 233—15)

This invention relates generally to improvements in centrifugal countercurrent exchange devices and, more particularly, to a countercurrent exchange device having a plurality of reacting or mixing chambers in which are employed novel interchangeable disc columns of the type disclosed in my co-pending applications entitled Centrifugal Countercurrent Exchange Device With Interchangeable Disc Columns, Serial No. 149,425, filed November 1, 1961; and Improved Disc Columns for Centrifugal Countercurrent Exchange Devices, Serial No. 155,111, filed November 27, 1961, and this application comprises a continuation-in-part of said co-pending applications.

As a general rule, exchange devices of the type disclosed in my aforementioned co-pending applications wherein the rotor comprises a single relatively large cylindrical mixing chamber are used in the majority of applications requiring such devices. This is particularly true in light of the great versatility and control over the droplet dispersion and mixing energy resulting from the inventions disclosed in said copending applications.

However, it is sometimes desirable that the individual mixing chamber be of a smaller dimension or capacity or that there be a plurality of such individual chambers in a single rotor. It will be apparent to those skilled in the art that a much greater degree of control may be exercised over the mixing and separating functions in a smaller mixing chamber. Similarly, certain processes involve the use of liquids containing a relatively high percentage of solids. Such processes invariably result in a deposit of sludge which affects the efficiency of the device for future use. The problem of properly cleaning out the prior single chambered cylindrical rotors of such sludge is not only difficult, but sometimes virtually impossible. However, this problem may be virtually eliminated by the use of a smaller mixing chamber to which maximum access may be had by virtue of the ready removability of the interior bands or discs.

It is, therefore, an important object of this invention to provide a centrifugal countercurrent exchange device having a plurality of mixing chambers to which ready access may be had for purposes of cleaning and process control. A related object is to construct said chambers with a readily removable band assembly.

Although multichambered exchange devices of the type under consideration have heretofore been suggested, the same have been characterized by disadvantages which have militated against more universal use thereof. Thus, for example, Patent No. 2,880,929 discloses such a device having such a limited throughput capacity that the use thereof is virtually limited to experimental or laboratory processes. Any possible control over the droplet dispersion characteristics within the chamber was extremely difficult and time consuming because the patented device employed a great many separate parts such as spacer rings and discs. Each of the discs was, of course, of a fixed perforation pattern. In addition, the inlet positions of the heavy and light liquids was fixed so that the number of stages of mixing or clarification could not readily be varied as desired.

It is, therefore, another important object of this invention to afford a multi-chamber centrifugal countercurrent exchange device of the character described having means

2

for readily controlling and varying the droplet dispersion characteristics and mixing energy within the chambers.

Another object is to provide a multi-chamber centrifugal countercurrent exchange device of the character described employing the novel disc columns disclosed in my aforementioned co-pending applications, said disc columns being readily insertable and removable as a unit.

A further object is to afford a multi-chamber centrifugal countercurrent exchange device of the character described employing disc columns wherein the discs may be readily indexed to afford any desired perforation characteristics.

Still another object is to provide a multi-chamber centrifugal countercurrent exchange device of the character described in which the inlet position of the light and heavy liquids may be readily varied according to the characteristics of the liquids and the number of mixing and clarification stages desired.

Yet another object is to afford a multi-chamber centrifugal countercurrent exchange device of the character described in which the heavy and light liquids are discharged, after mixing and separation, in common as a product of all of the combined chambers. An object relating thereto is to construct the rotor with a common inner annulus and outer annulus into which the light and heavy fluids respectively from each chamber may discharge and commingle.

Yet a further object is to provide a multi-chamber centrifugal countercurrent exchange device of the character described in which the rotor may be integrally formed or permanently welded for greater strength and durability.

Still a further object is to provide a multi-chamber centrifugal countercurrent exchange device of the character described which is comparatively inexpensive to manufacture and maintain, and yet is most efficient and durable for the purposes intended.

With the foregoing and other objects in view which will appear as the description proceeds, the invention consists of certain novel features of construction, arrangement and a combination of parts hereinafter fully described, illustrated in the accompanying drawings, and particularly pointed out in the appended claims, it being understood that various changes in the form, proportion, size and minor details of the structure may be made without departing from the spirit or sacrificing any of the advantages of the invention.

For the purpose of facilitating an understanding of my invention, I have illustrated in the accompanying drawings, a preferred embodiment thereof, from an inspection of which, when considered in connection with the following description, my invention, its mode of construction, assembly and operation, and many of its advantages should be readily understood and appreciated.

Referring to the drawings in which the same characters of reference are employed to indicate corresponding or similar parts throughout the several figures of the drawings:

FIG. 1 is a fragmentary vertical sectional view of a multi-chamber centrifugal countercurrent exchange device with removable disc columns embodying the principles of the invention;

FIG. 2 is a sectional view taken on the plane of line 2—2 in FIG. 1 of the drawings and viewed in the direction indicated;

FIG. 3 is a fragmentary sectional view taken on the plane of line 3—3 in FIG. 1 of the drawings and viewed in the direction indicated;

FIG. 4 is an enlarged vertical sectional view of one of the removable disc columns shown in FIGS. 1 and 2 of the drawings;

FIG. 5 is a sectional view taken on the plane of line 5-5 in FIG. 4 of the drawings and viewed in the direction indicated;

FIG. 6 is an exploded elevational view of another form of removable disc column which may be alternatively employed;

FIG. 7 is an enlarged fragmentary sectional view of one of the chambers showing the same packed with Raschig rings;

FIG. 8 is an elevational view, partially in section, of a Raschig ring; and

FIG. 9 is a perspective view of a Berl saddle comprising an alternative form of packing.

Turning first to FIG. 1 of the drawings, the reference numeral 10 indicates generally a centrifugal multi-chamber countercurrent exchange device embodying the principles of the invention. Since centrifugal countercurrent exchange devices as such are no longer new, only so much of the device 10 as is necessary for an understanding of the subject invention will be described. The device 10 thus comprises a shaft 12 journaled for rotation in a suitable supporting structure (not shown). A drum or rotor, designated generally by reference numeral 14, is rigidly connected to the shaft 12 for rotation therewith.

The drum 14 comprises a pair of circular end plates 16 and 18 connected by a cylindrical outer wall 20. Formed in the rotor 14 is a plurality of radially extending cavities or mixing chambers 22, all lying in the same vertical plane. There may be any number of mixing chambers 22 so long as they are arranged in radially balanced relationship to permit high-speed rotation of the rotor. A second series of radially extending cavities or mixing chambers 24 may likewise be formed in the rotor 14, said mixing chambers 24 lying in a second vertical plane and having no direct communication with the mixing chambers 22 as indicated. In a similar manner, the rotor 14 may comprise any number of series of mixing chambers 22 or 24 depending upon the desired size and capacity requirements of the device. The outer wall 20 may be formed with a plurality of openings or portholes such as 26 in alignment with the mixing chambers 22 and 24 whereby access may be readily gained to said mixing chambers. The portholes may be threaded as indicated and adapted to receive a threaded plug such as 28.

It is most important to note that the mixing chambers 22 and 24 do not extend over the full radius of the rotor or from the shaft 12 to the outer wall 20. Instead, there is provided an annular annulus 30 and an outer annulus 32, said annuli being common to all of the mixing chambers 22 and 24. One of the rotor end walls such as 16 is formed with a vertically extending heavy liquid outlet passageway 34 which may extend over the entire area thereof, and the outer annulus 32 communicates with said passageway by means of a plurality of heavy liquid outlet holes such as 36 (see FIG. 2).

To insure maximum strength and durability, the entire rotor 14 may be integrally formed from a single piece of metal or the like, in which the mixing chambers and other structures are merely bored or otherwise machined. As an alternative, the mixing chambers 22 or 24 may comprise individual units in the form of tubular cans or the like which may be connected to, or removed from, the rotor as desired. In any event, the completed rotor may comprise a permanently sealed unit to which access may be gained by means of the portholes 26 and plugs 28.

Directing attention back to the rotor shaft 12, it will be seen that the same is formed with customary suitable passageways for the admission and removal of the light and heavy liquids. The shaft 12 thus is provided with a light liquid inlet passageway 38, a heavy liquid inlet passageway 40, a light liquid outlet passageway 42 and a heavy liquid outlet passageway 44. As indicated, the light liquid outlet passageway 42 communicates with the inner annulus 30 whereas the heavy

liquid outlet passageway 44 communicates with the outer annulus 32 via the outlet holes 36 and passageway 34.

Formed in the rotor shaft 12 and communicating with the heavy liquid inlet passageway 40 is a plurality of heavy liquid inlet holes 46 radially arranged with one in alignment with each of the mixing chambers 24. A plurality of heavy liquid inlet holes 48 is similarly provided, one in alignment with each of the mixing chambers 22, and the same communicate with the heavy liquid passageway 40 by means of a connecting passageway, such as 50 (see FIG. 1). The walls of the heavy liquid inlet holes 46 and 48 may be screw threaded so that heavy liquid inlet tubes, such as 52, may be removably threaded therein.

In a similar manner, the light liquid inlet passageway 38 is provided with a plurality of radially positioned light liquid inlet holes 54, one in alignment with each of the mixing chambers 22. Light liquid inlet holes 56, in alignment with the mixing chambers 24, communicate with the light liquid inlet passageway 38 by means of a connecting passageway 58. The walls of the light liquid inlet holes 54 and 56 may be similarly screw threaded, and are adapted to removably receive elongated light liquid inlet tubes, such as 60, having openings such as 62 for admitting the light liquid adjacent the outer extremity of the mixing chambers.

It will be appreciated from the foregoing description that the point of admission of both the heavy and light liquids into the mixing chambers may be readily varied by simply inserting a heavy liquid inlet tube 52 of the desired length, or using a light liquid inlet tube 60 in which the opening 62 is differently positioned. Similarly, when it is desired that some of the mixing chambers remain idle during a particular operation, it is merely necessary to plug up the respective liquid inlet holes communicating therewith. Thus, for example, in FIG. 1 of the drawings, the mixing chambers 24 are illustrated in an idle condition, with inlet holes 46 and 56 being closed with blind or solid tubes 52 and 60.

Removably positioned in each of the working mixing chambers (the chambers 22 in FIG. 1) is a disc column like any of those described in my aforementioned co-pending applications and indicated generally by the numeral 61 (see FIG. 4). In the preferred form illustrated, the disc column 61 comprises a plurality of disc assemblies 64 removably mounted on a tie rod which in this case comprises the light liquid inlet tube 60. The disc assemblies are maintained in spaced apart relationship by a plurality of vertical spacers 66 and a pair of lock nuts such as 68, 68. Each of the disc assemblies 64 comprises a pair of superposed discs 70 and 72 having perforations 74. The light liquid inlet tube 60 may be formed of polygonal cross section (in this case octagonal), and the discs 70 and 72 are provided with a central opening 76 of complementary configuration. The discs 70 and 72 thus may be indexed with relation to each other to afford any desired perforation area and droplet dispersion characteristics (see FIG. 5).

Illustrated in FIG. 6 of the drawings is another form of disc column, such as was previously described in my aforementioned co-pending applications. In this instance, the disc column 61a is similar in all respects save for the addition of rigidifying comb-like members 78 having spaced notches 80. The discs 70a and 72a have cooperating peripheral notches (not shown) so that the vertical spacers 66 of the previous embodiment may, of course, be eliminated.

The operation of the device 10 heretofore described will be apparent to those skilled in the art. Thus, the heavy liquid enters the mixing chambers 22 or 24 near the inner end thereof through the heavy liquid inlet tubes 52 while the light liquid enters under pressure near the outer end thereof through the light liquid inlet tubes 60. The two liquids travel countercurrently through the mixing chambers, whereupon the desired mixing, exchange

5

and separation takes place. It is important to note, however, that the finally separated heavy and light liquids in each of the mixing chambers are not withdrawn separately therefrom. Instead, the heavy liquid from all of the mixing chambers commingles commonly in the outer annulus 32, while the light liquid from all of the mixing chambers commingles commonly in the inner annulus 30. The liquids are then, of course, withdrawn from the common annuli. This novel construction and operation, has the salutary effect of increasing the throughput possibilities of the device and also improving the efficiency of the final clarification stage.

When it is desired to clean a mixing chamber or disc column or substitute a different disc column, it is simply necessary to remove the plug 28 and take the entire disc column out as a unit.

Another form of the device 10 is illustrated in FIG. 7 of the drawings. Instead of using the described disc columns, the entire mixing chamber 22 or 24 may be fully packed with Raschig rings 82 which are well known in the art. The packed Raschig rings, of course, provide a tortuous or serpentine path for the two liquids traveling countercurrent therethrough, and causes the intimate mixing thereof. Where such packing is employed, a suitable sieve-like retaining disc (not shown) may be provided at the inner and outer ends of the mixing chambers.

Instead of Raschig rings, the mixing chambers may likewise be packed with Berl saddles 84 (see FIG. 9). The Berl saddles 84 likewise afford the desirable tortuous or serpentine path and are well known in the art. In a similar manner, the mixing chambers may be packed with any form of suitable packing known in the art, such as asbestos, glass wool, and the like. In any event, the packing may be inserted or removed from the mixing chambers with the same degree of ease as the disc columns.

From the foregoing description and drawings, it should be apparent that I have provided a novel centrifugal multi-chamber countercurrent exchange device with removable disc columns. The throughput capacity of the device is virtually unlimited, and the removal of the liquids from the various chambers via the described common annuli results in a more efficient final clarification stage. It will, of course, be appreciated that while the mixing chambers have been illustrated as being cylindrical with vertical walls, the same may likewise be of other configurations or tapered as disclosed in my aforementioned co-pending applications.

It is believed that my invention, its mode of construction and assembly, and many of its advantages should be readily understood from the foregoing without further description, and it should also be manifest that while a preferred embodiment of the invention has been shown and described for illustrative purposes, the structural details are nevertheless capable of wide variation within the purview of my invention as defined in the appended claims.

What I claim and desire to secure by Letters Patent of the United States is:

1. A centrifugal countercurrent exchange device comprising a rotor having a central shaft, a pair of end walls and a cylindrical outer wall, a plurality of individual mixing chambers in said rotor, said chambers extending radially about said shaft, said outer wall being formed with a plurality of portholes one in alignment with each of said chambers, a plug removably positioned in each of said portholes, a relatively short heavy liquid inlet tube removably positioned in each of said chambers for admitting heavier liquid thereinto near the inner end

6

thereof, a longer light liquid inlet tube removably positioned in each of said chambers for admitting lighter liquid thereinto nearer the outer end thereof, unitary disc columns removably positioned in at least some of said chambers, said disc columns including a central tie rod, a plurality of vertically spaced pairs of superposed perforated discs mounted on said tie rod and cooperating therewith to afford indexing means for adjusting said pairs of discs to obtain any desired perforation characteristics, said light liquid inlet tube comprising said tie rod, a first annulus in said rotor adjacent and concentric with said shaft, said first annulus communicating with the inner end of each of said chambers for removing the lighter liquid in common therefrom, and a second annulus in said rotor adjacent the periphery thereof and communicating with the outer end of each of said chambers for removing the heavier liquid in common therefrom whereby the free turbulent flow in said outer annulus facilitates the removal of solids with the heavy liquid.

2. The device of claim 1 in which one of said end walls is formed with an outlet passageway extending over substantially the entire area thereof, said second annulus being formed with a plurality of outlet holes for communicating with said passageway.

3. A centrifugal countercurrent exchange device comprising a rotor having a central shaft, a plurality of radially extending individual mixing and separating chambers in said rotor, integrated disc columns removably positioned in at least some of said chambers, each of said disc columns comprising an elongated connecting member and a plurality of perforated discs mounted in vertically spaced relationship on said member, means affixedly positioning said disc columns in said chambers, means for admitting heavier liquid into each of said chambers near the inner end thereof, means for admitting lighter liquid into each of said chambers nearer the outer end thereof, an annulus positioned in said rotor near said shaft and communicating with all of said chambers for removing the lighter liquid in common from all of said chambers, and an outer annulus in said rotor near the periphery thereof and communicating with all of said chambers for removing the heavier liquid in common from all of said chambers, whereby the free turbulent flow in said outer annulus facilitates the removal of solids with the heavy liquid.

4. The device of claim 3 in which each of said disc columns comprises a tie rod and a plurality of disc assemblies mounted in vertically spaced relationship on said tie rod, each of said disc assemblies comprising a pair of perforated superposed discs, said discs and tie rod cooperating to afford means for indexing said pairs of discs with relation to each other for varying the perforation characteristics of said disc assemblies.

5. The device of claim 4 in which said second-mentioned means comprises a passageway formed in each of said tie rods, said passageway terminating in an inlet hole communicating with the interior of said chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

1,796,501	Berl	Mar. 17, 1931
2,880,929	Podbielniak	Apr. 7, 1959
2,949,934	Schrenk	Aug. 23, 1960
3,013,780	Wistrich	Dec. 19, 1961
3,050,238	Doyle et al.	Aug. 21, 1962

FOREIGN PATENTS

872,499	Great Britain	July 12, 1961
1,227,578	France	Aug. 22, 1960

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,116,246

December 31, 1963

Wladzia G. Podbielniak

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the grant, line 12, for "his heirs" read -- her heirs --; column 2, line 51, for "accompanyign" read -- accompanying --; column 3, line 48, for "annular" read -- inner --.

Signed and sealed this 23rd day of June 1964.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents