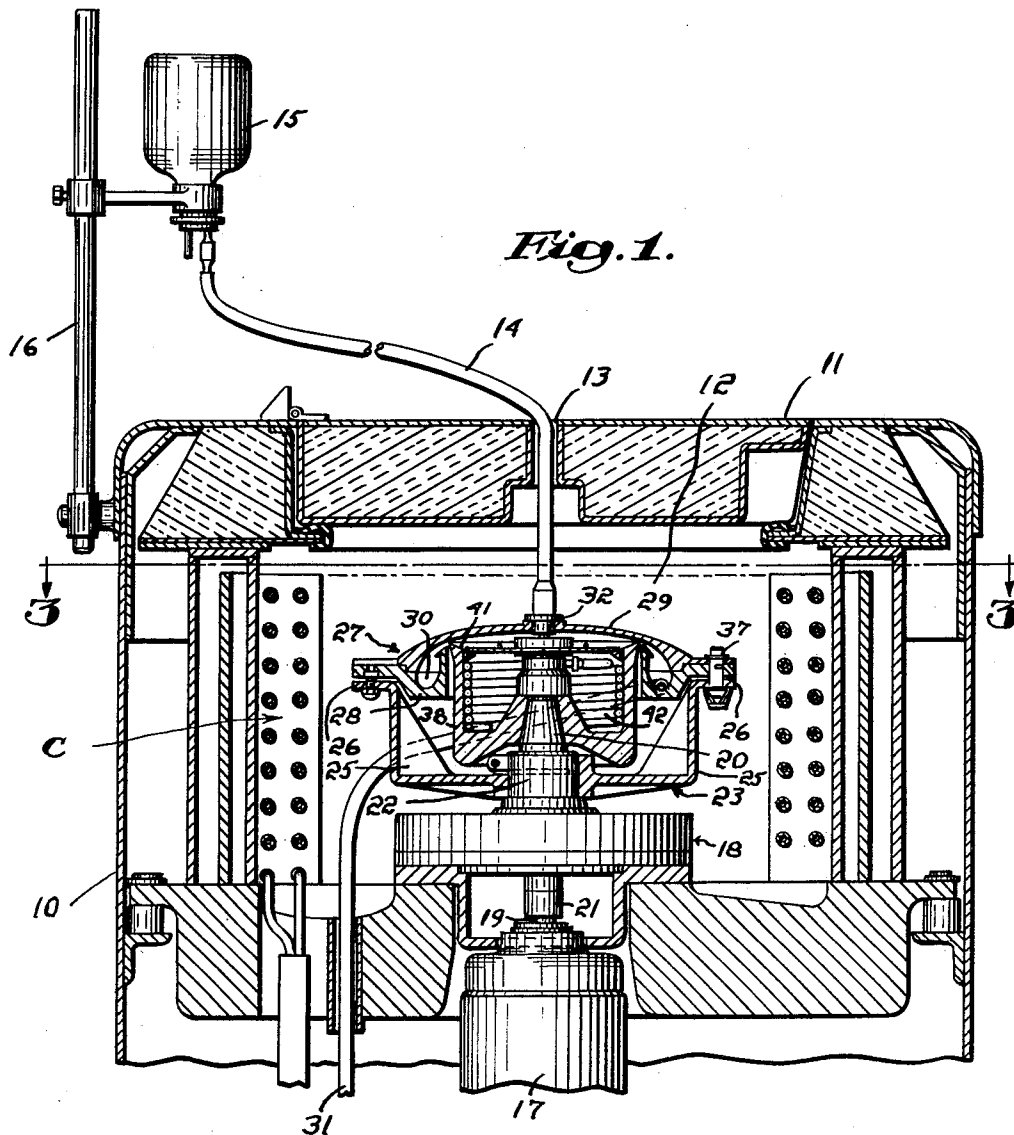


3,129,175

4 Sheets-Sheet 1



Inventors:
Alan Richardson Jones
Robert J. Mitchell,
David F. Mitchell,
by *Abel Spear,*
Attorney

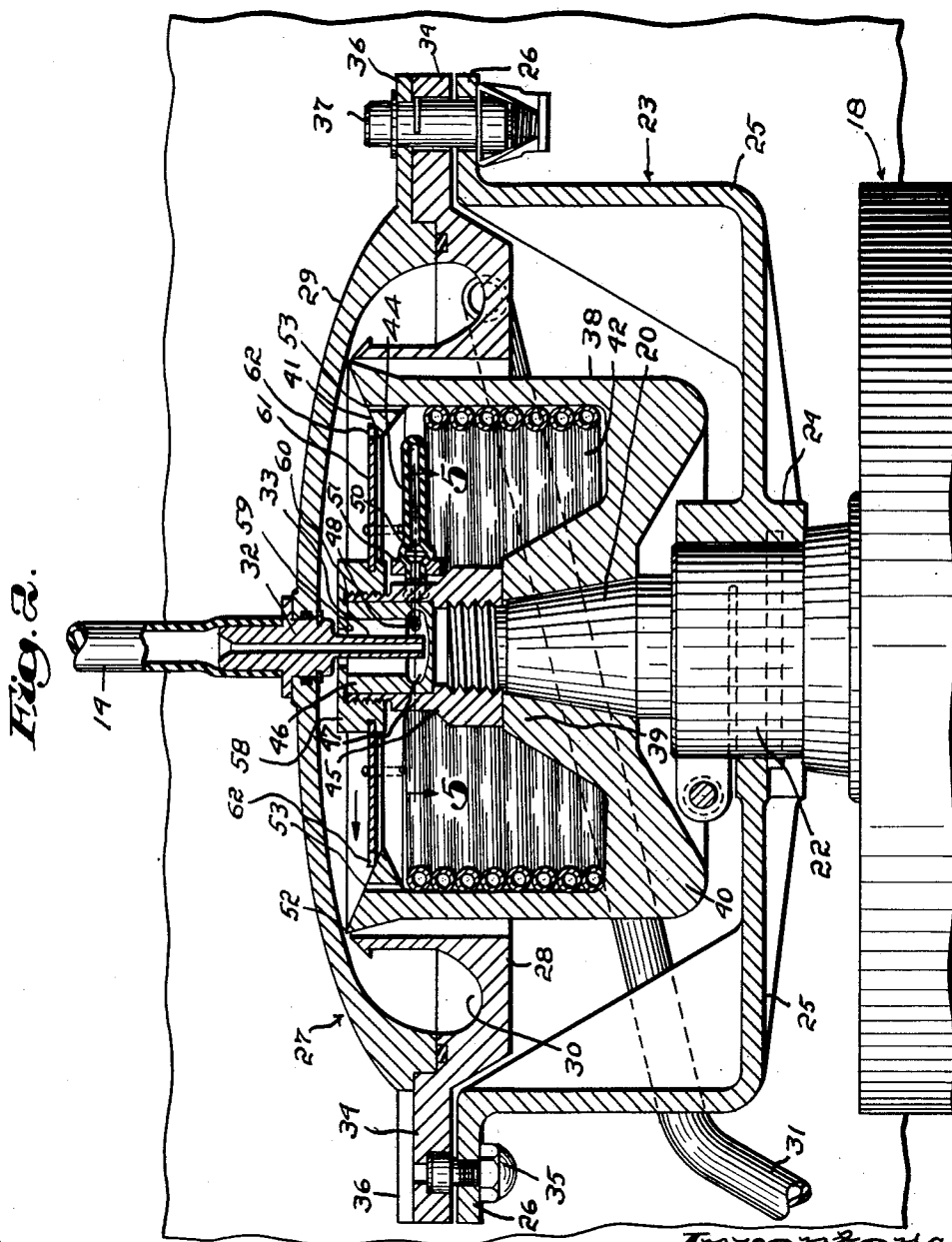
April 14, 1964

A. R. JONES ETAL
CENTRIFUGES

3,129,175

Filed Dec. 31, 1959

4 Sheets-Sheet 2.



Inventors:

*Alon Richardson Jones,
Robert J. Mitchell,
David F. Mitchell,
by Alldispear,
Attorney*

April 14, 1964

A. R. JONES ETAL

3,129,175

CENTRIFUGES

Filed Dec. 31, 1959

4 Sheets-Sheet 3

Fig. 3.

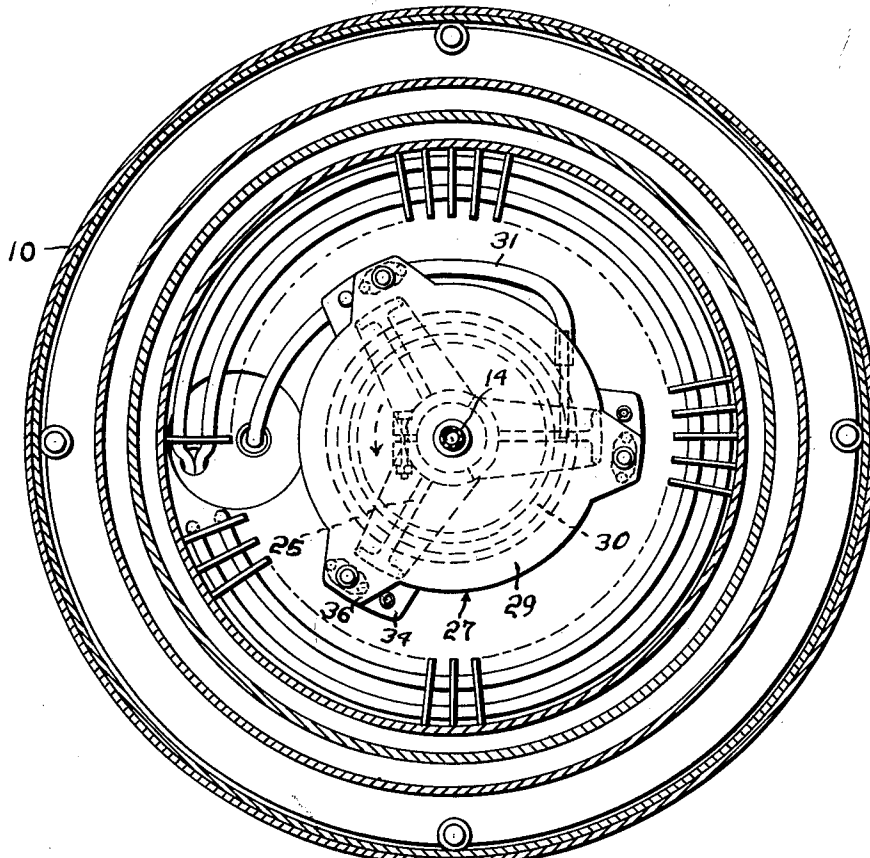
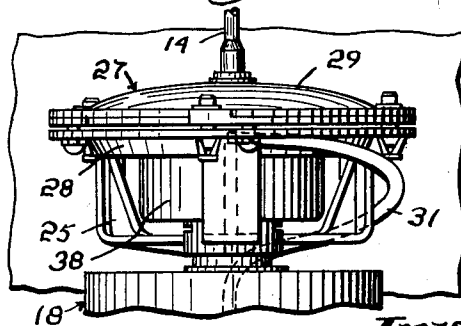


Fig. 4.



Inventors:

Alan Richardson Jones,

Robert J. Mitchell,

David F. Mitchell,

by *Charles E. Jones,*

Attorney

April 14, 1964

A. R. JONES ET AL
CENTRIFUGES

3,129,175

Filed Dec. 31, 1959

4 Sheets-Sheet 4

Fig. 5.

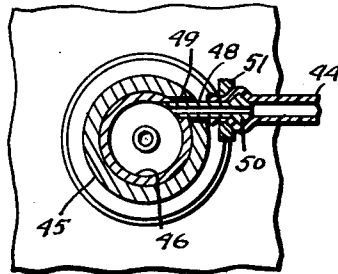


Fig. 6.

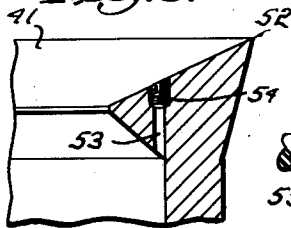


Fig. 7.

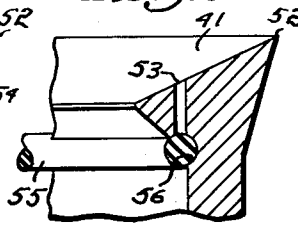


Fig. 8.

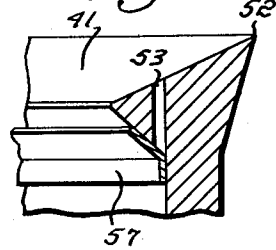
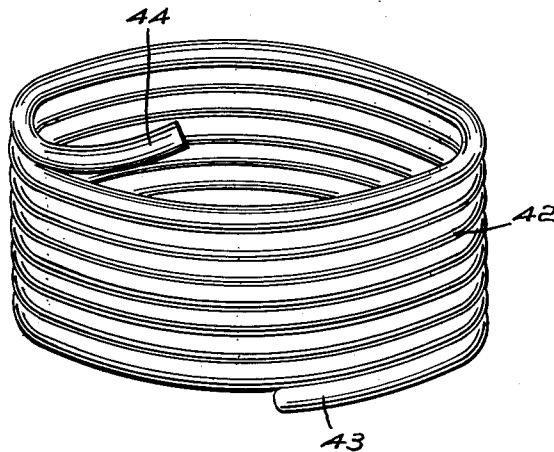


Fig. 9.



Inventors:
Alan Richardson Jones
Robert J. Mitchell,
David F. Mitchell,
by *Abbot J. Jones*
Attorney

1

3,129,175 CENTRIFUGES

Alan Richardson Jones, Sudbury, Robert J. Mitchell, Braintree, and David F. Mitchell, Tewksbury, Mass., assignors to International Equipment Company, Boston, Mass., a corporation of Massachusetts
Filed Dec. 31, 1959, Ser. No. 863,324
6 Claims. (Cl. 233—28)

The present invention relates to centrifuges and particularly to those of the continuous feed type.

In the centrifuging of various mixtures of immiscible phases, problems exist that not only make it desirable that relatively large volumes thereof be processed but also that the heavier phase or phases thereof be distributed along zones that are long as compared with the size of the centrifuge. In addition, it is a common criticism that the lighter phase or phases cannot be collected without foaming which is objectionable due to such factors as attendant oxidation, the tendency of the foamed mass to cause mal-functioning, and the loss of some of the effluent. The main objective of the present invention is to provide centrifuges that will satisfy the above generally indicated requirements.

One important object is to provide centrifuges utilizing flexible sample tubes of considerable length arranged as coils within the baskets with their turns coaxial and axially spaced and with one end of each coil discharging into its basket and its other end connected to an axial connection for communication with an external source of supply.

Another important object of the invention, of advantage in a wide range of continuous feed centrifuges, is to provide collecting means for the effluent phase of the suspension by which objectionable foaming is eliminated. This result is attained by providing liquid collecting and draining means that include an upwardly and outwardly inclined basket mouth, a fixed collecting trough surrounding the basket with its inner wall closely adjacent the outer edge of the basket mouth, and a member shaped and disposed to receive the effluent from said mouth as a thin film and to decelerate it suitably, without foaming, before its entry into the trough.

Still another important feature of the invention is a novel method of controlling the length of the zone, in the coiled sample tube, in which the heavier of the immiscible phases are deposited. This method comprises the steps of discharging the lighter of the immiscible phases into the basket against whose side wall the tube is seated, and providing for the flow of such lighter phase or phases upwardly out of the basket by way of alternate exits of which one creates an accumulation of the effluent resulting in a layer over the tubing whose thickness, in relation to the width of the tubing, determines the depth of the suspension stream passing therethrough relative to the side wall and, accordingly, the length of the zone through which said heavier phase or phases are deposited. When an exit is provided in the basket that prevents any appreciable accumulation of the effluent, the immiscible phases within the tubing are present as a thin film presenting a relatively short centrifugal path through which the heavier phase or phases must move before coming into contact with the wall of the tubing. This results in a relatively thick and short deposit zone and, where there is more than one phase deposited by centrifugal force, they are not distinct, one from the others, to a satisfactory extent. When the thickness of the effluent layer is approximately equal to the diameter of the tubing, its effect on the immiscible phases passing therethrough is at a maximum in that it is attended by a relatively long centrifugal path through which the heavier phase or phases must pass before coming into contact

2

with the wall of the tubing. This results in a phase of relatively higher specific gravity being deposited on the tubing wall nearer the inlet end thereof than any phase of relatively lower specific gravity so that the deposited heavier phases are each in a relatively thin and long zone with "grading" resulting as each deposited phase is distinct from any other to a satisfactory extent.

For the practice of the method, the basket has an inwardly disposed flange or shoulder, conveniently a part of its mouth, provided with venting or relief ports extending vertically therethrough usually, but not necessarily, in alinement with the inner surface of the basket side wall. When the venting ports are closed, the lighter phase or phases become a stream flowing over the shoulder which is so dimensioned that the thickness of the resulting effluent layer is approximately equal to the diameter of the largest tubing used, and, when the venting ports are open, the effluent flows, with a predetermined minimum effect or without any effect on the suspension within the tubing depending on whether or not the venting ports are spaced inwardly from or are in alinement with the basket wall. Usually, either it is desired that the heavier phase or phases be deposited throughout a zone of considerable length or the venting ports are opened so that the flowing stream of the lighter phase or phases has little or no effect on the suspension. Since the extent of "grading" depends on the length of the centrifugal path, it will be appreciated that, other considerations being equal, the thicker the effluent as determined by the dimensions of the shoulder, the greater the diameter of the tubing, the longer and the more distinct becomes the zone of each deposited phase.

In the accompanying drawings, there is shown an illustrative embodiment of the invention from which these and other of its objectives, novel features, and advantages will be readily apparent.

In the drawings:

FIG. 1 is a fragmentary, vertical section through a centrifuge of the continuous feed type,

FIG. 2 is a similar section, on an increased scale, of the collecting unit, the rotating basket, a coiled sample tube, and part of the supply conduit therefor,

FIG. 3 is a section taken approximately along the indicated lines 3—3 of FIG. 1,

FIG. 4 is a side elevation of the parts shown in FIG. 2, but on the scale of FIGS. 1 and 3,

FIG. 5 is a section taken approximately along the indicated lines 5—5 of FIG. 2,

FIG. 6 is a vertical section, on an increased scale, through the mouth of a basket illustrating the closing of a venting port by a threaded plug,

FIG. 7 is a like view showing the closing of a port by a sealing ring,

FIG. 8 is a similar view illustrating the closing of a port by a tape, and

FIG. 9 is a perspective view of a coiled tube unit.

In the embodiment of the invention illustrated by the drawings, a housing 10 of a centrifuge is provided that has a hinged cover 11 permitting access to the chamber 12 and having a central passage 13 for a tube 14 from a source of supply of the material to be centrifuged, such as a bottle 15 clamped to an upright 16 at the rear of the housing 10. The centrifuge illustrated by the drawings is of the refrigerated type and conventional refrigerator coils are indicated at C in FIGURE 1.

Within the chamber 12, supporting structure for the motor 17 is generally indicated at 18. The motor shaft 19 is connected to a spindle 20 by a coupling 21 and the spindle 20 is journaled in suitable bearings, not shown, within a hub 22 carried by the supporting structure 18. A generally indicated support bracket 23 has a central

sleeve 24 clamped to the hub 22 and three arms 25 terminating in outwardly disposed flanges 26 which support a drainage collecting unit, generally indicated at 27. The unit 27, see FIGS. 2 and 3, is shown as comprising a lower part 28 and an upper member in the form of a removable cover 29. The lower part 28 defines an annular gutter 30 to which a drain 31 is attached. The cover 29 has a central fitting 32 extending vertically therethrough to which the tube 14 is attached and which has an outlet 33. The lower part 28 has spaced ears 34, one for each arm flange 26 and connected thereto as by jack screws 35. The upper part 29 has ears 36, one for each arm flange 26 and connected thereto, through the ears 34, by separable connections 37.

A basket 38 has a central hub 39 projecting upwardly from the bottom wall which is locked to the upper end of the spindle 20. The basket 38 also is preferably provided with a depending skirt 40 which, and its bottom wall, are so dimensioned that the center of gravity of the basket is close to the hub 22. The basket 38, in practice, has a rate of deceleration closely related to that of the mixture being centrifuged and stainless steel has proved satisfactory in its production. At the upper end of the basket 38, there is an inwardly disposed shoulder 41 which serves as a retainer for a coil 42 of flexible tubing whose turns are axially spaced and whose outlet end 43 is shown as being proximate to the bottom of the basket 38 and whose free end 44 is the inlet. In practice, the coil 42 is preferably preformed, as illustrated by FIG. 9, with its turns releasably connected together.

A member 45, see FIGS. 2 and 5, is threaded on the upper end of the spindle 20 and its upper end is bored to receive a cup 46 having a concave under-cut lower part 47 with which an outlet 48 is in tangential communication and into which the outlet 33 discharges. Said upper spindle end is slotted as at 49 to receive the cup outlet 48, so that the cup and outlet can be slipped, as a unit, into place with the outlet 48 keying it to the spindle for rotation therewith. The outlet fitting 48 terminates in a double-tapered head 50 to be disposed within the free or inlet end 44 of the coil 42 and locked thereto by the retaining ring 51.

The shoulder 41 of the basket 38 is shown as having its lower edge as upwardly and inwardly inclined and its upper edge as upwardly and outwardly inclined and terminating in a peripheral, outwardly disposed, sharply defined mouth edge 52. The shoulder 41 is provided with a series of arcuately spaced ports 53 extending vertically therethrough close to the inner wall of the basket 38. In FIG. 6, these ports are shown as closed by a threaded plug 54 while in FIG. 7 an annular seal 55 in a groove 56 is employed for that purpose. As illustrated by FIG. 8, the ports 53, or any of them, may be closed by a tape 57.

In operation, the immiscible phases flow into the coil 42 with the wanted heavier phase or phases thereof remaining therein and being deposited in a desired zone. The lighter phase or phases flow through the coil and into the basket 38 and best results are obtained when the coil outlet 43 is trailing and adjacent the bottom. The lighter phases flow upwardly out of the basket, either through the venting ports 53 or over the inner edge of the shoulder 41, if the venting ports are closed. In the latter case, an effluent layer of the lighter phase or phases results that cause the tubing to be approximately full so that the heavier phase or phases are deposited throughout a long zone due to the longer centrifugal path, with the deposits being characterized by grading to a satisfactory extent. In the former case, the effluent has no effect on the phases within the tubing so that the heavier phase or phases are deposited in a short thick zone.

Because of the inlet 44 of the coil 42, rotation of the basket 38 is attended by air turbulence which is objectionable as causing some degree of imbalance, heat with attendant drying, and an aerosol effect in the chamber 27. For that reason, the upper end of the member 45 is shown

as threaded to receive the cap 58 which has a hole 59 for the member 33 and which seats against a seal 60. The cap 58 carries a plate 61 which serves as a closure for the mouth of the basket preventing objectionable air pumping and which has peripheral ports 62 to permit the outflow of the lighter phase or phases when the venting ports 53 are closed.

Where the condition of the effluent phase or phases is important, it is essential that it escape from the upper surface of the flange 41 as a film and that it not be materially disturbed by its impingement with the interior surfaces of the cover 29 and that its deceleration be commenced on and be occasioned by such impingement. Such deceleration must initially be relatively slight and the effluent must, to avoid foaming, remain as a film until sufficiently decelerated as it enters or nears the gutter 30.

While many variables must be considered depending on such factors as the nature of effluent phases, it will be appreciated that the requirements of a transfer of the effluent phases as a film necessitate that the edge 52 of the flange 41 be as close to the inner surface of the cover 29 as possible and that the angle between the flange 31 and said inner surface be an obtuse one causing a slight degree of immediate deceleration. As the jack screws 35 enable the drainage collecting unit 27 to be raised or lowered, relative to the support bracket 23, they also enable the desired position of the portions of the cover 29, against which the effluent impinges, to be easily and accurately established relative to the edge 52 of the basket mouth. In the practice of the method, the immiscible phases flow through the coiled tubing with effluent discharging from the outlet end thereof. If the outlets 53 are closed, the effluent is confined below and can escape only over the shoulder 41. As a consequence, the tubing is now full and centrifugation results in movement of particles outwardly with outward travel at a maximum. As a consequence, those particles are deposited through a substantial length of the tubing. If, however, the outlets 53 are open, the effluent is a thin layer as are the phases flowing through the tubing. The outward path of the particle is now at a minimum as is the length of the deposit zone.

With any size tubing and with any centrifugal force, the method enables the length of deposit zones to be controlled by varying the depth of the phases flowing through a spiral pathway with the thicker the flowing phases, the slower the deposit by centrifugal force, and the longer the zones of deposit.

We claim:

1. In the centrifuging of at least two immiscible phases having at least one wanted phase and at least one unwanted phase, the steps that comprise providing an open-ended, coiled tubular pathway whose turns are axially spaced and of the same outside diameter, feeding said phases through said pathway and rotating said pathway about its axis to effect the deposit of a wanted phase in a lengthwise zone thereof and the discharge of the unwanted phase, confining the effluent phase as a rotating layer inclusive of the pathway and of the same outside diameter, and controlling the thickness of said layer relative to the width of the pathway to control the thickness of the phases flowing along said pathway thus to control the length of said zone, the thicker the flowing phases, the slower the deposit by centrifugal force and the longer the zone.

2. In the centrifuging of at least two immiscible phases having at least one wanted phase and at least one unwanted phase, the steps that comprise providing an open-ended, coiled, tubular pathway whose turns are axially spaced and of the same outside diameter and whose outlet is lowermost and trailing, feeding said phases through said pathway and rotating said pathway about its axis to effect the deposit of a wanted phase in a lengthwise zone thereof and the discharge of the unwanted phase, confining the effluent phase as a rotating layer inclusive of the

5

pathway and of the same outside diameter to control the thickness of the phase flowing along said pathway thus to determine the length of said zone, the thicker the flowing phases the slower the deposit by centrifugal force and the longer the zone.

3. In the centrifuging of at least two immiscible phases having at least one wanted phase and one unwanted phase, the steps that comprise providing an open-ended, coiled, tubular pathway whose turns are axially spaced and of the same outside diameter and whose outlet end is trailing, feeding said phases through said pathway and rotating said pathway about its axis to effect the deposit of a wanted phase of the suspension in a lengthwise zone thereof and the discharge of the unwanted phase, confining the effluent phase as a rotating layer inclusive of the pathway and of the same outside diameter to control the thickness of the phases flowing along said pathway thus to determine the length of said zone, the thicker the flowing phases, the slower the deposit by centrifugal force and the longer the zone.

4. In a centrifuge, a length of flexible, open-ended tubing arranged as a coil with axially spaced turns, an open mouth, smooth-surfaced, solid walled basket mounted for rotation about a vertical axis and including an axial supply conduit portion to which one end of the tubing is connected and an inwardly disposed shoulder adjacent said mouth defining a subjacent zone in which the coil is seated against the basket wall, the other end of the tubing opening in said subjacent zone, and said shoulder also defining an exit for the effluent from the

6

other end of the tubing, said shoulder establishing the thickness of the effluent layer resulting from the discharge from the other end of said tube, said shoulder also having ports extending vertically therethrough, each spaced the same distance from the basket wall, the diameter of the tubing being greater than said distance.

5. The centrifuge of claim 4 in which the other end of the tubing is trailing.

6. The centrifuge of claim 4 in which the other end of the tubing is trailing and proximate to the bottom of the basket.

References Cited in the file of this patent

UNITED STATES PATENTS

556,567	Waring	Mar. 17, 1896
560,631	Peck	May 19, 1896
1,401,291	Touceda	Dec. 27, 1921
1,602,752	Cuthbert	Oct. 12, 1926
2,394,016	Schutte et al.	Feb. 5, 1946
2,553,936	Patrick	May 22, 1951
2,616,619	MacLeod	Nov. 4, 1952
2,730,299	Kelsey	Jan. 10, 1956
2,782,925	Morton	Feb. 26, 1957
2,834,541	Szent-Gyorgyi et al.	May 13, 1958
2,885,145	Danielsson et al.	May 5, 1959
2,889,044	Cloos	June 2, 1959
2,921,969	Loy	Jan. 19, 1960
3,004,050	Ayres	Oct. 10, 1961
3,090,549	Rastgeldi	May 21, 1963