United States Patent [19]

Miachon

[11] **3,756,505**

[45] **Sept. 4, 1973**

[54] **CENTRIFUGAL EXTRACTORS WITH MEANS FOR MOVING THE MATERIALS**

[75] Inventor: **Jean-Paul Miachon,** Lyon, France

[73] Assignee: **Robatel S.L.P.I. Zone Industrielle,** Genas (Rhone, France)

[22] Filed: **May 25, 1971**

[21] Appl. No.: **146,700**

[30] **Foreign Application Priority Data**

June 1, 1970 France 7019918

[52] **U.S. Cl.** **233/3**

[51] **Int. Cl.** **B04b 1/00**

[58] **Field of Search** ..... 233/3, 4, 10, 27, 233/28, 32, 34, 38, 40, 44, 45, 46, 4 R, 17, 18

[56] **References Cited**

UNITED STATES PATENTS

791,496	6/1905	Ponten	233/3
1,056,233	3/1913	Trent	233/3
2,448,038	8/1948	Lykken et al.	233/27 X
1,882,389	10/1932	MacIsaac	233/3 X
2,881,974	4/1959	Ruf	233/45
2,710,718	6/1955	Denman	233/4

FOREIGN PATENTS OR APPLICATIONS

362,652	7/1962	Switzerland	233/3
640,550	1/1937	Germany	233/18
535,596	4/1922	France	233/45

Primary Examiner—George H. Krizmanich
Attorney—Alexander & Dowell

[57] **ABSTRACT**

A centrifugal extractor or contactor comprises a substantially square tank divided by superposed annular partitions into a lower space, an intermediate space, and an upper space. The rotating bowl of the machine carries on its underside a suction chamber which communicates with the bowl through perforations provided in the bottom thereof. This chamber has a lower central opening equipped with inwardly projecting rotary vanes which project the liquids from the tank into the suction chamber. An axial vertical rod extends upwardly from the bottom of the tank, passes between the rotary vanes and carries above same outwardly extending stationary vanes which re-direct upwardly and outwardly the liquid stream issuing from the rotary vanes. The liquid to be treated and the treating liquid are both supplied to the lower space of the tank. They are mixed by paddles carried by the suction chamber, sucked by the vanes and forced into the bowl wherein they are separated by centrifugal action and discharged into the upper and the intermediate space. Wells provided in two opposed corners of the tank direct the separated liquids respectively into the lower space of the next tank and of the preceding tank in a succession of extractors operating in the counter-current mode.

5 Claims, 9 Drawing Figures

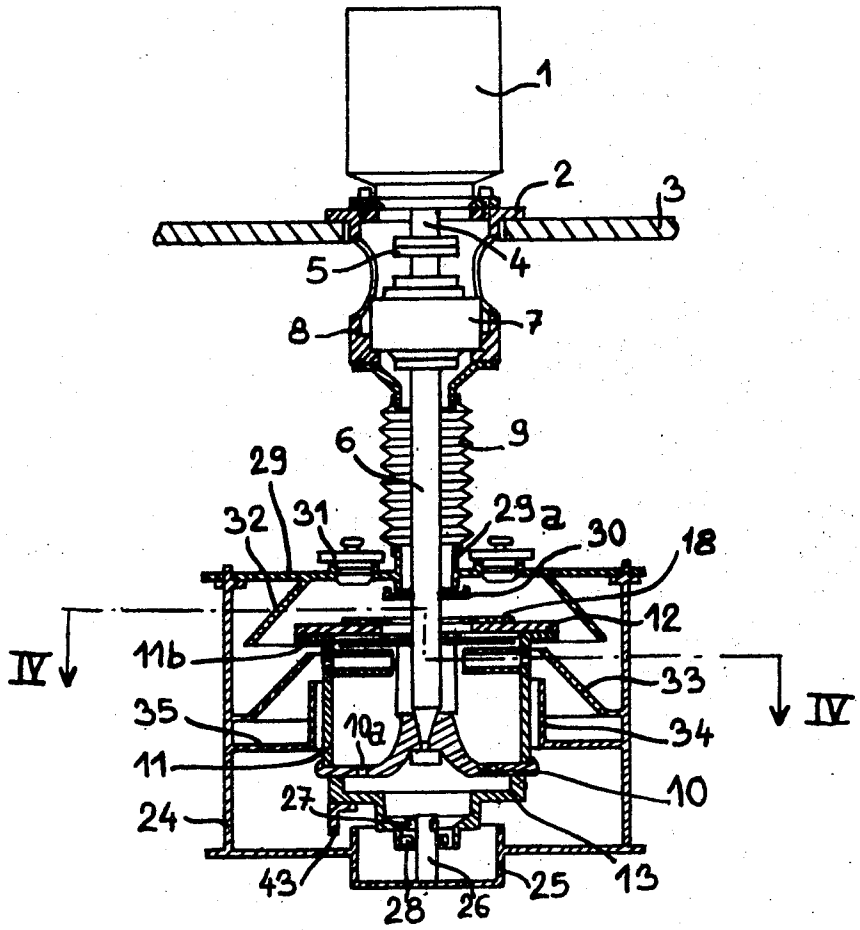
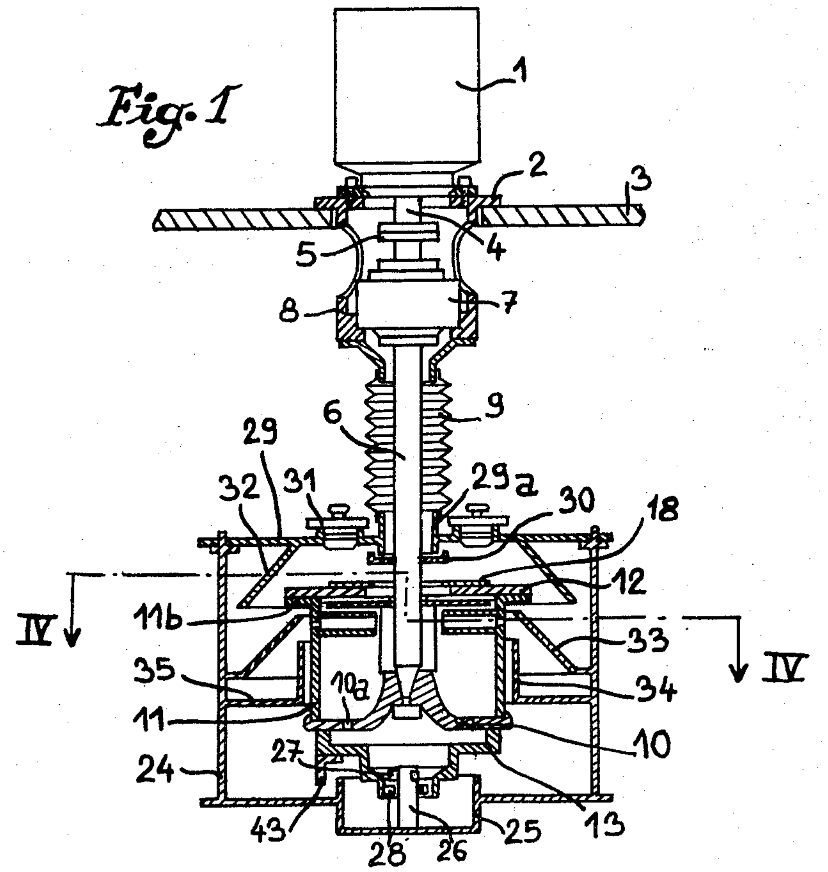


Fig. 1



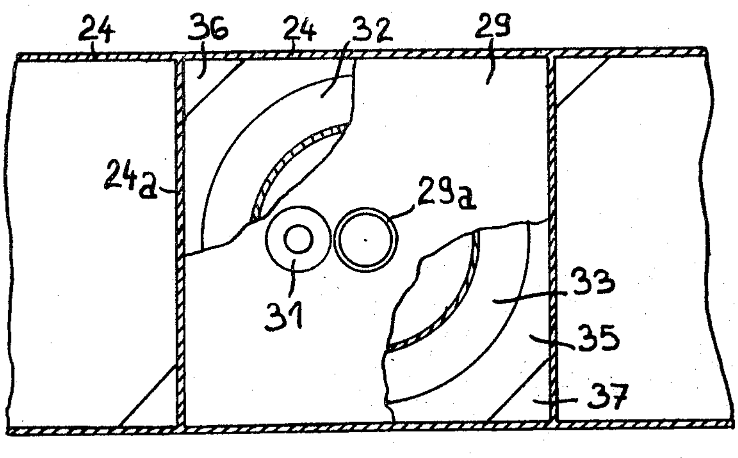


Fig. 4

INVENTOR.
Jean-Paul Mackon
BY Alexander Small
Attorneys

Fig. 2

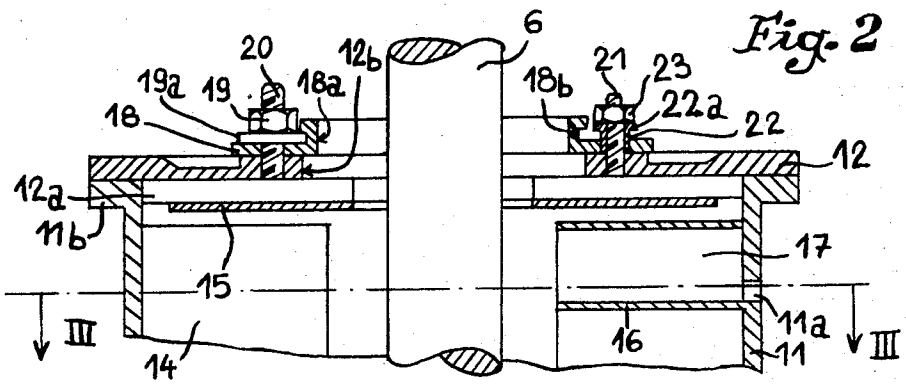


Fig. 3

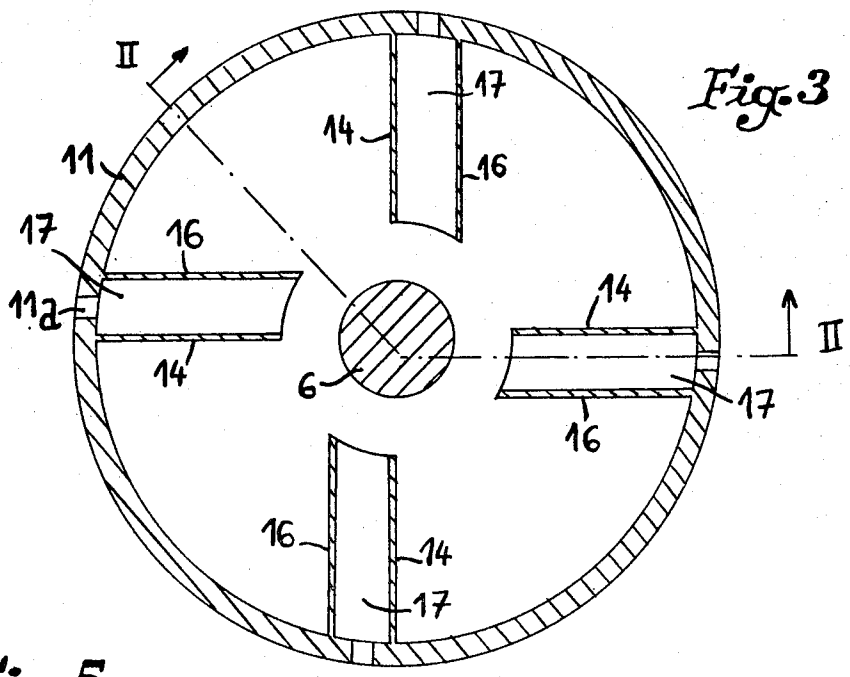


Fig. 5

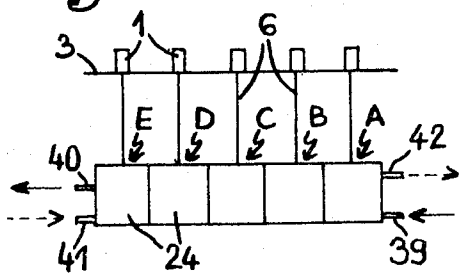
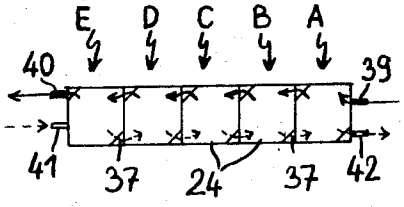


Fig. 6



INVENTOR.
Jean-Paul Miaclon
BY
Alexander Howell
attorneys

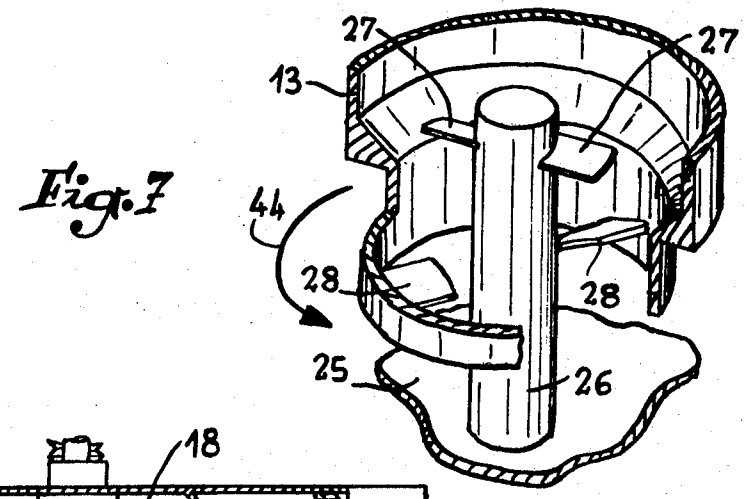


Fig. 7

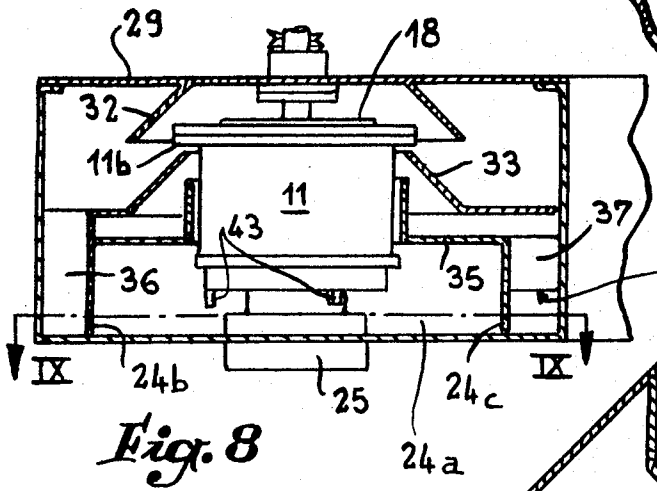


Fig. 8

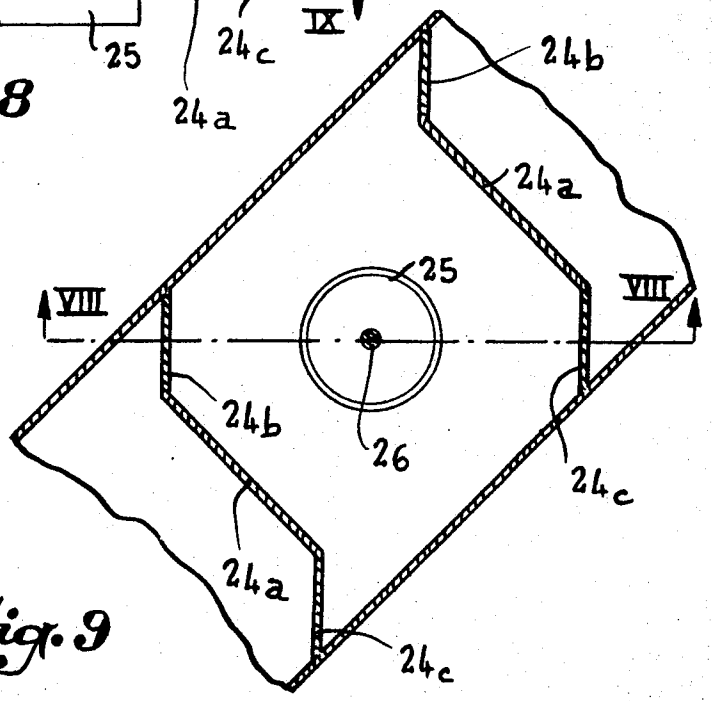


Fig. 9

CENTRIFUGAL EXTRACTORS WITH MEANS FOR MOVING THE MATERIALS

The present invention relates to centrifugal machines adapted to separate from each other two liquids or liquid phases of different specific weight which are not soluble in each other. It more particularly concerns such machines used for the treatment of an aqueous solution or suspension by a solvent or reagent which absorbs or extracts therefrom certain substances, as for instance non-ferrous metals from appropriate solutions, or phenolic compounds from waste water. In such cases the liquids are mixed or more exactly emulsified with each other in order to be brought into mutual contact as intimately as possible, and they are thereafter separated from each other. The machines used for such an operation are generally called contactors or extractors.

These machines are generally disposed in groups, the liquid to be treated and the solvent or like treating liquid which are separately discharged from any machine being respectively supplied to the next and to the preceding machine in the group, and so on. Each machine comprises a fixed container adapted to receive the liquids, a rotating bowl wherein the liquids are separated from each other, suction means which force the liquids from the container into the rotating bowl, and means to discharge the separated liquids issuing from the bowl. As to the intimate mixing of the liquids with each other, it is generally effected by the suction means themselves which are in the form of pumping paddles or vanes.

It is an object of the present invention to provide an extractor of the kind in question wherein the suction means are in the form of a rotating suction chamber disposed below the rotating bowl of the machine, this chamber having a lower inlet provided with inwardly projecting vanes which cooperate with fixed vanes disposed above them and carried by an axial rod, while the bottom of the bowl is formed with perforations through which the liquids may flow from the suction chamber into the bowl.

Another object of this invention is to provide an extractor wherein the fixed container is in the form of a tank in which the rotating bowl is enclosed, this tank being provided with partitions or deflectors which define therein at least three successive spaces to separately receive the heavier liquid issuing from the rotating bowl, the lighter liquid also issuing from the bowl, and both the heavier and the lighter liquids simultaneously supplied to the machine in order to be mixed with each other and thereafter separated from each other by same.

In a preferred embodiment, in the case of a plant comprising a number of successive extractors, the tank of each is formed with lateral wells which connect the first and the second space of the tank of the machine with the third or lower space of the tank of the next one, respectively of the preceding one.

In the annexed drawings :

FIG. 1 is a general vertical section of a centrifugal extractor according to this invention

FIG. 2 illustrates to an enlarged scale the upper portion of the rotating bowl.

FIG. 3 is a horizontal section taken along line III—III of FIG. 2.

FIG. 4 is a horizontal section taken along line IV—IV of FIG. 1, the extractor being adapted to be used in a plant comprising a succession of such machines.

FIG. 5 diagrammatically illustrates in side view such a succession of five extractors.

FIG. 6 is a plan view corresponding to FIG. 5, but with the rotating bowls of the machines being supposedly removed. 9

FIG. 7 is a fragmental perspective view with parts in section showing to an enlarged scale the arrangement of the rotary and stationary vanes which propel the liquid mixture upwardly into the suction chamber of the bowl.

FIG. 8 is a vertical section taken along a diagonal plane of a machine as illustrated in FIGS. 1 and 4 in a plant comprising a succesion of such machines as shown in FIGS. 5 and 6.

FIG. 9 is a horizontal section taken along line IX—IX of FIG. 8, the line of section of the latter being indicated at VIII—VIII.

Referring to FIG. 1, the centrifugal extractor illustrated comprises a vertical upper electric motor 1 mounted on a plate 2 which is removably secured to an upper supporting frame 3. The shaft 4 of this motor extends downwardly through frame 3 and it is connected by an appropriate joint 5 with a lower vertical shaft 6 rotatably carried by a swivel bearing 7 mounted within a tubular support 8 which extends downwardly from plate 2. Shaft 6 is passed through a flexible protecting sleeve 9 and its lower end carries the rotating bowl of the machine, this bowl comprising a bottom 10, a cylindrical lateral wall 11 secured to this bottom and extending upwardly therefrom, and an annular upper cover 12 secured to wall 11. The underside of bottom 10 carries a suction cup 13 provided with a lower central opening. This cup 13 is provided on its outer periphery with downwardly agitating members such as paddles 43 adapted to rotate within the stationary tank of the machine. The bottom 10 of the bowl has a number of perforations 10*a* through which the inner spaces of the bowl and of the cup communicate with each other, these perforations being situated at an intermediate position between the axis of the bowl and the lateral wall thereof.

As shown in FIGS. 2 and 3, the bowl is formed with inner radial partitions 14 adapted to cause the liquids to rotate with the bowl itself. These partitions terminate short of cover 12 so as to leave an intermediate space in which an annular horizontal partition 15 is disposed. Partition 15 is secured to cover 12 by means of radial ribs 12*a* and its outer diameter is less than the inner diameter of lateral wall 11, while its inner diameter is greater than the outer diameter of shaft 6. A gutter-shaped member 16 is welded or otherwise secured to one of the sides of each partition 14 in order to define therewith a radial discharging passage 17 in front of which the lateral wall 11 of the bowl is formed with a perforation 11*a*.

As explained below, the inner periphery 12*b* of cover 12 is adapted to form a primary discharging weir for the heavier liquid or phase, but there is associated therewith a secondary weir constituted by the inner periphery 18*a* of smaller diameter, of an auxiliary annular member 18 mounted on the said cover 12. Member 18 is clamped against the upper side of cover 12 by nuts 19 screwed on screw-threaded vertical studs 20 secured to cover 12. Each nut 19 is formed with an out-

wardly protruding lower circular shoulder 19*a* which engages a groove 18*b* provided in the outer periphery of the sleeve-like central portion of member 18. The latter is guided by screw-threaded studs 21, each disposed on the upper side of cover 12 between two successive studs 20 and each carrying a smooth guiding sleeve 22 which is axially retained in position by a nut 23, this sleeve being formed with an outwardly protruding upper circular shoulder 22*a*.

The bowl 10-11-12 rotates within the stationary square-shaped tank 24 (FIG. 1), the bottom of which is formed with a central circular cup 25 into which the lower cup 13 of the bowl dips. An upwardly extending rod 26 is centrally secured to the bottom of cup 25 and the upper end of this rod carries vanes 27 adapted for cooperation with vanes 28 fixed to the inner wall of the central opening provided in the bottom of the cup 13 carried by the bowl. As illustrated the outwardly extending stationary vanes 27 are disposed above the inwardly extending vanes 28 in such manner as to form guides re-directing longitudinally (i.e. upwardly) the liquids to which vanes 27 have imparted a rotational component. The number of vanes 27 and 28 is preferably quite reduced, as for instance three in each set, as this will be explained below. These vanes are preferably helical so as to force the liquids upwardly.

The perspective view of FIG. 7 clearly shows the respective arrangement of vanes 27 and 28, each set being supposed to only comprise two vanes in order not to overcrowd the drawing. The suction cup 13 rotating in the direction indicated by arrow 44, vanes 28 are at such an angle to the horizontal that they tend to force the liquid mixture upwardly, while of course imparting to the ascending liquid stream a noticeable rotational component. When this stream meets the stationary vanes 27, its rotational component is at least in part transformed into a longitudinal component, whereby the ascending velocity is increased.

Tank 24 is closed by a cover 29 which carries in its center a socket 29*a* to the upper end of which is fixed the lower end of the flexible protecting sleeve 9. The lower edge of socket 29*a* cooperates which a small cup 30 carried by shaft 6 so as to form a screen for liquid droplets and also an abutment by means of which the cover may be raised together with the shaft, as explained below. Cover 39 has an opening which is normally closed by a removable plug 31 and which permits easy access to nuts 19 (FIG. 2).

Cover 29 carries a downwardly flaring frustro-conical deflector 32 which surrounds the upper portion of bowl 10-11-12, its periphery being spaced from the walls of tank 24. Immediately below the upper flange-shaped edge of wall 11 there is provided another downwardly flaring frustro-conical deflector 33 the larger end of which is connected with the walls of tank 24, as for instance by means of a horizontal annular partition. Finally the bowl is rather closely surrounded below deflector 33 by a cylindrical screen the lower end of which is carried by a horizontal annular partition 35.

In use the treating liquid and the liquid to be treated are received in the lower portion of tank 24 where they are mixed with each other by paddles 43. The mixture overflows the upwardly protruding wall of the stationary cup 25 and it is sucked upwardly under the action of the rotary vanes 28 in cooperation with the stationary vanes 27. The liquid stream which has been deflected upwardly by vanes 27 is projected towards the periphery of the rotating cup 13. The differential between the angular velocities of the rotating parts 13,28 and of the stationary parts 25,26,27 enhances the mixing operation to such an extent that in some cases paddles 43 may be dispensed with. The liquid mixture received by cup 13 flows into the rotating bowl 10-11-12 through perforations 10*a*. It is driven into rotation with the bowl by partitions 14 and the heavier component separates from the lighter one under the action of centrifugal force. The lighter liquid flows through passages 17 and perforations 11*a* and it is collected above the horizontal partition 35 within tank 24, while the heavier one passes between partition 15 and wall 11, overflows the weir formed by the auxiliary annular member 18, and is finally collected in the space situated above deflector 33. It is obvious that with appropriate inlet and outlet conduits the machine described will mix and separate two liquid phases continuously supplied into the lower portion of tank 24, below partition 35.

It will be noted that if nuts 19 are unscrewed, their shoulders 19*a* raise the auxiliary annular member 18 which becomes ineffective as a discharging weir, the heavier liquid then overflowing the edge 12*b* of cover 12. There is thus possible to realize two adjustments in the operation of the machine without having to change any member within same. It is to be noted that the shoulders 22*a* of the guiding sleeves 22 play the role of abutments to limit the upward stroke of member 18 and therefore also the unscrewing of nuts 19.

When the extractor is to be disengaged from its tank for inspection or repair, it is sufficient to raise motor 1 together with plate 2 and support 8. Referring to FIG. 1 it may be seen that shaft 6 is raised by bearing 7 and that it raises in turn the cover 29 of tank 24 through cup 30 and sleeve 29*a*. The rotating bowl 10-11-12 is raised with shaft 6 above tank 24. Of course shaft 6 should be orientated about its own axis in such a manner that vanes 28 may pass between vanes 27, which may easily be obtained by providing appropriate marks on joint 5 and on support 8. It is clear that this operation is facilitated by the small number of vanes 27 and 28.

As above indicated the extractor described is more particularly adapted for use in a plant comprising a succession of such machines disposed so to speak in series. For this purpose the successive tanks 24 of these extractors may be realized in the form of an elongated rectangular trough having a number of equally spaced inner transverse partitions 24*a* (FIG. 4), the individual motors of these extractors being supported by a common beam-shaped longitudinal upper frame 3. There is thus obtained a multi-stage unit such as illustrated in FIGS. 5 and 6 wherein the elementary machines are five in number respectively referenced A to E.

In two opposed corners of the square horizontal profile of each individual tank 24 (FIG. 4,8 and 9) there is provided a well 36,37, as for instance by means of a vertical partition 24*b*, 24*c* disposed at 45° to the sides of the tank. The first well 36 opens in the space situated above deflector 33 (heavy liquid space) and its lower end communicates with the lower space of the adjacent tank 24 through an opening in the corresponding separating partition 24*a*. Considering the elementary machines in the order A to E in FIGS. 5 and 6, the well 36 of a given tank 24 communicates with the next tank 24 in the row. On the contrary the well 37 opens immedi-

ately above the horizontal partition **35**, i.e. in the light liquid space, and it communicates by its lower end with the lower space of the preceding tank **24** through and opening in the corresponding separating partition **24***a*. This opening may be seen at **24***d* in FIG. **8**.

Supposing for instance that the liquid to be treated is the heavier one, the lighter liquid being a solvent or the like, as this is generally the case (though the contrary may occur), the former, i.e. the liquid to be treated, is continuously introduced into the lower space of the first tank A through an inlet conduit **39** (FIG. **6**). It meets here the treating liquid or solvent which issues from the well **37** of the next tank B, as explained below. These liquids are mixed within tank A by paddles **43** and the resulting mixture flows into the central stationary cup **25** of the said tank A. It is sucked by the rotating vanes **28** and the fixed vanes **27**, and it is forced into the rotating cup or chamber **13** from which it flows through perforations **10***a* into the bowl **10-11-12** wherein the liquids are separated from each other. The heavier one is discharged above deflector **33** from which it flows through well **36** into the lower space of tank B, and so on until it reaches the last tank E, the well **36** of which is connected with an outlet conduit **40**. As to the treating liquid or solvent (lighter liquid), it flows in the opposed direction. It is supplied to the lower space of tank E through an inlet conduit **41** and is mixed with the heavier liquid discharged from tank D through the well **36** thereof, the mixture being sucked and forced into the rotating bowl of the extractor corresponding to tank E. The light or treating liquid is collected above partition **35** of tank E and it flows through the corresponding well **37** into the lower space of tank D, and so on, until it reaches the well **37** of tank A from which it issues through an outlet conduit **42**.

The flow of both liquids has been illustrated if FIGS. **5** and **6** by arrows in full lines for the liquid to be treated (heavier liquid or phase) and in broken lines for the treating liquid or solvent (lighter liquid or phase).

The heavier liquid is thus rationaly treated in counter-current by the lighter one and for instance a high rate of extraction may be obtained.

I claim:

1. A centrifugal extractor for the treatment of a liquid phase by another liquid phase of different specific weight, these two liquid phases being substantially insoluble in each other, comprising :

a stationary tank having a lower space to receive the heavier and the lighter liquid phases;

a rotating bowl with substantially vertical axis disposed within said tank to receive said heavier and lighter liquid phases from the lower space of said tank and to separate said liquid phases from each other, said bowl having a bottom with an underside, with said bottom being formed with at least one perforation;

means to rotatably support said rotating bowl within said tank so as to permit said bowl to rotate in a predetermined direction;

means on said rotating bowl to separately discharge the heavier liquid phase and the lighter liquid phase separated from each other;

means within said tank to separately collect said heavier liquid phase and said lighter liquid phase discharged from said bowl;

a suction chamber secured to the underside of the bottom of said rotating bowl, said chamber being formed with a lower central opening, and with said chamber communicating with said rotating bowl through said perforation;

rotary vanes carried by said chamber and projecting inwardly of the lower central opening thereof while terminating short of the vertical axis of said rotating bowl, said rotary vanes being arranged at such an angle to the horizontal as to propel said heavier and lighter phases upwardly from said tank into said suction chamber when said bowl rotates in said predetermined direction;

a substantially vertical rod secured to said tank and extending upwardly into said suction chamber substantially co-axially to said rotating bowl and between said rotary vanes;

and stationary vanes carried by said rod above said rotary vanes said stationary vanes being disposed at such an angle to the horizontal as to cooperate with said rotary vanes to direct upwardly and outwardly the rotating liquid stream issuing from said rotary vanes.

2. In an extractor as claimed in claim **1**, said rotary vanes and said stationary vanes being helical.

3. A unit for the treatment of a first liquid phase by a second liquid phase of different specific weight, these two liquid phases being substantially insoluble in each other, comprising :

a succession of stationary tanks each having a lower space to receive the heavier and the lighter liquid phases ;

a rotating bowl with vertical axis disposed in each tank to receive said heavier and lighter liquid phases from the lower space of said last-named tank and to separate said liquid phases from each other ;

means to rotatably support said rotating bowls within said tanks ;

means carried by each rotating bowl to suck said heavier and lighter liquid phases from the lower space of the corresponding tank ;

means on each rotating bowl to separately discharge the heavier liquid phase and the lighter liquid phase separated from each other ;

means within each tank to separately collect the heavier liquid phase and the lighter liquid phase discharged from the corresponding rotating bowl ;

means to direct the heavier liquid phase collected in each tank of said succession of tanks, except the last one, into the lower space of the next tank in the succession ;

means to direct the lighter liquid phase collected in each tank of said succession of tanks, except the first one, into the lower space of the preceding tank in the succession ;

means to supply the heavier liquid phase into the lower space of the first tank of said succession of tanks ;

means to supply the lighter liquid phase into the lower space of the last tank of said succession of tanks ;

means to discharge from said unit the heavier liquid phase collected in the last tank of said succession of tanks ;

and means to discharge from said unit the lighter liquid phase collected in the first tank of said succession of tanks.

4. In a unit as claimed in claim 3, said succession of tanks being in the form of an elongated substantially rectangular trough divided into a plurality of individual tanks by transverse partitions.

5. In a unit as claimed in claim 4 :

said means to separately collect within each individual tank the heavier liquid phase and the lighter liquid phase being formed of two superposed partitions which define said lower space, an intermediate space to receive one of said liquid phases, and an upper space to receive the other one of said liquid phases ;

said means to direct the heavier phase collected in one tank into the lower space of the next tank in the succession including a first vertical well formed in a first corner of said one tank, with the lower end of said first well communicating with the lower space of said next tank through an aperture in the adjacent transverse partition ;

and said means to direct the lighter liquid phase collected in one tank into the lower space of the preceding tank in the succession of tanks including a second vertical well formed in a second corner of said one tank opposed to said first corner thereof, with the lower end of said second well communicating with the lower space of said preceding tank through an aperture in the adjacent transverse partition.

* * * * *