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(54) Countercurrent centrifugal extractor

(57) A solid-wall countercurrent centrifugal extractor for extracting liquids containing an extract and preferably a high content of solids by means of an extracting agent has a centrifugal drum (2) provided with a conveyor screw and having a mixing zone (16) and clarifying zones (14, 15). Within the mixing zone, between the inflow of the light and heavy liquid phases at (23) and (26) respectively, is provided at least one overflow weir (17), which subdivides the mixing zone into mixing-separating chambers (18, 19). For supplying the light liquid phase from a chamber (22) within the screw boss, feed ducts (23) are provided in the first mixing-separating chamber (18) and issue into the vicinity of the specifically heavy liquid phase close to the inner wall of the drum shell. One or more overflow ducts (20) are arranged in the overflow weir (17), passing the light liquid phase separated in the first mixing-separating chamber (18) into the next or second mixing-separating chamber (19). The overflow ducts also issue into the vicinity of the heavy liquid phase. This leads to additional intense mixing contact points, which improve the extraction effect.

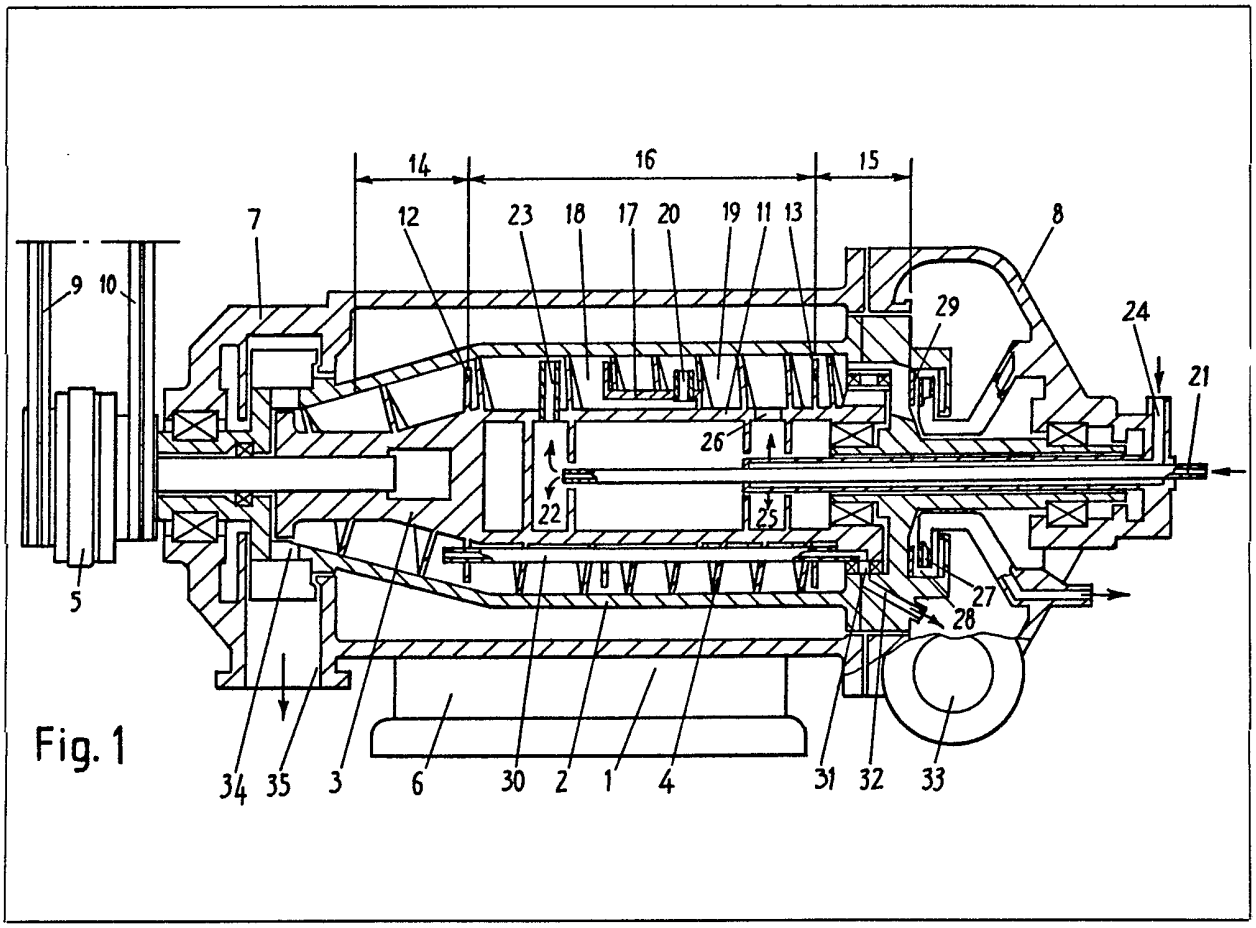

Fig. 1

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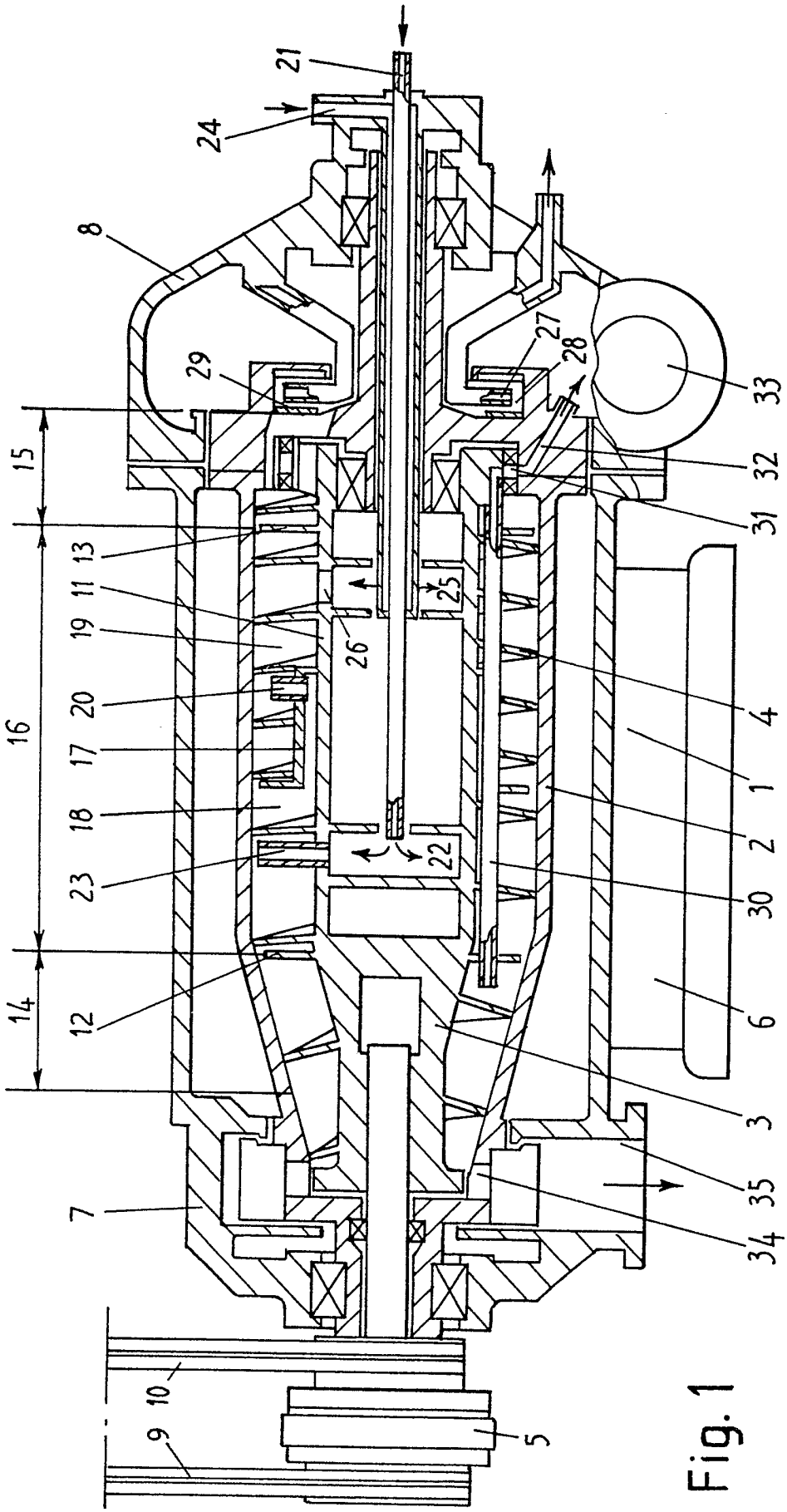
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Fig. 1

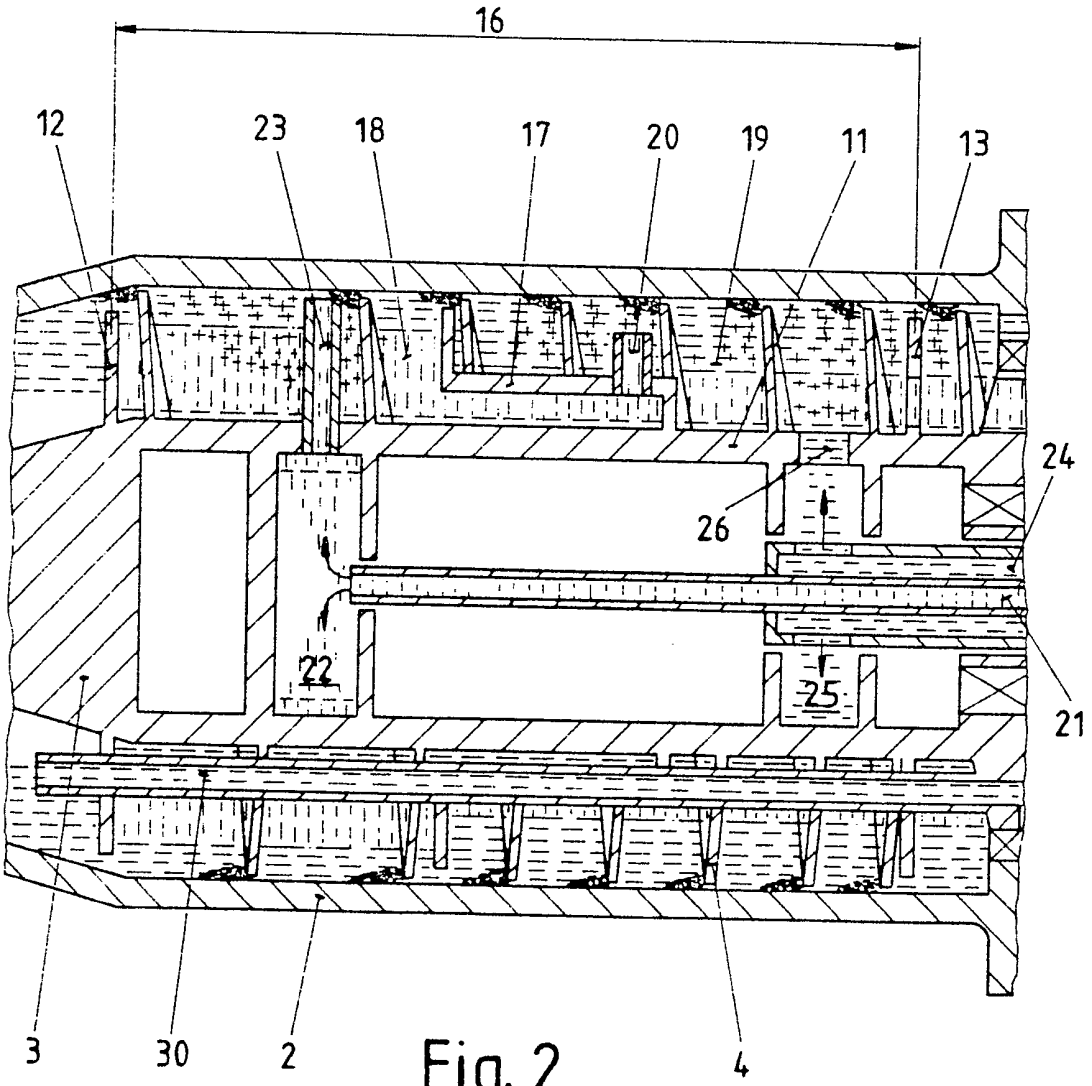

Fig. 2

SPECIFICATION

Continuously operating solid-wall countercurrent centrifugal extractor

The invention relates to a continuously operating solid-wall countercurrent centrifugal extractor for mixing and separating two liquids having different specific weights and supplied by means of separate intakes, having at least one partially conical centrifugal drum which can be driven in rotary manner about a horizontal axis and which has clarifying zones and a mixing zone, the supply of liquids to the mixing zone taking place from chambers arranged within the centrifugal drum, and a conveyor screw rotatable with a differential speed within the drum and whose spirals are adapted to the inner wall of the drum and convey the solids deposited in the separating space between the screw boss and the drum under the action of the centrifugal force to a solids outlet constructed in the conically contracting end area of the drum and with a paring device provided in a paring chamber for removing a first liquid phase, as well as with an outlet chamber for a second liquid phase, bounded towards the separating area by an overflow weir and closed with respect to the paring chamber.

Such a solid-wall, countercurrent centrifugal extractor is, for example, known from German Patent 2,901,607 (Fig. 2).

Centrifugal extractors of the aforementioned type are used for transferring the extract dissolved from liquids containing extract and preferably with a high solids content by means of a liquid extracting agent into the latter, the solubility of the extract to the extracting agent being greater than that to the extract-containing liquid. The extracting agent can either be the specifically light liquid phase or the specifically heavy liquid phase.

In order to obtain a high extraction yield it is necessary to have a good mixing or intimate contact between the two liquid phases for transferring the substance to be then extracted from the aqueous, extract-containing and solids-containing liquid phase into the extracting agent. The number of obtainable extraction stages and consequently the extraction yield is particularly high if the extraction process is performed in countercurrent in the mixing zone. In the case of countercurrent extraction, the extraction process can also be performed with the minimum quantity of extracting agent.

In the known centrifugal extractor, the two liquid phases are transferred by means of separate feed lines into separate chambers arranged within the screw boss and from these chambers are passed through openings into the mixing zone positioned in the vicinity of the spirals of the conveyor screw, the liquids flowing in counterflow through the spirals of the conveyor screw, accompanied by a powerful mixing influence.

It has been found that within the mixing area an intimate contact and therefore a good mixing effect between the two liquid phases is only obtained, if the density difference between the two liquid phases is not too great and the liquids have a good emulsification tendency.

It is admittedly known from German Patent 2,701,763 to arrange within the spirals and in the vicinity of the mixing zone, a plurality of contact points, such as segments or shaped members for making mixing more intensive, but as detailed tests have shown they only have a limited influence on the mixing effect because the mixed liquids within the spirals are very rapidly separated again under the influence of the centrifugal forces acting on them, so that the desired thorough mixing of the liquid is only achieved to a limited extent.

Tests have also shown that the best intensive mixing effect is obtained if, when the liquid passes from the chamber within the screw boss into the mixing zone, the liquid is directly introduced into the other liquid phase, as is the case with the inflow of the specifically heavier liquid phase into the mixing zone where, as a result of its higher specific weight, it must flow through the specifically lighter liquid phase into the outer area of the drum, so that the specifically heavier liquid phase comes into intimate contact with the specifically lighter liquid phase. However, on flowing into the mixing zone, the light liquid phase essentially only comes into contact with the surface of the specifically heavier liquid phase, so that only a reduced mixing effect is obtained here.

The problem of the present invention is to so construct the solid-wall countercurrent centrifugal extractors of the aforementioned type that more intense contact points are provided in the vicinity of the mixing zone, so that the extraction effect of the extractor is improved.

According to the invention, this problem is solved in that within the mixing zone between the inflow of the light and heavy liquid phases, there is at least one overflow weir, which subdivides the mixing zone into mixing and separating chambers, and feed ducts are provided for the supply of the light liquid phase from the chamber within the screw boss into the first mixing-separating chamber, said ducts issuing into the vicinity of the specifically heavy liquid phase close to the inner wall of the drum shell, one or more overflow ducts being arranged in the overflow weir for leading the light liquid phase separated from the first mixing-separating chamber into the next or second mixing-separating chamber, whereby said ducts also issue into the vicinity of the heavy liquid phase.

The arrangement of a feed duct for the supply of the specifically light liquid phase

and which extends into the vicinity of the inner wall of the drum shell and consequently into the vicinity of the specifically heavy liquid phase and additional arrangement of an overflow weir in the vicinity of the mixing zone with an overflow duct for the specifically light liquid phase separated in the first mixing-separating chamber and which also extends into the vicinity of the specifically heavy liquid phase ensures that two additional intense mixing contact points are formed in the extractor, which significantly improve the extraction effect therein.

An embodiment of the invention is described hereinafter relative to the drawings, wherein show:

Figure 1 the diagrammatic view of a solid-wall counter-current centrifugal extractor of the aforementioned type in a vertical longitudinal section.

Figure 2 a partial cross-section of Fig. 1 incorporating a larger-scale representation of the mixing zone of the centrifugal extractor.

Fig. 1 shows a solid-wall countercurrent centrifugal extractor comprising a cylindroconical drum 1 in which is arranged a conveyor screw 3 which can be driven at a differential speed with respect to the drum shell 2. Screw 3 has spirals 4, which are adapted to the inner wall of the drum shell. The differential speed control between the conveyor screw and the drum shell takes place by means of a cyclo gear 5 connected to both screw and shell. The drum is mounted in rotary manner in a casing 6 comprising a casing shell 7 and casing cover 8. The drum shell and conveyor screw are driven via the cyclo gear using e.g. a not shown electric motor which, by means of V-belts 9, 10, brings the cyclo gear and consequently the drum shell and the conveyor screw to the stipulated speeds.

The separating area, in the vicinity of spirals 4 between screw boss 11 and drum shell 2, contains separating disks 12, 13, which subdivide the separating area into clarifying zones 14, 15 and a mixing zone 16. Within the latter is arranged an overflow weir 17 having an annular clearance towards the inner wall of drum shell 2 and which is closed towards the screw boss. The weir has an angular construction and subdivides the mixing zone into first and second mixing-separating chambers 18, 19. In the axially directed member of the overflow weir is provided an overflow duct 20 issuing into the vicinity of the specifically heavier liquid phase in the second mixing-separating chamber 19 and serving for leading off the specifically lighter liquid phase separated in the first mixing-separating chamber 18.

For supplying the specifically lighter liquid phase, a feed pipe 21 is provided, which issues into a chamber 22 within screw boss 11. One or more feed ducts 23 emanate from chamber 22. In the vicinity of the specifically heavy liquid phase, these ducts issue into the first mixing-separating chamber 18, close to the inner wall of drum shell 2. The feed pipe 21 is embraced by a feed pipe 24 for supplying the specifically heavier liquid phase and issues into a chamber 25 within screw boss 11 at a distance from chamber 22. It has one or more outlets 26, which issue into the vicinity of the second mixing-separating chamber 19.

The specifically lighter liquid phase is drawn off by means of a paring or skimming device 27, arranged in a paring or skimming chamber 28 within casing cover 8, the paring chamber being bounded towards the clarifying zone 15 by an overflow weir 29, the removal of the specifically heavier liquid phase from clarifying zone 14 of the drum takes place by means of overflow pipes 30, which issue into an annular duct 31, from which the liquid is supplied by means of a drain duct 32 from the drum into casing cover 8, from which the heavy liquid phase is passed on by means of drain 33.

The solids centrifuged in the drum are conveyed by means of the conveyor screw 3 arranged in the conical area of the drum by means of the spirals 4 fixed to the said screw to the discharge opening 34 in the drum shell and are discharged via discharge opening 35 in casing shell 7.

The extractor functions as follows. After the extractor drum has been raised to the operating speed, the specifically heavier, solids-containing liquid is supplied by means of the feed pipe 24 into chamber 25 within the screw boss 11 and from there passes via outlets 26 into the vicinity of mixing zone 16. As soon as the drum is filled with a certain amount of specifically heavier liquid, the latter flows in the direction of the conical drum part and is discharged from the rotating drum in pressureless manner via overflow pipes 30, annular duct 31 and drain duct 32. At the same time, the solids centrifuged in the drum and which have been deposited on the inner wall of drum shell 2 are taken up by the spirals 4 of conveyor screw 3 and conveyed in the direction of the discharge opening 34 in the drum shell and are discharged from the drum in a relatively dry form.

After filling the drum with the specifically heavier liquid, the specifically lighter liquid, e.g. the extracting agent, is supplied to the drum by means of feed pipe 21 in countercurrent manner to the specifically heavier liquid and passes into chamber 22 within the screw boss 11 and from there via supply duct 23 and as a result of the liquid which has been dammed back in chamber 22 and the resulting pressure gradient into the vicinity of the specifically heavier liquid phase in the mixing-separating chamber 18 within the mixing zone 16, between spirals 4 of the conveyor screw. As all the specifically lighter liquid

flows through the specifically heavier liquid and there is an additional swirling motion of the liquid between the rotating conveyor screw 3 and drum shell 2 rotating at a differential speed, there is an intense mixing of the liquid in mixing-separating chamber 18.

As a function of the specific weight difference between the two liquids and a function of the residence time of the liquids in the drum, a certain separation between the two liquids takes place again between the spirals 4 during the countercurrent of said liquids. Thus, the at least partially re-separated, specifically lighter liquid phase in the first mixing-separating chamber 18 can be used for a further intense mixing with the specifically heavier liquid phase, by passing this specifically lighter liquid phase separated from the first mixing-separating chamber 18 via the overflow weir 17 separating mixing-separating chambers 18, 19 and via overflow duct 20 into the specifically heavier liquid phase of the second mixing-separating chamber 19, where once again there is an intense mixing between the liquids. On the way towards the discharge side into clarifying zone 15, the specifically lighter liquid phase flows in countercurrent manner through the specifically heavy liquid phase flowing in through outlets 26, so that at this point there is a third intense mixing between the liquids. The specifically lighter liquid passes via clarifying zone 15 into paring chamber 28, from which it is discharged from the drum under pressure by means of paring device 27.

Fig. 2 essentially shows the mixing zone 16 of Fig. 1 on a larger scale, the liquids and solids in the drum being represented graphically for ease of understanding.

The invention is naturally also usable for solid-wall countercurrent centrifugal extractors, in which the spent specifically heavy liquid phase is discharged from the drum together with the solids.

List of reference numerals

1 Drum
2 Drum shell
3 Conveyor screw
4 Spirals
5 Cyclo gear
6 Casing
7 Casing shell
8 Casing cover
9 V-belt
10 V-belt
11 Screw boss
12 Separating disk
13 Separating disk
14 Clarifying zone
15 Clarifying zone
16 Mixing zone
17 Overflow weir
18 First mixing-separating chamber
19 Second mixing-separating chamber
20 Overflow duct
21 Feed pipe
22 Chamber
23 Feed duct
24 Feed pipe
25 Chamber
26 Outlets
27 Paring device
28 Paring chamber
29 Overflow weir
30 Overflow pipes
31 Annular duct
32 Drain duct
33 Drain
34 Discharge opening
35 Discharge opening

CLAIMS

1. Continuously operating solid-wall countercurrent centrifugal extractor for mixing and separating two liquids having different specific weights and supplied by means of separate intakes, having at least one partially conical centrifugal drum which can be driven in rotary manner about a horizontal axis and which has clarifying zones and a mixing zone, the supply of liquids to the mixing zone taking place from chambers arranged within the centrifugal drum, and a conveyor screw rotatable with a differential speed within the drum and whose spirals are adapted to the inner wall of the drum and convey the solids deposited in the separating space between the screw boss and the drum under the action of the centrifugal force to a solids outlet constructed in the conically contracting end area of the drum and with a paring device provided in a paring chamber for removing a first liquid phase, as well as with an outlet chamber for a second liquid phase, bounded towards the separating area by a overflow weir and closed with respect to the paring chamber, in which within the mixing zone between the inflow of the light and heavy liquid phases, there is at least one overflow weir, which subdivides the mixing zone into mixing and separating chambers, and feed ducts are provided for the supply of the light liquid phase from the chamber within the screwboss into the first mixing-separating chamber, said ducts issuing into the vicinity of the specifically heavy liquid phase close to the inner wall of the drum shell, one or more over-flow ducts being arranged in the overflow weir for leading the light liquid phase separated from the first mixing-separating chamber into the next or second mixing-separating chamber, whereby said ducts also issue into the vicinity of the heavey liquid phase.

2. Continuously operating solid-wall countercurrent centrifugal extractor according to claim 1, in which the mixing zone is arranged

between the spirals of the conveyor screw.

3. Continuously operating solid-wall countercurrent centrifugal extractor according to claims 1 and 2, in which the mixing zone is bounded with respect to clarifying zones by separating disks.

4. Continuously operating solid-wall countercurrent centrifugal extractor according to claim 1, in which towards the inner wall of the drum shell, overflow weir has an annular clearance and is closed towards the screw boss.

5. Continuously operating solid-wall countercurrent centrifugal extractor according to claims 1 and 4, in which the overflow weir is constructed in angular manner.

6. Continuously operating solid-wall countercurrent centrifugal extractor according to any one of the claims 1 to 5, in which the overflow ducts are arranged in the axially directed member of the overflow weir.

7. Continuously operating solid-wall countercurrent centrifugal extractor for mixing and separating two liquids having different specific weights substantially as described herein with reference to and as shown in the accompanying drawings.

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