

[54] **CENTRIFUGAL SEPARATOR**
[76] Inventor: **Georg Hiller**, Bergstrasse 8,
Vilsbiburg, Germany
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[58] **Field of Search**..... **233/1 R, 7, 16, 27,**
233/28, 23 R, 20 R, 19 R, 3

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Primary Examiner—George H. Krizmanich
Attorney—Charles E. Brown et al.

[57] **ABSTRACT**
A centrifugal separator comprising a rotary bowl and a screw conveyor rotatable in said bowl on the uniflow principle, wherein liquid separated from slurry in the bowl is withdrawn under suction through a conduit disposed beyond the level of the liquid in the bowl.
19 Claims, 6 Drawing Figures

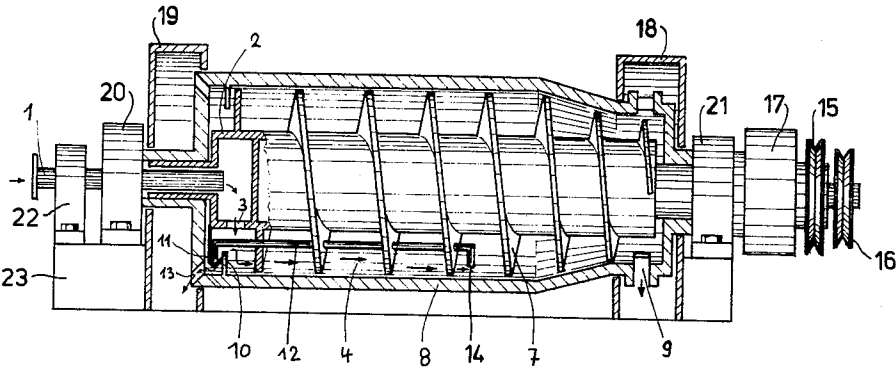
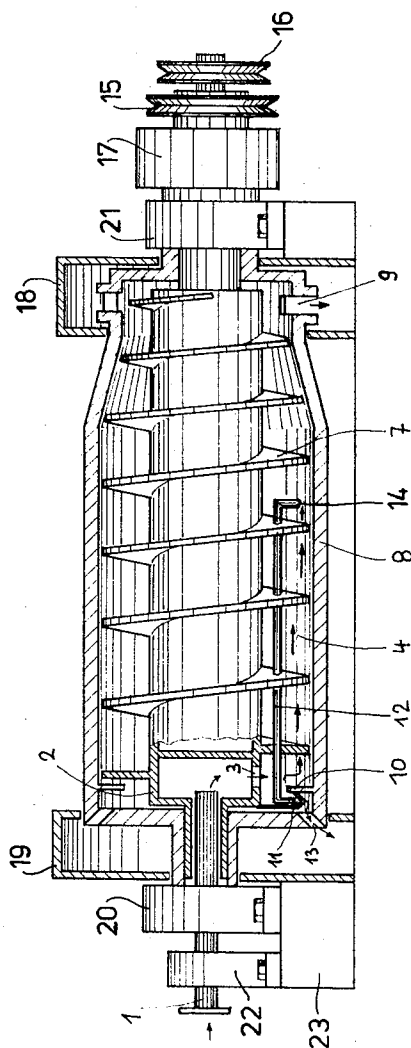


Fig. 1



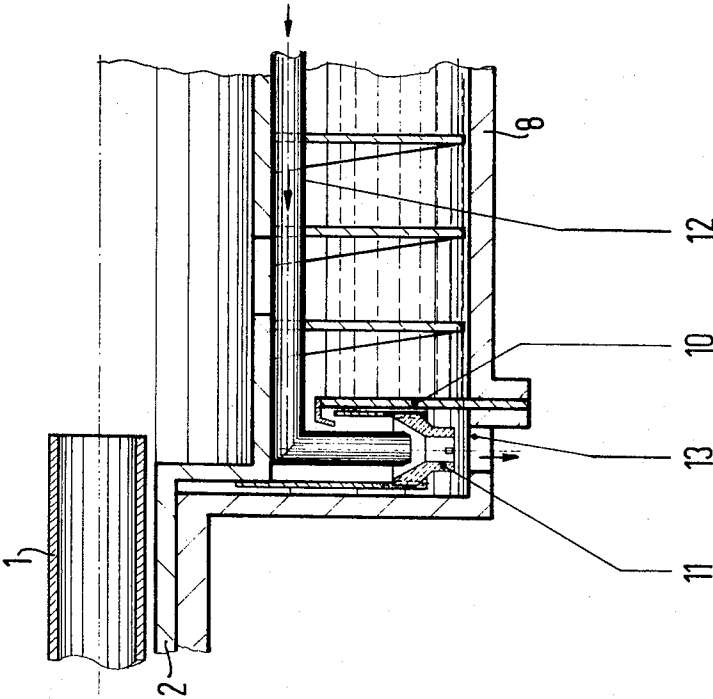


Fig. 2

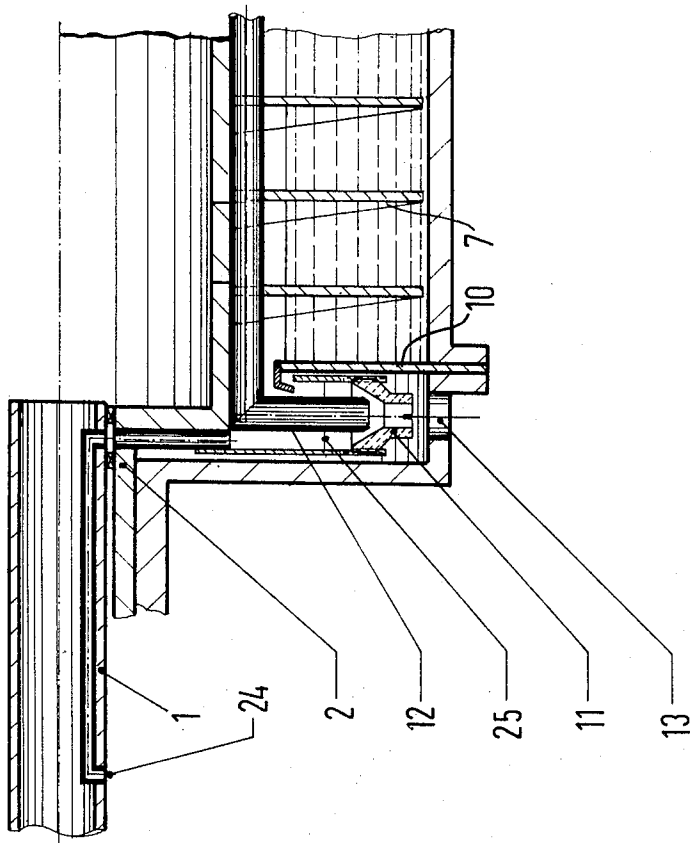


Fig. 3

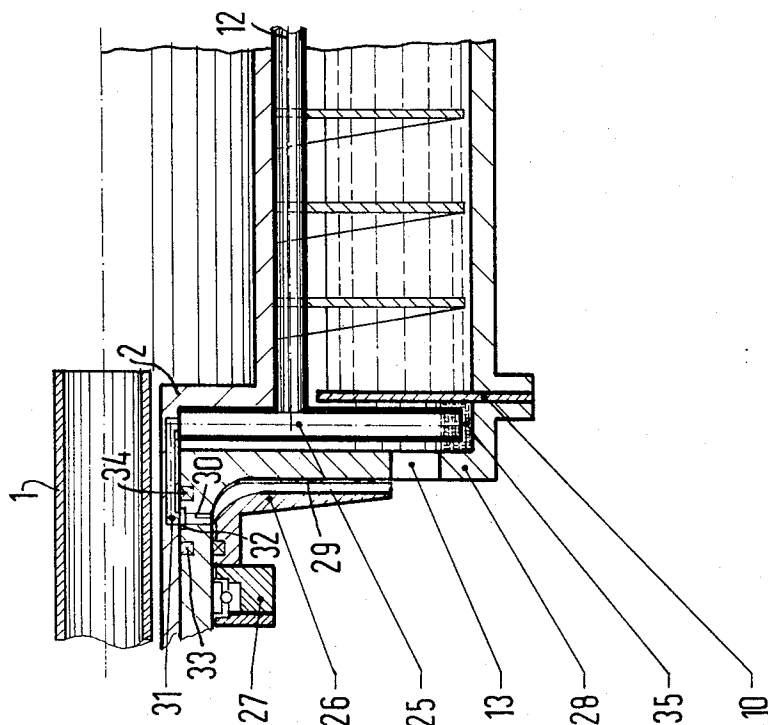


Fig. 4

Fig. 5

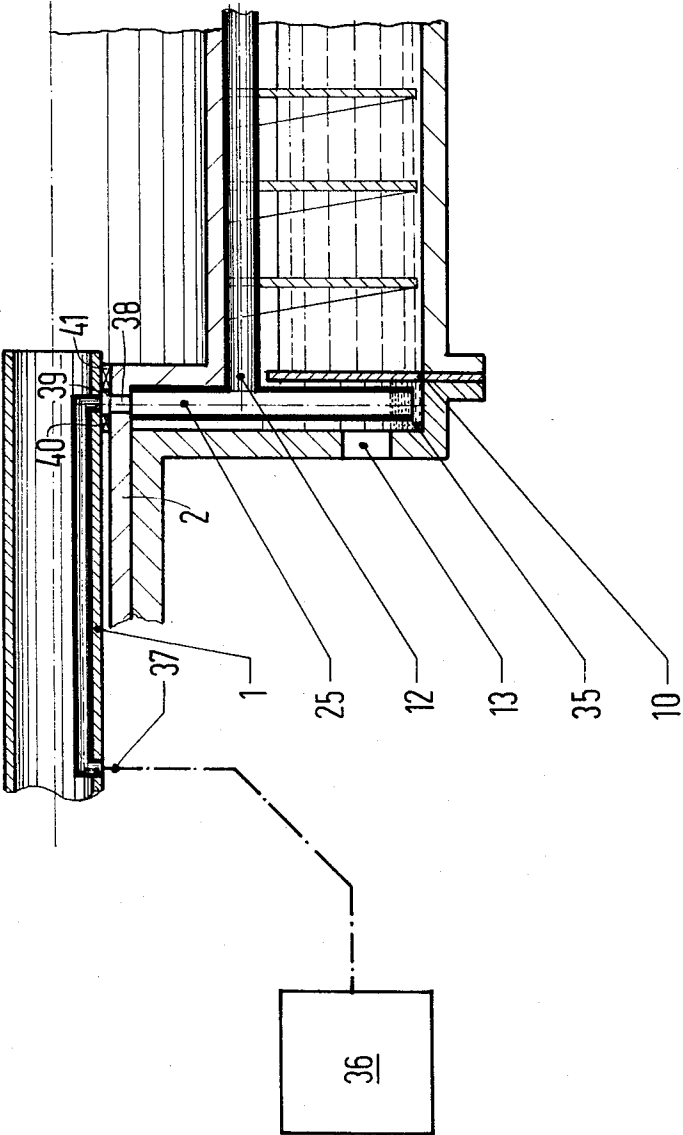
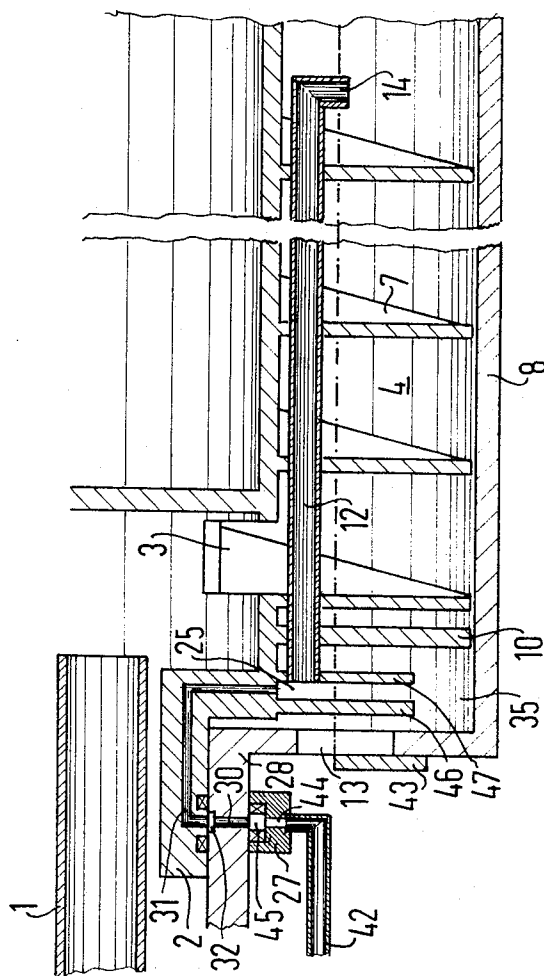


Fig. 6



CENTRIFUGAL SEPARATOR

The invention relates to a centrifugal separator, also termed decanter, which makes use of a feed screw and works on the uniflow principle.

More particularly, the invention relates to a centrifugal separator for use in thickening sewerage slurries. In a separator of this kind, the material to be centrifuged is provided with an additive of a chemical flocculant to achieve a clear run-off out of the decanter. The addition of chemical flocculants makes it unnecessary to operate the separator at a high rotary speed. It has been found that a multiple of between 500 and 800 of the acceleration due to gravity will suffice for satisfactorily separating the solids.

In centrifugal separators working on the uniflow principle, the material to be centrifuged is challenged into the separator at the largest diameter of the bowl. In a known uniflow decanter (German Specification 1 020 575), the cleaned liquid runs off through the hub of the conveyor in a direction towards the large diameter of the bowl and there passes to the outside through apertures which are sealed from the contents of the bowl. In another known uniflow decanter (German Specification 1 274 997), the clean liquid is withdrawn by a peeling or paring element within the conveyor hub. At the position where the peeling element operates, the hub is of enlarged diameter and provided with apertures. The diameter of the peeling element is adjustable so that the element can work at different liquid levels.

Both of the above-mentioned uniflow separators suffer from certain disadvantages which the present invention aims to avoid.

In the first-mentioned separator or decanter, the withdrawal of the cleaned liquid in the interior of the conveyor hub necessitates the selection of a hub diameter which is so large that the entire wall of the hub must in every case dip into the annulus of liquid. This reduces the clear volume and gives rise to eddy effects in the upper layer of the annulus of liquid. In addition, the supply of the material to be centrifuged and withdrawal of the clean liquid are possible only with the aid of components of relatively complicated construction. A change in the liquid level within the bowl is possible only within very restricted limits. It is hardly possible to influence the speed of flow within the conveyor and with certain materials this leads to additional sedimentation within the conveyor.

In the second of the above-mentioned known uniflow separators, the liquid is withdrawn by an adjustable peeling element. The peeling element is disposed in the interior of the hub of the conveyor and at the position where the peeling element passes into the annulus of liquid the hub is enlarged and provided with apertures. The cleaned liquid flows through the apertures into a chamber within the hub and is there pared off by the peeling element. Here, too, the hub dips into the liquid annulus at the paring position and thereby considerably constricts the passage for solids. Further, the peeling element, which is stationary relatively to the bowl, gives rise to eddies, the effect of which is also transmitted to the separating chamber. The peeling element within the conveyor hub is a very expensive piece of equipment and of complicated construction. Again, adjustment of the liquid level is possible only within restricted limits.

The invention aims to provide a centrifugal separator which operates on the uniflow principle and does not possess the above-mentioned disadvantages.

According to the invention, the return flow of the cleaned liquid is through pipes or channels which lie beyond the level of the liquid in the bowl.

Such channels or pipes can operate only if a certain vacuum is established within the pipes. In separators of this kind operating at high rotary speeds, the difference in liquid level that can be achieved with the aid of a vacuum is so small that it cannot be utilised. On the other hand, in separators for thickening slurries and operating with the aid of flocculants, the rotary speed is so low that a difference of level up to 4 cm can be achieved by vacuum. This vacuum can be created by a built-in pump or, in accordance with a preferred feature of the invention, by the outflowing liquid itself.

The material to be centrifuged enters the separating chamber at the largest diameter of the bowl. The direct outflow of the material to be centrifuged towards outlet openings is restrained by a disc which is fixed to the wall of the bowl and which projects beyond the normal level of the annulus of liquid. The liquid is thereby dammed until the pipe, through which the liquid is to pass and which is radially angled at the outlet, dips into the annulus of liquid. The liquid now continues to rise until it flows over the disc at the end of the larger bowl diameter. The overflow is caught in a channel having two or more nozzles. The axially extending outlet pipe or pipes terminate at these nozzles and now begin to operate under the effect of the suction produced by the liquid flowing over the disc.

Of course the suction could also be produced by water introduced from the outside and a small quantity of which flows constantly. As already mentioned, in an alternative construction a vacuum pump could be built into the machine for producing a vacuum in this pipe when the front of the pipe dips into the liquid.

The principal advantages of the invention are that the outlet pipes dip into the liquid only with their suction orifice so that eddying at the surface is avoided. This is of particular importance in the case of apparatus used for removing water from slurries.

Examples of the invention are illustrated in the accompanying drawings, wherein:

FIG. 1 is a sectional view of a separator operating on the uniflow principle, comprising outlet pipes or conduits above the liquid level and operating under vacuum;

FIG. 2 is an enlarged detail of the vacuum-producing nozzles of the FIG. 1 separator;

FIG. 3 is a fragmentary cross-section of a separator in which the vacuum in the outlet pipes is produced by water supplied from the exterior;

FIG. 4 is a fragmentary cross-section of a separator in which the vacuum in the outlet pipes is produced by a pump built into the separator;

FIG. 5 is a fragmentary cross-section of a separator in which the vacuum in the outlet pipes is produced by a pump remote from the separator, and

FIG. 6 is a fragmentary cross-section of another embodiment of separator in which the vacuum in the outlet pipes is produced by a pump installed remote from the separator.

Referring to FIGS. 1 and 2, material that is to be centrifuged enters a hub 2 of a screw conveyor through an inlet pipe 1 and passes through apertures 3 into a sepa-

rating chamber 4. Thereafter, the material follows the helical blade 7 of the conveyor and flows towards the smaller diameter of the bowl 8. A sediment of solids is formed on the interior of the wall of the bowl 8, is engaged by the blade 7 and conveyed towards the smaller drum diameter, where it is ejected through discharge openings 9. The cleaned liquid accumulates at the surface of the liquid and eventually flows over the annular partition 10 at the larger diameter of the bowl. In so doing, it produces a suction in the outlet conduits 12 at the location of the nozzles 11. These conduits 12 are mounted closely above the surface of the liquid. The suction that is produced causes the cleaned liquid within the conduit 12 to flow towards the larger bowl diameter, where it leaves the bowl through outlet openings 13. The outlet conduits 12 are so arranged that, at the suction orifice 14, they are immersed several centimetres more deeply than the inner diameter of the partition 10. Accordingly, when the outlet conduits 12 are operating, liquid will no longer flow over the partition 10. The bowl 8 is driven by a pulley 15 and the screw conveyor is driven by a pulley 16. Gearing 17 is operatively interposed between the pulleys on the one hand and the conveyor and bowl on the other hand. Solids discharged through the opening 9 are collected in a housing 18.

A housing 19 is provided for the central withdrawal of cleaned liquid flowing out of the openings 13. The entire arrangement is mounted on plummer blocks or bearings 20 and 21. In addition, there is a holder 22 for supporting the inlet pipe 1. The holder 22 as well as the plummer blocks 20 and 21 are supported by a base or foundations 23.

The nozzle arrangement is more clearly indicated in FIG. 2. The nozzles 11 producing the suction may be so arranged by means of a screw connection that they are accessible through the outlet openings 13 for the purpose of adjusting the gap between the outlet conduit 12 and the nozzle 11.

FIG. 3 illustrates an inlet pipe fourteen for water disposed within the inlet pipe 1 for the material to be centrifuged. Water from the pipe fourteen is fed to the chamber 25 formed at the hub 2 of the conveyor. The inflowing water produces suction in the pipe 12 with the aid of the nozzles 11, and the pipe 12 begins to operate. In this case the nozzle 11 is also adjustable from the exterior by means of access through the opening 13.

In FIG. 4, suction is produced by a fixed disc 26 which may be fixed to a bearing cover 27 of the plummer block 20. The disc 26 carries radial ribs 29 and is disposed at a very close spacing from the cover 28 of the bowl 8. In an alternative construction, the radial ribs 29 could be mounted on the cover 28, in which case the disc 26 will be plain.

The vacuum that is produced extends into the chamber 25 through a passage 30 in the bowl cover 28 and through a passage 31 in the conveyor hub 2. The chamber 25 is connected to the hub 2. The passages 30 and 31 are in constant communication with one another by means of a circumferential groove 32 in the cover 28. This connection is sealed by sealing rings 33 and 34.

When the separator commences to operate, a certain amount of clean liquid flows from the cleaned surface layer over the partition 10 into the chamber 35 and closes the annular gap. The suction produced by the disc 26 now brings the outlet conduits 12 into opera-

tion, which likewise dip into the liquid at the location of the suction orifice 14 (FIG. 1). The cleaned liquid now leaves the chamber 35 through the opening 13.

In the FIG. 5 embodiment the vacuum for operating the conduits 12 is produced by a vacuum pump 36 disposed outside the separator. Vacuum is produced in the chamber 25 through a pipe 37 which extends through the inlet pipe 1. When the chamber 35 is filled by liquid flowing over the partition 10, the chamber 25 becomes sealed and a vacuum is set up in the conduit 12, which commences to operate. The overflow of cleaned liquid flows through the opening 13 to the exterior.

The vacuum produced by the pump 36 reaches the chamber 25 through the pipe 37 in the inlet pipe 1 via an annular gap 39 and a passage 38 in the hub 2. The annular gap 39 may be formed by sealing means between the hub 2 and the pipe 1. Constant communication between the chamber 25 and the vacuum pump 36 is thereby established.

Referring to FIG. 6, the partition 10 is secured to the hub 2 of the conveyor. As soon as liquid flows through the opening 3 in the hub 2 into the separating chamber 4, liquid flows between the outer edge of the partition 10 and the inside of the wall of the bowl 8 into the chamber 35 so that the chamber 25 is separated from the separating chamber 4, or rather from the suction orifice 14 in the outlet conduit 12. The suction orifice 14 projects into the surface layer of the liquid to be cleaned, this surface layer being already purified to a considerable extent. The surface of the liquid is indicated by a chain-dotted line.

By means of a vacuum pump (not shown) connected to the conduit 42, vacuum is produced in the chamber 25 through a passage 44 in the bearing cover 27 and through a passage 31 in the conveyor hub 2. The conduit 42 is in constant communication with the passage 31 by means of circumferential grooves 32 and 45 (which may be sealed by suitable sealing means) and by means of the passage 30 in the cover 28.

The vacuum in the chamber 25 causes water from the surface in the separating chamber to be sucked through the outlet conduits 12 into the chamber 25 and the chamber 35. The collected water eventually flows over the restraining plate 43 and leaves as cleaned liquid through the opening 13.

To maintain the vacuum in the chamber 25 and at the same time to seal this chamber, two annular discs 46, 47 are provided on the conveyor hub 2. Together with the surface of the water in the chamber 35, the two discs 46 and 47 define the chamber 25 which is to be subjected to vacuum. This chamber 25 can, however, be formed by a bent pipe which is connected to the outlet conduit 12 and dips into the water in the chamber 35 and is also in communication with the passage 31.

The outlet conduits 12 are, as especially evident from FIGS. 1 and 6, arranged beyond the surface of the water so that they will not give rise to swirling motion in the water in which the solids are being propelled towards the wall of the bowl under centrifugal forces. The outlet conduits are thus disposed at a certain spacing from the surface of the water. Only the suction orifice 14 dips into the water.

I claim:

1. A centrifugal separator comprising a rotatable bowl, means for feeding a slurry into said bowl, a conveyor including a helical blade mounted on a generally

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cylindrical hub, said conveyor being rotatably supported inside said bowl, means for rotating said bowl and said conveyor at a differential speed, whereby centrifugal action produces a radially outermost layer of solids and an inner liquid layer, an opening near one end of the bowl for discharging the solids, at least one outlet opening in the bowl through which the liquid component of the slurry is discharged, a conduit on said conveyor having at least one suction orifice within said inner liquid layer and arranged at a distance from said means for feeding the slurry into said bowl, said conduit having at least one discharge orifice near said outlet opening for the liquid, means for producing a pressure difference between said suction orifice and said discharge orifice of the conduit, and means for restraining the slurry from said outlet opening and said discharge orifice of the conduit.

2. A separator according to claim 1, wherein said slurry restraining means comprise an annular partition arranged near said outlet opening.

3. A separator according to claim 2, wherein said partition is mounted on said bowl.

4. A separator according to claim 2, wherein said partition is mounted on said conveyor.

5. A separator according to claim 1, wherein said outlet opening is arranged near said slurry feeding means.

6. A separator according to claim 1, wherein said slurry feeding means comprise an aperture in said hub near one end of said bowl and wherein said discharge opening for the solids is arranged near the other end of said bowl.

7. A separator according to claim 1, wherein said bowl has a frusto-conical portion and wherein said discharge opening for the solids is arranged on that portion of the bowl which has the smallest diameter.

8. A separator according to claim 1, wherein said means for producing a pressure difference comprise at least one nozzle arrangement.

9. A separator according to claim 8, wherein the nozzle arrangement is of annular form.

10. A separator according to claim 8 or, wherein the nozzle arrangement is mounted on the conveyor.

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11. A separator according to claim 8, including at least one pipe for delivering a secondary fluid to the nozzle arrangement.

12. A separator according to claim 1, wherein said means for producing a pressure difference comprise a pipe connected to said outlet opening, the discharge opening of said pipe being arranged at a lower level than said bowl.

13. A separator according to claim 1, wherein said means for producing a pressure difference comprise a vacuum pump attached to the separator housing, and connecting means are provided establishing communication between said pump and said conduits.

14. A separator according to claim 1, wherein said means for producing a pressure difference comprise a vacuum pump disposed beyond and separate from the separator, and connecting means are provided in said slurry feeding means and in said conveyor for establishing communication between said pump and said conduits.

15. A separator according to claim 1, wherein said means for producing a pressure difference comprise a vacuum pump disposed outside the separator housing, and comprising connecting means outside the separator and connecting means in the cover of the bowl and in the conveyor for establishing communication between said pump and said conduits.

16. A separator according to claim 1, including means at said outlet opening for setting the level of liquid.

17. A separator according to claim 1, including a chamber in communication with said conduits.

18. A separator according to claim 17, including means for sealing said chamber and comprising a liquid surface produced by the overflow of liquid over said slurry retaining means from the separating chamber into a further chamber adjacent the chamber to be sealed.

19. A separator according to claim 1, wherein said conduits are disposed at a predetermined spacing from said liquid layer with the exception of said suction orifice, which is immersed in said liquid layer.

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