United States Patent

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[33] **Sweden**
[31] **11779-67, 11780-67 and 11781-67**

[54] **CENTRIFUGAL SEPARATOR WITH ADJUSTABLE OUTLET MEANS**
13 Claims, 8 Drawing Figs.

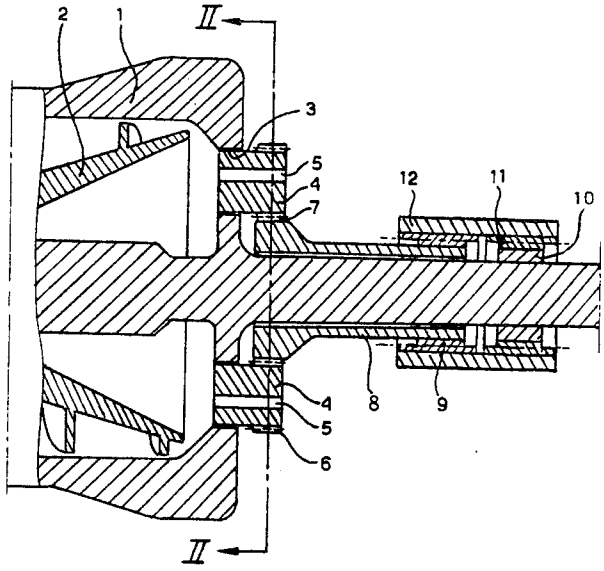
[52] **U.S. Cl.** **233/7,** 233/47
[51] **Int. Cl.** **B04b 1/20**
[50] **Field of Search** ..... 233/7, 19, 20, 19 (A), 20 (A), 46, 47, 8, 9

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ABSTRACT: In a centrifugal separator of the kind having a conveyor screw arranged in the rotor for discharging sludge, or the like, separated from the liquid fed to the rotor, the overflow outlets for the liquid are movable between radially inner and outer positions while the rotor is in operation. For this purpose the overflow outlets are at least partly formed by separate members rotatable with the rotor but journaled for rotation relative thereto so as to effect such radial movements of the outlets, and means are provided for rotating all of the journaled members synchronously relative to the rotor and through the same angle.



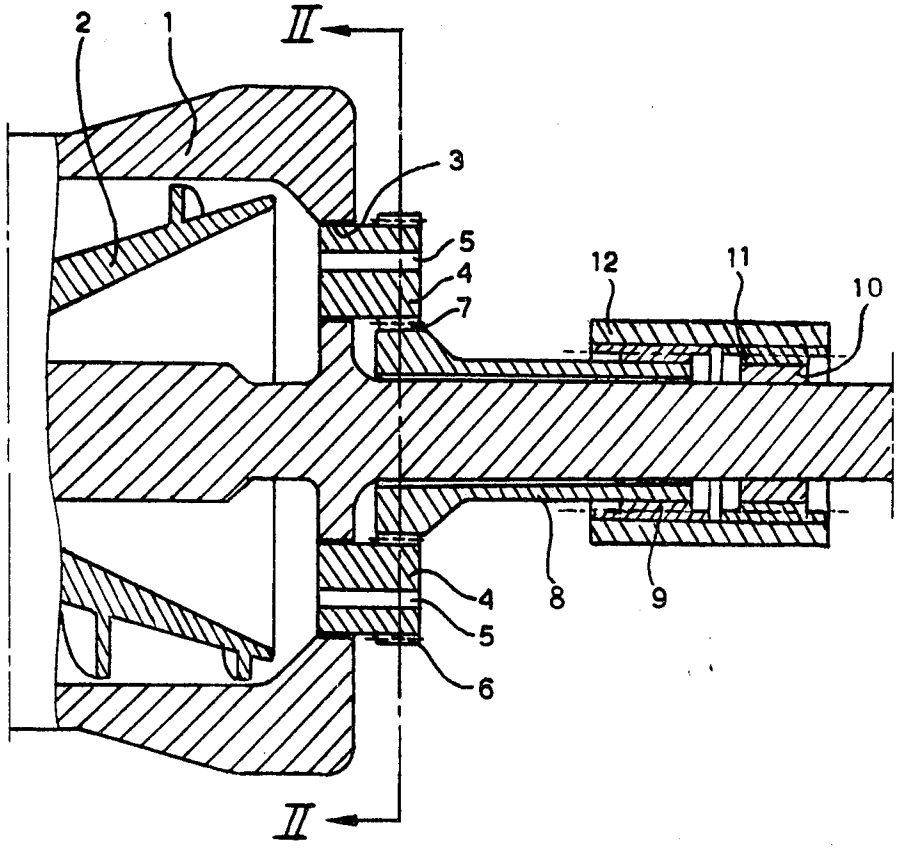


FIG. 1

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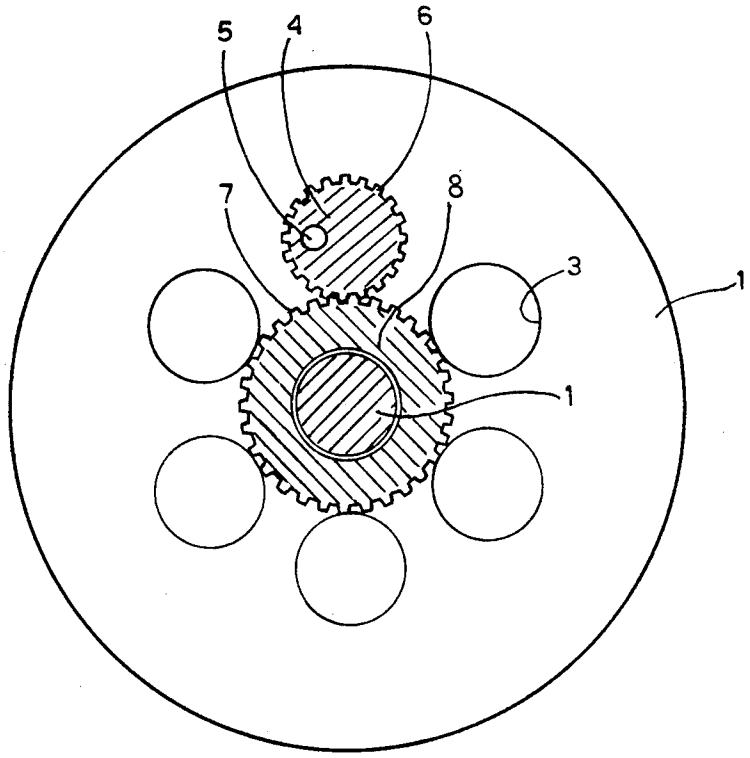


FIG. 2

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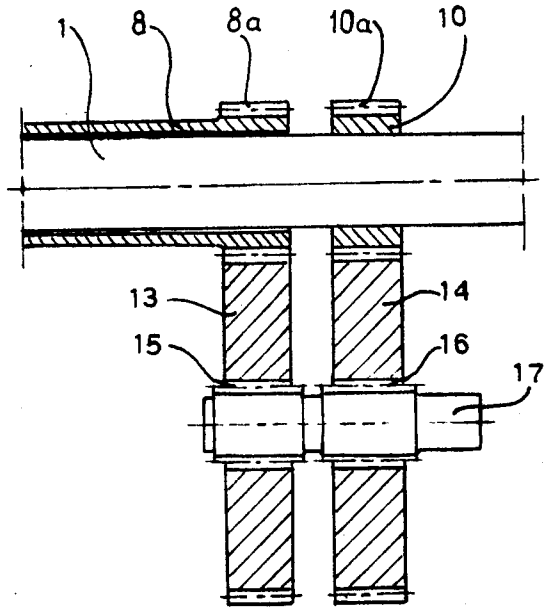


FIG. 3

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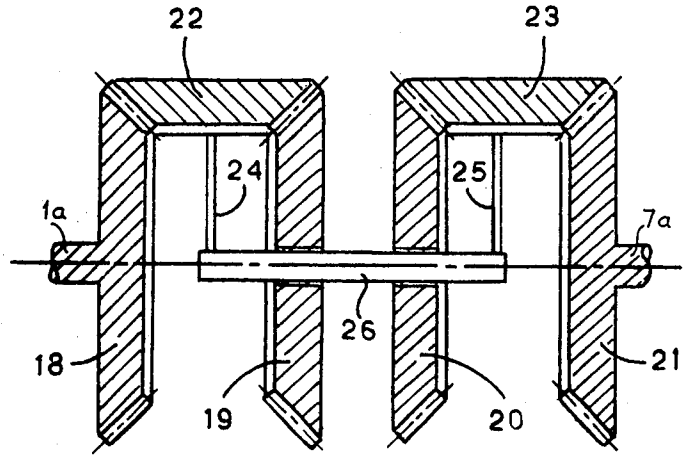


FIG. 4

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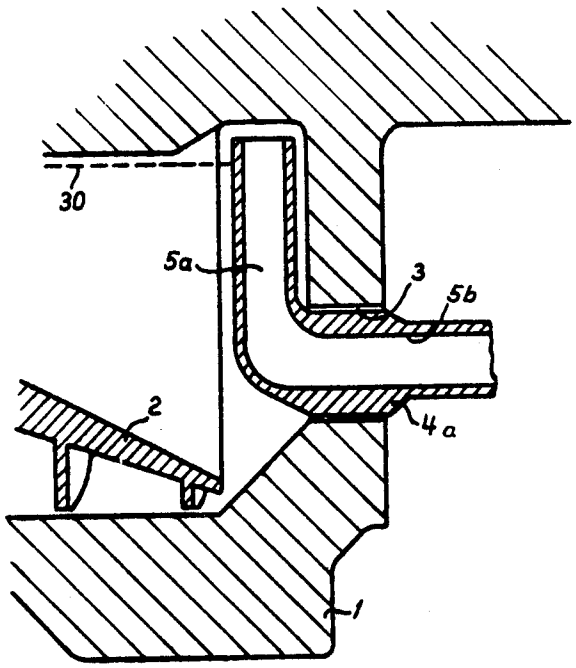


Fig. 5

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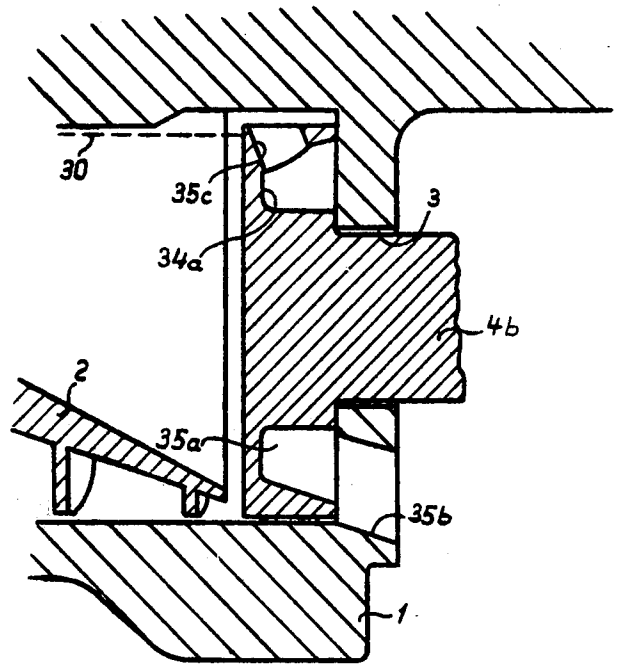


Fig. 6

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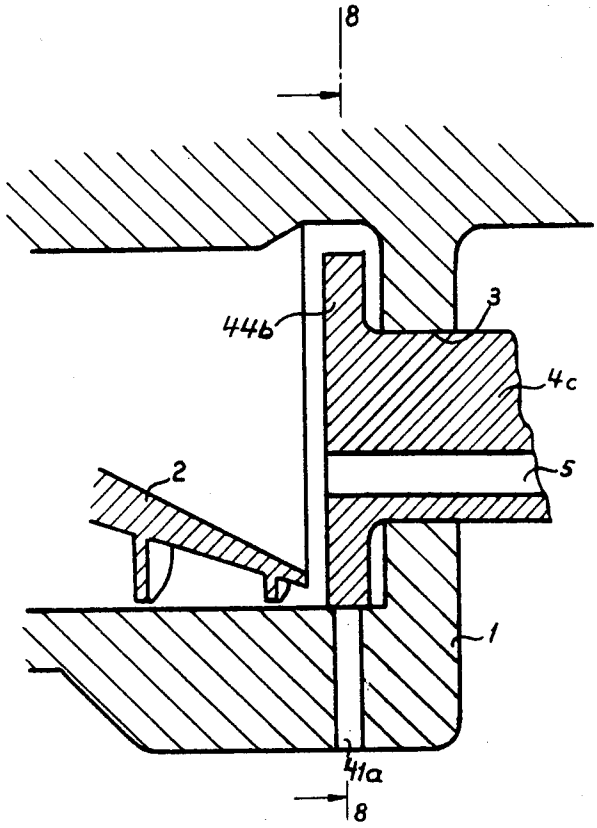


Fig. 7

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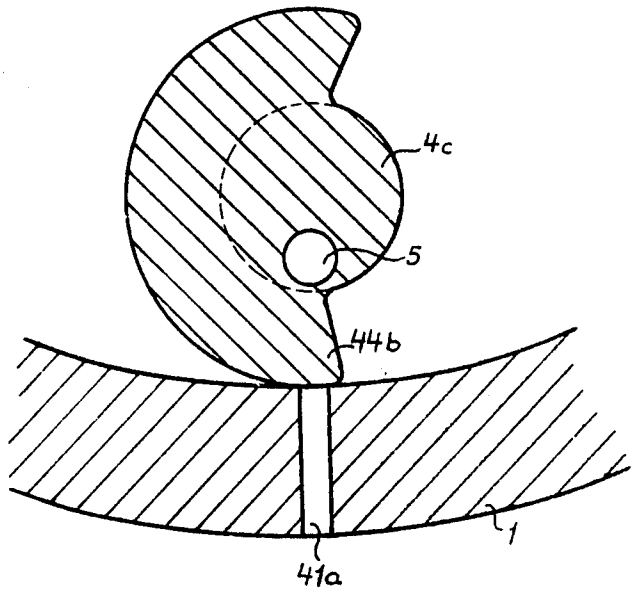


Fig.8

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CENTRIFUGAL SEPARATOR WITH ADJUSTABLE OUTLET MEANS

The present invention relates to centrifugal separators of the kind comprising a rotor and a conveyor screw arranged therein for the discharge of sludge, or the like, separated from the liquid fed to the rotor, the liquid that has been freed from sludge being discharged through overflow outlets which are movable between radially inner and outer positions by means of separate members rotatable together with the rotor but adjustable relative thereto.

In prior centrifugal separators of this type, each of the aforesaid separate members is arranged to be fastened to the rotor by means of several screws or the like. The separate members sometimes are formed as polygons so that they can be more easily adjusted to absolutely correct positions relative to the rotor, such members being incapable of displacement from their adjusted positions during the rotation of the rotor. This means, however, that when the liquid level within the rotor is to be changed, the rotor has to be stopped and each of the adjustable members (generally between six and eight) must be dismounted and then remounted again in another position. This adjusting operation is very time consuming and causes undesired interruptions of the operation of the centrifugal separator.

According to the present invention, the centrifugal separator is provided with an arrangement which greatly facilitates adjustment of the liquid level formed within the rotor during operation. The arrangement is characterized by adjustable members which are journaled relative to the rotor, and by means arranged for synchronous rotation of all of these journaled members through the same angle. Preferably, the latter means common to the journaled members is also arranged for retaining or locking them in various positions relative to the rotor, whereby it is possible to control the liquid level within the rotor during operation.

In a preferred embodiment of the centrifugal separator, such means common to the journaled members comprises a gear ring movable relative to the rotor and positively engaging the journaled members. Of course, any functionally equivalent arrangement, such as one or more chains, belts, or the like, may be used as well. For the moving and locking of the gear ring relative to the rotor, two rotatable members are provided which are adjustable relative to each other in their directions of rotation. These members may be firmly connected to (i.e., have the same axis is of rotation as) the rotor and the gear ring but may also be positively engaged by these parts (e.g., through gear wheels) so that when one of the rotatable members is moved relative to the other, the gear ring is moved relative to the rotor. In cases where the two rotatable members have coaxially extending axes of rotation (which is not necessary), they preferably are provided, around the periphery of each or in a hub at the center of each, with helically extending splines having different pitches, these splines being in engagement with correspondingly formed splines on a sleeve or pin rotatable together with the members but movable axially and lockable in various positions relative to such members. Preferably, the pitches of the splines of the two rotatable members are oppositely directed.

Due to the feature whereby the members for adjusting the overflow outlets of the rotor are journaled relative to the latter and arranged to be actuated during operation, it is possible to empty the rotor entirely of its liquid content without stopping its rotation. One way, of course, is to arrange the journaled members in the rotor so that the overflow outlets in one position of the journaled members are situated near the periphery of the rotor. The diameter of the journaled members cannot be too large, however, and consequently such an arrangement of members without special construction would mean that the maximum liquid depth maintainable within the rotor would be rather low. According to the invention, therefore, each of the journaled members defines a channel which along at least part of its length forms an angle with the rotor axis and which at one end communicates with a liquid outlet of the rotor, the other end of the channel determining the position of the liquid level formed within the rotor during operation, when situated radially inside the outer part of the rotor outlet.

Often there is no need for controlling the liquid level over the whole radial range, ie., all the way out to the rotor periphery; but it is desirable to be able to close the liquid outlets in order to direct all substance supplied to the rotor to the sludge outlets of the rotor. Therefore, the channels defined by the journaled members may extend so that, in one position of the journaled members, they open radially inside inside the sludge outlets of the rotor. In such cases it may be suitable to have the liquid outlets of the rotor at a distance from the periphery of the rotor, and at least one (preferably all) of the journaled members may be arranged to open, in one position thereof, a normally closed separate outlet at the rotor periphery, thus enabling the rotor during operation to be entirely emptied of its liquid content.

The invention will be described in more detail below with reference to the accompanying drawings, in which FIG. 1 is a longitudinal sectional view of part of a centrifugal separator of the above-described kind embodying one form of the invention for controlling the overflow outlets for the clarified liquid; FIG. 2 is a sectional view on line II–II in FIG. 1; FIGS. 3 and 4 are detailed sectional views of alternative embodiments of the central control means for the overflow outlets; FIGS. 5 through 7 are detailed sectional views of different embodiments of the journaled members for controlling the overflow outlets; and FIG. 8 is a sectional view on line 8–8 in FIG. 7.

Referring to FIGS. 1 and 2, they show part of a centrifugal rotor 1 and a conveyor screw 2 arranged therein for the discharge of sludge, or the like, separated from the feed material supplied to the rotor. The rotor 1 may be mounted in a conventional manner for rotation about a central horizontal axis, and the conveyor screw 2 may be driven as usual at a different angular speed than the rotor so that the sludge is conveyed to the left, seen in FIG. 1, and leaves the rotor through sludge outlets (not shown) in the circumferential wall of the rotor, as is well known in the art.

The end wall of the rotor is provided with openings 3 arranged angularly around and at the same distance from the rotor axis. Journaled in each of the openings 3 is a member 4 through which a bore 5 extends in a location eccentric to the axis of rotation of the member 4. The through-bores 5 constitute overflow outlets of the rotor 1 for discharging clarified liquid. The journaled members 4 are cylindrical and are provided at one end with gear teeth 6 through which they engage a gear ring 7 common to all of the journaled members 4. The gear ring 7 is arranged coaxially relative to the rotor 1 and is rotatable relative to the rotor for turning the members 4 on their own axes of rotation, i.e., putting them into different positions relative to the rotor. To effect the relative rotation between the gear ring 7 and the rotor 1, the gear ring as well as the rotor may be connected to respective rotatable members which are adjustable relative to each other in their directions of rotation.

In the embodiment shown in FIG. 1, the rotatable member connected to and rotating with the gear ring 7 is constituted by a sleeve 8 which at its end remote from the gear ring is provided with external, helically extending splines 9. The rotatable member connected to and rotating with the rotor 1 is constituted by a sleeve 10 provided with external, helically extending splines 11. The pitch of the helical splines 9 differs from that of the helical splines 11, and in a preferred embodiment these pitches are oppositely directed. Arranged coaxially with the two sleeves 8 and 10, and surrounding the same, is a further sleeve 12. This sleeve 12 is provided with internal splines (not shown) through which it positively engages the splines of the sleeve 8 as well as the splines of the sleeve 10. The sleeve 12 is thus arranged to rotate together with the rotor 1 and the gear ring 7 during operation of the separator.

Due to different pitches of the splines of the sleeves 8 and 10, the sleeve 12 is adapted, when axially displaced relative to the sleeves 8 and 10, to rotate the gear ring 7 relative to the

rotor 1. The means for effecting this axial displacement of the sleeve 12 may be of any suitable kind and is therefore not shown in the drawing. For example, such means may consist of a yoke engageable with the opposite ends of sleeve 12 and movable manually or otherwise to displace this sleeve endwise in either direction.

Of course, the arrangement for rotation of the gear ring 7 relative to the rotor 1 may be modified in different ways. For example, the above described sleeve 12 may be replaced by a pin extending parallel with the rotor axis and provided with helically extending splines for engaging the splines of the sleeves 8 and 10. The pin must be axially displaceable relative to the sleeves 8 and 10 when rotating around its own axis, so as to have the same function as the above-described sleeve 12.

A further modification of the means for rotating the gear ring 7 relative to the rotor 1 is shown in FIG. 3. According to this modification, the rotational movement of the gear ring 7 and the rotor 1 is transferred to two gear wheels 13 and 14 through gear teeth 8*a* and 10*a* provided externally on the sleeves 8 and 10, respectively, in FIG. 1. The gear wheels 13 and 14 have hubs which are provided with internal, helically extending splines 15 and 16, respectively, having different pitches, in which splines a correspondingly formed pin 17 is axially displaceable relative to the gear wheels 13 and 14. The pin 17 is arranged to rotate together with the gear wheels 13 and 14, but axial displacement of pin 17 causes a rotational movement of the gear wheel 13 relative to gear wheel 14 and thus causes rotational movement of the gear ring 7 relative to the rotor 1 through the gear teeth 8*a* and 10*a* and the sleeves 8 and 10, respectively.

Each of the above-described means for rotating the gear ring 7 relative to the rotor 1 requires for this rotation an axially displaceable member (sleeve 12 or pin 17). In the means shown in FIG. 4, an axially displaceable member is not required.

As shown in FIG. 4, four coaxially arranged gear wheels 18, 19, 20 and 21 have conical or beveled tooth portions. The two outer gear wheels 18 and 21 are firmly connected to, or at least positively engaged with, the rotor 1 and the gear ring 7, respectively, as through connections 1*a* and 7*a*, respectively. The two inner gear wheels 19 and 20 are free from the rotor 1 and the gear ring 7 and are intended to stand still during normal operation of the separator. However, they are rotatable relative to each other to various adjusting positions. Two further conical or beveled gear wheels 22 and 23 are provided, each of which engages and is arranged to roll around one inner and one outer of the four gear wheels 18, 19, 20 and 21. As can be seen from FIG. 4, the gear wheels 22 and 23 are journaled on shafts 24 and 25, respectively, these shafts being interconnected by means of another shaft 26, so that the gear wheels 22 and 23 are forced to accompany each other, when rolling around the four gear wheels 18, 19, 20 and 21.

The gear wheels 19 and 20, as previously mentioned, are intended to stand still during normal operation of the separator, while the gear wheels 18 and 21 are arranged to rotate together with the rotor 1 and the gear ring 7, respectively. For a better understanding of how rotation of one of the gear wheels 19 and 20 relative to the other results in a relative rotation between the rotor 1 and the gear ring 7, it is assumed in the following that the gear wheels 18 and 21 are also standing still, which is the case when the adjusting operation is performed with the rotor standing still.

It is assumed that the gear wheels 20 and 21 are firmly locked against rotation. If then the gear wheel 19 is rotated relative to the gear wheel 20, the following will happen. The conical gear wheel 22 is caused to rotate around its own axis without moving around the common axis of the gear wheels 18 and 19. A movement around this common axis is prevented by the fact, that the shaft 26, owing to the engagement between the conical gear wheel 23 and the gear wheels 20 and 21, is prevented from being rotated. The rotational movement of the wheel 22 consequently is transferred to the gear wheel 18 which, owing to its positive connection with the gear ring 7, causes a rotation of the latter relative to the rotor 1. The gear ring 7 may be retained in its new position relative to the rotor simply by locking the gear wheel 19 relative to the gear wheel 20.

By means of the arrangement described above, it is possible at any time during the operation of the centrifugal separator to control the liquid level formed within the rotor.

Two modifications of the journaled member 4, enabling an extended control of the liquid level within the rotor 1, are shown in FIGS. 5 and 6. According to these embodiments, the journaled member defines within the rotor a channel 5*a* (FIG. 5) or a channel 35*a* (FIG. 6), which extends in a direction forming an angle with the rotor axis. According to the embodiment shown in FIG. 5, one end of the channel 5*a* formed by journaled member 4*a* communicates with the separating chamber of the rotor 1, while the other end of the channel forms the exit part 5*b* of the liquid outlet opening of the rotor. As can be easily understood, the position of the end of the channel 5*a* situated remote from the outlet opening part 5*b* determines the position of the liquid level formed within the rotor during operation, as long as this end is situated radially inside the outermost parts of the outlet opening 5*b*. When the said end of channel 5*a* is situated radially outside the outermost part of the outlet opening 5*b*, the latter determines the position of the liquid level formed within the rotor. If desired, the openings 3 in the end wall of the rotor 1 may be situated at a distance from the rotor axis such that the rotor may be entirely emptied through the outlet opening 5*b*.

The embodiment shown in FIG. 6 differs from that in FIG. 5 in that the liquid outlet opening 35*b* is not formed by the rotatable journaled member but is apart therefrom. As shown in FIG. 6, the journaled member 4*b* is formed as a disc inside the rotor wall, which disc is provided with an annular recess 34*a* forming together with the rotor an annular channel 35*a*. The channel 35*a* extends so that it always communicates with the liquid outlet opening 35*b*, regardless of the position of the journaled member 4*b* relative to the rotor 1. For communication between the channel 35*a* and the separating chamber of the rotor, the journaled member 4*b* has a bore 35*c* therethrough. The position of this through-bore 35*c* determines the position of the liquid level formed within the rotor during operation.

In the two embodiments shown in FIGS. 5 and 6, the entrance to the overflow outlet, in one position of the journaled member 4*a* or 4*b*, opens radially inside the sludge outlets of the rotor. The radial position of the sludge outlets of the rotor is indicated in FIGS. 5 and 6 by a dotted line 30. If desired, the rotor 1 or the journaled members 4*a* or 4*b* may be provided with means arranged, in one position of the journaled members, to block the overflow outlets entirely. Further, the channels 5*b* and 35*b* may be formed outside the rotor end wall. Of course, the annular recess 34*a* may be provided in the rotor end wall instead of in the journaled member 4*b*.

A further modification of the journaled members 4 is shown in FIGS. 7 and 8. The member 4*c* according to this embodiment is provided at the inner side of the rotor end wall with a flange 44*b* extending circumferentially around the member 4*c* through an angle of a little more than 180 . In the position shown in the drawing, the flange 44*b* is closing a radial opening 41*a* through the circumferential wall of the rotor 1. As can be seen from FIG. 8, the overflow outlet 5 may be moved between its radially innermost and outermost positions while the flange 44*b* still covers the radial opening 41*a*. It can also be seen from FIG. 8 that it is possible to uncover the opening 41*a* by turning the journaled member 4*c* clockwise from the position shown in this Figure, thus enabling emptying of the rotor.

In the drawings, the present invention has been illustrated quite schematically, and means such as bearings, sealings, and the like, the use of which is obvious to a person skilled in the art, have not been shown. Of course, the invention is not restricted to the embodiments shown in the drawing, and modifications are possible within the scope of the appended claims.

We claim:

1. In a centrifugal separator, the combination of a rotor mounted for rotation about an axis, a conveyor screw mounted in the rotor and operable to discharge therefrom sludge, or the like, centrifugally separated from a liquid supplied to the rotor, the rotor having overflow outlets for liquid which has been freed from sludge, journaled members associated with said overflow outlets, respectively, the journaled members being rotatable with the rotor but journaled thereto for independent rotation to move the overflow outlets between radially inner and outer positions relative to said rotor axis, and adjustment means operatively connected to the journaled members for rotating said members synchronously through the same angle relative to the rotor.

2. The combination according to claim 1, in which said adjustment means are operable to retain the journaled members in adjusted positions relative to the rotor.

3. The combination according to claim 1, in which said adjustment means include a gear ring positively engaging all of said journaled members and movable relative to the rotor.

4. The combination according to claim 1, wherein each journaled member at least partly defines a channel of which at least part of the length extends in a direction forming an angle with said rotor axis, the channel communicating at one end with the corresponding outlet opening of the rotor.

5. The combination according to claim 4, in which said corresponding outlet opening of the rotor is located coaxially with the rotation axis of the journaled member.

6. The combination according to claim 1, wherein each journaled member includes a substantially L-shaped pipe portion defining a channel having part of its length extending at an angle to said rotor axis, the channel communicating at one end with the corresponding outlet opening of the rotor.

7. The combination according to claim 1, wherein each journaled member at least partly defines a channel of which at least part of the length extends in a direction forming an angle with said rotor axis, the channel communicating at one end with the corresponding outlet opening of the rotor, said outlet opening being located apart from the journaled member, said journaled member having a flange opposite said outlet opening and coacting with the rotor to form said channel, said flange having a bore extending therethrough, said channel being curved and communicating with both said outlet opening and said bore.

8. The combination according to claim 1, wherein each journaled member at least partly defines a channel of which at least part of the length extends in a direction forming an angle with said rotor axis, the channel communicating at one end with the corresponding outlet opening of the rotor, the conveyor screw being adapted to discharge said sludge from the rotor at a predetermined minimum radius from the rotor axis, said channel, in one position of the journaled member, opening into the rotor radially inward from said minimum radius.

9. The combination according to claim 1, in which the rotor also has at least one peripheral outlet, at least one of said journaled members being operable to open and close said peripheral outlet.

10. The combination according to claim 1, in which said adjustment means include a gear ring positively engaging all of said journaled members and movable relative to the rotor, and a pair of rotatable members rotatably adjustable relative to each other and positively connected to the gear ring and the rotor, respectively, whereby rotation of one of said pair relative to the other causes relative movement between the rotor and the gear ring.

11. The combination according to claim 10, in which the rotatable members of said pair have coaxially extending axes of rotation and are provided with helically extending splines of different pitches, respectively, the adjustment means also including an element provided with helically extending splines of different pitches corresponding to said first pitches, respectively, and mating with the respective splines of said rotatable members, said element being rotatable with said rotatable members but displaceable axially relative thereto rotatably adjusting one of said rotatable members relative to the other.

12. The combination according to claim 11, in which the spline pitches of said two rotatable members are oppositely directed.

13. The combination according to claim 1, in which said adjustment means include a gear ring positively engaging all of said journaled members and movable relative to the rotor, four coaxially arranged gear wheels having beveled toothed portions, the two outer gear wheels being positively connected to said gear ring and the rotor, respectively, the two inner gear wheels being free from said gear ring and rotor and being rotatable to various positions relative to each other, two beveled gears each engaging and rollable around one outer and one inner of said four coaxially arranged gear wheels, and means interconnecting said two beveled gears to cause them to accompany each other when rolling around said four gear wheels.