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(54) Benævnelse: **Fuldkappe-snekkecentrifuge med en overløbskant**

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JP-A- 11 179 236
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Description

Background of the invention

[0001] The invention relates to a solid bowl screw centrifuge having a centrifuge drum rotatable about a longitudinal axis, which comprises at least one outlet opening for discharging clarified material from the centrifuge drum via a weir edge to be flowed over by the outflowing material and an outlet channel for conveying all of the discharged material, wherein the weir edge is arranged at the front side of the centrifuge drum and the outlet channel extends in the direction of flow downstream of the weir edge, the outlet channel has a curved design in order to divert the outflowing material in a substantially tangential direction, and the outlet channel has a bottom surface, which is at least partially is of flat design. Such a solid bowl screw centrifuge is also described in particular in WO 2012 089492 A1, which was published subsequently.

[0002] Drive energy is known to be required to rotate the centrifuge drum of such a solid bowl screw centrifuge because kinetic energy is transferred to the material to be clarified or centrifuged when said material is introduced. Conversely, the kinetic energy of the clarified outflowing material is converted into friction energy when the drum is emptied.

[0003] Attempts are known to use the kinetic energy of the outflowing material wherever possible such that this outflowing material contributes again to drive the rotational movement of the centrifuge drum. Outlet channels in the form of pipes at outlet openings on the front side of the centrifuge drum are known *inter alia* for this purpose, which divert the flow of material in a tangential direction. The material then exiting not in an axial but in a tangential direction imparts impulse to the centrifuge drum in the direction of rotation on account of its centrifugal force, which drives the centrifuge drum in the direction of rotation. Such outlet channels are known, for example, from DE 31 12 585 A1, US 2004/0072668 A1 and US 2004/0072667 A1.

[0004] A solid bowl centrifuge is known from JP 11 197547 A, in which a deflector plate is provided which deflects the outflowing material from the axial direction of flow radially outwards. The deflector plate is open radially to the outside.

[0005] A solid bowl centrifuge with wing plates is known from JP 11 179236 A, which are struck by outflowing material in flight.

Underlying task

[0006] The object of the invention is to create a solid bowl screw centrifuge in which energy recovery can be provided particularly cost-effectively and at the same time particularly efficiently on account of an impulse feedback from the outflowing material.

Solution according to the invention

[0007] This object is achieved according to the invention with a solid bowl screw centrifuge having a centrifuge drum rotatable about a longitudinal axis, which comprises at least one outlet opening for discharging clarified material from the centrifuge drum via a weir edge to be flowed over by the outflowing material and an outlet channel for conveying away all the discharged material, wherein the weir edge is arranged at the front side of the centrifuge drum and the outlet channel extends in particular outwards, in the direction of flow downstream of the weir edge, wherein the outlet channel has a curved shape in order to divert the outflowing material in a substantially tangential direction, and the outlet channel has a bottom surface, which is at least partially of flat design, wherein the flat portion of the bottom surface is inclined radially inwards at an angle of 8° to 28° to the tangential direction.

[0008] The discharge device according to the invention is provided at the front side of the centrifuge drum for discharging clarified material from a centrifuge drum and an associated outlet opening is arranged there partially overlapping in a fixed or adjustable manner. The discharge device comprises a weir with a weir edge and an outlet channel arranged externally upstream of the weir for conveying all of the discharged material. The then axially outflowing material flows through the outlet opening and flows out over the weir edge aligned there in a radial direction, i.e. transversely to the longitudinal axis. In this connection the weir edge is in particular of curved design and is spaced at a distance of a first radius from the longitudinal axis. The outlet channel following in the direction of flow has a curved design in order to divert the outflowing material in a substantially tangential direction. The outlet channel is designed with a bottom surface, over which the material flows away. This bottom surface is spaced, preferably at least in sections, at a further distance from the longitudinal axis than the first radius measurement.

[0009] In the solid bowl screw centrifuge according to the invention, a weir is provided at the front side, which, as in the case in conventional weirs, has its weir edge in the radial plane of the front side. The weir arranged in this manner leads to particularly precise control of the material level inside the centrifuge drum. Moreover, such a weir only has a slight tendency to clog and is also extremely cost-effective to produce. It can optionally be provided with a weir edge designed to be particularly wear-resistant in the manner of conventional weirs. Furthermore, it can be well maintained and replaced. The device according to the invention can therefore also be installed in existing systems as a particularly good alternative. The outlet channel is configured on the outside of the weir, the bottom surface of said channel preferably lying, at least in sections, radially further to the outside than the weir edge. This produces an at least slightly radially outwardly directed flow downstream of the radially oriented weir edge according to the invention on account of the centrifugal force acting on the material, which leads to a suction effect at the weir edge and a slightly higher flow velocity there. This type of flow at the weir edge has proven particularly advantageous in terms of the controlled discharge of the material and also in terms of potential clogging.

[0010] After the stream overflows the weir edge the stream of the discharged material is diverted by means of the outlet channel according to the invention, such that its movement impulse that is essentially oriented radially outwardly on account of the centrifugal force is deflected in a tangential direction and thus in a direction that drives the centrifuge drum. The outlet channel according to the invention thus achieves two effects: it enables a controlled overflow over the weir edge in a radial direction with only slight turbulence, low risk of imbalance and low risk of clogging. At the same time the outlet channel leads the outflowing material in the desired direction in a targeted manner in order to recover a significant amount of energy from the outflowing material.

[0011] The bottom surface of the outlet channel of this type is designed as flat or largely flat at least in sections. Such a bottom surface can be manufactured favourably. Moreover, the outflowing material experiences a uniform acceleration over a relatively long distance, which can be easily replicated using technical models. This acceleration leads to an increased conversion of the centrifugal force impulse into a movement impulse in a tangential direction. A particularly large proportion of the centrifugal force energy is converted into tangential drive energy.

[0012] The flat portion of the bottom surface is inclined radially inwards at an angle of 8° to 28°, preferably 18°, to the tangential direction. Such an orientation of the diverted jet of material leads to a specifically targeted deceleration of the exiting stream compared to a purely tangential flow and thus to a certain blockage effect. This blocking increases the potential energy and is thus accompanied by an improved subsequent conversion into tangential energy of motion.

[0013] In a particularly preferred embodiment, the bottom of the outlet channel according to the invention is designed such that its flat or largely flat portion starts from the centre of the outlet opening at an angle of 3.5° counter to the direction of rotation of the centrifuge drum. Such a flat or largely flat portion starts at the outlet opening only at a predefined distance behind the centre of the outlet opening. The acceleration of the exiting material achieved there according to the invention therefore starts only further behind in the outlet channel. The suction effect produced as a result of the acceleration therefore also occurs comparatively further behind in the outlet channel, whereby there is an overall increase in speed in the outlet channel that sucks the material out. This suction effect reduces the risk of clogging and at the same time increases the kinetic energy in a tangential direction.

[0014] Viewed from the centre of the outlet opening, the flat portion of the bottom surface ends particularly preferably counter to the direction of rotation of the centrifuge drum after an angle of 15° to 30°, preferably 21.5°. Such a flat or largely flat portion has a particularly advantageous length, which has proven extremely effective even in the case of different outlet diameters and drum sizes.

[0015] In a further particularly advantageous embodiment of the solution according to the invention, a curved portion, in particular a circular arc-shaped curved portion, of the bottom surface adjoins the flat portion of the bottom surface, viewed in the direction of rotation of the centrifuge drum. Such a curved portion can be manufactured at low-cost and over a certain range of angles leads to a radially unchanged, and thus radially also to a non-accelerated or decelerated flow. Such a flow has proven particularly advantageous over a certain portion in the circumferential direction. This curved, radially constant bottom surface, viewed counter to the direction of rotation, is particularly advantageous over the first circumferential portion of the respective outlet opening. This bottom surface leads to a largely turbulence-free overflow at the weir edge and thus to less imbalance development at the multiple weirs distributed over the circumference of the centrifuge drum and over which outflowing material flows in each case.

[0016] The outlet channel of curved design according to the invention preferably has a first width viewed in the longitudinal direction of the centrifuge drum, and a second width viewed in the radial direction, wherein the second width is designed smaller than the first width. The outlet channel therefore tapers starting from the outlet openings in the direction of flow to the end of the outlet channel at which the outflowing material is released largely in a tangential direction. This tapering brings about a constant increase in the speed of the material flow and thus the kinetic energy of the outflowing material.

[0017] It is therefore particularly advantageous if the curved outlet channel viewed in the discharge direction is designed to be continuously tapering in terms of its width. Acceleration then occurs largely turbulence-free with at the same time specifically directed flow through the outlet openings and the subsequent outlet channels.

[0018] An outlet channel of this type is preferably designed to be radially inwardly open. The outlet channel is therefore unlike solutions known from the prior art, in which the outflowing material is diverted through one or more pipes in a tangential direction. The radially inwardly open channel according to the invention can therefore be manufactured not only cheaper, but overall also has less risk of clogging. Furthermore, such a channel can be cleaned more easily during maintenance work as it is more accessible.

[0019] The weir edge and the outlet channel of the solid bowl screw centrifuge according to the invention are preferably designed with a component or as one piece or integrally, wherein the component can be in particular be advantageously attached from the outside to the front side of the centrifuge drum and detached therefrom. The component can then be retrofitted easily depending on the intended use and can also be easily replaced during maintenance. Furthermore, the position of the weir edge can be easily adjusted. Adjusting the weir edge also changes the position of the associated outlet channel in an advantageous manner without requiring further time-consuming adjustment or alignment work.

Brief description of the drawings

[0020] One embodiment of the solution according to the invention is explained in detail below using the attached schematic drawings, in which:

Fig. 1 shows a view of the front side of a centrifuge drum of a solid bowl screw centrifuge according to the invention with a discharge device arranged thereon for discharging material from the centrifuge drum,
Fig. 2 shows an enlarged view of the discharge device according to Fig. 1,
Fig. 3 shows a side view of the discharge device according to Fig. 2 and
Fig. 4 shows a top view of the discharge device according to Fig. 2.

Detailed description of the embodiment

[0021] Fig.1 shows the front side of a centrifuge drum 10, which has a centrifuge screw inside (not shown) in accordance with a conventional design of a solid bowl screw centrifuge. The centrifuge drum 10 is rotatable in a direction of rotation 14 about a longitudinal axis 12 at a high number of revolutions per minute.

[0022] Six circular outlet openings 16 are arranged on the front side of the centrifuge drum 10 in a circle at regular intervals about the longitudinal axis 12. The outlet openings 16 serve to convey or discharge clarified (not shown) material from the centrifuge drum 10.

[0023] A discharge device 18 is attached upstream of each outlet opening 16 externally on the front side of the centrifuge drum 10. Each discharge device 18 is formed as an integral component from a weir plate 20 and an outlet channel 22. The individual weir plate 20 extends in a radial direction, i.e. transversely to the longitudinal axis 12, and is fixedly attached to the front side by means of two screws 24 and in this connection is slightly adjustable in terms of its position. A weir edge 26 is configured on each weir plate 20, which edge is of curved design and is spaced at a radius 28 from the longitudinal axis 12. The outflowing material has to flow over this weir edge 26, whereby the level of material in the centrifuge drum 10 can be specifically adjusted depending on the desired clarification performance.

[0024] The associated outlet channel 22 is arranged externally on each of the weir plates 20 in a longitudinal direction or in the direction of flow over the weir edge 26, wherein the outlet channel 22 has been manufactured in one piece with the weir plate 20 by means of a milling operation.

[0025] The outlet channel 22 receives all the material flowing over the weir edge 26 and thus serves to discharge all of the material discharged from the respective outlet opening 16.

[0026] The outlet channel 22 following the weir edge in the direction of flow is substantially rectangular in shape in cross-section and has a bottom surface 30. The bottom surface comprises a curved portion 32, which begins along the weir edge 20 (i.e. in a circumferential direction) viewed counter to the direction of rotation 14 at the start of the outlet opening 16 and ends after an angle 34 of 3.5° upstream of the centre of the outlet opening 16. The curved portion 32 is of curved design as per the curved surface area of a circular cylinder with the radius 28.

[0027] A flat portion 36 of the bottom surface 30 adjoins the curved portion 32 viewed counter to the direction of rotation 14. This portion 36 extends starting from the angle 34 to an angle 38 of 21.6°. The flat portion 36 is inclined radially inwards at an angle 40 of 18° to the tangential direction. The flat portion 36 is therefore spaced further away from the longitudinal axis 12 than the length of the radius 28. The material flowing out over the flat portion 36 experiences a uniform acceleration over a relatively long distance and thus can be easily verified using technical models. The acceleration leads to increased conversion of the centrifugal force impulse into a tangentially directed movement impulse. Since in particular the entire quantity of material also flows through the outlet channel 22, a particularly large proportion of the centrifugal force energy of the outflowing material is converted into tangential drive energy for the rotational movement of the centrifuge drum 10.

[0028] This acceleration effect in the outlet channel 22 assisted by a continuous tapering of the outlet channel 22 in the direction of flow of the material, i.e. in a tangential direction. This tapering is formed in that the outlet channel 22 starting from a first width 42 for the inflowing material, i.e. viewed in a longitudinal direction, tapers to a second width 44 for the outflowing material, i.e. viewed in a tangential or radial direction. The widths 42 and 44 are defined by two side walls 46 and 48 of the outlet channel 22, which starting from the longitudinal direction are curved accordingly in the tangential direction.

[0029] At the same time the outlet channel 22 of this type is designed with a radially inwardly completely open region 50. This region 50 allows a free adjustment of the material level in the outlet channel 22. Since the material can therefore flow away freely through the outlet channel 22, no clogging can occur and the material level can be freely adjusted at the associated weir edge 26 depending on the level of material in the centrifuge drum 10.

[0030] Not least, a particularly precise control of the material level inside the centrifuge drum 10 is possible with the weir plates 20 and the weir edges 26 radially aligned there, even if the operating conditions fluctuate significantly.

[0031] Once the material has flowed over the radially aligned weir edge 26, the material flows are diverted such that on account of their flow through the outlet channel 22, on leaving the disharge device 16 they have a movement impulse rotated radially inwards from the tangential direction in the region of 8° to 28°, preferably 18°. The movement impulse aligned in this manner has proven particularly advantageous in terms of the thereby generated energy recovery back into the centrifuge drum 10.

<u>List of reference numerals</u>

[0032]

10 Centrifuge drum
12 Longitudinal axis
14 Direction of rotation
16 Outlet openings
18 Discharge device as integral component
20 Weir plate
22 Outlet channel
24 Screw
26 Weir edge
28 Radius
30 Bottom surface
32 Curved portion of bottom surface

34 Angle (3.5°)

36 Flat portion of bottom surface

38 Angle (21.6°)

40 Angle (18.0°)

42 First width (viewed in longitudinal direction)

44 Second width (viewed in radial direction)

46 Side wall

48 Side wall

50 Radially inwardly open region

Patentkrav

1. Fuldkappe-snekkecentrifuge der har en centrifugetromle (10), der er rotérbar rundt om en længdeakse, som omfatter mindst en udløbsåbning (16) til udtømning af renset materiale fra centrifugetromlen (10) via en overløbskant (26) som overløbes af det udflydende materiale og en udløbskanal (22) til bortledning af hele det udledte materiale, hvor overløbskanten (26) er anbragt på fronten af centrifugetromlen (10) og udløbskanalen (22) udstrækker sig i strømningsretning bag overløbskanten (26), udløbskanalen (22) er buet i konstruktion for at bortlede det udflydende materiale i en i det væsentlige tangential retning, og udløbskanalen (22) har en bundoverflade (30) som i det mindste delvist er flad i konstruktion, **kendetegnet ved at**, den flade del (36) af bundoverfladen (30) er skrånende radialt indad i en vinkel på 8° til 28° i forhold til den tangentiale retning.

2. Fuldkappe-snekkecentrifuge ifølge krav 1, hvor bundoverfladens (30) flade del (36) er skrånende radialt indad i en vinkel på 18° i forhold til den tangentiale retning.

3. Fuldkappe-snekkecentrifuge ifølge krav 1 eller 2, hvor bundoverfladens (30) flade del (36) begynder efter en vinkel på 3,5° fra udløbsåbningens centrum, set modsat centrifugetromlens (10) rotationsretning (14).

4. Fuldkappe-snekkecentrifuge ifølge et af kravene 1 til 3, hvor bundoverfladens (30) flade del (36) slutter efter en vinkel på fra 15° til 30°, fortrinsvis 21,5°, fra udløbsåbningens centrum, set modsat centrifugetromlens (10) rotationsretning (14).

5. Fuldkappe-snekkecentrifuge ifølge krav 4, hvor en buet del (32), i særdeleshed en cirkulær-hvælvingsformet buet del af bundoverfladen støder op til bundoverfladens (30) flade del (36), set i centrifugetromlens (10) rotationsretning (14).

6. Fuldkappe-snekkecentrifuge ifølge et af kravene 1 til 5, hvor udløbskanalen (22), der har en buet konstruktion, har en første bredde (42) til det indstrømmende materiale, set i centrifugetromlens (10) længderetning, og en anden bredde (44) til det udstrømmende materiale, set i den radiale retning, og hvor den anden bredde (44) er konstrueret mindre end den første bredde (42).

7. Fuldkappe-snekkecentrifuge ifølge krav 6, hvor udløbskanalen (22), der har buet konstruktion, har en konstruktion der mindskes kontinuerligt med hensyn til dens bredde, set i udledningsretningen.

8. Fuldkappe-snekkecentrifuge ifølge et af kravene 1 til 7, hvor udløbskanalen (22) er konstrueret radialt åben indadtil.

9. Fuldkappe-snekkecentrifuge ifølge et af kravene 1 til 8, hvor overløbskanten (26) og udløbskanalen (22) er konstrueret med en komponent (18) som, i særdeleshed fra ydersiden, er fast forbindelig til centrifugetromlens front (10) og aftagelig derfra.

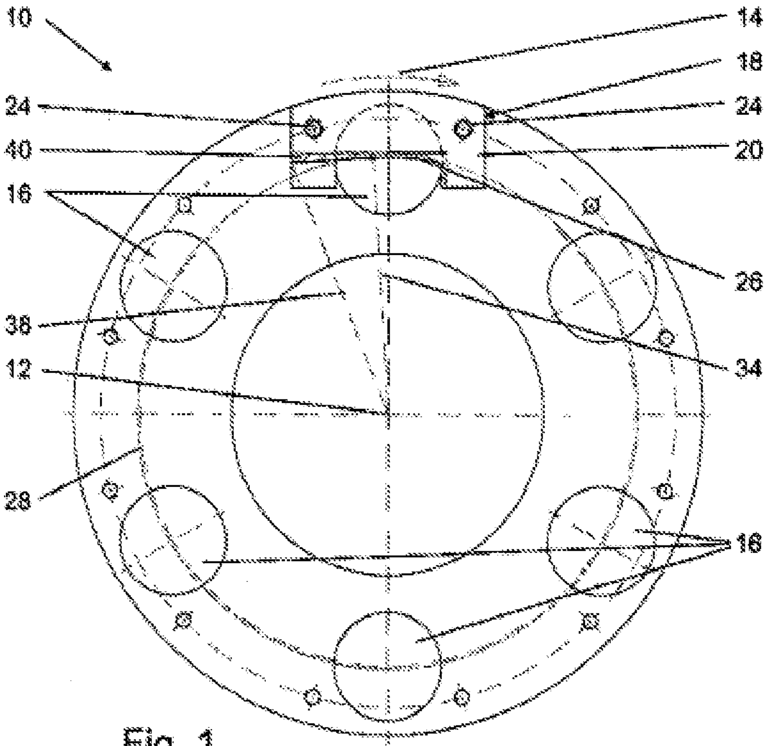

Fig. 1

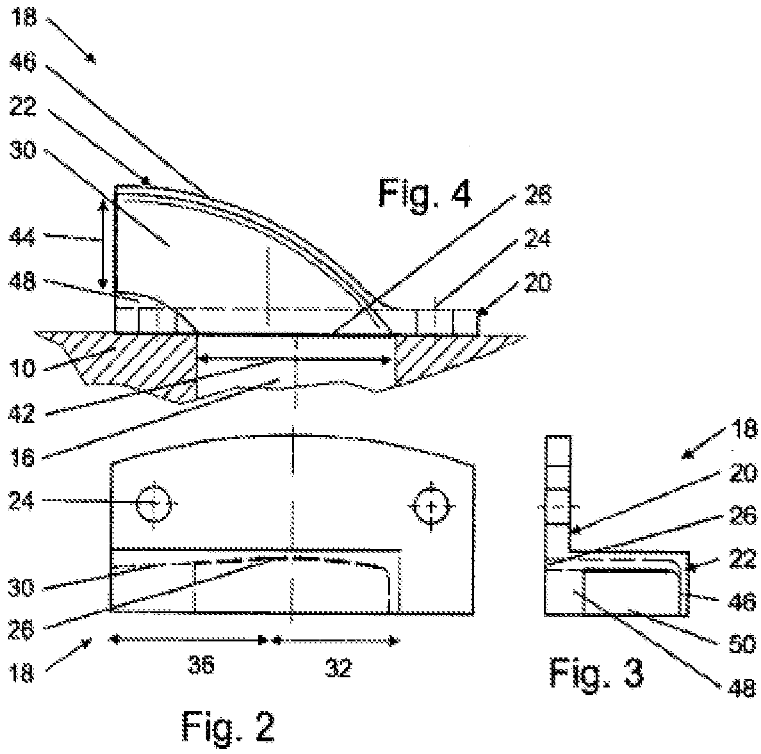
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Fig. 4
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Fig. 2
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Fig. 3