

Separator

The present invention relates to a self-emptying separator according to the preamble of claim 1.

5 In addition to one or more drains for one or more liquid phases, self-emptying separators as defined in this document have an emptying mechanism with a piston valve, which can be moved alternately into an open and a closed position by an actuator, preferably a fluid-actuated actuator, in particular with liquid as the fluid, whereby the piston valve discontinuously opens (open position) and closes (closed position) solids discharge openings in the drum wall for a certain period of time. In the
10 open position, a solid phase is discharged from the centrifuge drum. This is not the case in the closed position.

In such emptying mechanisms with a piston valve, the closing liquid used is injected into a closing chamber - usually below the piston valve. The geometry of this closing
15 liquid and acting on the piston valve is greater than the liquid pressure of the product to be clarified in the separation chamber above the piston valve. This pressure difference causes the piston valve to rise during operation and closes the emptying openings in the drum or closes them again after the solids have been discharged.

By means of a corresponding valve assembly, such as one or more piston valves, which
20 are in fluid connection with the closing chamber, the closing liquid can be drained from the closing chamber during solids discharge, so that the liquid escapes from the closing chamber - usually below the piston valve - which lowers the pressure acting on the piston valve in the closing chamber, so that the liquid pressure, which the product usually exerts on the piston valve above it, moves the piston valve downwards. This
25 releases or opens the emptying openings in the drum.

An adjustable, variable solids volume that can be emptied from the separator per time unit is desirable.

DE 22 14 487 discloses a separator in which some of the emptying openings are designed as permanently open nozzles, while another part of the set of emptying
30 openings is provided as openings/nozzles that can be opened intermittently.

A separator is known from US 2020/ 029935 in which the drum is provided with two sets of emptying openings. A piston valve is required to open each set of openings.

US 3 403 849 describes an electromagnetically operated valve for the controlled draining of closing fluid.

However, the emptying devices according to the prior art involve a relatively high design effort and/or offer only an unsatisfactory solution with regard to the adjustability of the time period in which the solids discharge openings are open as well as in the adjustability of the cross-section of the solids discharge openings and thus the variability and adjustability of the solids volume that is emptied from the separator per time unit.

The object to be solved is to create a separator with an advanced, optimized emptying mechanism.

The invention achieves this objective by means of the subject matter of claim 1.

According to claim 1, there is provided a separator, in particular a self-emptying separator, for centrifugal separation of a flowable product P into at least one liquid phase L and at least one solid phase S, which has a rotatable centrifuge drum with a vertical rotation axis D, which has a separation chamber, in which a disc stack is preferably provided, and which has solids discharge openings and an emptying mechanism with a single piston valve, which is designed to open and close the solids discharge openings discontinuously, wherein a control assembly is provided for the emptying mechanism, wherein the centrifuge drum has, on its circumference, a first set of solids discharge openings and a second set of solids discharge openings, wherein the first set of solids discharge openings and the second set of solids discharge openings are arranged at two different axial heights on the circumference of the centrifuge drum and thus are vertically spaced from each other, wherein the two sets of solids discharge openings are openable and closable with the single piston valve or are opened or closed, respectively.

This creates a separator with an emptying device for the solid phase, which has a simple design and allows the cross-section of the open solids discharge openings for solids discharge to be easily adjusted. The cross-section of the open solids discharge openings for solids discharge is variable due to the two sets of solids openings, as either one set or both sets of solids openings can be opened by the piston valve. This makes the volume of solids discharged from the separator per unit of time variable and adjustable.

In a particularly preferred embodiment variant of the invention, it is provided that the control assembly for the emptying mechanism comprises a closing chamber for a fluid

and comprises a valve assembly having at least one closing chamber valve which communicates with the closing chamber in order to actuate the single piston valve by discharging closing fluid in a switching position.

5 In a further particularly preferred embodiment variant of the invention, it is provided that the control assembly for the emptying mechanism acts on the valve assembly with the at least one closing chamber valve, which is electrically switchable. This creates a simple possibility, in particular for the closing chamber valve(s), to provide variable adjustability of the solids volume to be emptied. This is because the piston valve can be enabled to move to any intermediate position in order to make the emptying of the
10 solids volume particularly variable.

This means that the closing chamber valve for draining the closing fluid can be opened and closed in a controlled manner. This allows the solids emptying process to be controlled independently of the rest of the centrifuge's separation or clarification process. In particular, it may be decoupled in terms of time.

15 In a further particularly preferred embodiment of the invention, it may be provided that the piston valve is in a closed position due to a completely filled closing chamber and closes the first set of solids discharge openings and the second set of solids discharge openings.

20 Furthermore, in a further particularly preferred embodiment variant of the invention, it may be provided that the piston valve is in an open position due to a completely emptied closing chamber and releases and opens the first set of solids discharge openings and the second set of solids discharge openings. In this way, an opening position of the piston valve is easily achieved by proven means, in which a maximum possible solids volume can be emptied per unit of time.

25 Likewise, in a further preferred embodiment variant of the invention, it may be provided that the piston valve is in a central position due to a partially emptied closing chamber and only releases the first set of solids discharge openings arranged at the top. In this way, a minimum possible emptying of the solids volume per unit of time is simply achieved by design.

30 Furthermore, in another particularly preferred embodiment variant of the invention, it may be provided that the piston valve can be lowered to the middle position and raised to the middle position. As a result, the middle position of the piston valve can be approached easily and quickly to empty the solids volume.

Furthermore, according to a further embodiment variant of the invention, it may be provided that the piston valve can be positioned in a respective intermediate position in which the cross-section of the solids discharge openings of the first set of solids discharge openings or the cross-section of the solids discharge openings of the second set of solids discharge openings is axially only partially open or axially closed. This achieves a particularly variable adjustability of the dischargeable solids volume during partial discharge.

In a further particularly preferred embodiment variant of the invention, it is provided that the solids discharge openings of the first set of solids discharge openings and the solids discharge openings of the second set of solids discharge openings are placed at an angle offset to one another on the circumference of the centrifuge drum. This results in a structurally simple, strength-optimized arrangement of the two sets of solids discharge openings in the centrifuge drum.

In a further particularly preferred embodiment variant of the invention, it is provided that the number of solids discharge openings of the first set of solids discharge openings and the number of solids discharge openings of the second set of solids discharge openings are different. This simply results in a non-linear correlation between the degree of opening of the piston valve and the solids discharge volume per unit of time.

Furthermore, in a further particularly preferred embodiment variant of the invention, it is provided that the first set of solids discharge openings and the second set of solids discharge openings are each rotationally symmetrical. In this way, a centrifuge drum without imbalance is simply achieved by design. Rotational symmetry is understood here to mean the rotational symmetry around the angular offset of the individual solids openings relative to one another.

Alternatively, in a further preferred embodiment variant of the invention, it may be provided that the combination of the first set of solids discharge openings and the second set of solids discharge openings results in rotational symmetry. This also makes it easy to achieve a centrifuge drum without imbalance.

Furthermore, in a further particularly preferred embodiment variant of the invention, it is provided that an opening cross-section of the solids discharge openings of the first set of solids discharge openings or the solids discharge openings of the second set of solids discharge openings are identical.

This results in a simple linear correlation between the degree of opening of the piston valve and the solids discharge volume per unit of time.

Alternatively, in a further preferred embodiment variant of the invention, it may be provided that the opening cross-sections of the solids discharge openings of the first set of solids discharge openings and the opening cross-sections of the solids discharge openings of the second set of solids discharge openings are dimensioned differently. This creates a non-linear relationship between the position of the piston valve and the volume of solids that can be discharged per unit of time by means of a simple design measure.

Also alternatively, in a further preferred embodiment variant of the invention, it may be provided that the opening cross-sections of the solids discharge openings of the first set of solids discharge openings are of different dimensions and the opening cross-sections of the solids discharge openings of the second set of solids discharge openings are of different dimensions. In a further particularly preferred embodiment variant of the invention, it is provided that the cross-section of the solids discharge openings of the second set of solids discharge openings is smaller than the cross-section of the solids discharge openings of the first set of solids discharge openings. In each case, a non-linear relationship between the position of the piston valve and the volume of solids that can be discharged per unit of time is produced by a simple design measure.

Furthermore, in a further particularly preferred embodiment variant of the invention, it is provided that the respective solids discharge opening is adjoined in each case by a circumferentially closed nozzle-like channel, which in each case extends through a wall of the centrifuge drum and through which the solids S are discharged radially outwards from the centrifuge drum.

The object is also solved by a method for controlling the solids discharge of a separator, wherein the one single piston valve can be controlled in such a way that it opens the first set of solids discharge openings and/or the second set of solids discharge openings completely axially or partially axially.

In order to increase the precision of this emptying system, it is conceivable to detect the axial position of the piston valve by measurement, transmit it to the control unit, evaluate it there and control the closing fluid valve or the closing chamber valve depending on this evaluation. In this way, the exact positioning of the piston valve is not only controlled but also regulated.

Further advantageous designs of the invention can be found in the other sub-claims.

In the following, the invention is described in more detail with reference to the drawing by means of an exemplary embodiment. The invention is not limited to this exemplary embodiment, but can also be realized in other ways according to the wording or in other equivalent ways, wherein:

- Fig. 1: shows in Fig. 1a) a schematic full section of a separator according to the invention and in Fig. 1b) a sectional enlargement of Fig. 1a;
- Fig. 2: shows a sectional enlargement of a schematic full section of an embodiment variant of the separator according to the invention from Fig. 1a;
- Fig. 3: shows a schematic full section through a hood of a separator according to the invention;
- Fig. 4: shows a schematic full section through a hood of an embodiment variant of a separator according to the invention;
- Fig. 5: shows a schematic full section through the housing and through a machine housing of a purifier separator according to the prior art; and
- Fig. 6: shows a schematic full section through the drum of a clarifier according to the prior art.

In the following description of the figures, several exemplary embodiments of a separator are described. The individual features of these exemplary embodiments can also be combined with exemplary embodiments not shown and are also suitable in each case as advantageous designs of the objects described in individual or several of the main and sub-claims.

The separator according to the prior art has a rotatable centrifuge drum 1, which can have a vertical rotation axis D as shown in Figs. 5 and 6. The centrifuge drum 1 can be enclosed by a hood H that does not rotate during operation of the separator. The centrifuge drum 1 is rotated by a drive motor M, which, according to the embodiment in Fig. 5, acts indirectly via a belt drive on a drive spindle SP of the centrifuge drum 1. The drive spindle SP is rotatably mounted in a machine frame G. It carries the centrifuge drum 1, which is placed on a free end of the drive spindle SP. Alternatively, other drive

variants can also be realized, for example a direct drive of the centrifuge drum 1, wherein a drive motor acts directly on the drive spindle SP of the centrifuge drum 1.

The centrifuge drum 1 can have a single and/or double conical design (bottom and/or top and in particular inside). The centrifuge drum 1 can have a lower drum part 2 and an upper drum part 3. These drum parts 2, 3 can be connected to each other in various ways, for example with a locking ring (not shown here). The centrifuge drum 1 also has a product feed pipe 4.

The separator is designed for continuous and not just batchwise operation.

A distributor 5 is formed in the centrifuge drum 1 to feed the product from the product feed pipe 4 into a separation chamber 6. The product P is transferred into the rotating system in distributor 5.

The actual centrifugal separation of the product P takes place in the separation chamber 6, which has a disc stack 7 consisting of separation discs. It also has a solids collection chamber 8 radially on the outside, in which the solid phase S separated from the suspension or the flowable product P is collected during the separation and/or clarification process.

The centrifuge drum 1 has at least one liquid outlet for a liquid phase L. The centrifuge drum 1 can also have more than one liquid discharge, as shown in Fig. 5. According to Fig. 6, the liquid discharge is designed as a paring disc 9. The liquid discharge can also be realized in a different way.

Fig. 6 shows an example of a so-called clarifier separator, which is designed to clarify a product P to be processed in a centrifugal field or to separate a solid phase S and a liquid phase L from it. The separator can also be designed as a so-called purifier separator, in which two liquid phases and a solid phase are separated from each other, as shown in Fig. 5.

An emptying mechanism is used to discharge the solid phase S, which has a piston valve 10 for opening and closing solids discharge openings 11. The solids discharge openings 11 present here in a single set can be circumferentially distributed in the area of the largest diameter of the centrifuge drum 1. It is expedient to arrange the solids discharge openings 11 on the circumference of the centrifuge drum 1 in such a way that the solids discharge openings 11 do not lead to an imbalance of the centrifuge drum 1. The piston valve 10 is vertically movable here.

The emptying mechanism further comprises a control assembly 12 associated with the piston valve 10 for controlling its opening and closing movements.

5 The left half of the centrifuge in Fig. 6 shows the piston valve 10 in a lowered opening position, while the right half of the centrifuge shows the piston valve 10 in a raised closing position.

The control assembly 12 can have a computer-like electronic control device 13 (see Fig. 6) or be connected to it. A higher-level controller of the centrifuge can also be used as this control device 13.

The control assembly 12 also comprises a closing chamber 14 for fluid.

10 This closing chamber 14 is designed in such a way that the closing movement of the piston valve 10 can be initiated by introducing fluid via a closing fluid valve 15 and in such a way that a closed position of the piston valve 10 can be maintained during rotation at an operating speed for centrifugal processing. The closing fluid valve 15 can be controlled by the electronic control device 13. For the closing movement of the piston
15 valve 10, it is necessary for the closing chamber valve 16 to be closed.

The fluid can be drained from the closing chamber 14 by a valve assembly, which can comprise at least one or more closing chamber valves 16, which are in fluid connection with the closing chamber 14, and thus the solids collection chamber 8 can be emptied through the solids discharge openings 11.

20 The closing chamber valve 16 is often designed as a centrifugal valve that closes by centrifugal force at the operating speed of the centrifuge drum 1. By introducing an opening fluid via the opening fluid valve 19 into the closing chamber valve 16, the opening movement of the piston valve 10 is initiated and the water is emptied from the closing chamber 14.

25 What is not optimal about the prior art is that the targeted discharge of only a partial quantity of the fluid from the closing chamber 14 cannot be precisely reproduced, as this depends on the hydraulic pressures above and below the piston valve 10. The cross-section of the solids discharge openings 11 is also not variably adjustable. The invention therefore takes a different approach.

30 Departing from the prior art, the centrifuge drum 1 of a separator according to the invention has a first set of solids discharge openings 11a and a second set of solids

discharge openings 11b on its circumference, as shown in Figs. 1a, 1b, 2, 3 and 4. Preferably, the first set of solids discharge openings 11a and the second set of solids discharge openings 11b are arranged on the largest radius of the centrifuge drum 1. The first set of solids discharge openings 11a and the second set of solids discharge openings 11b are arranged at two different axial heights on the circumference of the centrifuge drum 1 and are thus vertically spaced apart, as shown in Figs. 1a, 1b, 2, 3 and 4, and can be opened or closed with a single piston valve 10.

The respective solids discharge opening 11a, 11b is adjoined by a respective channel 18a, 18b, which extends through a respective wall of the centrifuge drum 1 and through which the solids S are discharged radially outwards from the centrifuge drum 1.

When the piston valve 10 is in the closed position (Fig. 1a, right half of the picture) due to a completely filled closing chamber 14, the first set of solids discharge openings 11a and the second set of solids discharge openings 11b are closed by the piston valve 10.

When the piston valve 10 is in the open position (Fig. 1a, left half of image) due to a completely empty closing chamber 14, the first set of solids discharge openings 11a and the second set of solids discharge openings 11b are released and opened by the piston valve.

However, if the closing chamber 14 is only partially emptied, the piston valve 10 is in a middle position and only releases the first set of solids discharge openings 11a arranged at the top here (see Fig. 1b and Fig. 2).

In order to be able to position the piston valve 10 to such a "center position", it is necessary to be able to open and close the closing chamber valve 20 (see Fig. 1a) for a defined period of time in order to drain the closing fluid.

It may therefore be provided that the control assembly 12 for the emptying mechanism acts on the valve assembly with the at least one closing chamber valve 20 and on the single piston valve 10, wherein the closing chamber valve 20 is electrically switchable, i.e. having an electromechanical or piezoelectric operating mechanism. With such a closing chamber valve 20, opening and closing can take place independently of the hydraulic pressures in the centrifuge drum 1.

Accordingly, the at least one closing chamber valve 20 preferably operates as an electric valve, such as a solenoid valve or piezo valve, which can be opened and closed by electrical control pulses from the control device 13. This control pulse could, for

example, be sent by radio into the rotating system to a receiver on the valve (not shown). The electrical energy required for this can, for example, be transmitted to the rotating centrifuge drum 1 by means of a system that operates according to the inductive principle. However, an energy storage device, such as a battery, can also be provided in the centrifuge drum 1. The closing chamber valve 20 can also work according to another suitable operating principle.

This allows part of the closing fluid to be emptied from the closing chamber 14 if required. In combination with the product P located above the piston valve 10, which exerts a pressure on the piston valve 10, the piston valve 10 lowers until the pressures below and above the piston valve 10 have equalized and the desired middle position of the piston valve 10 is reached.

In Fig. 1a, Fig. 1b and Fig. 2, the solids discharge opening 11a of the first set of solids discharge openings and the solids discharge opening 11b of the second set of solids discharge openings are shown axially directly above one another, but this is not necessary and is also not advantageous for reasons of strength.

The solids discharge openings 11a of the first set of solids discharge openings and the solids discharge openings 11b of the second set of solids discharge openings can also be positioned at an angle offset to one another on the circumference of the centrifuge drum 1, as shown in Fig. 3.

Likewise, the number of solids discharge openings 11a of the first set of solids discharge openings and the number of solids discharge openings 11b of the second set of solids discharge openings can be different, as shown in Fig. 4.

The channels 18a, 18b of the individual solids discharge openings 11a, 11b (which in Fig. 1a and Fig. 1b each show a horizontal course) can also be arranged vertically in a fan shape, so that the inlets of the channels 18a, 18b facing the piston valve 10 have a smaller vertical distance from each other than the outlets of the channels 18a, 18b facing away from the piston valve 10 (see Fig. 2). In each case, two of the channels 18a, b, which lie correspondingly one above the other in the circumferential direction, can thus extend at an angle to each other.

In order to avoid an imbalance of the centrifuge drum 1, it is advantageous if the first set of solids discharge openings 11a and the second set of solids discharge openings 11b are each rotationally symmetrical. However, it is also conceivable that only the combination of the first set of solids discharge openings 11a and the second set of

solids discharge openings 11b results in rotational symmetry.

Furthermore, an opening cross-section of the solids discharge openings 11a of the first set of solids discharge openings 11a or the solids discharge openings 11b of the second set of solids discharge openings 11b can be identical. However, it is also conceivable that the opening cross-sections of the solids discharge openings 11a of the first set of solids discharge openings 11a and the opening cross-sections of the solids discharge openings 11b of the second set of solids discharge openings 11b are dimensioned differently. For example, the respective cross-section of the solids discharge openings 11b of the second set of solids discharge openings 11b may be larger than the respective cross-section of the solids discharge openings 11a of the first set of solids discharge openings 11a.

In this way, small quantities of solid S can be emptied from the centrifuge drum 1 per unit of time when the piston valve 10 is in the middle position, while significantly larger quantities of solid S can be emptied from the centrifuge drum 1 per unit of time when the piston valve 10 is fully lowered. In this way, the emptying quantity per unit of time is not linear to the stroke of the piston valve 10.

It is also conceivable that the sum of the opening cross-sections of the solids discharge openings 11a of the first set of solids discharge openings and the sum of the opening cross-sections of the solids discharge openings 11b of the second set of solids discharge openings are dimensioned differently.

The cross-section of the respective solids discharge openings 11a, 11b can be circular, elongated or slot-shaped, oval or elliptical, triangular, rectangular or polygonal.

The open piston valve 10 only rises back to the closed position when closing fluid is again fed into the closing chamber 14 via the closing fluid valve 15. Similarly to lowering the piston valve 10 to the middle position, it is also possible to raise the piston valve 10 to the middle position, as the stroke of the piston valve 10 depends on the amount of closing fluid introduced, the density of the closing fluid and the pressure in the closing chamber 14 caused by the centrifugal force.

Alternatively or additionally, it may also be provided that the piston valve 10 can also be positioned in a respective intermediate position in which the respective cross-section of the solids discharge openings 11a of the first set of solids discharge openings 11a or the respective cross-section of the solids discharge openings 11b of the second set of solids discharge openings 11b is only partially open or closed. The term "partially"

means that the piston valve 10 opens the first set of solids discharge openings 11a or the second set of solids discharge openings 11b, e.g. halfway, i.e. not completely.

Precise dosing of the closing fluid quantity can be easily realized with the closing fluid valve 15 and the control device 13.

- 5 To increase the precision of this emptying system, it is conceivable to detect the axial position of the piston valve 10 by measurement, transmit it to the control unit 13, evaluate it there and actuate the closing fluid valve 15 or the closing chamber valve 20 depending on this evaluation. In this way, the exact positioning of the piston valve is not only controlled but also regulated.
- 10 With the separator described, both the opening time of the solids discharge openings 11a, 11b and the opening cross-section (sum of the cross-sections of the solids discharge openings 11a, 11b released by the piston valve 10) can therefore be adjusted.

List of reference signs

	1	Centrifuge drum
	2	Lower drum part
5	3	Upper drum part
	4	Product feed pipe
	5	Distributor
	6	Separation chamber
	7	Disc stack
10	8	Solids collection chamber
	9	Paring disc
	10	Piston valve
	11, 11a, 11b	Solids discharge opening
	12	Control assembly
15	13	Control device
	14	Closing chamber
	15	Closing fluid valve
	16	Closing chamber valve
	17	Drainage channel
20	18a, 18b	Channel
	19	Opening fluid valve
	20	Closing chamber valve
	D	Rotation axis
25	S	Solid
	L	Liquid phase
	P	Product
	M	Drive motor
	SP	Drive spindle
30	G	Machine frame
	H	Hood

CLAIMS

1. Separator, in particular self-emptying separator, for centrifugal separation of a flowable product (P) into at least one liquid phase (L) and at least one solid phase (S), which has a rotatable centrifuge drum (1) with a vertical rotation axis (D),
5 which has a separation chamber (6), in which a disc stack (7) is preferably provided, and which has solids discharge openings (11) and an emptying mechanism with a single piston valve (10), which is designed to open and close the solids discharge openings (11) discontinuously, wherein a control assembly (12) is provided for the emptying mechanism, **characterized in that** the centrifuge
10 drum (1) has, on its circumference, a first set of solids discharge openings (11a) and a second set of solids discharge openings (11b), wherein the first set of solids discharge openings (11a) and the second set of solids discharge openings (11b) are arranged at two different axial heights on the circumference of the centrifuge drum (1) and thus are vertically spaced from each other, wherein the two sets of
15 solids discharge openings are openable and closable with the single piston valve (10).
2. Separator according to claim 1, **characterized in that** the control assembly (12) for the emptying mechanism comprises a closing chamber (14) for a fluid and comprises a valve assembly having at least one closing chamber valve (20) which
20 communicates with the closing chamber (14) in order to actuate the single piston valve (10) by discharging closing fluid.
3. Separator according to claim 1 or 2, **characterized in that** the control assembly (12) for the emptying mechanism acts on the valve assembly with the at least one closing chamber valve (20), which has an electromechanical or piezoelectric
25 operating mechanism.
4. Separator according to one of the preceding claims, **characterized in that** the piston valve (10) is in a closed position due to a completely filled closing chamber (14) and closes the first set of solids discharge openings (11a) and the second set of solids discharge openings (11b).
- 30 5. Separator according to one of the preceding claims, **characterized in that** the piston valve (10) is in an open position due to a completely emptied closing chamber (14) and releases and opens the first set of solids discharge openings (11a) and the second set of solids discharge openings (11b).

6. Separator according to one of the preceding claims, **characterized in that** the piston valve (10) can be moved into a central position so that it only releases the first set of solids discharge openings (11a), preferably arranged vertically at the top.
- 5 7. Separator according to one of the preceding claims, **characterized in that** the piston valve (10) can be positioned in a respective intermediate position in which the cross-section of the solids discharge openings (11a) of the first set of solids discharge openings or the cross-section of the solids discharge openings (11b) of the second set of solids discharge openings is only partially open axially.
- 10 8. Separator according to one of the preceding claims, **c characterized in that** the centrifuge drum (1) has a single and/or double conical design.
9. Separator according to claim 8, **characterized in that** the first set of solids discharge openings (11a) and the second set of solids discharge openings (11b) are arranged on the largest radius of the single and/or double conical centrifuge drum (1).
- 15 10. Separator according to one of the preceding claims, **characterized in that** the solids discharge opening (11a) of the first set of solids discharge openings and the solids discharge opening (11b) of the second set of solids discharge openings are arranged axially directly one above the other.
- 20 11. Separator according to one of the preceding claims, **characterized in that** the solids discharge openings (11a) of the first set of solids discharge openings and the solids discharge openings (11b) of the second set of solids discharge openings are placed at an angle offset to one another in the circumferential direction on the circumference of the centrifuge drum (1).
- 25 12. Separator according to one of the preceding claims, **characterized in that** the number of solids discharge openings (11a) of the first set of solids discharge openings and the number of solids discharge openings (11b) of the second set of solids discharge openings are different.
- 30 13. Separator according to one of the preceding claims, **characterized in that** the first set of solids discharge openings (11a) and the second set of solids discharge openings (11b) are each designed to be rotationally symmetrical.

14. Separator according to one of the preceding claims, **characterized in that** an opening cross-section of the solids discharge openings (11a) of the first set of solids discharge openings or of the solids discharge openings (11b) of the second set of solids discharge openings is in each case identically dimensioned.
- 5 15. Separator according to one of claims 1 to 13, **characterized in that** the opening cross-sections of the solids discharge openings (11a) of the first set of solids discharge openings and the opening cross-sections of the solids discharge openings (11b) of the second set of solids discharge openings are each dimensioned differently.
- 10 16. Separator according to one of claims 1 to 13, **characterized in that** the sum of the opening cross-sections of the solids discharge openings (11a) of the first set of solids discharge openings and the sum of the opening cross-sections of the solids discharge openings (11b) of the second set of solids discharge openings are each dimensioned differently from one another.
- 15 17. Separator according to one of the preceding claims, **characterized in that** the cross-section of the respective solids discharge openings (11b) of the second set of solids discharge openings (11b) is smaller than the cross-section of the respective solids discharge openings (11a) of the first set of solids discharge openings (11a).
- 20 18. Separator according to one of the preceding claims, **characterized in that** the cross-section of the respective solids discharge openings (11a, 11b) is circular, slot-shaped, oval or elliptical, triangular, rectangular or polygonal.
- 25 19. Separator according to one of the preceding claims, **characterized in that** the respective solids discharge opening (11a, 11b) is adjoined by a respective channel (18a, 18b) which extends through a respective wall of the centrifuge drum (1) and through which the respective solids S are discharged radially outwards from the centrifuge drum (1).
20. Separator according to claim 19, **characterized in that** the channels (18a, 18b) of the individual solids discharge openings (11a, 11b) each have a horizontal course.
- 30 21. Separator according to claim 19, **characterized in that** the channels (18a, 18b) of the individual solids discharge openings (11a, 11b) are arranged in a fan shape, so that the inlets of the channels (18a, 18b) facing the piston valve (10) have a

smaller vertical distance from one another than the outlets of the channels (18a, 18b) facing away from the piston valve (10).

- 5 22. Method for controlling the solids discharge of a separator according to one of the preceding claims, **characterized in that** the one single piston valve (10) can be actuated in such a way that it opens or closes the first set of solids discharge openings (11a) and/or the second set of solids discharge openings (11b) completely axially or partially axially.