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(54) **Centrifugal separator**

(57) A centrifugal separator (1) comprising an outer casing (2), within which at least one hollow drum (3) is actuated so that it can rotate, at least one first screw feeder (4) which is actuated so that it can rotate, at a speed which is substantially higher than the speed of the respective drum (3) and within the drum (3), skimming

its internal surfaces (5), a circuit (6) for feeding a solid-liquid mix and respective circuits for the separate expulsion of the solid phase and of the liquid phase. The mix feed circuit (6) comprises an inlet (7) and a respective channel (8) which leads out along at least one portion (9) of the internal surface (5) of the drum (3) to dispense mix along the internal surface (5) of the rotatable drum (3).

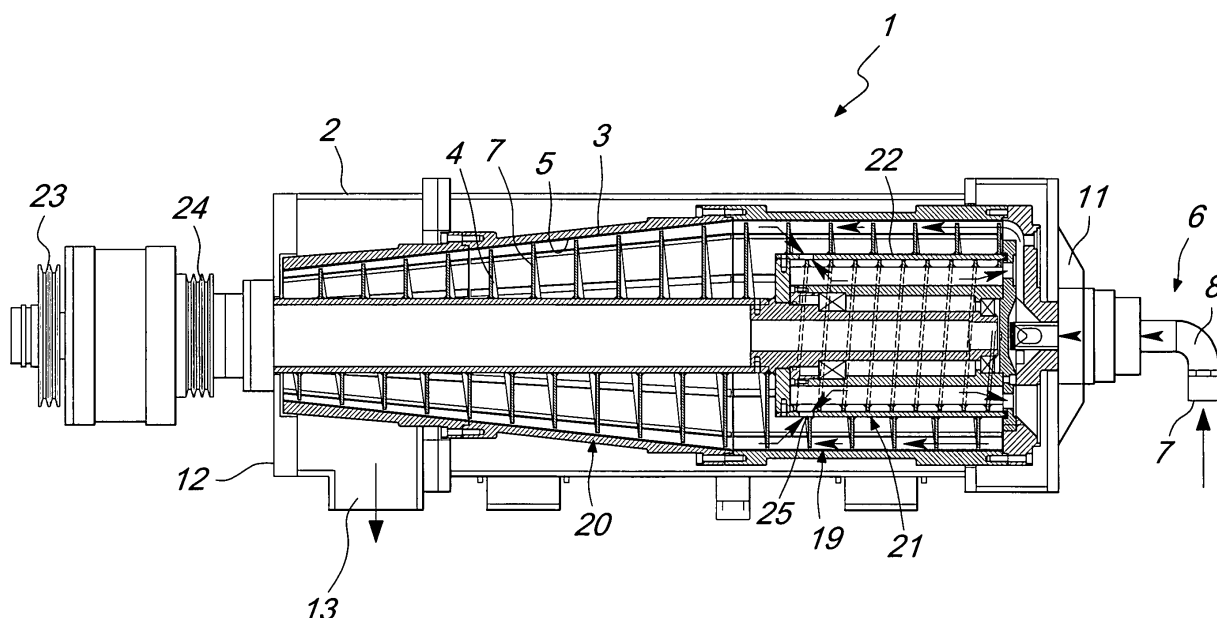


Fig. 1

Description

[0001] The present invention relates to a centrifugal separator for treating sludges, suspensions and, in general, mixes of substances in the liquid phase and substances in the solid phase, adapted to separate more or less accurately the liquid phase from the solid phase.

[0002] Known types of centrifugal separator consists of a drum which rotates at high speed and is provided with an internal screw feeder. The loaded sludge undergoes centrifugation, during which the phases stratify; the phase with highest density (solid phase) is arranged on the outermost annular region.

[0003] The screw feeder rotates at a different rate with respect to the drum and entrains the solid phase toward the discharge. The water (liquid phase) exits from the opposite side.

[0004] Known types of centrifugal separator have several drawbacks.

[0005] First of all, the liquid phase discharged by the separator is generally rather rich in the solid sediments: this means that the separation process does not ensure the result of correct separation of the solid phase from the liquid phase. When separation is required by environmental needs (separation of pollutants) or by the need to recover valuable material (treatment of mining sludges), it is absolutely necessary for the separation to be as thorough as possible.

[0006] Secondly, it should be noted that continuous settling of solid material occurs along the path of the discharge of the liquid phase and leads, in the medium and long term, to obstruction of such path.

[0007] It is therefore necessary to provide continuous maintenance to clean the path: these operations must provide for a rather complex machine architecture in order to ensure easy access to the path to be cleaned. This constructive architecture necessarily causes an increase in the production and design costs of the machine.

[0008] The aim of the present invention is to provide a centrifugal separator which is suitable for high-performance separation of the solid phase and of the liquid phase of a mix.

[0009] Within this aim, an object of the present invention is to provide a centrifugal separator in which settling of the solid phase along the liquid phase expulsion path does not occur.

[0010] Another object of the present invention is to provide a centrifugal separator which can be operated easily, since it does not require particular maintenance.

[0011] Another object of the present invention is to provide a centrifugal separator with an architecture which is particularly simple and can be assembled easily.

[0012] Another object of the present invention is to provide a centrifugal separator which has low costs, is relatively simple to provide in practice and is safe in application.

[0013] This aim and these and other objects, which will become better apparent hereinafter, are achieved by the

present centrifugal separator, of the type that comprises an outer casing, within which at least one hollow drum is actuated so that it can rotate, at least one screw feeder which is actuated so that it can rotate, at a speed which is substantially higher than the speed of the respective drum, within said drum, skimming its internal surfaces, a circuit for feeding a solid-liquid mix and respective circuits for the separate expulsion of the solid phase and of the liquid phase, **characterized in that** the mix feed circuit comprises an inlet and a respective channel which leads out along at least one portion of the internal surface of said drum to dispense mix along the internal surface of said rotatable drum.

[0014] Further characteristics and advantages of the invention will become better apparent and evident from the following detailed description of a preferred but not exclusive embodiment of a centrifugal separator, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a sectional front view, taken along an axial longitudinal plane, of a centrifugal separator according to the invention;

Figure 2 is an enlarged-scale sectional front view, taken along an axial longitudinal plane, of a detail of a centrifugal separator according to the invention.

[0015] With reference to the figures, the reference numeral 1 generally designates a centrifugal separator according to the invention.

[0016] A particularly simple and efficient embodiment is described hereafter: any structural complication that entails the adoption of multiple equivalent components and/or the partial use of the components that are present is to be understood as being comprised in any case within the scope of the present description.

[0017] The centrifugal separator 1 comprises an outer casing 2, within which a hollow drum 3 is actuated so that it can rotate: with reference to the general nature of the description, for example, the separator 1 might also comprise a plurality of mutually independent drums 3 contained within a common casing 2 or within respective separate casings 2.

[0018] A first screw feeder 4 is actuated so that it can rotate, at a speed which is substantially higher than the speed of the respective drum 3, inside the drum 3 itself; the first screw feeder 4, during its relative rotation with respect to the corresponding drum 3, skins internal surfaces 5 thereof.

[0019] This relative motion is intended to convey the solids toward the outlet.

[0020] The same result can be achieved by working on the following parameters:

- direction of rotation
- turn winding direction
- relative speed of the screw feeder 4 and of the drum 3

[0021] The possible combinations for achieving correct operation (and therefore the desired outflow of the solids) are the following:

- > screw feeder 4 with right-handed helix, operating condition in which the drum 3 is faster than the screw feeder 4 with a clockwise rotation (if viewed from the liquid discharge region);
- > screw feeder 4 with right-handed helix, operating condition in which the drum 3 is slower than the screw feeder 4 with a counterclockwise rotation (if viewed from the liquid discharge region);
- > screw feeder 4 with left-handed helix, operating condition in which the drum 3 is slower than the screw feeder 4 with a clockwise rotation (if viewed from the liquid discharge region);
- > screw feeder 4 with left-handed helix, operating condition in which the drum 3 is faster than the screw feeder 4 with a counterclockwise rotation (if viewed from the liquid discharge region).

[0022] Although only one of these constructive solutions is described in detail, it is evident that they are equivalent from a mechanical standpoint and therefore are fully within the scope of the protection of the present invention.

[0023] The separator 1 further comprises a circuit 6 for feeding a solid-liquid fit mix and respective circuits for separate expulsion of the solid phase and of the liquid phase.

[0024] The solid-liquid mix can be of different kinds: in particular, the separator 1 according to the invention is suitable for treating sludge and the like, but use with other mixes of another kind which require separation of the solid phase from the liquid phase is not excluded.

[0025] It is noted that the separators 1 are particularly suitable for treating mixes for purification purposes (therefore environmental use and the like) and for selection purposes (use in mines or other plants adapted to provide a raw material which contains a small part of valuable material to be selected).

[0026] In the centrifugal separator 1 according to the invention, the mix feed circuit 6 comprises an inlet 7 and a respective channel 8 which leads out along at least one portion 9 of the internal surface 5 of the drum 3: this embodiment allows the delivery of mix along the internal surface 5, proximate to its initial edge 10, of the rotating drum 3.

[0027] This constructive choice to provide the separator 1 with the mix directly proximate to the internal surface of the drum 3 allows to facilitate the immediate stratification of the mix, with consequent centrifugal separation of the solid phase from the liquid phase. In known types of separator, the mix is introduced coaxially with respect to the drum and this entails a subsequent transfer by centrifugal action of such mix toward the walls of the drum: of course, a transfer of the mix in this manner entails the onset of turbulence which compromises the desired solid/liquid stratification.

[0028] Determining a constructive architecture in which the mix is dispensed directly in the separator 1 proximate to the internal surface 5 of the drum 3 ensures that an optimum centrifugal stratification is achieved immediately, minimizing interference caused by any turbulence and the like.

[0029] In particular, the feed circuit 6 comprises one inlet 7 which is arranged at one end 11 of the casing 2.

[0030] The end 11 is opposite to an end 12 in which an opening 13 for expelling the solid phase is located.

[0031] The inlet 7 leads, by means of the respective channel 8, to an annular chamber 14, which lies inside the casing 2 and the drum 3. The chamber 14 is adapted to force the translational motion of the introduced mix in a radial direction by centrifugal action toward the portion 9 of the internal wall 5 of the drum 3.

[0032] The annular input chamber 14 is arranged upstream of the beginning of a first start 15 of the first screw feeder 4.

[0033] The circuit for expelling the liquid phase comprises a channel 16, which is coaxial to the at least one first screw feeder 4 and lies inside it in its portion located further upstream. The channel 16 is adapted to convey the liquid phase with an axial orientation with respect to the rotation axis of the separator 1 and in the opposite direction with respect to the advancement direction of the solid phase on the drum 3 by way of the action of the first screw feeder 4.

[0034] In particular, the channel 16 comprises at least one portion of at least one second screw feeder 17, in which the crests face, and are proximate to, an internal surface 18 of the channel 16 to remove any solid sediment from the surface 18 and to convey the removed sediment toward the main screw feeder 4. Continuous removal of sediment by the crests of the second screw feeder 17 from the internal surface 18 of the channel 16 ensures that such sediment does not accumulate and therefore that the operation of the separator 1 is not compromised by the presence of solid sediment in the liquid phase discharge channel 16. In practice, this solution entails the possibility to reduce greatly maintenance interventions (aimed at cleaning the liquid phase discharge channel) and therefore allows less expensive and simpler operation than known types of separator.

[0035] It should be noted that the second screw feeder 17, in an embodiment of particular interest in practice and in application, is constituted by a ribbonlike ring which is arranged in a helical pattern on a plurality of radial supporting arms which extend from the channel 16: this embodiment ensures that a channel 16 of large size is available although the second screw feeder 17 designed to remove the sediment from the surface 18 is present.

[0036] The drum 3 and the first screw feeder 4 have a first upstream portion 19 which is substantially cylindrical and a second downstream portion 20 which is substantially frustum-shaped.

[0037] The first portion 19 is arranged directly downstream of the region where the mix is introduced by the

feed circuit 6, while the second portion 20 has its end part substantially aligned with the opening 13 for expelling the solid phase.

[0038] The crest of the first screw feeder 4 faces, and is proximate to, the internal surface 5 of the drum 3, while the crest of the second screw feeder 17 faces, and is proximate to, the internal surface 18 of the channel 16.

[0039] During operation, both crests skim the corresponding surfaces 5 and 18 to remove and convey the solid phase deposited thereon.

[0040] The first screw feeder comprises, at a part 21 of the first portion 19, at least one tubular portion 22, within which the second screw feeder 17 is accommodated so that it can rotate.

[0041] The second screw feeder 17 is jointly connected to the corresponding drum 3; the corresponding crests therefore slide proximate to the internal surface of the tubular portion 22 of the first screw feeder 4: the starts of the second screw feeder 17 are arranged in a helical winding direction which is opposite with respect to the direction of the first screw feeder 4.

[0042] A relative speed of the first screw feeder 4 with respect to the drum 3 causes an advancement, toward the respective expulsion opening 13, of the solid phase, in the drum 3, by way of the action of the first screw feeder 4, and in the tubular portion 22, by way of the action of the second screw feeder 17. A positive relative speed (which therefore corresponds to a higher rotation rate for the screw feeder 4 with respect to the drum 3) in fact entails entrainment toward the opening 13 of the solid matter comprised between the starts of the first screw feeder 4. Simultaneously, the relative speed is such that the tubular portion 22 (connected to the first screw feeder 4) move at a higher speed than the second screw feeder 17 (the relative speed is therefore negative in this case): since the helical winding direction is opposite with respect to the one of the first screw feeder 4, transfer of the sediment that is present on the surface of the channel 16 (internal surface of the portion 22) toward the opening 13 still occurs.

[0043] The separator 1 further comprises at least one external traction unit (not shown in the figure), which is intended to drive rotationally the drum 3, jointly with the second screw feeder 17, and the first screw feeder 4.

[0044] In particular, it is possible to adopt a single unit which is associated with respective pulleys 23 and 24 having different diameters, one pulley 23 being coupled to the drum 3 and to the second screw feeder 17 and the other pulley 24 being coupled to the first screw feeder 4.

[0045] The different diameter of the pulleys 23, 24 determines the different rotation rate of the drum 3 with respect to the first screw feeder 4.

[0046] Introduction of the mix through the circuit 6 entails that such mix flows by way of the action of the first screw feeder along the part 21 until it reaches the end of the first upstream portion 19.

[0047] At the end of the portion 19 there are passages 25 designed to allow the outflow of the liquid phase

through the respective channel 16.

[0048] The remaining solid phase continues to be entrained by the first screw feeder 4 to the opening 13: the centrifugal action contributes, throughout the entrainment, to separate from the solid phase the liquid phase, which tends to retract to be then expelled through the channel 16.

[0049] The second screw feeder 17 (by way of its relative movement with respect to the walls of the channel constituted by the internal surface of the tubular portion 22 of the screw feeder 4) removes sediment from the surfaces that face it.

[0050] It has thus been shown that the invention achieves the proposed aim and objects.

[0051] The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims.

[0052] All the details may further be replaced with other technically equivalent ones.

[0053] In the exemplary embodiments shown, individual characteristics, given in relation to specific examples, may actually be interchanged with other different characteristics that exist in other exemplary embodiments.

[0054] Moreover, it is noted that anything found to be already known during the patenting process is understood not to be claimed and to be the subject of a disclaimer.

[0055] In practice, the materials used, as well as the shapes and dimensions, may be any according to requirements without thereby abandoning the scope of the protection of the appended claims.

[0056] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A centrifugal separator (1), of the type that comprises an outer casing (2), within which at least one hollow drum (3) is actuated so that it can rotate, at least one first screw feeder (4) which is actuated so that it can rotate, at a speed which is substantially higher than the speed of the respective drum (3), within said drum (3), skimming its internal surfaces (5), a circuit (6) for feeding a solid-liquid mix and respective circuits for the separate expulsion of the solid phase and of the liquid phase, **characterized in that** the mix feed circuit (6) comprises an inlet (7) and a respective channel (8) which leads out along at least one portion (9) of the internal surface (5) of said drum (3) to dispense mix along the internal surface (5) of said rotatable drum (3).

2. The centrifugal separator according to claim 1, **characterized in that** said feed circuit (6) comprises an inlet (7) which is arranged at an end (11) of said casing (2), said end (11) being arranged opposite the end (12) in which the opening (13) for expelling the solid phase is arranged, said inlet (7) leading, by means of a channel (8), to an annular chamber (14) which lies inside said casing (2) and said at least one drum (3), said chamber (14) being adapted to impose a translational motion in a radial direction by centrifugal action, toward at least one portion (9) of the internal wall (5) of said at least one drum (3), of the introduced mix. 5
3. The centrifugal separator according to claim 2, **characterized in that** said annular intake chamber (14) is arranged upstream of the beginning of the first start (15) of said at least one first screw feeder (4). 10
4. The centrifugal separator according to claim 1, **characterized in that** said circuit for expelling the liquid phase comprises a channel (16) which is coaxial to said at least one first screw feeder (4) and is internal thereto in its portion located further upstream, said channel (16) being adapted to convey said separated liquid phase in an axial orientation with respect to the rotation axis of the separator (1) and in the opposite direction with respect to the advancement direction of said solid phase on the at least one drum (3) by way of the action of said at least one first screw feeder (4). 20 25 30
5. The centrifugal separator according to claim 4, **characterized in that** said channel (16) comprises at least one portion of at least one second screw feeder (17) whose crests face, and lie proximate to, the internal surface (18) of said channel (16) for the removal of any solid sediment from said surface (18) and for the conveyance of said removed sediment towards the at least one first main screw feeder (4). 35 40
6. The centrifugal separator according to claim 1, **characterized in that** said at least one drum (3) and said corresponding at least one first screw feeder (4) have a first upstream portion (19) which is substantially cylindrical and a second downstream portion (20) which is substantially frustum-shaped, said first portion (19) being arranged directly downstream of the region where the mix is introduced by said feed circuit (6) and said second portion (20) having its end part which is substantially aligned with an opening (13) for expelling the solid phase. 45 50
7. The centrifugal separator according to claim 1, **characterized in that** the crest of said at least one first screw feeder (4) and the crest of said at least one second screw feeder (17) face, and lie proximate to, respectively the internal surface (5) of said drum (3) and to the internal surface (18) of said channel (16), skimming, during the operation of said separator (1), said surfaces (5) and (18) to remove and convey the solid phase deposited thereon. 55
8. The centrifugal separator according to one or more of the preceding claims, **characterized in that** said at least one first screw feeder (4) comprises, at a part (21) of said first portion (19), at least one tubular portion (22), within which the at least one second screw feeder (17) is accommodated so that it can rotate.
9. The centrifugal separator according to one or more of the preceding claims, **characterized in that** said at least one second screw feeder (17) is coupled to the corresponding drum (3), the corresponding crests sliding proximate to the internal surface (18) of said tubular portion (22) of said first screw feeder (4), the starts of said at least one second screw feeder (17) being arranged in the opposite direction with respect to the starts (15) of said at least one first screw feeder (4), a relative speed of the first screw feeder (4) with respect to the drum (3) producing an advancement, toward the respective expulsion opening (13), of the solid phase in the drum (3) by way of the action of the at least one first screw feeder (4) and in the tubular portion (22) by way of the action of the at least one second screw feeder (17).
10. The centrifugal separator according to one or more of the preceding claims, **characterized in that** it comprises at least one external traction unit which is intended to entrain rotationally said at least one hollow drum (3) jointly with the at least one second screw feeder (17) and said at least one first screw feeder (4).
11. The centrifugal separator according to the preceding claim, **characterized in that** said unit is a single unit and is associated with respective pulleys (23, 24) having different diameters, one pulley (23) being coupled to said at least one drum (3) and to said second screw feeder (17) and the other pulley (24) being coupled to said first screw feeder (4), the different diameter of the pulleys (23, 24) determining the different rotation rate of the at least one drum (3) with respect to the at least one first screw feeder (4).

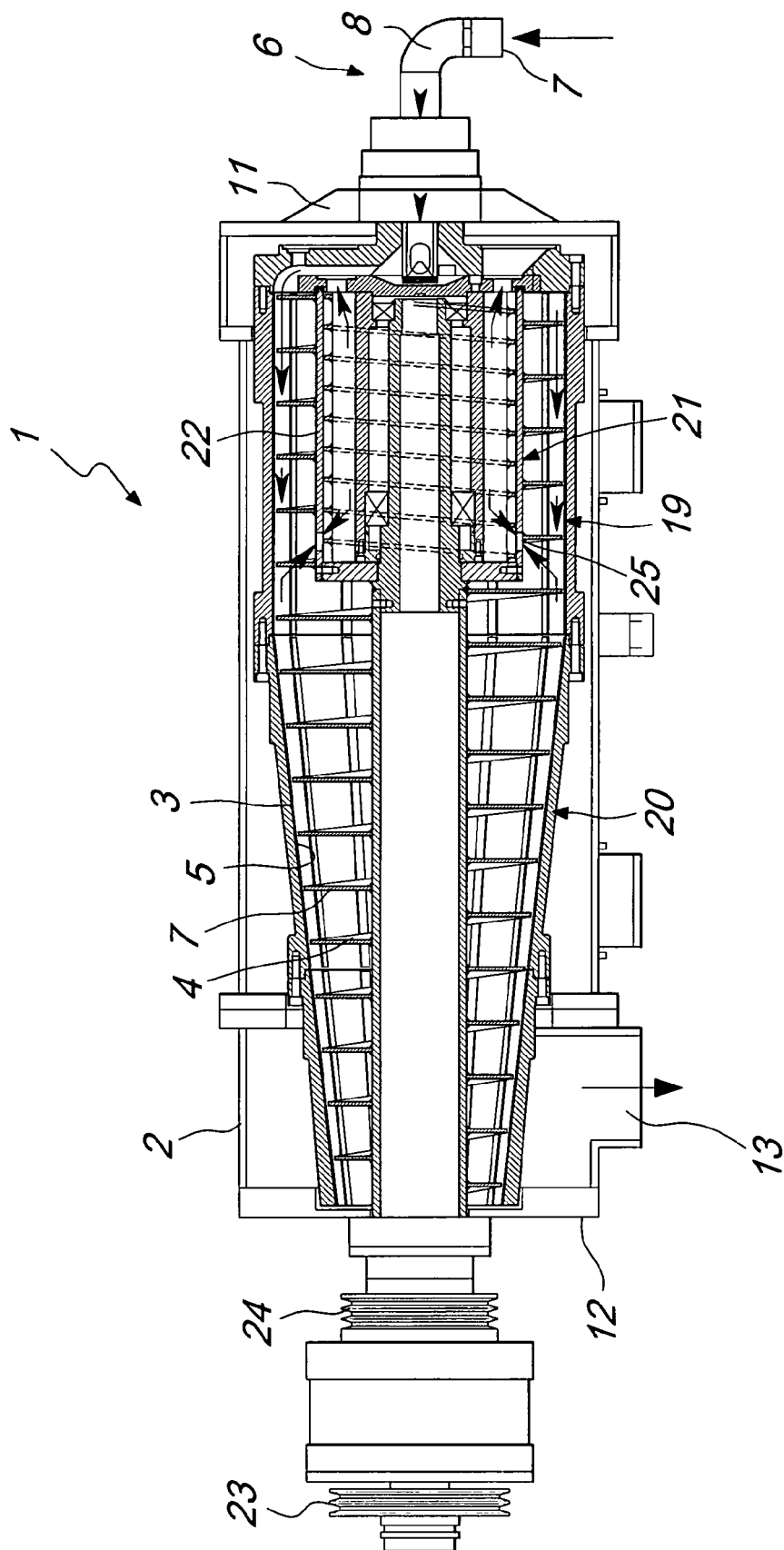


Fig. 1

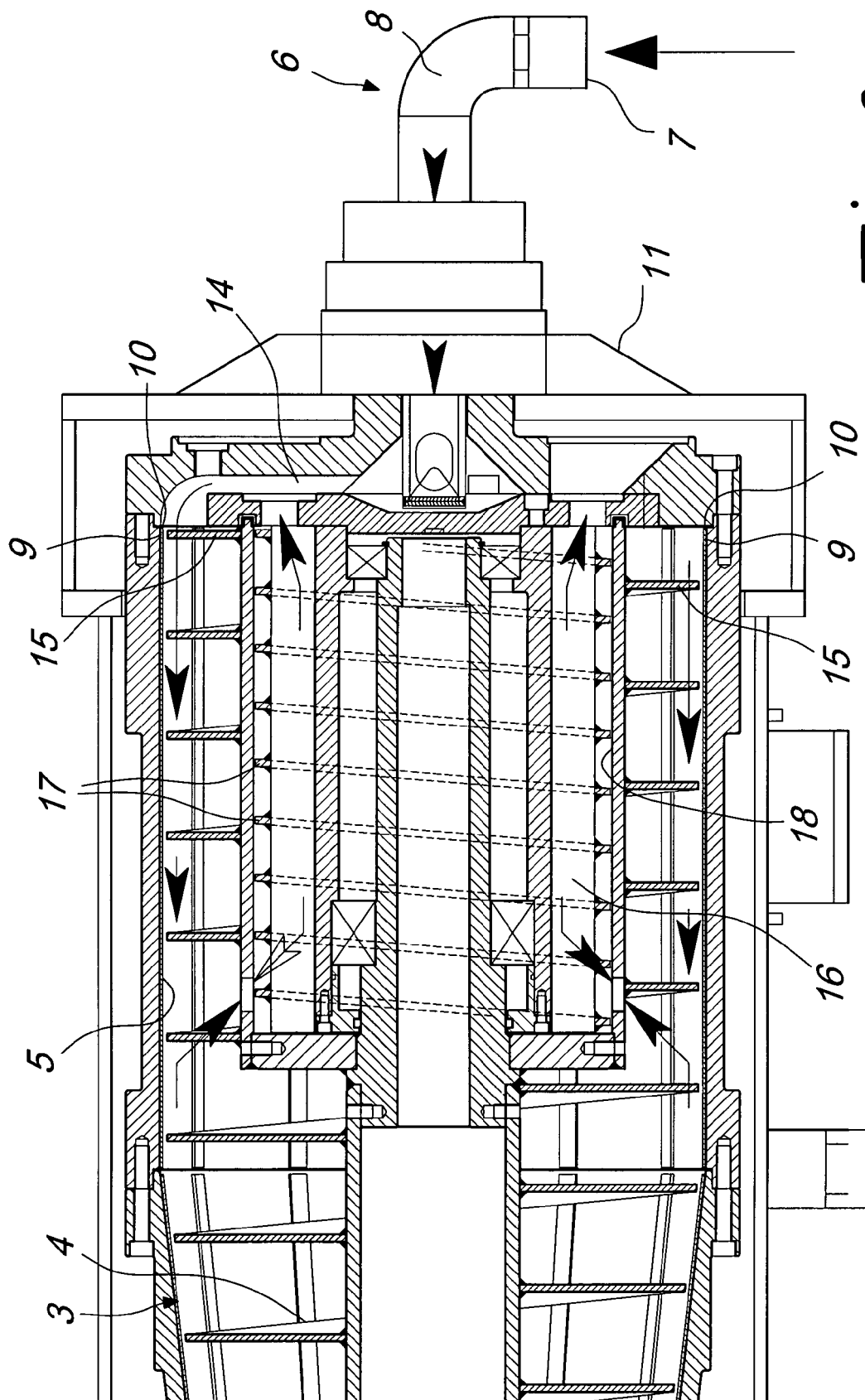


Fig. 2



EUROPEAN SEARCH REPORT

Application Number
EP 08 42 5404

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 October 2008	Examiner Leitner, Josef
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 08 42 5404

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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