

(19) **DANMARK**

(10) **DK/EP 3398687 T3**



Patent- og
Varemærkestyrelsen

(12) Oversættelse af
europæisk patentskrift

-
- (51) Int.Cl.: **B 04 B 1/20 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2020-04-20**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2020-03-18**
- (86) Europæisk ansøgning nr.: **17169366.6**
- (86) Europæisk indleveringsdag: **2017-05-04**
- (87) Den europæiske ansøgnings publiceringsdag: **2018-11-07**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
- (73) Patenthaver: **Andritz S.A.S., 3 Allée de la Garenne , ZI Le Buxerieux, 36000 Châteauroux, Frankrig**
- (72) Opfinder: **Huyghe, Jean-Marc, 47 allée Paul Rue, 36330 Le Poinconnet, Frankrig**
LAMY, Denis, 97 avenue de Blois, 36000 Chateauroux, Frankrig
PASOL, Laurentiu, 9 Rue de Coulmiers, 78800 Houilles, Frankrig
- (74) Fuldmægtig i Danmark: **Patrade A/S, Ceresbyen 75, 8000 Århus C, Danmark**
- (54) Benævnelse: **DEKANTERCENTRIFUGE**
- (56) Fremdragne publikationer:
DE-A1- 3 345 400
DE-A1-102006 053 491
FR-A- 778 407
JP-U- S5 169 965
JP-U- S6 074 750
US-A- 3 520 473

DESCRIPTION

[0001] The present invention relates to a decanter centrifuge comprising a centrifugal bowl rotating around a preferably horizontal axis of rotation including at least one liquid discharge outlet at one end and at least one solids discharge opening at the other end, and a scroll conveyor mounted substantially concentrically inside the bowl for rotation of said centrifugal bowl at a slightly different speed relative to the bowl for transporting the solid phase towards said solids discharge openings.

[0002] Among the factors affecting cake moisture are long residence time and compacting pressure on the cake. One part of the compacting pressure can be generated by the hydraulic pressure of liquid column difference between solid and liquid discharges which is used to compact the cake at the baffle / cone and to support scroll transportation towards the conical section. Besides the rotational speed, differential speed between bowl and scroll and torque control of the scroll conveyor, the relative pond depth (difference between liquid and solids discharge diameters) represents an important parameter to operate a decanter. At the end of the feed tube slurry enters the decanter centrifuge through the feed ports of the feed chamber. Said slurry is separated in at least one clarified liquid moving through liquid outlets and a separated solid (cake) which is transported by the scroll towards and through solids discharge openings.

[0003] Different concepts have been proposed to change the relative pond depth. The most common way to vary the hydraulic pressure generated by the relative pond depth is the weir plate or port member installed at the liquid discharge where it can be adjusted radially in order to change the diameter of the liquid discharge at the same time as keeping the solids discharge diameter fixed. This way to change the relative pond level, however, has some limits for deep pond decanters where there is too little space to adjust the pond depth radially at the liquid discharge side. In addition this adjustment on a small radius has lower effect on the hydraulic pressure than adjustment at the solids discharge openings.

[0004] The present invention relates to radially adjustable bushings at the solids discharge openings by which the internal cake level can be adjusted to achieve optimal cake moisture or it can be used as an additional parameter to control the decanter. The bushings can be adjusted in such a way as to reduce the total power consumption of the decanter, using hydraulic pressure difference as a scroll transport support.

[0005] In the present invention the relative pond depth is generated by varying the solids discharge diameter and by keeping the liquid discharge diameter fixed. This variation is enabled by using exchangeable or adjustable bushings moving the bushing entrance in radial direction together with a special shape of the scroll flight or the bowl at the end of the conical section. The bushings can be screwed or fixed with any system allowing radial movement or by exchangeable bushings with different lengths. Said bushings are oriented relative to the plane perpendicular to the rotational axis with an angle (α) in the range of 1° to 90° , preferably 30° to

60°.

[0006] In EP 0 747 127 A2 is proposed an adjustable gate mounted on the hub of the scroll conveyor with a locking mechanism which can control the cake compaction at the solids discharge openings. This system is used to improve cake moisture or it is an additional method for operating a decanter centrifuge.

[0007] In EP 0 798 045 A1 is presented a system to control the flow of solid discharge by varying the cross-sectional area of the solids discharge openings with a sleeve which can help to improve moisture content in the cake and it can be used as an additional method for operating a decanter centrifuge.

[0008] Another system to control flow of solids discharge openings is shown in US 7 311 654 B2 where the adjusting of cross-section is made by a disk adjustable in the axial direction.

[0009] The patent application WO 2012/003407 A2 presents a cone-less decanter with a baffle where the solid lifts from the bowl wall in a radially inward manner along a plough and is pumped into a heavy phase discharge flow where it is re-suspended and exits the machine with that flow. There is no level difference on the two sides of the baffle. In order to adjust the solid phase flow across the baffle, air injection is used to change the density at one side of the baffle and thus generating a flow through the baffle gap.

[0010] In US 9 393 574 B1 are presented exchangeable wear inserts for the solids discharge openings of a decanter centrifuge with a holder fixed with screws from the outside. The discharge diameter is not varied in this case.

[0011] FR778407A discloses a clarifier and centrifugal separator with liquid evacuation at the bottom through nozzles and with sediment evacuation at the top. The description explains that the clarified liquid is forced to exit at the bottom base through the nozzles, which can be accessed for changing or setting of the nozzles. It is disclosed that the nozzles have their length determined so that their inner end, with respect to the thickness of the liquid layer, is such that a desired quantity of water is removed by them; which at the same time regulates the consistency of sediment. DE3345400A discloses a solid bowl screw centrifuge with sludge discharge nozzles with a control device which allows for periodic opening or closing of the sludge nozzles. According to this disclosure the control device is a rotor being operated as a "Schleusenorgan" at the peripheral area and is volumetrically metering the discharge of the sludge through the available nozzles. The diameter of the nozzle openings is without influence on the discharged sludge volume per time unit. The nozzle may be fastened with screws and for sealing the nozzle body against the bowl a sealing body may be used, which thickness may be reduced in order to move the nozzle body inwardly in order to compensate for wear.

[0012] None of these patents are presenting solutions incorporating exchangeable or adjustable bushings in a radial manner without changing the outlet cross-section in order to change the solid discharge diameter, thereby reducing the solid flow capacity.

[0013] The invention will now be described in further details based on exemplary, but not limiting, embodiments with reference to the drawings. In the drawings,

Fig. 1 shows a schematic cross-sectional view of a decanter centrifuge, according to prior art,

Fig. 2a shows a standard method of changing relative pond level of a decanter centrifuge with sliding weir plates at the liquid phase discharge, according to prior art,

Fig. 2b shows the method of changing relative pond level according to the invention,

Fig. 3 shows a schematic cross-sectional view in a plane parallel to the rotational axis of a decanter centrifuge at the solids discharge openings side with radially adjustable bushings mounted at the maximum discharge diameter according to one embodiment of the invention,

Fig. 4 shows a schematic cross-sectional view in a plane parallel to rotational axis of a decanter at the solids discharge openings with radially adjustable bushings according to the embodiment of Fig. 3 set at the minimum discharge diameter,

Fig. 5a shows a schematic cross-sectional view in a plane perpendicular to the rotational axis at the middle of solids discharge openings with exchangeable bushings according to another embodiment of the invention allowing the change of solids discharge diameter,

Fig. 5b shows a schematic cross-sectional view in a plane perpendicular to the rotational axis at the middle of solids discharge openings with exchangeable bushings according to another embodiment of the invention,

Fig. 5c shows a schematic cross-sectional view in a plane perpendicular to the rotational axis at the middle of solids discharge openings with bushings according to a further embodiment of the invention,

Fig. 5d shows a schematic cross-sectional view in a plane perpendicular to the rotational axis at the middle of solids discharge openings with exchangeable bushings according to another embodiment of the invention,

Fig. 5e shows a schematic cross-sectional view in a plane perpendicular to the rotational axis at the middle of solids discharge openings with exchangeable bushings according to a further embodiment of the invention,

Fig. 5f shows a schematic solids discharge opening arrangement according to a another embodiment of the invention,

Fig. 6a shows a 3D example of a radially adjustable bushing with a locking mechanism system according to one embodiment of this invention,

Fig. 6b shows a cross-sectional view at solids discharge openings of an adjustable bushing screwed into the bowl according to one embodiment of this invention.

[0014] Fig. 1 shows a decanter centrifuge according to the state of the art with a rotating bowl 1 and a scroll conveyor 2 which is pivoted coaxially with the rotating axis of the bowl 1, an axial feed 3, a feed chamber 4, slurry outlet 5, a liquid phase discharge outlet 6 for clear liquid phase and a solids discharge opening 7 for the recovery of the solid phase.

[0015] Fig. 2a shows a schematic sketch of a decanter centrifuge according to the state of the art. Here the pond depth 14 is defined by the overflow weir 13 at the liquid phase discharge outlet 6 and results in the liquid discharge diameter. In standard decanters the relative pond depth 12 is generated by varying the liquid discharge diameter 14 with sliding or exchangeable weir plates 13 or discharge port members while the solids discharge diameter 15 at solids discharge opening 7 is fixed. In this way the relative pond depth 12 can be varied.

[0016] Fig. 2b presents an embodiment of the invention where the solids discharge diameter 15 can be changed in a simple and cheap manner by exchanging or adjusting the bushing 10 at solids discharge opening 7. Here the relative pond depth 12 is adjusted by varying the solids discharge diameter 15 by means of radially adjustable bushings or exchangeable bushings 10 with different lengths while the liquid discharge diameter 14 is fixed.

[0017] In another embodiment of the invention the relative pond depth 12 is established by changing both discharge diameters at the same time: adjustable or exchangeable weir plates 13 or discharge port members for the liquid discharge and radially adjustable or exchangeable bushings 10 for the solids discharge openings. This invention can also be implemented in a 3-phase decanter and serves to improve the decanter performance.

[0018] Fig. 3 and Fig. 4 show a variant of the invention at the end of the solids discharge openings. The solids 17 are transported by the scroll flights to the solids discharge openings 7. The scroll flight 16 is reduced relative to the bowl inner diameter at the position of the solids discharge opening 7 in order to not touch the bushing 10 when it is moved radially inward. This scroll modification will not influence the cake transportation inside the decanter, because at the end of the conical section (close to the flat section) the cake level is low and as conveyed by the scroll, it collapses and it is pushed by the flowing cake to the level of the bushings' edges. When the bushings 10 are set at maximum discharge diameter (close to the bowl inner diameter at the solid discharge openings) as shown schematically in Fig. 3, a cresting is generated at bushings' edges in a similar manner as for liquid discharge. The size of the cresting is depending of cake dryness, product rheology, bowl speed, scroll pitch and speed, outlet surface and shape. In the case of the maximum inward position of bushing 10 presented in Fig. 4 a stagnation cake flow is created mainly in front of the inside part of the bushing 10 generating an additional cone of cake which helps to transport the product at the smaller solids discharge diameter 15.

[0019] More embodiments of this invention are presented in Fig. 5a-5f where the exchangeable bushings 10 with different lengths are inserted in a holder with a different kind of fixation mechanism. The variation of the solid discharge diameter can be done without

changing the bushing 10 by adding different spacers 21 with different thickness between the bowl 1 and the bushing 10 (Fig. 5 c). The bushing holder allows changing the orientation of the solids discharge opening relative to the bowl rotation and to a plane perpendicular to the rotational axis. Discharging the cake in opposite direction of the bowl rotation is state of the art known in the patent EP 0 798 045 A1 where the changing of flow direction is achieved by manufacturing the opening of the bowl wall in the form of inclined channels angled backwards with respect to the direction of bowl rotation. In the present embodiment of the invention the bowl openings are manufactured in standard radial direction and the changing of the cake flow is done in the bushing holder as shown in Fig. 5b. The modification of cake flow direction relative to bowl speed direction improves the total power consumption and reduces the wear on the hopper. Another embodiment to improve the power consumption is presented on Fig. 5c where the holder bushing is provided with a shoulder to discharge the solids on a smaller diameter relative to the bushing thickness. The wear on the hopper can also be reduced by modifying the cake flow direction at the outlet of the decanter relative to a plane perpendicular to the rotational axis as presented in Fig. 5d. The exchangeable bushing 10 may be oriented in the opposite direction of bowl rotation with an angle α in the range of 1° - 85° , more preferably in view of an easier manufacture. It is also possible to have an angle α of 90° with a specific bushing 10 as shown in Fig. 5e. With such orientation against the direction of bowl rotation the maximum power recovery can be achieved. A further embodiment of the invention is shown in Fig. 5f where the discharge is achieved at an angle β in the range of -45° to 45° , more preferably between -15° and 15° . This helps to avoid product impact in the same plane from all bushings 10, thereby reducing the wear on the hopper.

[0020] In the Fig. 6a is presented a 3D example of a radially adjustable bushing 10 according to one embodiment of this invention. It is provided with a locking mechanism 18 to avoid that the bushing loosens during the rotation of the decanter. Fig. 6b shows a cross-sectional view of an adjustable bushing mounted on the bowl 1. The bushing holder 19 is screwed into the bowl thread and it is retaining the wear resistant insert 20. The drawing is showing a round shape of the insert cross-section but it can be manufactured with any other shape and mounted in the holder 19.

[0021] The example in Fig. 6 is showing but not limiting the fixation mechanism of radially adjustable or exchangeable bushings 10 used to adjust the solid discharge overflow diameter 15.

[0022] The invention is not limited to the examples shown in the drawings. It may be used for any kind of decanter where the discharge of liquid and solids and thus the separation shall be adjusted.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not

form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP0747127A2 [0006]
- EP0798045A1 [0007] [0019]
- US7311654B2 [0008]
- WO2012003407A2 [0009]
- US9393574B1 [0010]
- FR778407A [0011]
- DE3345400A [0011]

PATENTKRAV

1. En dekantercentrifuge omfattende:

- 5 - en centrifugalskål (1), der kan drejes rundt om en fortrinsvis vandret rotationsakse (11), der inkluderer mindst et væskefaseudløb (6) i den ene ende og mindst en faststofsudløbsåbning (7) i den anden ende;
- en rullebane (2) monteret i det væsentlige koncentrisk inden i skålen (1) til rotation omkring centrifugalskålens (1) rotationsakse med en lidt anden hastighed i forhold til skålen (1) til transport af den faste fase mod nævnte faststofsudløbsåbning (7);
- 10 - nævnte væskefaseudløbsåbning (6) muliggøres gennem portelementer **kendetegnet ved, at**
- et sæt bøsninger (10) til fast udledning er tilvejebragt for at justere den faste udledningsdiameter (15) inde i skålen (1).

15 2. Dekantercentrifugen ifølge krav 1, hvor nævnte bøsninger (10) er udskiftelige.

3. Dekantercentrifugen ifølge krav 1, hvor nævnte bøsninger (10) er radialt justerbare.

20 4. Dekantercentrifugen ifølge ethvert af kravene 1-3, hvor nævnte bøsninger (10) er skruet, fikseret eller forsynet med et afstandsstykke (21).

25 5. Dekantercentrifugen ifølge ethvert af kravene 1-3, hvor nævnte bøsninger (10) er monteret med et hvilket som helst system, der tillader ændring af fast udledningsdiameter (15) inde i skålen (1).

6. Dekantercentrifuge ifølge ethvert af kravene 1-5, hvor nævnte bøsninger (10) er fremstillet af slidbestandigt materiale.

30 7. Dekantercentrifugen ifølge ethvert af kravene 1-6, hvor nævnte bøsninger (10) er orienteret med modsat retning i forhold til skålens rotation.

8. Dekantercentrifugen ifølge ethvert af kravene 1-7, hvor nævnte bøsninger (10) er udformet med en skulder.

9. Dekantercentrifugen ifølge ethvert af kravene 1-8, hvor nævnte bøsninger (10) er orienteret relativt til et plan vinkelret på rotationsaksen (11) med en vinkel (α) i størrelsesområdet $1^\circ - 90^\circ$, fortrinsvis $30^\circ - 60^\circ$.

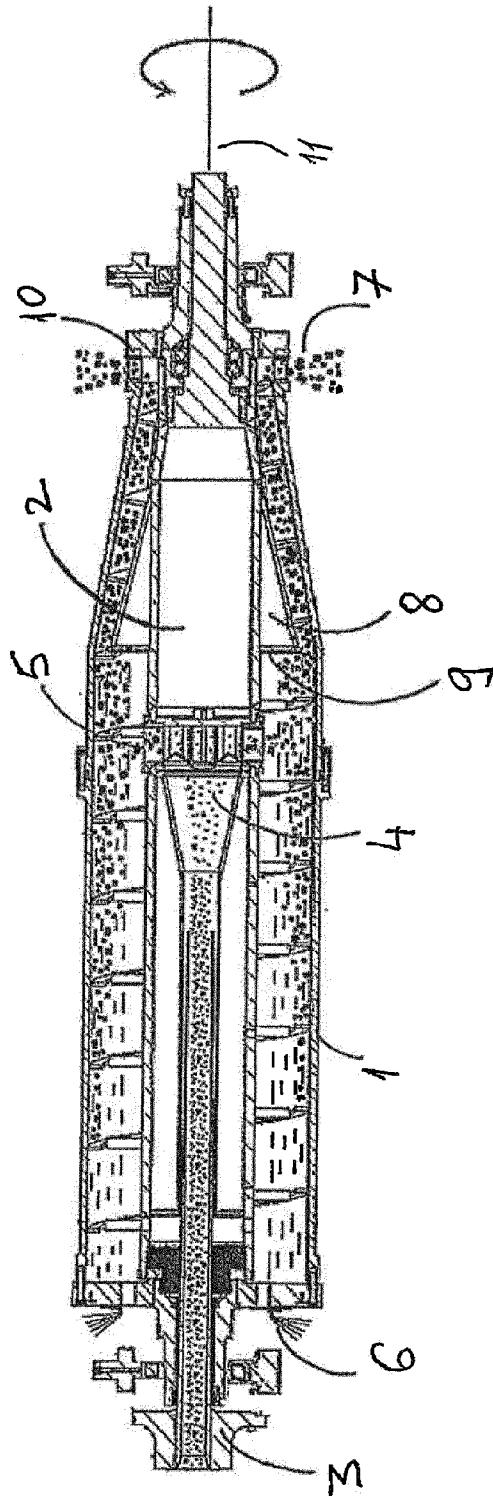
5

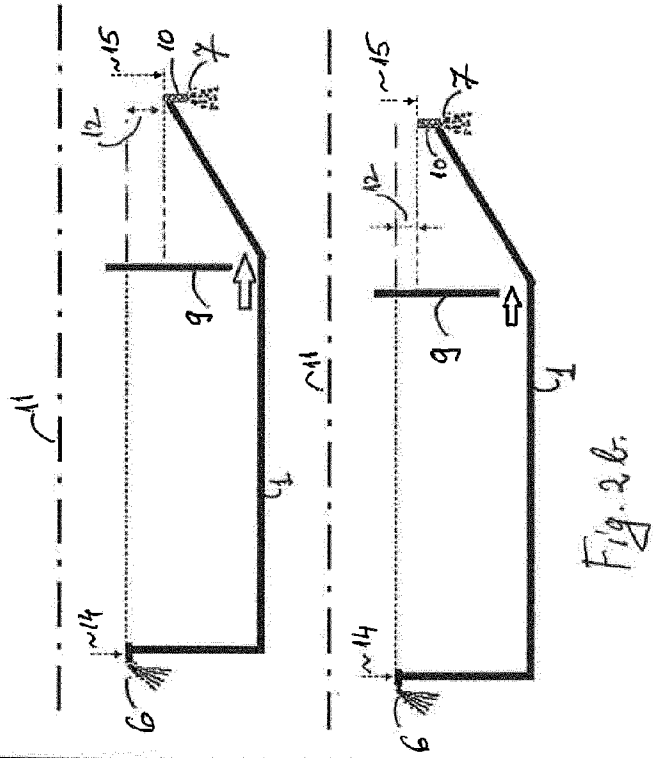
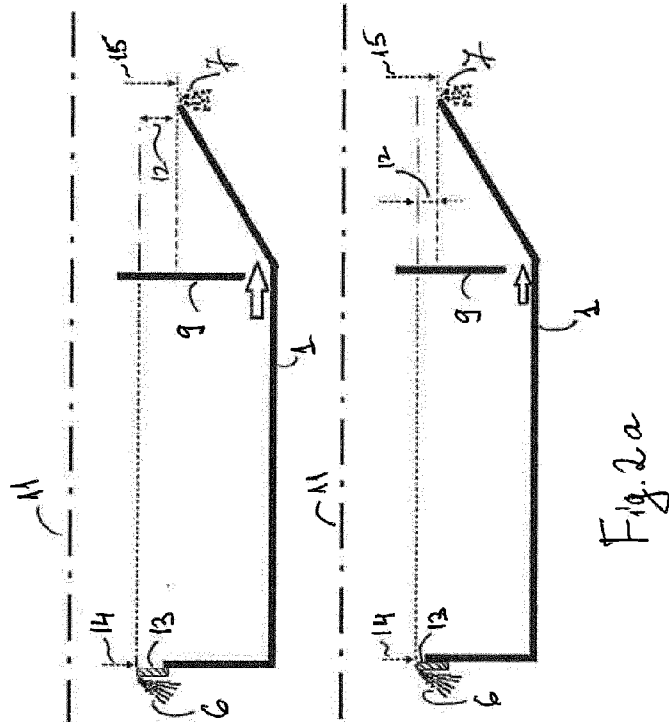
10. Dekantercentrifugen ifølge ethvert af kravene 1-8, hvor nævnte bøsninger (10) er orienteret således at den faste udledning er opnået ved en vinkel (β) i størrelsesområdet $-45^\circ - 45^\circ$, fortrinsvis $-15^\circ - 15^\circ$.

10

11. Dekantercentrifugen ifølge krav 1, hvor nævnte væskeudløbsåbning (6) er forsynet med slidplader (13).

DRAWINGS





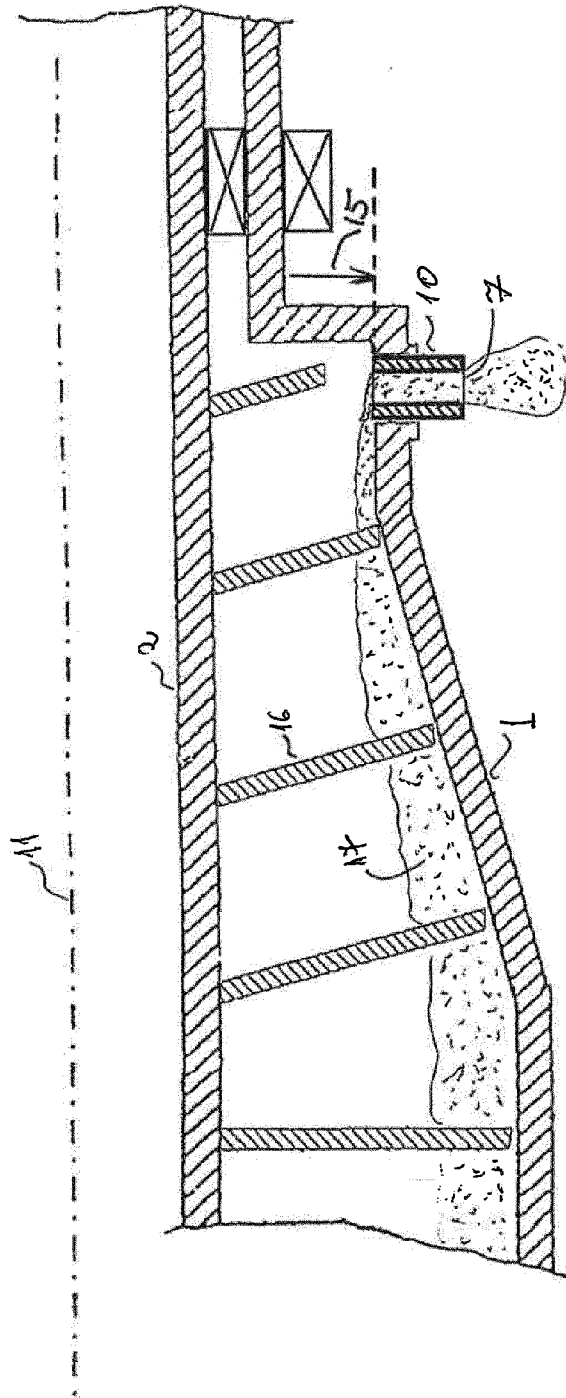


Fig. 3

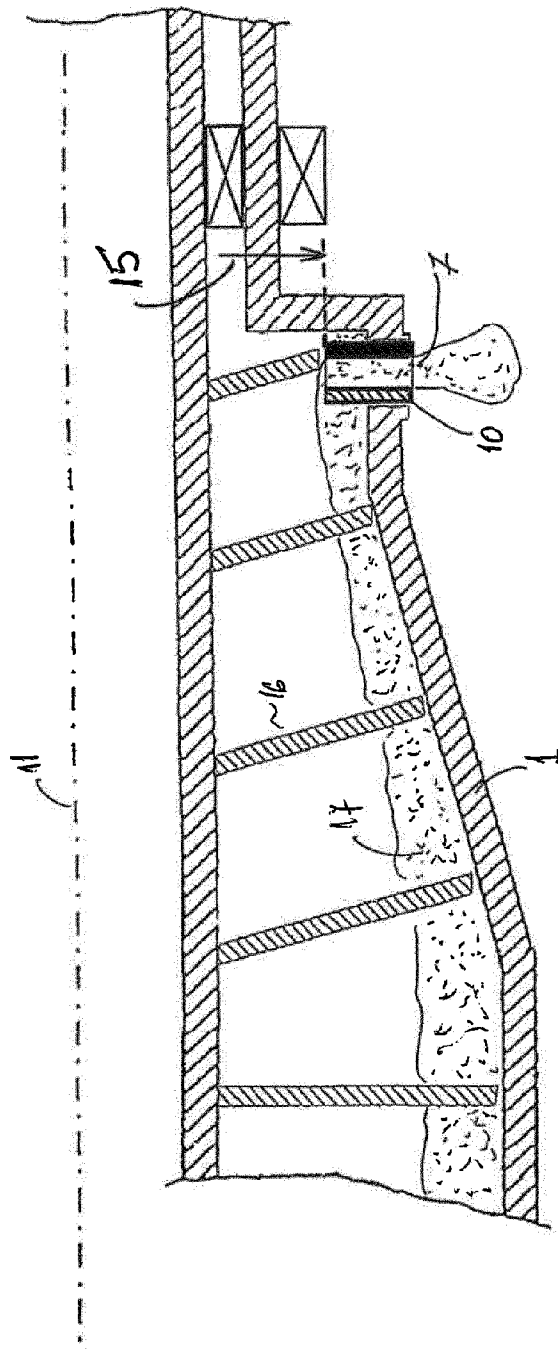
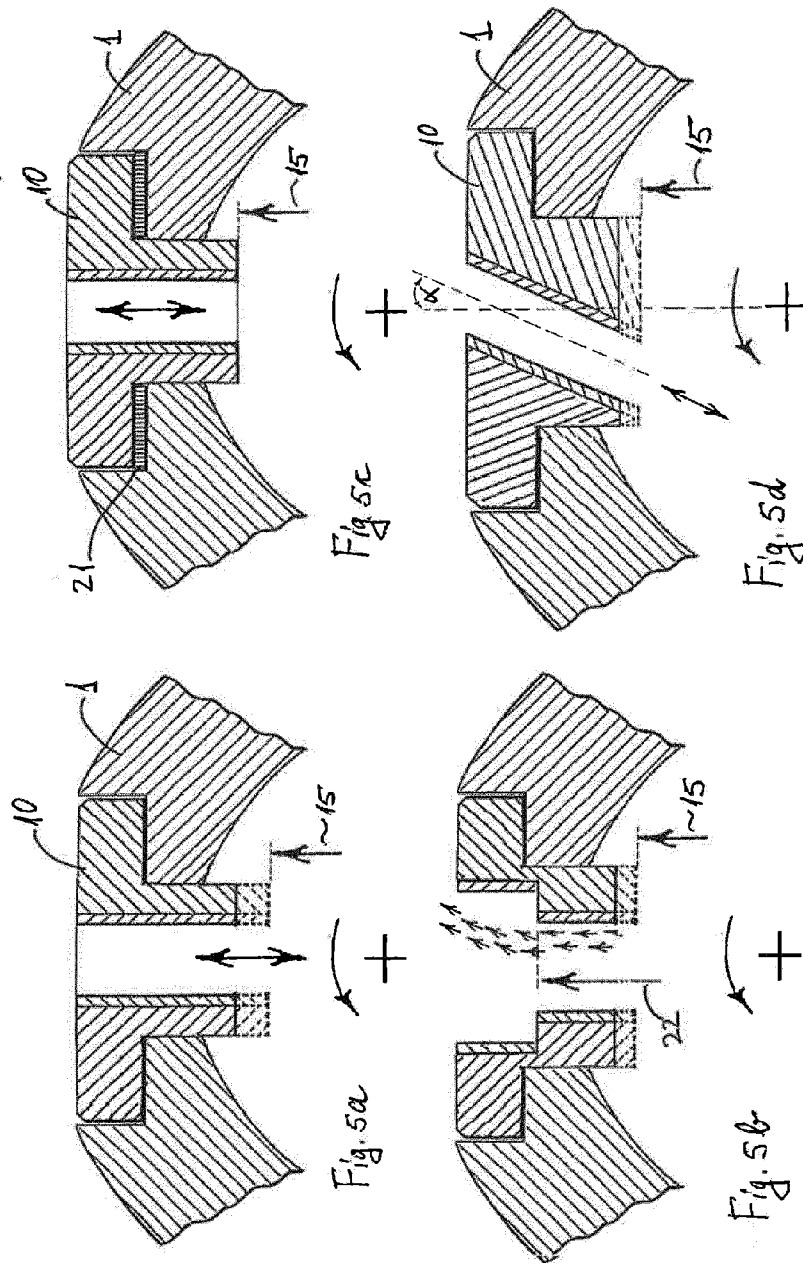


Fig. 4



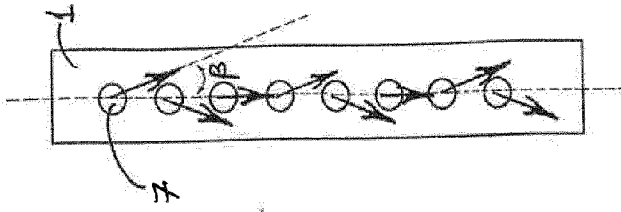


Fig. 5d

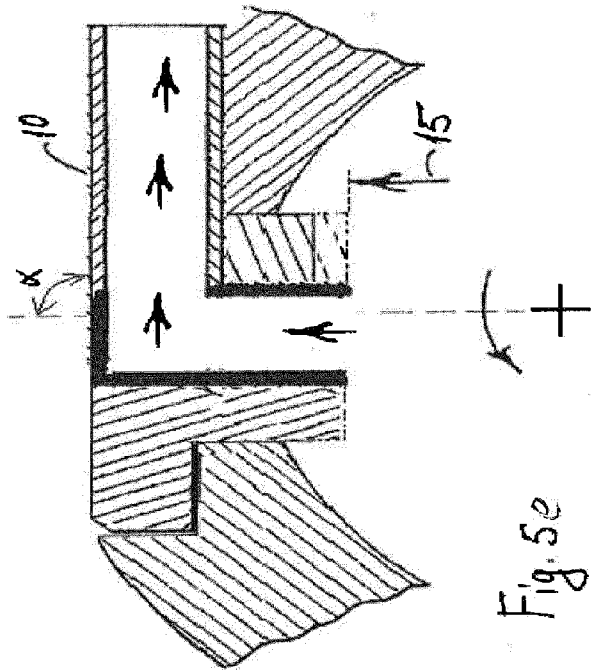


Fig. 5e

