(19) DANMARK

(10) **DK/EP 2659985 T4**

(12) Oversættelse af ændret europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: ***B 04 B 1/20 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2020-02-03**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om opretholdelse af patentet i ændret form: **2019-11-06**

(86) Europæisk ansøgning nr.: **13178930.7**

(86) Europæisk indleveringsdag: **2011-07-29**

(87) Den europæiske ansøgnings publiceringsdag: **2013-11-06**

(62) Stamansøgningsnr: **11006261.9**

(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: **Flottweg SE, Industriestrasse 6-8, 84137 Vilsbiburg, Tyskland**

(72) Opfinder: **Schlarb, Manfred, Flottweg SE, Braunsberger Weg 8, 84137 Vilsbiburg, Tyskland**
**Vielhuber, Benno, Flottweg SE, Am Sonnenhang 51, 84137 Vilsbiburg, Tyskland**
**Zaglauer, Wieland, Flottweg SE, Pinienstraße 19, 84032 Altdorf, Tyskland**

(74) Fuldmægtig i Danmark: **Plougmann Vingtoft A/S, Strandvejen 70, 2900 Hellerup, Danmark**

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

(56) Fremdragne publikationer:

**WO-A1-2008/138345**
**WO-A1-2010/076750**
**JP-A- H11 179 236**
**JP-A- H11 197 547**
**WO-A1-2012/089492**
**JP-A- 11 179 236**
**JP-A- 11 197 547**

# SOLID BOWL WORM CENTRIFUGE WITH A WEIR EDGE

## 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, the outlet channel has a first width, viewed in the longitudinal direction of the centrifuge drum, and a second width, viewed in the radial direction, and the second width is designed smaller than the first width. 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] Efforts are known which use the kinetic energy of the outflowing material wherever possible such that said outflowing material contributes again to driving the rotational movement of the centrifuge drum. Outlet channels in the form of pipes on 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 direction, but in a tangential direction, supplies the centrifuge drum with an impulse in the direction of rotation on account of its centrifugal force energy 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.

Underlying object

[0004] The object underlying 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 effectively based on impulse feedback from the outflowing material.

Solution according to the invention

[0005] 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 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 particular outwards, 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, the outlet channel has a first width, viewed in the longitudinal direction of the centrifuge drum, and a second width, viewed in the radial direction, and the second width is designed smaller than the first width, wherein the outlet channel, proceeding from the outlet opening to the end of the outlet channel at which the outflowing material is released, viewed in the discharge direction, is designed to be continuously tapering in terms of its width.

[0006] 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 added there partially overlapping in a fixed or adjustable manner. The discharge device comprises a weir with a weir edge and an outlet channel arranged outside upstream of the weir for conveying all of the discharged material. The then axially outflowing material flows through the outlet opening and out over the weir edge aligned there in a radial direction, i.e. transversely to the longitudinal axis. The weir edge has an in particular curved design here 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 preferably with a bottom surface over which the material flows. Said bottom surface is spaced at a further distance from the longitudinal axis than the first radius measures, preferably at least in sections.

[0007] In the solid bowl screw centrifuge according to the invention, a weir is thus 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 propensity to clog and is also extremely cost-effective to produce. It can be provided with a weir edge designed to be particularly wear-resistant in the style of conventional weirs. Furthermore, it can be easily maintained and replaced. The device according to the invention can therefore be used 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 lies radially further to the outside than the weir edge, preferably at least in sections.

[0008] This produces a flow that is at least slightly oriented in an external, radial direction downstream of the radially aligned weir edge according to the invention on account of the centrifugal force acting on the material, which leads to eddying at the weir edge and a slightly higher speed of flow there. This type of flow at the weir edge has proven particularly advantageous in terms of controlled discharge of the material and also in terms of potential clogging.

[0009] After the stream of outflowing material has flowed over the weir edge, said stream is diverted by means of the outlet channel according to the invention such that its movement impulse essentially oriented in an external radial direction due to centrifugal force is turned 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 flow 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 required direction in a targeted manner in order to recover a significant amount of energy from the outflowing material.

[0010] The outlet channel according to the invention has a first width, viewed in the longitudinal direction, and a second width, viewed in the radial direction, wherein the second width is designed smaller than the first width. The outlet channel tapers continuously proceeding 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.

[0011] It is particularly advantageous if the bottom surface of the outlet channel of this type is designed at least partially as flat or largely flat. Such a bottom surface can be manufactured at low cost. Moreover, the material flowing out over it experiences a uniform acceleration over a longer distance which can be verified relatively easily using technical models. This acceleration leads to increased conversion of the centrifugal force impulse into a movement impulse in a tangential direction. A particularly large percentage of the centrifugal force energy is converted into tangential drive energy.

[0012] In a first embodiment according to the invention, 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 orientation of the diverted jet of material leads to a specifically targeted deceleration of the exiting stream compared with a purely tangential flow and thus to a certain blockage effect. Such blocking increases the potential energy and thus improves subsequent conversion into tangential kinetic energy.

In a second embodiment according to the invention, 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 does not start at the outlet opening until a predefined distance downstream of the centre of the outlet opening. The acceleration of the exiting material achieved there according to the invention therefore also does not start until further downstream in the outlet channel. The eddying produced as a result of the acceleration therefore also occurs comparatively further downstream in the outlet channel, whereby there is an overall increase in speed in the outlet channel which sucks the material out. This eddying effect reduces the risk of clogging and at the same time increases the kinetic energy in a tangential direction.

[0014] In a third embodiment according to the invention, viewed from the centre of the outlet opening, the flat portion of the bottom surface ends counter to the direction of rotation of the centrifuge drum at an angle of 15° to 30°, preferably 21.5°. Such a 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 flow which is radially unchanged, and thus radially also not accelerated or decelerated. Such a flow has proven particularly advantageous over a certain portion in the circumferential direction. Particularly advantageous is said curved, radially constant bottom surface, viewed counter to the direction of rotation over the first circumferential portion of the respective outlet opening. Said bottom surface leads to a largely turbulence-free flow at the weir edge and thus to less imbalance development at the plurality of weirs distributed over the circumference of the centrifuge drum over which outflowing material flows.

[0016] It is particularly advantageous if the outlet channel, viewed in the discharge direction, is designed as continuously tapering in terms of its width. Acceleration is then largely turbulence-free, with simultaneous specifically directed flow through the outlet openings and the subsequent outlet channels.

[0017] The 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 where the outflowing material is diverted through one or more pipes in a tangential direction. The radially inwardly open channel according to the invention can not only be manufactured at low cost, but overall has less risk of clogging. Furthermore, such a channel can be cleaned more easily during maintenance work as it is more accessible.

[0018] The weir edge and the outlet channel of the solid bowl screw centrifuge according to the invention are preferably designed with one component or as one piece or integrally, wherein the component can be advantageously attached, in particular 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 of the centrifuge 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

[0019] An exemplary embodiment of the solution according to the invention is explained in detail below using the attached schematic drawings.

Fig. 1 shows a view of the front side of a centrifuge drum of a solid bowl screw centrifuge 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

[0020] Fig.1 shows the front side of a centrifuge drum 10, which accommodates a centrifuge screw (not shown) inside in accordance with the 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.

[0021] 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.

[0022] 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 is slightly adjustable in terms of its position. A weir edge 26 is formed on each weir plate 20, which is of curved design and spaced at a radius 28 from the longitudinal axis 12. The outflowing material has to flow over said weir edge 26, whereby the level of material in the centrifuge drum 10 can be specifically adjusted depending on the clarification performance required.

[0023] 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. Said outlet channel 22 has been manufactured such that it is integrated with the weir plate 20 by means of a milling operation.

[0024] 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.

[0025] The outlet channel 22 following the weir edge 26 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 at 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 surface area of a circular cylinder with the radius 28.

[0026] A flat portion 36 of the bottom surface 30 adjoins the curved portion 32, viewed counter to the direction of rotation 14. Said portion 36 extends from the angle 34 up 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 radius 28 measures. The material flowing out over the flat portion 36 experiences a uniform acceleration over a longer distance which can be easily verified using technical models. This acceleration leads to increased conversion of the centrifugal force impulse into a movement impulse in a tangential direction. Since, in particular the entire quantity of material flows through the outlet channel 22, a particularly large percentage of the centrifugal force energy from the outflowing material is converted into tangential drive energy for the rotational movement of the centrifuge drum 10.

[0027] Said acceleration effect in the outlet channel 22 is supported by a continuous tapering of the outlet channel 22 in the direction of flow of the material, i.e. in a tangential direction. Said tapering is formed in that the outlet channel 22, proceeding 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, proceeding from the longitudinal direction, are curved accordingly in the tangential direction.

[0028] At the same time, the outlet channel 22 of this type is designed with a radially inwardly completely open region 50. Said region 50 allows free adjustment of the material level in the outlet channel 22. Since the material can therefore flow away freely through the outlet channel 22, there can be no clogging 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.

[0029] Not least, particularly precise control of the material level inside the centrifuge drum 10 is possible using the weir plates 20 and the weir edges 26 radially aligned there, even if the operating conditions fluctuate significantly.

[0030] 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, when leaving the discharge 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 directed in this manner has proven particularly advantageous in terms of the energy feedback into the centrifuge drum 10 that is produced.

**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 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 den anden bredde (44) er konstrueret mindre end den første bredde (42),
hvor
udløbskanalen (22) har en konstruktion der mindskes kontinuerligt med hensyn til dens bredde (42, 44), begyndende fra udløbsåbningen (16) i strømningsretning op til den ene ende af udløbskanalen (22), ved hvilken det udflydende materiale overvejende bliver udledt i tangential retning,
hvor
udløbskanalen (22) har en bundoverflade (30) som i det mindste delvist er flad i konstruktion, **kendetegnet ved, at**
bundoverfladens (30) flade del (36) er skrånende radialt indad i en vinkel på 8° til 28°, fortrinsvis 18° i forhold til den tangentiale retning.

**2.** 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 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 den anden bredde (44) er konstrueret mindre end den første bredde (42), hvor udløbskanalen (22) har en konstruktion der mindskes kontinuerligt med hensyn til dens bredde (42, 44), begyndende fra udløbsåbningen (16) i strømningsretning op til den ene ende af udløbskanalen (22), ved hvilken det udflydende materiale overvejende bliver udledt i tangential retning, hvor udløbskanalen (22) har en bundoverflade (30) som i det mindste delvist er flad i konstruktion, **kendetegnet ved, at** bundoverfladens (30) flade del (36) begynder efter en vinkel på 3,5° fra udløbsåbningens centrum, set modsat centrifugetromlens (10) rotationsretning (14).

**3.** 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 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 den anden bredde (44) er konstrueret mindre end den første bredde (42), hvor udløbskanalen (22) har en konstruktion der mindskes kontinuerligt med hensyn til dens bredde (42, 44), begyndende fra udløbsåbningen (16) i strømningsretning op til den ene ende af udløbskanalen (22), ved hvilken det udflydende materiale overvejende bliver udledt i tangential retning, hvor udløbskanalen (22) har en bundoverflade (30) som i det mindste delvist er flad i konstruktion, **kendetegnet ved, at** hvor bundoverfladens (30) flade del (36) slutter efter en vinkel på 15° til 30°, fortrinsvis 21,5°, fra udløbsåbningens centrum, set modsat centrifugetromlens (10) rotationsretning (14).

**4.** Fuldkappe-snekkecentrifuge ifølge et af de foregående krav, 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).

**5.** Fuldkappe-snekkecentrifuge ifølge et af de foregående krav, hvor udløbskanalen (22) er konstrueret radialt åben indadtil.

**6.** Fuldkappe-snekkecentrifuge ifølge et af de foregående krav, 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.

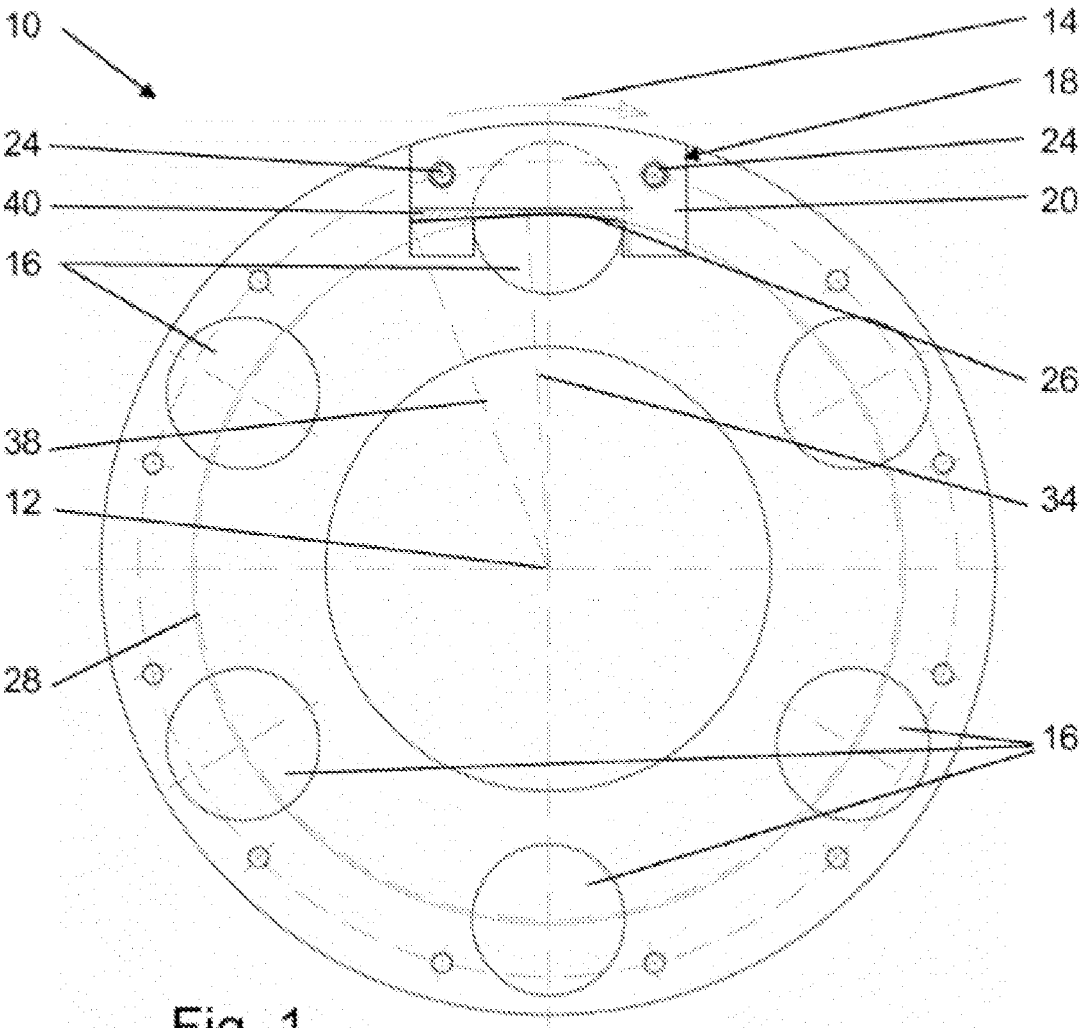


Fig. 1

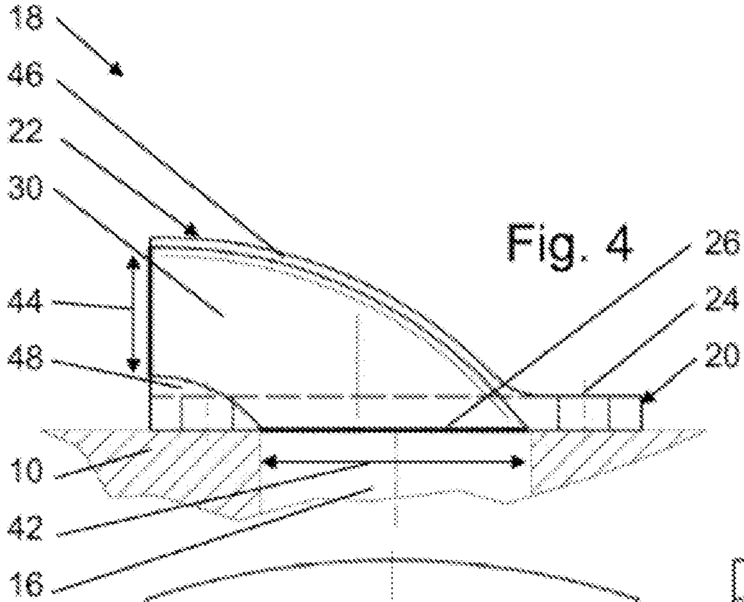


Fig. 4

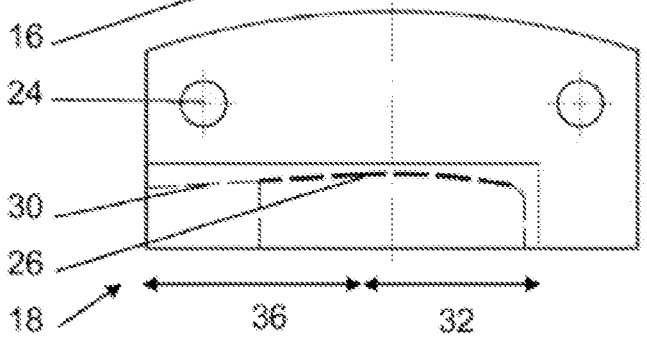


Fig. 2

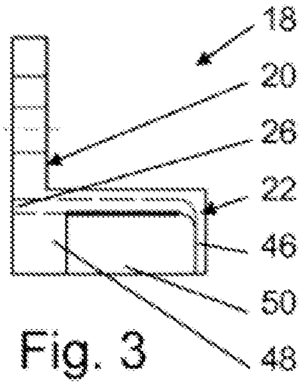


Fig. 3