(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 563 231 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
04.06.2025 Bulletin 2025/23

(21) Application number: **23213451.0**

(22) Date of filing: **30.11.2023**

(51) International Patent Classification (IPC):
B04B 1/20 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B04B 1/20; B04B 2001/2083

(84) Designated Contracting States:
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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(71) Applicant: **Alfa Laval Corporate AB**
221 00 Lund (SE)

(72) Inventor: **MADSEN, Bent**
2820 GENTOFTE (DK)

(74) Representative: **Alfa Laval Attorneys**
Alfa Laval Corporate AB
Group Patent
P.O. Box 73
221 00 Lund (SE)

(54) A DECANTER CENTRIFUGE FOR SEPARATING FEED MATERIAL

(57) The present invention relates to a circular base for a decanter centrifuge. The base accommodated at one longitudinal end of a rotatable bowl of the decanter centrifuge. The base defining an inner surface configured to face an inner space of the bowl, a radial direction extending outwardly from a centre point of the base and a longitudinal direction extending perpendicular to the radial direction. The base defining a first outlet passage extending through the base and a first outlet housing provided at the inner surface and protruding away in the longitudinal direction. The first outlet housing having a first outlet opening for receiving a light phase from the inner space. The first outlet opening comprising a first weir edge defining in normal use a level of a surface of the light phase in the inner space. The first outlet housing is rotatable around a first adjustment axis.

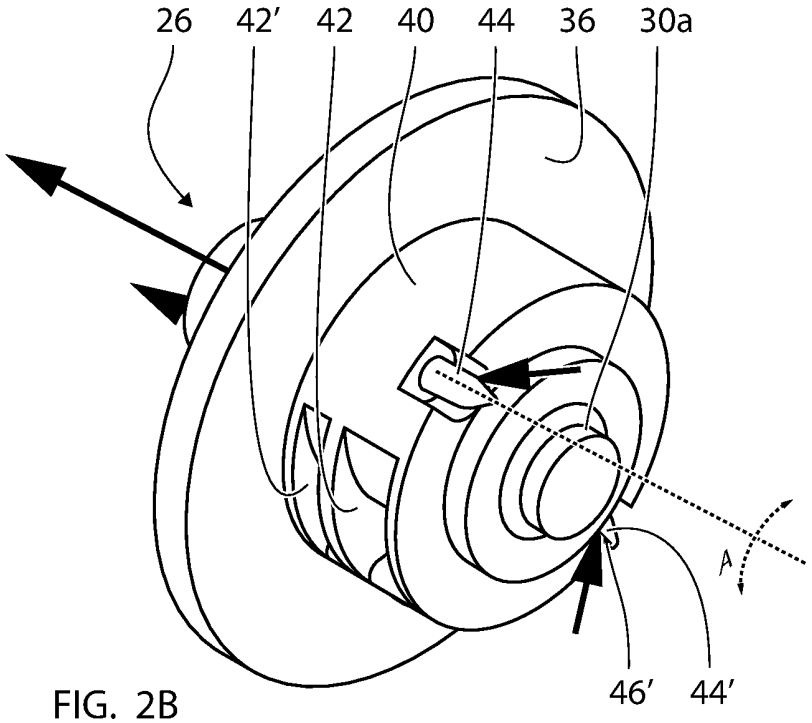


FIG. 2B

EP 4 563 231 A1

Description

[0001] The present invention relates to a circular base for a decanter centrifuge, a decanter centrifuge and a method of operating a decanter centrifuge.

Introduction

[0002] Centrifugal based methods, and in particular decanter centrifuges, can be used for separating the oil and fat from the residual solids and liquids when extracting oil and/or fat from oil containing plant- or animal items. In most conventional applications of oil extraction from oil-containing plant- or animal items, such as fish oil extraction, oil from food waste and vegetable oil extraction and in particular corn oil extraction from corn seeds/whole stillage, the solids of the plant- or animal items are removed in a first separation stage, leaving a residue of liquids. The liquids mainly consist of water and oil/fat. The oil/fat is separated from the water in a second separation stage after the solids have been removed.

[0003] By using the above technique, some oil/fat will inevitably be trapped in the compacted solids cake. This oil/fat is considered to be lost as it is not easily recoverable even by resuspension of the solids.

[0004] It has therefore been suggested to remove the oil already in the first separation stage using a two-phase decanter and leaving a residue of solids and liquids. In this way a higher oil yield and a cleaner oil can be obtained.

[0005] WO 2010/142299 A1 relates to a decanter centrifuge having a conveyor hub with a tubular steel body with an inner core made of a material such as carbon fibre reinforced epoxy.

[0006] WO 2020/109135 A1 relates to a method of producing a low-fat product from a starting material made of a fat and/or oil containing plant- or animal item. The method comprises extracting ta greater part of the extractable oil and/or fat originally contained in the plant- or animal item using a first decanter and leaving a residue of solids and liquids.

[0007] US 7156801 relates to a decanter centrifuge comprising a conveyor screw with one or more flights and having a nominal transport speed varying along the longitudinal axis. The nominal transport speed depends in a non-linear way on the screw pitch.

[0008] DE 102019102623 describes a centrifugal decanter for products that are difficult to de-oil, such as olive pulp, must be mixed particularly intensively so that all or even a residual liquid/residual moisture that is still contained in the solid can be separated more easily. The screw used having two radially offset helices extending over the cylindrical region of the drum and the worm with the same or different winding directions and/or different pitches, so that a radially outer first screw thread and a radially inner second screw thread are formed, so that a part of the suspension to be processed when the drum and screw rotates through the second radially - in relation to the axis of rotation - further inward helix or in conveyed in the radially inner screw flight in a different direction and/or in the same direction and/or at a different speed than at the same time another part of the suspension that is located in the area of the radially further outer helix or the radially outer screw flight.

[0009] US 20150209804 describes an apparatus comprising an outer drum, an inner
drum, an activation spiral and a heavy-material discharging spiral.

[0010] EP 0868217 discloses a decanter centrifuge having several blades arranged to convey axially in the outer drum sludge having settled on the inside of this drum.

[0011] EP 2130607 B1 relates to a decanter centrifuge having the inlet arranged at an end of the casing opposite the end in which the opening for expelling the solid phase is arranged.

[0012] DE 2651657 relates to a centrifugal decanter having a clear fluid discharge between the inlet and the solids outlet.

[0013] US 3268159 relates to a centrifugal decanter in which the feed zone is closer to large end hub than both conveyor bearings.

[0014] JP 62106856 relates to a centrifugal decanter in which the solids and liquids discharge are on the same side.

[0015] US 3494472 relates to a centrifugal separator in the form of a sieve drum.

[0016] US 7022061 describes a centrifugal separator with power recovery discharge pipes for the light phase.

[0017] US 9089852 describes a centrifugal decanter mentioning that the solid discharge port may be oriented at an angle to the radial to achieve an energy-saving repulse effect.

[0018] WO 2012/062337 A2 relates to a centrifugal separator comprising an outlet housing being rotatable around an adjustment axis.

[0019] DE 10 2020 129 478 A1 relates to a conveyor screw body having web elements.

[0020] EP 0506835 B1 relates to a decanter centrifuge having at least one bearing of the conveyor supported at the free end of a trunnion.

[0021] EP 0602766 B1 relates to a decanter centrifuge having a central hub having radially projecting support ribs.

[0022] EP 2440335 A1 relates to a decanter centrifuge having conveyor screw comprising a hub with a cylindrical part and a generally conical part, the two parts being interconnected by broad mutually spaced ribs extending in the longitudinal direction.

[0023] EP 2926911 B1 relates to a decanter centrifuge having a centrifuge worm which is mounted at one of its axial end areas by means of a connecting flange.

[0024] EP 3177403 B1 relates to a decanter centrifuge having individual openings in the cylindrical section of the screw hub.

[0025] WO 2021122878A1 relates to a decanter cen-

trifuge having, at least in the inlet area, a screw hub with an open wall structure.

[0026] WO 2021122884A1 relates to a decanter centrifuge having a transverse disk for stabilizing the worm hub construction.

[0027] WO 2022096734A1 relates to a centrifuge screw having rods between at least two winding sections. The rods are formed completely or almost completely spaced.

[0028] WO 2022096739A1 relates to a screw hub for a centrifuge screw having in the longitudinal direction having at least sections of an open wall structure.

[0029] WO 2022096745A1 relates to a centrifuge screw having an open wall structure. The open wall structure extending at most over a length of 50% of the total length of the cylindrical longitudinal section.

[0030] US 8841469 relates to a method of recovering oil from corn by adding a chemical additive.

[0031] When separating the oil and fat already in the first separation stage, it is necessary to allow the solids sufficient time to release the oil/fat. It is therefore an object of the present invention to provide technologies for increasing the release of oil from the feed and in particular the oil trapped in the solids of the feed.

Summary of the invention

[0032] The object of the present invention is in a first aspect achieved by a circular base for a decanter centrifuge, the base being configured to be accommodated at one longitudinal end of a rotatable bowl of the decanter centrifuge, the base defining an inner surface configured to face an inner space of the bowl, a radial direction extending outwardly from a centre point of the base and a longitudinal direction extending perpendicular to the radial direction, the base defining a first outlet passage extending through the base and a first outlet housing provided at the inner surface of the base and protruding away from the inner surface in the longitudinal direction, the first outlet housing having a first outlet opening for receiving a light phase from the inner space, the first outlet housing communicating with the first outlet passage for passing the light phase from the first outlet housing to the first outlet passage, the first outlet opening comprising a first weir edge defining in normal use a level of a surface of the light phase in the inner space, wherein the first outlet housing is rotatable around a first adjustment axis.

[0033] The circular base is used for closing off the decanter centrifuge at the large end hub and provide a bearing surface for the conveyor screw of the decanter centrifuge. The bowl has one or more light phase outlet provided in the circular base at the longitudinal end of the bowl. The heavy phase outlet is located at the opposite longitudinal end of the bowl. The feed in the present case is oil containing plant- or animal items, such as fish oil extraction, oil from food waste and vegetable oil extraction and in particular corn oil extraction from corn seeds/whole stillage. The light phase in the present case is a substantially clean fat/oil in liquid phase separated from the feed, whereas the heavy phase is a residue of the feed being a mixture of other liquids and solids, mainly water and solids.

[0034] By allowing the outlet housing to protrude into the inner space of the bowl, the oil can be discharged at a distance from the base of the bowl. In that way the feed inlet can be located adjacent the base without interfering with the discharge.

[0035] By allowing the outlet housing to be rotatable around the first adjustment axis, the position of the weir edge, and thereby the level of the light phase, can be adjusted by rotating the outlet housing about the adjustment axis. Hereby is obtained that the level of the light phase in the bowl may be adjusted by simply rotating the outlet housing around the adjustment axis, as such rotation will entail an adjustment of the radial distance of the weir edge from the axis of rotation. The weir edge is defined as the point where no information can be transmitted through the discharged medium back into the separation volume inside the decanter. "Information" is anything that can affect the light phase level.

[0036] It should be understood that the centre point means the point on the base corresponding to the axis of rotation of the bowl when is use, the longitudinal direction being parallel to the axis of rotation and the radial direction being perpendicular to the longitudinal direction. The expression "level" refers to a distance in the radial direction from the centre point. In use the bowl rotates causing the feed inside the bowl to separate in a heavy phase and light liquid phase having a surface at a level, which is slightly above the level of the weir edge thereby providing a pressure head driving the light phase out of the bowl through the weir.

[0037] The outlet housing is set in a position relative to the adjustment axis so that the weir edge is positioned further from the axis of rotation than an opposite edge of the outlet opening, and the weir edge can be either the trailing or the leading edge of the outlet opening relative to the rotational movement of the bowl.

[0038] According to a further embodiment of the first aspect, the outlet housing comprises a first side wall offset from the first adjustment axis, the first outlet opening being present in the first side wall. Hereby is obtained that the level of the light phase in the bowl may be adjusted by simply rotating the outlet housing around the adjustment axis, as such rotation will entail an adjustment of the radial distance of the weir edge from the axis of rotation.

[0039] According to a further embodiment of the first aspect, the first outlet housing being at least partially cylindrical having a cylinder axis coaxial with the first adjustment axis. This provides for a simple construction and accordingly cost-efficient production.

[0040] According to a further embodiment of the first aspect, the first weir edge is extending in parallel with the first adjustment axis. In this way the weir edge will be

parallel to the light phase surface during use for a well-defined level of the light phase in the bowl.

[0041] According to a further embodiment of the first aspect, the first outlet housing is cylindroconical having the outlet opening in a conical part. By having the outflow in a conical part, the outflow may be smoother and recirculation inside the outlet housing may be avoided.

[0042] According to a further embodiment of the first aspect, the first outlet opening is extending over an angle of 30° to 75°, preferably 45° to 60°, around the first adjustment axis. In this way the outlet opening and especially its angular range of extension around the adjustment axis can be sufficiently large that the outlet opening does not run full during normal operation, but an air-vent can be left between the surface of the out-flowing light phase and the edge opposite the weir edge.

[0043] According to a further embodiment of the first aspect, the first outlet housing has an axial length in the direction of the first adjustment axis, and that the first outlet opening is extending an axial length in the direction of the first adjustment axis shorter than the axial length of the first outlet housing.

[0044] According to a further embodiment of the first aspect, the first adjustment axis is parallel to the longitudinal direction. In this way the position of the weir edge, and thereby the level of the light phase, can be adjusted by rotating the outlet housing about the adjustment axis.

[0045] According to a further embodiment of the first aspect, the base further comprising a bearing surface for a conveyor screw, the bearing surface being located at the inner surface of the base. The base preferably has the additional purpose of accommodating the bearing surface for the conveyor screw.

[0046] According to a further embodiment of the first aspect, the base further comprising a feed inlet for introducing a flowable material into the bowl of the decanter centrifuge, the feed inlet being located at the inwardly oriented surface of the base. The base preferably has the additional purpose of accommodating the feed inlet. The heavy phase of the feed will thereby have a longer travel time through the bowl to reach the heavy phase outlet opposite the base. In this way the solids will have more time to release oil.

[0047] According to a further embodiment of the first aspect, the feed inlet, the bearing surface and the outlet housing are located on a cylindrical part at the inner surface of the base, the cylindrical part protruding in the longitudinal direction. There is a tendency for the conveyor screw to deflect and bend during use, in particular when running at high rotational velocities which are near the eigenfrequency of the conveyor. This problem increases for longer conveyor screw, where the distance between the conveyor bearings is long. By having the bearing surface protruding into the bowl, the distance between the conveyor bearings can be reduced and the eigenfrequency will be higher.

[0048] According to a further embodiment of the first aspect, the first weir edge extends further away from the inner surface than the feed inlet. In this way the feed can be introduced as close as possible to the base without interfering with the light phase outlet.

[0049] According to a further embodiment of the first aspect, the base defining a second outlet passage extending through the base, and a second outlet housing provided at the inner surface, the second outlet housing communicating with the second outlet passage to pass a part of the light phase from the second outlet housing to the second outlet passage, the second outlet housing having a second outlet opening for receiving a part of the light phase from the inner space together with the first outlet opening, the second outlet opening comprising a second weir edge defining in normal use the level of the surface of the light phase in the bowl together with the first weir edge, wherein the second outlet housing is rotatable around a second adjustment axis. To better distribute the outflow from the bowl more than one outlet housing preferably can be used, such as two outlet housings. Even three or more outlet housing can be used to distribute the outflow even better. The weir edges should preferably be set at the same level, i.e. angular position and have the same angular distance in between themselves for them to distribute the outflow optimally between themselves. The outlet housings are preferably identical having the same features as described above.

[0050] The object of the present invention is in a second aspect achieved by decanter centrifuge comprising bowl rotating in use in a direction of rotation around an axis of rotation, the bowl comprising a base according to any of the preceding embodiments of the first aspect at one end of the bowl in the axis of rotation and a heavy phase outlet at an opposite end of the bowl in the axis of rotation, the longitudinal direction of the base coinciding with the axis of rotation. The decanter centrifuge according to the second aspect can preferably be used together with the base according to the first aspect. The heavy phase outlet is located at an opposite end of the bowl relative to the light phase outlet and the feed inlet.

[0051] The object of the present invention is in a third aspect achieved by method of operating a decanter centrifuge according to the second aspect, wherein the method comprising:

rotating the outlet housing around the first adjustment axis,

continuously introducing a flowable material into the bowl while rotating the bowl about the axis of rotation, the flowable material including light phase and a heavy phase, and

allowing the light phase in the bowl to flow out of the bowl via the outlet opening.

[0052] The method according to the third aspect can preferably be used together with the decanter centrifuge according to the second aspect.

Brief description of the drawings

[0053]

FIG. 1A is a side view of a decanter centrifuge according to the present invention.
FIG. 1B is a side view of a decanter centrifuge according to the present invention.
FIG. 2A is a perspective view of a circular base according to the present invention.
FIG. 2B is a perspective view of the base showing the discharge of the light phase.
FIG. 2C is a perspective view of the base from the rear side showing the discharge.
FIG. 3A is a perspective view of the base showing the inflow of the flowable material.
FIG. 3B is a perspective cutaway view of the base showing the trunnion interior.
FIG. 3C is a perspective view of the base from the rear side showing the inflow.
FIG. 4A is a perspective view of the conveyor screw.
FIG. 4B is a perspective view of the conveyor screw.

Detailed description of the drawings

[0054] Fig. 1A is a side view of a decanter centrifuge 10 according to the present invention. The decanter centrifuge 10 comprises a rotatable bowl 12 and a conveyor screw 14. The bowl 12 has a cylindrical part 12a and a conical part 12b. The conveyor screw 14 has a corresponding cylindrical part 14a and conical part 14b. The bowl 12 is rotated by a drive motor 16a and the conveyor screw 14 is rotated by a back drive motor 16b. The back drive motor 16b is typically connected via a gearbox (not shown). An inlet 18 is provided for introducing the feed into the decanter centrifuge 10. The bowl 12 comprises a heavy phase outlet 20 at a small end hub 22 at the conical part 12b of the of the bowl 12 and a light phase outlet 24 at a base 26 forming a large end hub at the cylindrical part 12a of the bowl 12.

[0055] The conveyor screw 14 comprises a central body 28 extending in a longitudinal direction between a first bearing surface 30a at the cylindrical part 14a and a second bearing surface 30b at the conical part 14b. The conveyor screw 14 comprises a first flight 32 being attached to the central body 28. The first flight 32 extends over both the cylindrical part 14a and the conical part 14b of the conveyor screw 14. The first flight 32 extending to an inner wall 12c of the bowl 12 and defines a pitch angle being less than 20°. The present embodiment further comprises a second flight 34 not extending to the inner wall 12c of the bowl 12 and defining a pitch angle being greater than 30°. The pitch angle is here calculated by the expression: Pitch angle = ATAN(Pitch/(π*(Bowl diameter))). The second flight 34 does not extend to the inner wall 12c and extends over only the cylindrical part 14a of the conveyor screw 14. The base 26 comprising a trunnion 40 which encompasses feed inlets 42 42' for the feed and the bearing surface 30a for the conveyor screw 14. The feed inlets 42 42' communicating with the inlet 18. The trunnion 40 also comprises at outlet housings 44 extending into the bowl 12 for transporting the light phase from the bowl 12 to the light phase outlet 24.

[0056] Fig. 1B is a side view of a decanter centrifuge 10 according to the present invention showing the inlet and outlet flows. The feed is introduced via the inlet 18 as shown by the arrow. The feed can be a crushed oil-containing plant- or animal item such as crushed corn seeds. The feed enters the bowl 12 via feed inlets 42 42'. The feed is separated into a slurry fraction and an oil fraction by centrifugal forces from the rotation of the bowl 12. The slurry fraction is a mixture of solids and water. The slurry fraction form a heavy phase and are conveyed by the conveyor screw 14 as a slurry which is discharged at the heavy phase outlet 20 as shown by the arrow. The oil fraction forms a light phase which is discharged via the outlet housings 44 and light phase outlet 24 as shown by the arrow. The slurry fraction being heavier than the oil fraction and will thus flow outwards and accumulate at the inner wall 12c of the bowl 12, the oil fraction being lighter than the slurry fraction and will thus flow inwards and accumulates near the central body. The first flight 32 collects the slurry fraction and conveys it towards the heavy phase outlet 20 of the bowl 12, whereas the second flight 34 being able to scrape and spread out the slurry fraction.

[0057] FIG. 2A is a perspective view of a circular base 26 according to the present invention. The base 26 comprises an inner surface 36 facing the interior of the bowl (not shown here) and an outer surface (not visible here) being opposite the inner surface 36 and facing the outside of the bowl. The base 26 comprising the trunnion 40 which constitutes a cylindrical element positioned about a centre point C of the base 26 protruding in a longitudinal direction L from the inner surface 36 of the base 26 into the bowl.

[0058] The trunnion 40 comprising a bearing surface 30a for the conveyor screw and feed inlets 42 42' for introducing feed (not shown) into the bowl. The bearing surface 30a being located further away in the longitudinal direction L from the inner surface 36 than the feed inlets 42 42' and encircles the centre point C. The bearing surface 30a being spaced apart from the centre point C in a radial direction r. The radial direction r being perpendicular to the longitudinal direction L. The feed inlets 42 42' is located more spaced apart in radial direction r from the centre point C than the bearing surface 40. In the present embodiment, two feed inlets 42 and 42' are provided, whereby the feed inlet 42 is the main feed inlet and the feed inlet 42' is an overflow inlet used during temporary high inflows.

[0059] The trunnion 40 further comprising the outlet housing 44. The outlet housing 44 being at least partially cylindrical and extending from the base 26 through the trunnion 40 in the longitudinal direction L into the bowl. The outlet housing 44 is located spaced apart in radial

direction r from the centre point C, typically further spaced apart from the centre point C than the bearing surface 30a. In the present embodiment, the screw flight 34 ends at the outlet housing 44. Further, in the present embodiment two outlet housings 44 and 44' are provided spaced apart by 180 degrees about the centre point C.

[0060] The light phase being oil/fat. During use, the light phase flows inwardly due to centrifugal forces and enters one of the outlet housings 44 44' as shown by the arrows. The light phase enters the outlet housing 44 44' via a light phase opening 46. (Only the light phase opening 46' of the outlet housing 44' is visible in the present view, however, the outlet housing 44 has an identically configured light phase opening). The light phase opening 46 defines a weir edge extending in parallel with the first adjustment axis of the outlet housing 44 44' and defining in normal use a level of the light phase within the bowl. In the present embodiment, the outlet housing 44 44' has a cylindroconical shape having the light phase opening 46' in a conically shaped part of the outlet housing 44 for a smoother flow.

[0061] FIG. 2B is a perspective view of the base showing the discharge of the light phase. The light phase enters the outlet housings 44 44' at a radial distance from the centre point C. The radial distance of the opening 46 (and thereby the weir) from the centre point C can be adjusted by rotating the outlet housing 44 44' about an adjustment axis A. In this way the level of the light phase within the bowl can be adjusted. In use the bowl (not shown) rotates causing the feed (not shown) inside the bowl to separate in a heavy phase (not shown) and light liquid phase having a surface at a level, which is slightly above the level of the weir edge thereby providing a pressure head driving the light phase out of the bowl through the opening 46 and the outlet housing 44.

[0062] FIG. 2C is a perspective view of the base from the rear side showing the outer surface 36' and the discharge of the light phase as shown by the arrows. The outlet housing 44 extends to the outer surface 36' of the base 26 and defines an outlet 48 at the outer surface 36' of the base 26 for ejecting the light phase. The outlet housing 44 can be adjusted about the adjustment axis A from the outside.

[0063] FIG. 3A is a perspective view of the base showing the inflow of the flowable material. The flowable material is introduced centrally in the longitudinal direction and flows out in the radial direction into the bowl (not shown) via the feed inlets 42 42'.

[0064] FIG. 3B is a perspective cutaway view of the base 26 showing the interior of the trunnion 40. As can be seen the flowable material is deflected by deflectors 50 from flowing in the longitudinal direction to a direction substantially corresponding to the tangential direction of the rotation of the bowl (not shown). In this way, less time within the bowl is needed to accelerate the flowable material to the bowl rotation speed, and the separation can therefore be more efficient.

[0065] FIG. 3C is a perspective view of the base from the rear side showing the inlet 18. The inlet is centrally in the longitudinal direction.

[0066] Fig. 4A is a perspective view of the conveyor screw 14 according to the present invention. The conveyor screw 14 comprises the first flight 32 and the second flight 34 being attached to the central body 28. The first flight 32 extends over both the cylindrical part 14a and the conical part 14b of the conveyor screw 14 and defines a pitch angle being less than 20° for being able to collect the slurry fraction and convey it towards the heavy phase outlet of the bowl. The second flight 34 extends in the longitudinal direction along the cylindrical portion of the conveyor screw 14 only. The first flight 32 and the second flight 34 being at least partially intertwined.

[0067] Both the first flight 32 and the second flight 34 has the same winding direction, however, the second flight 34 defining a pitch angle being more than 30° for scraping and spreading out the slurry at the inner surface of the bowl. The second flight 34 extends to a smaller outer perimeter than the first flight 32 for the slurry to be spread out on the inner surface of the bowl. This will allow more oil to be released from the slurry.

[0068] The conveyor screw 14 is further provided with a baffle plate 60 between the cylindrical part 14a and the conical part 14b for preventing oil from flowing towards the heavy phase outlet of the bowl. The conveyor screw 14 is further provided with a third flight 52 extending to a smaller outer perimeter than the second flight 34. The purpose of the third flight 52 is to define an oil channel 54 between the second flight 34 and the third flight 52 to allow the oil to flow towards the light phase outlet of the bowl.

[0069] The first flight 32 comprises gaps 56 for allowing the second flight 34 and the third flight 52 to pass through. The first flight 32 is slightly offset at the gaps 56 to scrape any slurry which would otherwise be missed due to the gaps 56. The conveyor screw 14 further comprises a cage structure 58 extending from the first bearing surface 30a away from the second bearing surface 30b for carrying the first screw 32 beyond the first bearing surface 32a.

[0070] The present conveyor screw 14 also includes an additional fourth flight 34' and fifth flight 52' which essentially correspond to the second flight 34 and third flight 52, respectively, albeit being 180° phase shifted. In this way there will be an additional oil channel 54' and two spread-out effects on the slurry for each turn of the conveyor screw 14.

[0071] The present view also shows the base 26 being attached to the first bearing surface 30a during use. The base 28 comprises the feed inlet 42 42' and the outlet housing 44.

[0072] Fig. 4B is a perspective view of the conveyor screw 14 according to the present invention when the base 26 is connected to the first bearing surface 30a. The central body 28 being free from any fluid openings between the first bearing surface 30a and the second bearing surface 30b for increasing the structural stability

and stiffness of the conveyor screw 14.

Claims

1. A circular base for a decanter centrifuge, the base being configured to be accommodated at one longitudinal end of a rotatable bowl of the decanter centrifuge, the base defining an inner surface configured to face an inner space of the bowl, a radial direction extending outwardly from a centre point of the base and a longitudinal direction extending perpendicular to the radial direction, the base defining a first outlet passage extending through the base and a first outlet housing provided at the inner surface of the base and protruding away from the inner surface in the longitudinal direction, the first outlet housing having a first outlet opening for receiving a light phase from the inner space, the first outlet housing communicating with the first outlet passage for passing the light phase from the first outlet housing to the first outlet passage, the first outlet opening comprising a first weir edge defining in normal use a level of a surface of the light phase in the inner space, wherein the first outlet housing is rotatable around a first adjustment axis.

2. The circular base according to claim 1, wherein the outlet housing comprises a first side wall offset from the first adjustment axis, the first outlet opening being present in the first side wall.

3. The circular base according to any of the preceding claims, wherein the first outlet housing being at least partially cylindrical having a cylinder axis coaxial with the first adjustment axis.

4. The circular base according to claim 3, wherein the first weir edge is extending in parallel with the first adjustment axis.

5. The circular base according to any of the preceding claims, wherein the first outlet housing is cylindro-conical having the outlet opening in a conical part.

6. The circular base according to any of the preceding claims, wherein the first outlet opening is extending over an angle of 30° to 90°, preferably 45° to 75°, around the first adjustment axis.

7. The circular base according to any of the preceding claims, wherein the first outlet housing has an axial length in the direction of the first adjustment axis, and that the first outlet opening is extending an axial length in the direction of the first adjustment axis shorter than the axial length of the first outlet housing.

8. The circular base according to any of the preceding claims, wherein the first adjustment axis is parallel to the longitudinal direction.

9. The circular base according to any of the preceding claims, wherein the base further comprising a bearing surface for a conveyor screw, the bearing surface being located at the inner surface of the base.

10. The circular base according to any of the preceding claims, wherein the base further comprising a feed inlet for introducing a flowable material into the bowl of the decanter centrifuge, the feed inlet being located at the inwardly oriented surface of the base.

11. The circular base according to claim 9 and 10, wherein the feed inlet, the bearing surface and the outlet housing are located on a cylindrical part at the inner surface of the base, the cylindrical part protruding in the longitudinal direction.

12. The circular base according to any of the claims 10-11, wherein the first weir edge extends further away from the inner surface than the feed inlet.

13. The circular base according to any of the preceding claims, wherein the base defining a second outlet passage extending through the base, and a second outlet housing provided at the inner surface, the second outlet housing communicating with the second outlet passage to pass a part of the light phase from the second outlet housing to the second outlet passage, the second outlet housing having a second outlet opening for receiving a part of the light phase from the inner space together with the first outlet opening, the second outlet opening comprising a second weir edge defining in normal use the level of the surface of the light phase in the bowl together with the first weir edge, wherein the second outlet housing is rotatable around a second adjustment axis.

14. A decanter centrifuge comprising bowl rotating in use in a direction of rotation around an axis of rotation, the bowl comprising a base according to any of the preceding claims at one end of the bowl in the axis of rotation and a heavy phase outlet at an opposite end of the bowl in the axis of rotation, the longitudinal direction of the base coinciding with the axis of rotation.

15. A method of operating a decanter centrifuge according to claim 14, wherein the method comprising:

    rotating the outlet housing around the first adjustment axis,
    continuously introducing a flowable material into the bowl while rotating the bowl about the axis of

rotation, the flowable material including light phase and a heavy phase, and
allowing the light phase in the bowl to flow out of the bowl via the outlet opening.

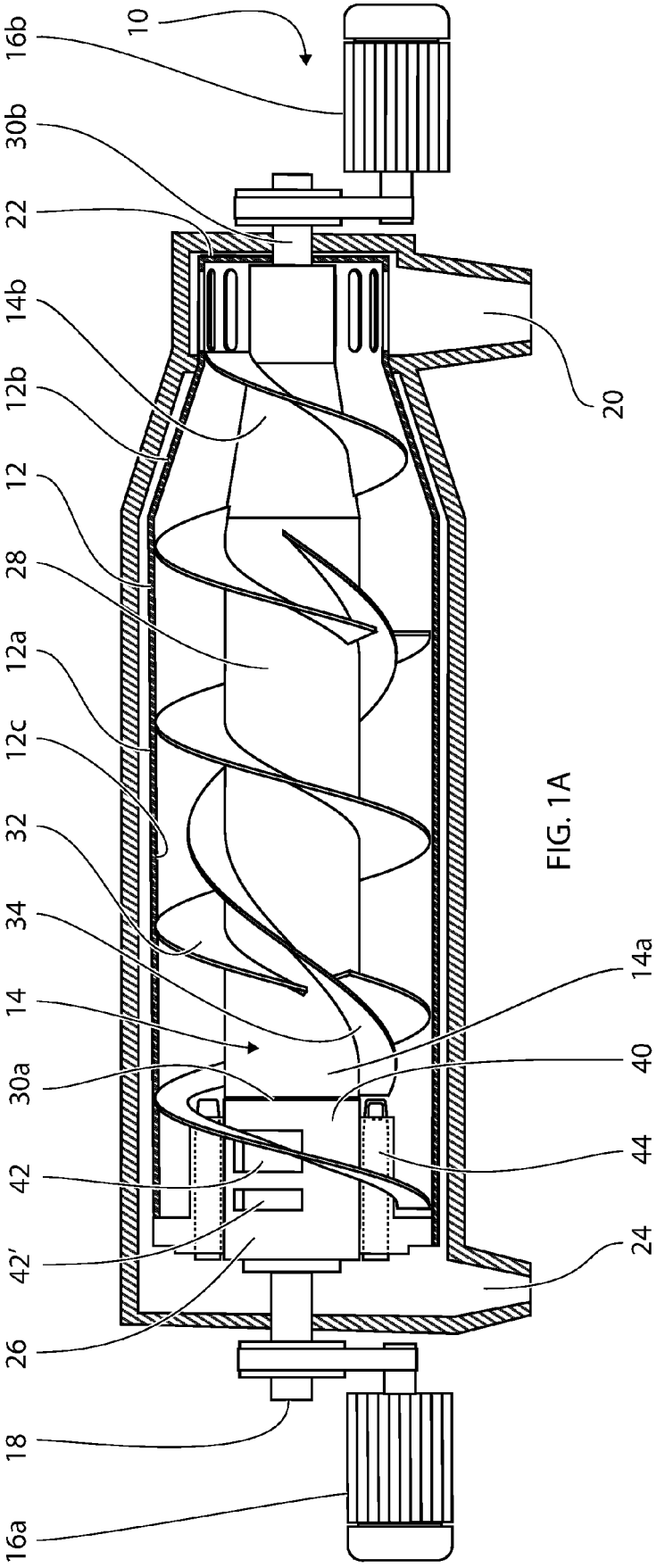

10
16b
30b
22
14b
12b
12
28
12a
12c
32
34
14
30a
42
42'
26
18
16a
20
14a
40
44
24

FIG. 1A

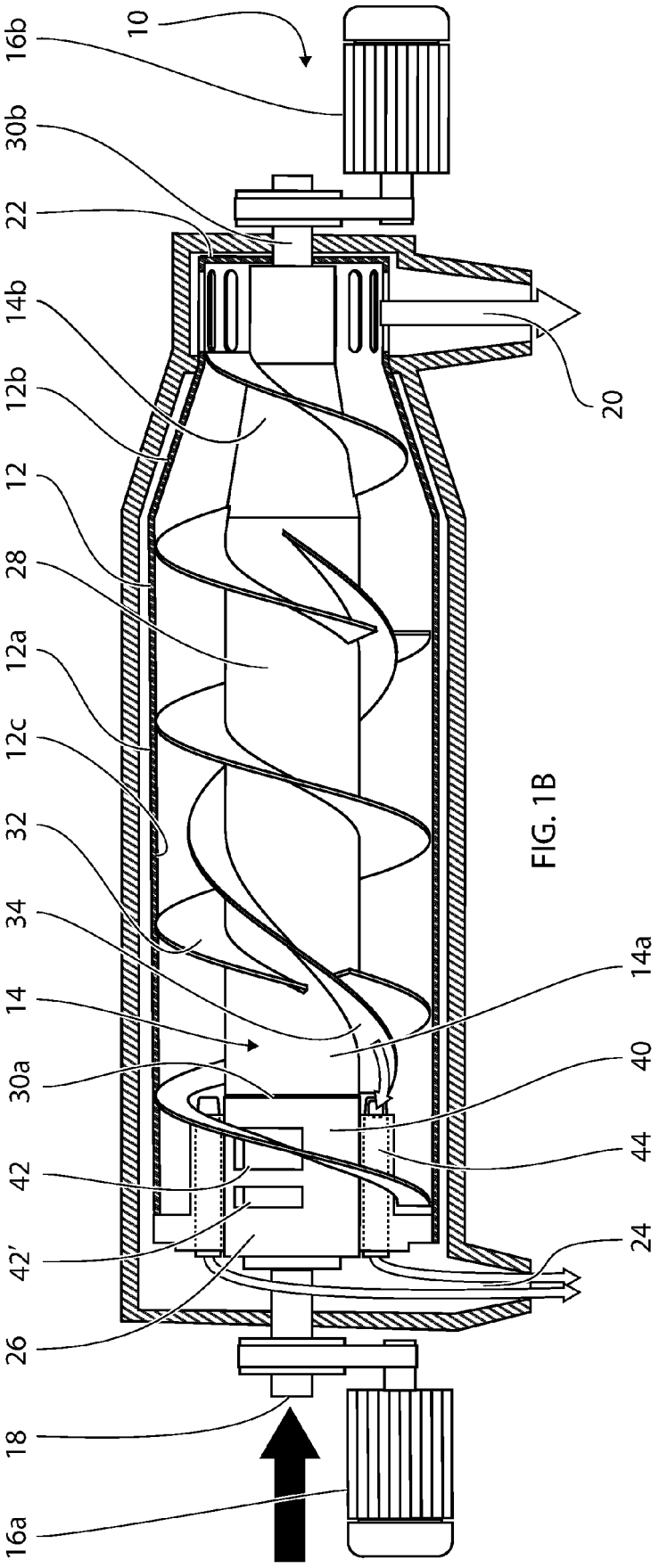
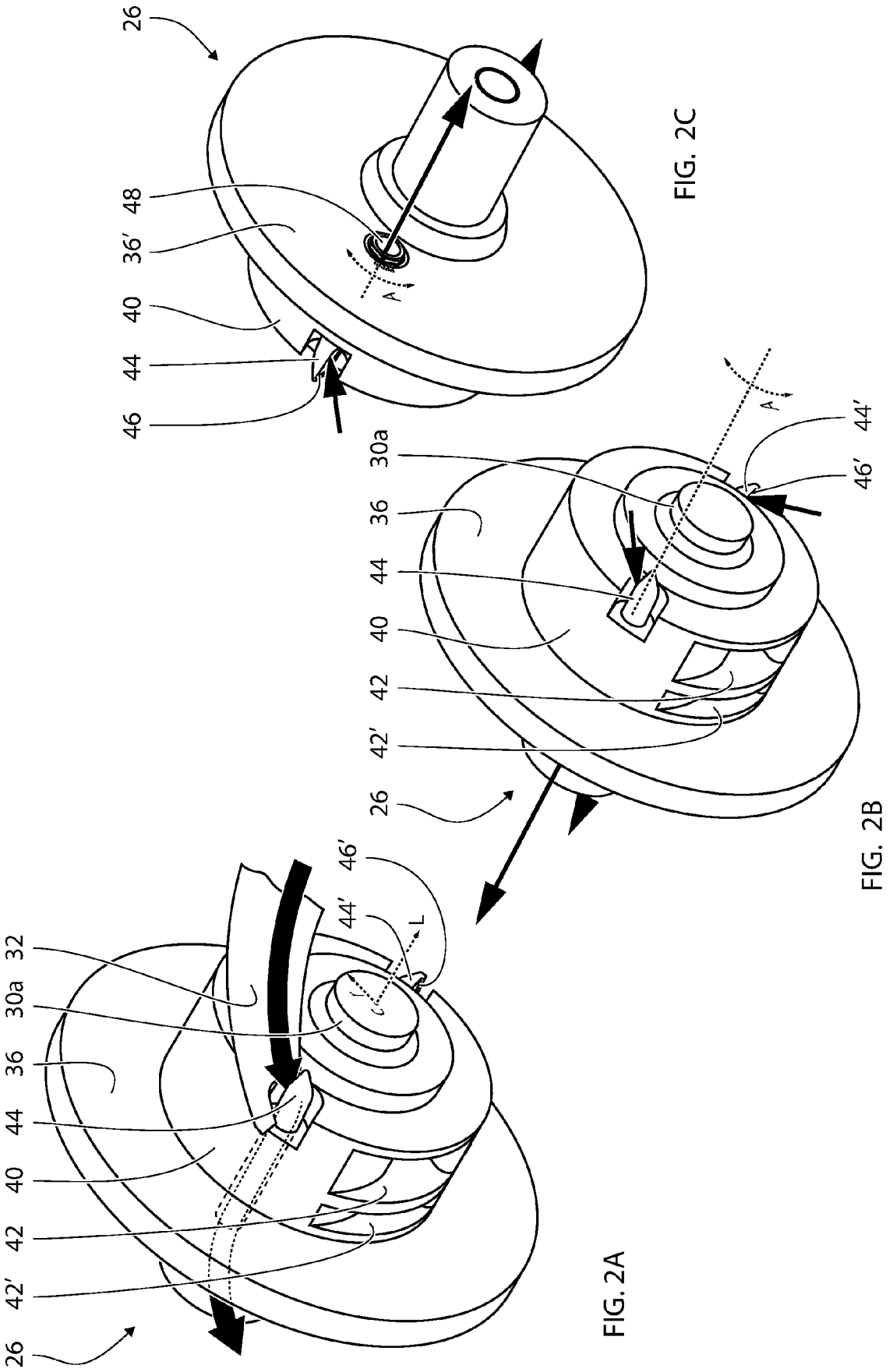

10
16b
30b
22
14b
12b
12
28
12a
12c
32
34
14
30a
42
42'
26
18
16a
20
14a
40
44
24

FIG. 1B


26
48
36'
40
44
46
A
FIG. 2C
26
42'
42
40
44
36
30a
32
46'
44'
L
FIG. 2A
26
42'
42
40
44
36
30a
46'
44'
A
FIG. 2B

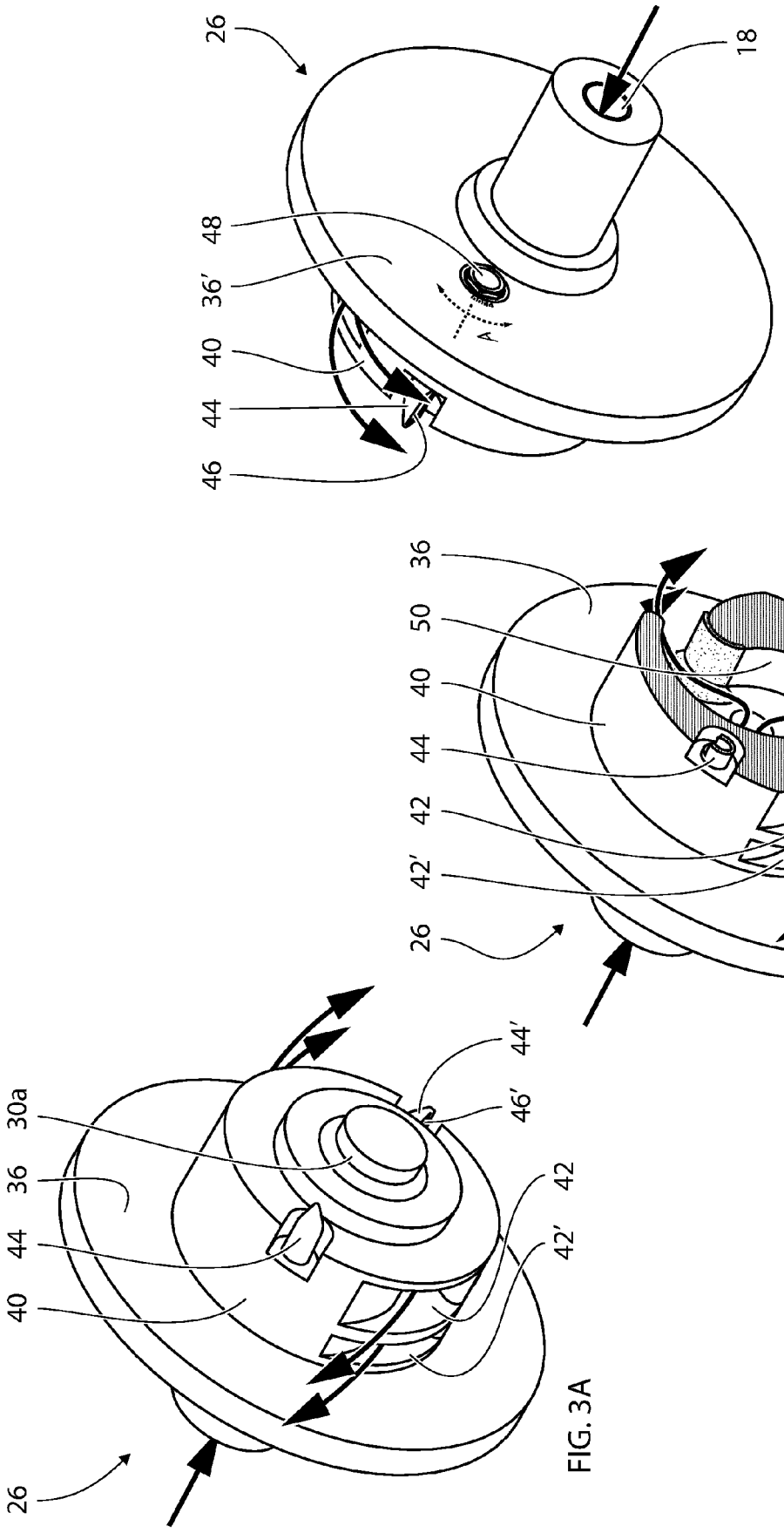


FIG. 3A

FIG. 3B

FIG. 3C

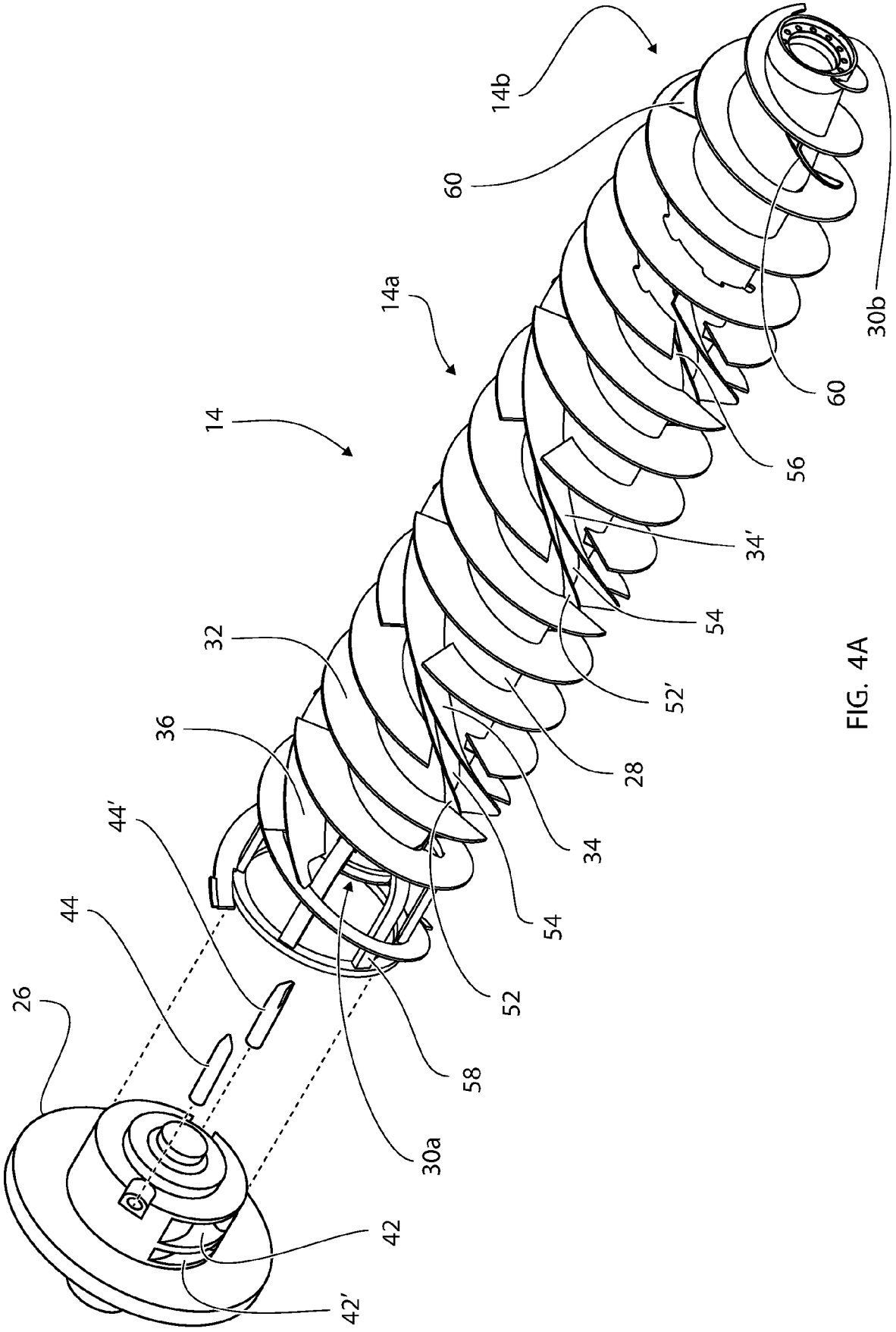

14b
60
14a
30b
14
60
56
34'
54
32
52'
36
28
34
44'
54
44
52
26
58
30a
42
42'

FIG. 4A

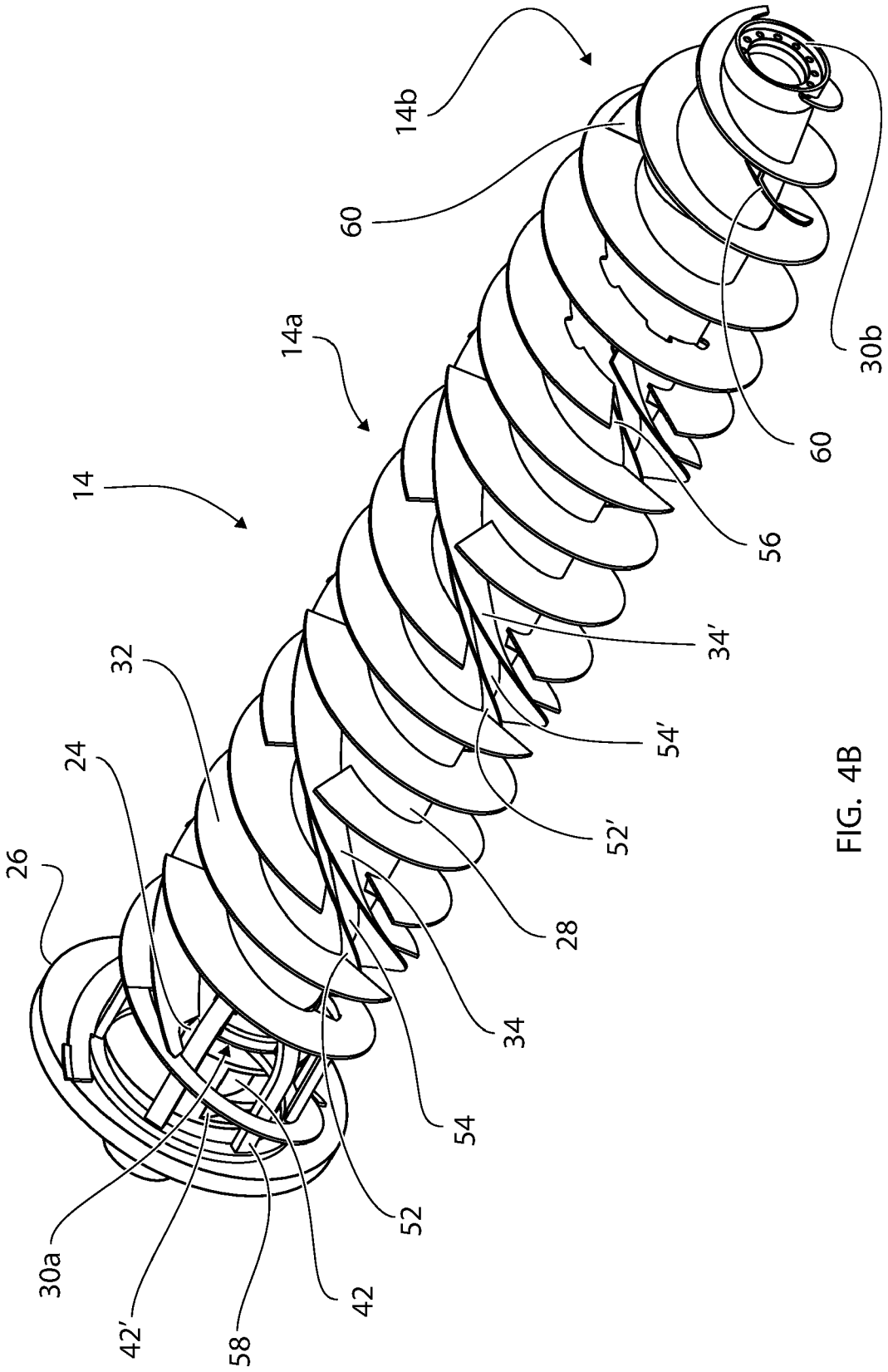


FIG. 4B

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 21 3451

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	EP 2 637 795 B1 (ALFA LAVAL CORP AB [SE]) 18 January 2017 (2017-01-18) * paragraphs [0031], [0035], [0036], [0037]; figures 1,4-6 *	1-4,6-8, 13-15 5,12	INV. B04B1/20
X A	CN 110 721 824 A (JIANGSU TONGZE FILTER TECH CO LTD) 24 January 2020 (2020-01-24) * paragraph [0021]; figures 1-4 *	1-4,6-9, 13-15 5,12	
X A	JP 2001 314779 A (TOMOE KOGYO KK) 13 November 2001 (2001-11-13) * paragraph [0029]; figures 1-5 *	1,3,9, 13-15 5,12	
X A	KR 102 000 530 B1 (BUSUNG CENTRIFUGE CO LTD [KR]) 16 July 2019 (2019-07-16) * paragraphs [0023] - [0028]; figures 1-3 *	1-4, 7-11,14, 15 5,12	
			TECHNICAL FIELDS SEARCHED (IPC) B04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	28 March 2024	Pössinger, Tobias

CATEGORY OF CITED DOCUMENTS

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

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 21 3451

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

28-03-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 2637795 B1	18-01-2017	AU 2011328569 A1	30-05-2013
		BR 112013010751 A2	02-05-2018
		CA 2816348 A1	18-05-2012
		CN 103209767 A	17-07-2013
		DK 178253 B1	12-10-2015
		DK 2637795 T3	24-04-2017
		EP 2637795 A2	18-09-2013
		HK 1183271 A1	20-12-2013
		JP 5931894 B2	08-06-2016
		JP 2013545602 A	26-12-2013
		KR 20130140775 A	24-12-2013
		NZ 610065 A	26-09-2014
		PL 2637795 T3	30-06-2017
		RU 2534768 C1	10-12-2014
		SG 190119 A1	28-06-2013
		US 2013310242 A1	21-11-2013
		WO 2012062337 A2	18-05-2012
CN 110721824 A	24-01-2020	NONE	
JP 2001314779 A	13-11-2001	NONE	
KR 102000530 B1	16-07-2019	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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

- WO 2010142299 A1 **[0005]**
- WO 2020109135 A1 **[0006]**
- US 7156801 B **[0007]**
- DE 102019102623 **[0008]**
- US 20150209804 A **[0009]**
- EP 0868217 A **[0010]**
- EP 2130607 B1 **[0011]**
- DE 2651657 **[0012]**
- US 3268159 A **[0013]**
- JP 62106856 B **[0014]**
- US 3494472 A **[0015]**
- US 7022061 B **[0016]**
- US 9089852 B **[0017]**
- WO 2012062337 A2 **[0018]**
- DE 102020129478 A1 **[0019]**
- EP 0506835 B1 **[0020]**
- EP 0602766 B1 **[0021]**
- EP 2440335 A1 **[0022]**
- EP 2926911 B1 **[0023]**
- EP 3177403 B1 **[0024]**
- WO 2021122878 A1 **[0025]**
- WO 2021122884 A1 **[0026]**
- WO 2022096734 A1 **[0027]**
- WO 2022096739 A1 **[0028]**
- WO 2022096745 A1 **[0029]**
- US 8841469 B **[0030]**