

(19)



(11)

EP 4 512 530 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
26.02.2025 Bulletin 2025/09

(51) International Patent Classification (IPC):
B04B 1/08 (2006.01) B04B 11/02 (2006.01)
B04B 7/14 (2006.01)

(21) Application number: **23192563.7**

(52) Cooperative Patent Classification (CPC):
B04B 1/08; B04B 7/14; B04B 11/02

(22) Date of filing: **22.08.2023**

(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

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(54) A CENTRIFUGAL SEPARATOR FOR SEPARATING A LIQUID MIXTURE

(57) The present invention provides a centrifugal separator (1) for separating a liquid mixture into at least a light phase and a heavy phase. The separator comprises a centrifuge bowl (5) and a drive member (3) for rotating the centrifuge bowl around an axis of rotation (X). The centrifuge bowl (5) further comprises an inlet (14) for receiving the liquid mixture, a first outlet (7) for said separated light phase and a second outlet (6) for said separated heavy phase, and wherein the centrifuge bowl (5) encloses a separation space (9a) and a sludge space

(9b). The separation space (9a) further comprises a stack (10) of separation discs arranged coaxially around the axis of rotation (X) and wherein the sludge space (9b) is arranged radially outside the stack (10) of separation discs. The centrifuge bowl (5) further comprises at least one outlet conduit (30) for transport of heavy phase from said sludge space (9b) to the second outlet (6). At least one outlet conduit (30) is arranged at least with a portion within the stack (10) of separation discs.

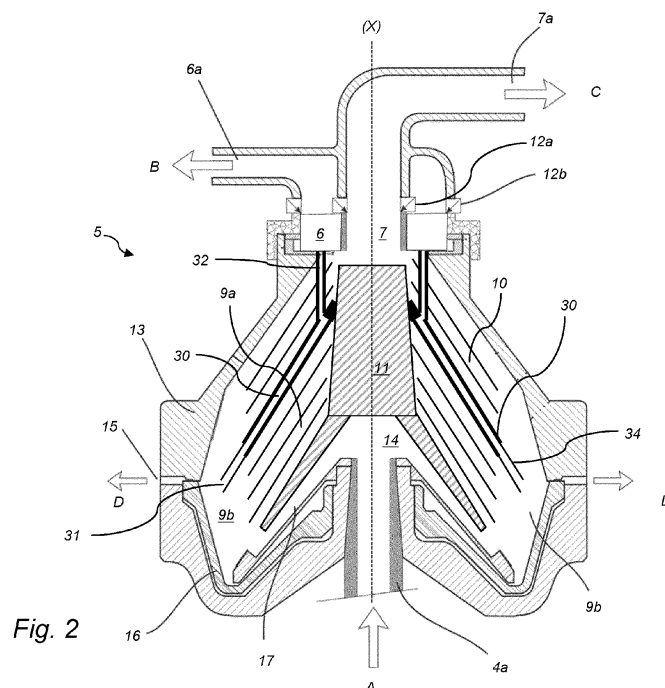


Fig. 2

Description

Field of the Invention

[0001] The present invention relates to the field of centrifugal separators, and more specifically to a method of separating a liquid mixture into a light phase and a heavy phase with a centrifugal separator.

Background of the Invention

[0002] Centrifugal separators are generally used for separation of liquids and/or for separation of solids from a liquid. During operation, liquid mixture to be separated is introduced into a rotating bowl and heavy particles or denser liquid, usually water, accumulates at the periphery of the rotating bowl whereas less dense liquid accumulates closer to the central axis of rotation. This allows for collection of the separated fractions, e.g. by means of different outlets arranged at different radii from the rotational axis.

[0003] A centrifugal separator for clarification of beer is disclosed in WO2021058287. This document describes a centrifugal separator with a first outlet for the clarified liquid, a second outlet for yeast concentrate and a third outlet for intermittent discharge at the periphery of the centrifuge bowl. The yeast concentrate is flowing into a set of pipes from a position close to the periphery in the sludge space to the second outlet. Having the yeast concentrate flowing to a second outlet, the discharge frequency can be lowered and yeast cells leaving the centrifugal separator by the second outlet, have a high probability to survive the centrifugation and may be used for the next brewing batch, while much of the yeast cells that are ejected at the intermittent discharges in the third outlet are dead and are not usable in further fermentation.

[0004] However, in these separators having pipes extending into the sludge space above the disc stack for collecting and discharging a heavy phase, it may be difficult to safeguard against clogging of the pipes. Furthermore, having long pipes going from the sludge space (periphery of the bowl) to a position close to the center of rotation may create void spaces between the pipes where liquid risk standing still during process. Such standstill may lead to unwanted deposits accumulations and the positions may be hard to clean during CIP (cleaning-in-process/cleaning-in-place) procedures.

[0005] Thus, there is a need in the art to improve centrifugal separators in which the separated liquid heavy phase is collected with a set of pipes in the sludge space.

Summary of the Invention

[0006] It is an object of the invention to at least partly overcome one or more limitations of the prior art. In particular, it is an object to provide a centrifugal separator having a decreased risk of clogging pipes for discharging

a heavy phase and a decreased risk of unwanted deposit accumulations.

[0007] As a first aspect of the invention, there is provided a centrifugal separator for separating a liquid mixture into at least a light phase and a heavy phase. The centrifugal separator is comprising

a centrifuge bowl and a drive member for rotating the centrifuge bowl around an axis of rotation (X); wherein the centrifuge bowl further comprises an inlet for receiving the liquid mixture, a first outlet for said separated light phase and a second outlet for a separated heavy phase, and wherein the centrifuge bowl encloses a separation space and a sludge space, and wherein separation space comprises a stack of separation discs arranged coaxially around the axis of rotation (X) and wherein the sludge space is arranged radially outside the stack of separation discs.

[0008] The centrifuge bowl further comprises at least one outlet conduit for transport of heavy phase from said sludge space to the second outlet, and further wherein said at least one outlet conduit is arranged at least with a portion within the stack separation discs.

[0009] The centrifugal separator is for separation of a liquid mixture. The liquid mixture may be an aqueous liquid or an oily liquid. As an example, the centrifugal separator may be for separating a liquid mixture into at least a liquid light phase and a liquid heavy phase and potentially also a sludge phase from the liquid mixture. The heavy phase has a density that is higher than the density of the light phase.

[0010] As used herein, the term "axially" denotes a direction which is parallel to the rotational axis (X). Accordingly, relative terms such as "above", "upper", "top", "below", "lower", and "bottom" refer to relative positions along the rotational axis (X). Correspondingly, the term "radially" denotes a direction extending radially from the rotational axis (X). A "radially inner position" thus refers to a position closer to the rotational axis (X) compared to "a radially outer position".

[0011] Moreover, the centrifugal separator may be a single use centrifugal separator or a multiple use centrifugal separator.

[0012] Thus, the centrifuge bowl may form at least a part of an exchangeable unit made for single use, whereas the drive member is for multiple use. A new centrifuge bowl may then be used before each separation process. The single use bowl may be as described in WO2020120357A1. The single use centrifuge bowl may be of a polymeric material or at least comprise to a larger extent a polymeric material, such as plastic. Thus, in embodiments of the first aspect, the centrifuge bowl is part of an exchangeable single use insert or a complete exchangeable single use insert.

[0013] As an alternative, the centrifuge bowl may be for

multiple use and may comprise or consist of stainless steel. Such a centrifuge bowl is described in e.g. WO2021058287A1. Thus, in embodiments of the first aspect, the centrifuge bowl is for multiple use.

[0014] The centrifuge bowl comprises at least one outlet conduit for transport of heavy phase from the sludge space to the outlet for heavy phase and the at least one outlet conduit has at least a portion that is arranged within the stack separation discs. The portion arranged within the disc stack may have the same angle as the separation discs in the stack.

[0015] "Within the stack of separation discs" may refer to "axially within the disc stack".

[0016] Thus, instead of arranging the outlet conduit or conduits axially above or below the disc stack, the outlet conduit or conduits are arranged with the disc. Thus, the stack of separation discs may be divided in an upper portion that is axially above the at least one outlet conduit and an axially lower portion that is arranged axially below the at least one outlet conduit.

[0017] The first aspect of the invention is based on the insight that having the at least one outlet conduit within the stack of separation discs decreases any hygienic problem since void spaces between individual outlet conduits may be avoided, as will further be discussed below.

[0018] The inventors have found that having the outlet conduits within the stack also allows for having the outlet conduits arranged with the same angle as the separation discs, thereby decreasing the number of bends in the outlet pipes. Such bends may otherwise give rise to clogging of the outlet conduits.

[0019] Furthermore, by integrating the outlet conduit or conduits within the disc stack, mounting of the outlet conduits are avoided.

[0020] The at least one outlet conduit may be a single conduit or a plurality of conduits.

[0021] A plurality of outlet conduits may be equidistantly arranged around the axis of rotation (X). In embodiments of the first aspect, the plurality of outlet conduits are formed as pipes at their inlet end portions, i.e. at the radially outer portion.

[0022] The outlet conduits may comprise individual pipes or channels within the centrifuge bowl. Further, the plurality of outlet conduits may be formed as a plurality of pipes and/or channels extending all the way to the second outlet.

[0023] The at least one outlet conduit may be arranged for continuous removal of heavy phase, such as liquid heavy phase, from the sludge space.

[0024] The second outlet for a separated heavy phase may for example be arranged at the top or the bottom of the centrifuge bowl.

[0025] In embodiments of the first aspect, the at least one outlet conduit is arranged within a thick disc that has an axial thickness of an individual separation disc in the stack of separation discs.

[0026] Such a thick disc is may thus be mounted inside

of the disc stack with the same disc angle as the rest of the disc stack. The thick disc may comprise long holes or channels forming part of the outlet conduit. These channels or holes are thus in connection with the sludge space and are arranged for transporting the heavy phase further radially inwards.

[0027] The thick disc may be arranged such that no flow other than the flow within the at least one outlet conduit is allowed within the thick disc. Use of a thick disc may thus decrease the risk of void spaces between individual outlet conduits.

[0028] The thick disc may be of or at least comprise metal. The thick disc is thus not a separation disc, but facilitates holding the outlet conduits within the disc.

[0029] As an example, the at least one outlet conduit may comprise at least one pipe that is extending radially outwards from said thick disc into said sludge space.

[0030] Thus, the thick disc may have radius that is substantially similar to the radius of the separation discs in the disc stack. On the outer edge of the thick disc there may thus be pipes mounted that extend out in the sludge space for heavy phase pick-up. The outer periphery of the thick disc may otherwise be closed for any other process flow, i.e. the outer periphery of the thick disc may be closed except for the at least one outlet conduit extending radially outwards from the periphery of the thick disc.

[0031] As an alternative example, the thick disc may have a radius that is larger than the radius of the separation discs in the stack of separation discs such that said thick disc protrudes into said sludge space.

[0032] Consequently, the thick disc in itself may have a larger radius and may protrude into the sludge space for heavy phase pick-up. Then, said at least one outlet conduit may not protrude radially from said thick disc. Instead, the inlet to the outlet conduit may be a hole arranged in a radially outer portion of the thick disc, such as a hole in the outer periphery of the thick disc. Thus, as an example, the inlet to the outlet conduits may take the form of at least one hole arranged at the outer periphery of the thick disc.

[0033] However, a thick disc is not necessary for arranging the at least one outlet conduit within the disc stack. In embodiments of the first aspect, said at least one outlet conduit is arranged between two adjacent discs in the stack of separation discs and is further arranged in contact with at least one of the two adjacent discs.

[0034] Thus, the at least one outlet conduit may be arranged as a spacing element between two discs in the stack. Then, process flow may be allowed between individual outlet conduits, such as flow of separated light phase flowing radially inwards between outlet conduits.

[0035] In embodiments of the first aspect, said at least one outlet conduit comprises a radially outermost portion extending into the sludge space, and wherein said radially outermost portion has the same angle relative the rotational axis (X) as the discs in the stack of separation discs.

[0036] The radially outermost portion may be a pipe

extending from the stack of separation discs, such as a pipe protruding from a thick disc as discussed above. Further, the radially outermost portion may be a channel arranged within a thick disc as discussed above.

[0037] The outermost portion having the same angle as the rest of the disc stack decreases the need for the outlet conduit having bent portions, thus decreasing the risk of clogging within the outlet conduits.

[0038] In embodiments of the first aspect, said at least one outlet conduit comprises a radially inner portion extending axially from within said stack of separation discs out to the second outlet.

[0039] Thus, on a desired radius vertical pipes or channels may be used for leading the heavy phase out to the second outlet of the centrifugal separator.

[0040] The radially inner portion may be parallel to rotational axis X. The radially inner portion may extend into e.g. a thick disc in which the outlet conduits are arranged, as discussed above.

[0041] As an example, the at least one outlet conduit may have the same angle relative the rotational axis (x) from said radially inner portion out to and including the radially outermost portion. This angle may thus be the same angle as the discs of the separation discs of the disc stack.

[0042] The at least one outlet conduit may thus comprise a pipe and or channel extending in a straight direction from the radially inner portion to the radial end of the outlet conduit.

[0043] In embodiments of the first aspect, at least 5% of the number of discs in said stack of separation discs are arranged axially above said at least one outlet conduit. As an example, at least 10 %, such as at least 15 % of the number of discs in said stack of separation discs may be arranged axially above said at least one outlet conduit.

[0044] As a further example, between 5-50%, such as between 5-25 % of the number of discs in said stack of separation discs may be arranged axially above said at least one outlet conduit.

[0045] In embodiments of the first aspect, said at least one outlet conduit is arranged within the upper half of the number of discs in said stack of separation discs.

[0046] This may be an advantage if also the second outlet for the heavy phase is arranged in the upper half of the centrifuge bowl.

[0047] As a further example, said at least one outlet conduit is arranged within the upper 30 %, such as within the upper 20 % of the number of discs in said stack of separation discs.

[0048] The centrifuge bowl may be enclosed in a hood, which forms part of a stationary frame. The centrifuge bowl may be supported by the frame by at least one bearing device and be arranged to be rotated around vertical axis of rotation, i.e. the axis of rotation (X) may extend vertically. The centrifuge bowl is usually supported by a spindle, i.e. a rotatable shaft, and may thus be mounted to rotate with the spindle. Consequently, the centrifugal separator may comprise a spindle that is

rotatable around the axis of rotation (X). The centrifugal separator may be arranged such that the centrifuge bowl is supported by the spindle at one of its ends, such as the bottom end or the top end of the spindle.

[0049] The drive member for rotating the centrifuge bowl may comprise an electrical motor having a rotor and a stator. The rotor may be fixedly connected to the rotatable part, such as to a spindle. Alternatively, the drive member may be provided beside the spindle and rotate the rotatable part by a suitable transmission, such as a belt or a gear transmission.

[0050] The centrifuge bowl encloses by its walls a separation space and a sludge space. The centrifugal separator may be a disc stack centrifugal separator.

Therefore, the separation space may comprise a stack of separation discs arranged coaxially around the axis of rotation (X) and the sludge space may then be arranged radially outside the stack of separation discs. The separation discs may e.g. be of metal or a polymer. Further, the separation discs may be frustoconical separation discs, i.e. having separation surfaces forming frustoconical portions of the separation discs. Radially outside of the stack of separation discs is the sludge space, in which separated sludge and liquid heavy phase is collected during operation. The sludge space thus extends radially from the outer portion of the stack of separation discs to the inner wall of the centrifuge bowl. The separation discs are arranged coaxially around the axis of rotation (X) at a distance from each other to form passages between each two adjacent separation discs. The stack of separation discs thus forms a surface enlarging insert that increases the separation efficiency as liquid mixture flows in the passages of the stack. In embodiments, the stack of separation discs comprises more than 100 separation discs.

[0051] The centrifugal separator also comprises an inlet for receiving the liquid mixture to be separated. This inlet may be arranged centrally in the centrifuge bowl, thus at rotational axis (X). The centrifugal separator may be arranged to be fed from the bottom, such as through a spindle, so that the liquid mixture is delivered to the inlet from the bottom of the separator. Alternatively, the centrifugal separator may be arranged to be fed from the top, through a stationary inlet pipe extending into the centrifuge bowl to the inlet.

[0052] Further, the centrifuge bowl comprises outlets for the separated phases. The first outlet for the light phase may be in fluid connection with a stationary light phase outlet pipe, and the second outlet for the heavy phase may be in fluid connection with a stationary heavy phase outlet pipe. The first and second outlets may be arranged on the upper portion of the centrifuge bowl.

[0053] If also a sludge phase is separated from the liquid mixture, the centrifuge bowl may comprise sludge outlets. In embodiments of the first aspect, the sludge outlet is in the form of a set of intermittently openable outlets arranged at the periphery of the centrifuge bowl. The intermittently openable outlets may be equidistantly

spaced around the axis of rotation (X). Consequently, in embodiments of the first aspect, the centrifugal separator is comprising sludge outlets at the periphery of the centrifuge bowl. The sludge outlets may be in the form of a set of intermittently openable outlets.

[0054] As an alternative, the sludge outlets may be nozzles arranged for continuous discharge of a separated sludge phase.

[0055] The first and second outlets may be sealed to the liquid outlet pipes by means of e.g. a mechanical seal or a liquid seal. The seal may be a hermetic seal, such as a mechanical hermetic seal, used when the material to be separated in the centrifugal separator must not be exposed to or come in contact with the atmosphere. The mechanical seal may be a double mechanical seal, i.e. comprising a rotatable portion and a stationary portion forming the sealing interface therebetween.

[0056] Also the inlet may be hermetically sealed, such as with a mechanical hermetic seal.

Brief description of the Drawings

[0057] The above, as well as additional objects, features and advantages of the present inventive concept, will be better understood through the following illustrative and non-limiting detailed description, with reference to the appended drawings. In the drawings like reference numerals will be used for like elements unless stated otherwise.

Figure 1 shows a schematic drawing of a centrifugal separator.

Figure 2 shows a schematic drawing of an example of a centrifuge bowl which forms part of a centrifugal separator.

Figure 3 shows a schematic drawing of an example of a stack of separation discs comprising a thick disc. Figure 4 shows a perspective view of a schematic drawing of a stack of separation discs comprising a thick disc.

Figure 5 shows a perspective view of a schematic drawing of a stack of separation discs comprising a thick disc having a larger radius than the discs in the stack.

Detailed Description

[0058] The centrifugal separator according to the present disclosure will be further illustrated by the following description with reference to the accompanying drawings.

[0059] Figs. 1 and 2 schematically show an example of centrifugal separator and a centrifuge bowl according to the present disclosure.

[0060] Fig. 1 show a cross-section of an embodiment of a centrifugal separator 1 configured to separate a heavy phase and a light phase from a liquid mixture. The centrifugal separator 1 has a rotatable part 4, comprising the

centrifuge bowl 5 and drive spindle 4a.

[0061] The centrifugal separator 1 is further provided with a drive motor 3. This motor 3 may for example comprise a stationary element and a rotatable element, which rotatable element surrounds and is connected to the spindle 4a such that it transmits driving torque to the spindle 4a and hence to the centrifuge bowl 5 during operation. The drive motor 3 may be an electric motor. Alternatively, the drive motor 3 may be connected to the spindle 4a by transmission means such as a drive belt or the like, and the drive motor may alternatively be connected directly to the spindle 4a.

[0062] The centrifuge bowl 5, shown in more detail in Fig. 2, is supported by the spindle 4a, which is rotatably arranged in stationary frame 2 around the vertical axis of rotation (X) in a bottom bearing 22 and a top bearing 21. The stationary frame 2 has an upper hood that surrounds centrifuge bowl 5.

[0063] In the centrifugal separator as shown in Fig. 1, liquid mixture to be separated is fed to the bottom to the centrifuge bowl 5 via the drive spindle 4a. The drive spindle 4a is thus in this embodiment a hollow spindle, through which the feed is supplied to the centrifuge bowl 5. However, in other embodiments, the liquid mixture to be separated is supplied from the top, such as through a stationary inlet pipe extending into the centrifuge bowl 5.

[0064] After separation has taken place within the centrifuge bowl 5, separated liquid heavy phase is discharged through stationary outlet pipe 6a, whereas separated liquid light phase is discharged through stationary outlet pipe 7a.

[0065] Fig. 2. shows a more detailed view of the centrifuge bowl 5 of the centrifugal separator 1.

[0066] The centrifuge bowl 5 forms within itself a separation space 9a and a sludge space 9b, located radially outside the separation space 9a. In the separation space 9a, a stack 10 of separation discs is arranged coaxially around the axis of rotation (X). The stack 10 is arranged to rotate together with the centrifuge bowl 5 and provides for an efficient separation of the liquid mixture into at least a liquid light phase and a liquid heavy phase. Thus, in the separation space 9a, the centrifugal separation of the liquid mixture takes place during operation. The sludge space 9b is in this embodiment confined between an inner surface of the centrifuge bowl wall 13 and an axially movable operating slide 16.

[0067] The disc stack 10 is supported at its axially lowermost portion by distributor 11. The distributor is arranged to conduct liquid mixture from the center inlet 14 of the centrifuge bowl 5 to a predetermined radial level in the separation space 9a.

[0068] The inlet 14 is arranged for receiving the liquid mixture and is in the form of a central inlet chamber formed within or under the distributor 11. The inlet 14 communicates with the separation space 9a via passages 17 formed in the distributor 11.

[0069] There is a number of outlet conduits 30 in the form of channels or pipes for transporting separated

liquid heavy phase from the sludge space 9b to the second outlet 6 for the separated heavy phase. This second outlet 6 of the centrifuge bowl 5 communicates with a stationary outlet pipe 6a for discharging the separated liquid heavy phase from the centrifuge bowl 5.

[0070] In Fig. 2 the outlet conduits 30 are executed at is radial outer portion as pipes having their inlet end portions 31 stretching out in the sludge space 9b to a diameter larger than the disc stack diameter. The plurality of outlet conduits 30 have thus their inlet end portions 31 extending into the sludge space 9b. Furthermore, the plurality of outlet conduits 30 is arranged within the stack 10 of separation discs. This will further be discussed in relation to Figs. 3-5 below.

[0071] In embodiments, the centrifuge bowl 5 comprises at least four outlet conduits 30, such as at least 8 outlet conduits 30, such as at least twelve outlet conduits 30. However, the centrifuge bowl 5 may comprises a single outlet conduit.

[0072] The radially inner portion of the disc stack 10 communicates with a first outlet 7 for a separated light phase of the liquid mixture. This first outlet 7 of the centrifuge bowl 5 communicates with a stationary outlet pipe 7a for discharging the separated liquid light phase from the centrifuge bowl 5.

[0073] The first and second outlet chambers 6, 7 are mechanically sealed with seals 12a, 12b. As this is an airtight design, they are also often called hermetic seals. The inlet channel 4b is also sealed at lower end of the hollow spindle 4a, thus preventing communication between the inlet channel 4b and the surroundings. This mechanical seal is not shown in the Figures.

[0074] In this example, the centrifuge bowl 5 is further provided with outlets 15 at the radially outer periphery of the sludge space 9b. These outlets 15 are evenly distributed around the rotor axis (X) and are arranged for intermittent discharge of a sludge component of the liquid mixture. The opening of the outlets 15 is controlled by means of an operating slide 16 actuated by operating water channels below the operating slide 16, as known in the art. In its position shown in the drawing, the operating slide 16 abuts sealingly at its periphery against the upper part of the centrifuge bowl 5, thereby closing the sludge space 9b from connection with outlets 15, which are extending through the centrifuge bowl 5.

[0075] During operation of the separator as shown in Fig. 1 and 2, the centrifuge bowl 5 is brought into rotation by the drive motor 3. Via the spindle 4a, liquid mixture to be separated is brought into the separation space 9a, as indicated by arrow "A". Depending on the density, different phases in the liquid mixture is separated between the separation discs of the stack 10. Heavier component, such as a liquid heavy phase and a sludge phase, move radially outwards between the separation discs of the stack 10 to the sludge space 9b, whereas the phase of lowest density, such as a liquid light phase, moves radially inwards between the separation discs of the stack 10 and is forced through the outlet pipe 7a via the first

outlet 7, as indicated by arrow "C". The liquid of higher density is instead discharged via the outlet conduits 30 to the second outlet 6 and further out via stationary outlet pipe 6a, as indicated by arrow "B".

[0076] Solids, or sludge, that accumulate at the periphery of the sludge space 9b and is emptied intermittently from within the centrifuge bowl by the sludge outlets 15 being opened, whereupon sludge is discharged from the separation chamber 15 by means of centrifugal force, as indicated by arrow "D". However, the discharge of sludge may also take place continuously, in which case the sludge outlets 17 take the form of open nozzles and a certain flow of sludge and/or heavy phase is discharged continuously by means of centrifugal force.

[0077] The centrifugal separator 1 may also be in the form of a single-use centrifugal separator, such as a separator shown in WO2020120357A1. The separator 1 may thus comprise a drive unit in which an exchangeable single use centrifuge bowl 5 is inserted.

[0078] Fig. 3 schematically shows a section view of the left half of the disc stack 10 arranged within the separation space 9a. The plurality of outlet pipes 30 are arranged axially within the disc stack 10 so that the protruding outer portion 34 extends into the sludge space 9b from within the disc stack. In this example the plurality of outlet conduits 30 is arranged within the upper half of the number of discs in the stack of separation discs. Thus, the disc stack 10 has an upper portion 41 that is arranged axially above the outlet conduits 30 and a lower portion 42 that is arranged axially below the outlet conduits. As an example, at least 5% of the number of discs in the stack 10 may be arranged within the upper portion 41, such as between 5-35 % of the number of discs.

[0079] The plurality of outlet pipes 30 is mounted inside of the disc stack 10 with the same disc angle relative the rotational axis (X) as the rest of the disc stack 10. Further, the radially outermost portion 34 of the outlet conduit 30 that extends into the sludge space 9b has the same angle as the discs in the stack 10 of separation discs. The outermost portion 34 of the outlet pipes 30 may extend radially into the sludge space 9b such that the inlet 31 into the outlet pipe 30 is arranged at an axial position X1 that is substantially in the middle of the axial extension X2 of the outer periphery of the disc stack 10.

[0080] Further, within the disc stack at a desired radius there are vertical pipes 32 that function as an extension of the part of the outlet conduits 30 that has the same angle as the discs in the disc stack 10. These vertical pipes 32 lead the separated heavy phase out from the disc stack 10 to the second outlet 6 of the separator 1. The vertical pipes 32 may thus function as the radially inner portion 32 of the outlet pipes 30 and extending axially from within the stack 10 of separation discs out to the second outlet 6.

[0081] As illustrated in Fig 3, the outlet conduit 30 has the same angle relative the rotational axis (X) from the vertical pipes 32 out to and including the radially outermost portion 34.

[0082] The plurality of outlet pipes 30 may be arranged

between two adjacent discs in the stack 10 of separation discs so that is in contact with at least one of the two adjacent discs. As an alternative and discussed in relation to Figs 4-5 below, the plurality of outlet pipes may be arranged within thick disc is mounted inside of the disc stack 10 with the same disc angle as the rest of the disc stack 10.

[0083] Fig. 4 shows a schematic perspective view of a disc stack 10 in which a thick disc 40 is mounted. The plurality of outlet conduits 30 is arranged within the thick disc 40 and the thick disc 40 has an axial thickness that is larger than the axial thickness of an individual separation disc in the stack 10 of separation discs. Within the thick disc 40 the plurality of outlet conduits is in the form of long holes or channels that transport the heavy phase further inwards. On a desired radius vertical pipes (not shown in Fig. 4) may connect to the conduits in the thick disc 40 and be arranged to lead the separated heavy phase out from the thick disc 40 to the second outlet of the separator. On the outer edge of the thick disc 40 the outlet conduit 30 takes the form of pipes 34 that extend out in the sludge space 9b for heavy phase pick-up. The outermost portion of the outlet conduit 30 thus comprises at least one pipe 34 that are extending radially outwards from the thick disc 40 into said sludge space 9b.

[0084] The thick disc 40 minimizes any hygienic problem of having individual pipes since the void spaces between the pipes does not longer exist. Furthermore, the whole configuration of outlet conduits for transport of separated heavy phase from the sludge space 9b to the second outlet 6 can be one single part, which can quickly and easily be mounted inside the separator 10. Finally, any bending of the outlet conduits 30 within sludge space 9b may be avoided, i.e. further decreasing the risk of clogging of the conduits 30.

[0085] The thick disc 40 could as an alternative have a larger radius than the discs in the stack 10. This is illustrated in Fig. 5, which shows a schematic perspective view of a disc stack 10 in which such a thick disc 40 is mounted. The thick disc 40 has a radius R1 that is larger than the radius R2 of the disc stack. The radius R1 may extend into the sludge space 9b a distance which is similar to the outer radius of the outer portions 34 of the outlet conduits 30 as shown in Figs 2-4. The outer side surface 40a of the thick disc 40 is perforated to form the inlets 31 of the outlet conduits 30. Thus, the thick disc 40 protrudes into the sludge space 9b but the at least one outlet conduit 30 does not protrude radially from the thick disc 40. This may decrease the interference with liquid movement within the sludge space 9b.

[0086] The invention is not limited to the embodiment disclosed but may be varied and modified within the scope of the claims set out below. The invention is not limited to the orientation of the axis of rotation (X) disclosed in the figures. The term "centrifugal separator" also comprises centrifugal separators with a substantially horizontally oriented axis of rotation. In the above the inventive concept has mainly been described with refer-

ence to a limited number of examples. However, as is readily appreciated by a person skilled in the art, other examples than the ones disclosed above are equally possible within the scope of the inventive concept, as defined by the appended claims.

Claims

1. A centrifugal separator (1) for separating a liquid mixture into at least a light phase and a heavy phase, comprising

a centrifuge bowl (5) and a drive member (3) for rotating the centrifuge bowl around an axis of rotation (X);

wherein the centrifuge bowl (5) further comprises an inlet (14) for receiving the liquid mixture, a first outlet (7) for said separated light phase and a second outlet (6) for said separated heavy phase, and

wherein the centrifuge bowl (5) encloses a separation space (9a) and a sludge space (9b), and wherein separation space (9a) comprises a stack (10) of separation discs arranged coaxially around the axis of rotation (X) and wherein the sludge space (9b) is arranged radially outside the stack (10) of separation discs;

and wherein the centrifuge bowl (5) further comprises at least one outlet conduit (30) for transport of heavy phase from said sludge space (9b) to the second outlet (6),

and further wherein said at least one outlet conduit (30) is arranged at least with a portion within the stack (10) of separation discs.

2. A centrifugal separator (1) according to claim 1, wherein said at least one outlet conduit (30) is arranged within a thick disc (40) that has an axial thickness that is larger than the axial thickness of an individual separation disc in the stack (10) of separation discs.

3. A centrifugal separator (1) according to claim 2, wherein said at least one outlet conduit (30) comprises at least one pipe (34) that is extending radially outwards from said thick disc (40) into said sludge space (9b).

4. A centrifugal separator (1) according to claim 2, wherein thick disc (40) has a radius that is larger than the radius of the separation discs in the stack (10) of separation discs such that said thick disc (40) protrudes into said sludge space (9b).

5. A centrifugal separator (1) according to claim 4, wherein said at least one outlet conduit (30) does not protrude radially from said thick disc (40).

6. A centrifugal separator (1) according to claim 1, wherein said at least one outlet conduit (30) is arranged between two adjacent discs in the stack (10) of separation discs and is further arranged in contact with at least one of the two adjacent discs. 5
7. A centrifugal separator (1) according to any previous claim, wherein said at least one outlet conduit (30) comprises a radially outermost portion (34) extending into the sludge space (9b), and wherein said radially outermost portion (34) has the same angle relative the rotational axis (X) as the discs in the stack (10) of separation discs. 10
8. A centrifugal separator (1) according to any previous claim, wherein said at least one outlet conduit (30) comprises a radially inner portion (32) extending axially from within said stack (10) of separation discs out to the second outlet (6). 15
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9. A centrifugal separator (1) according to claim 7 and 8, wherein said outlet conduit (30) has the same angle relative the rotational axis (x) from said radially inner portion (32) out to and including the radially outermost portion (34). 25
10. A centrifugal separator (1) according to any previous claim, wherein at least 5% of the number of discs in said stack (10) of separation discs are arranged axially above said at least one outlet conduit (3). 30
11. A centrifugal separator (1) according to any previous claim, wherein said at least one outlet conduit (30) is arranged within the upper half of the number of discs in said stack (10) of separation discs. 35

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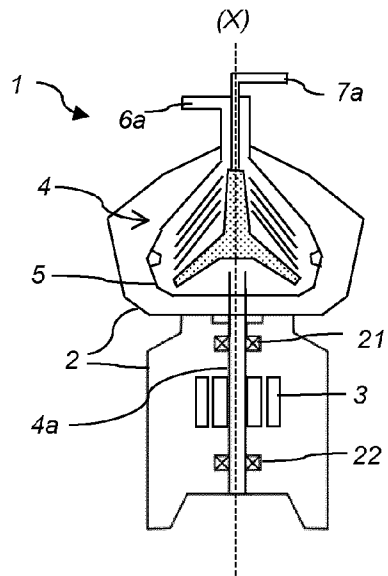


Fig. 1

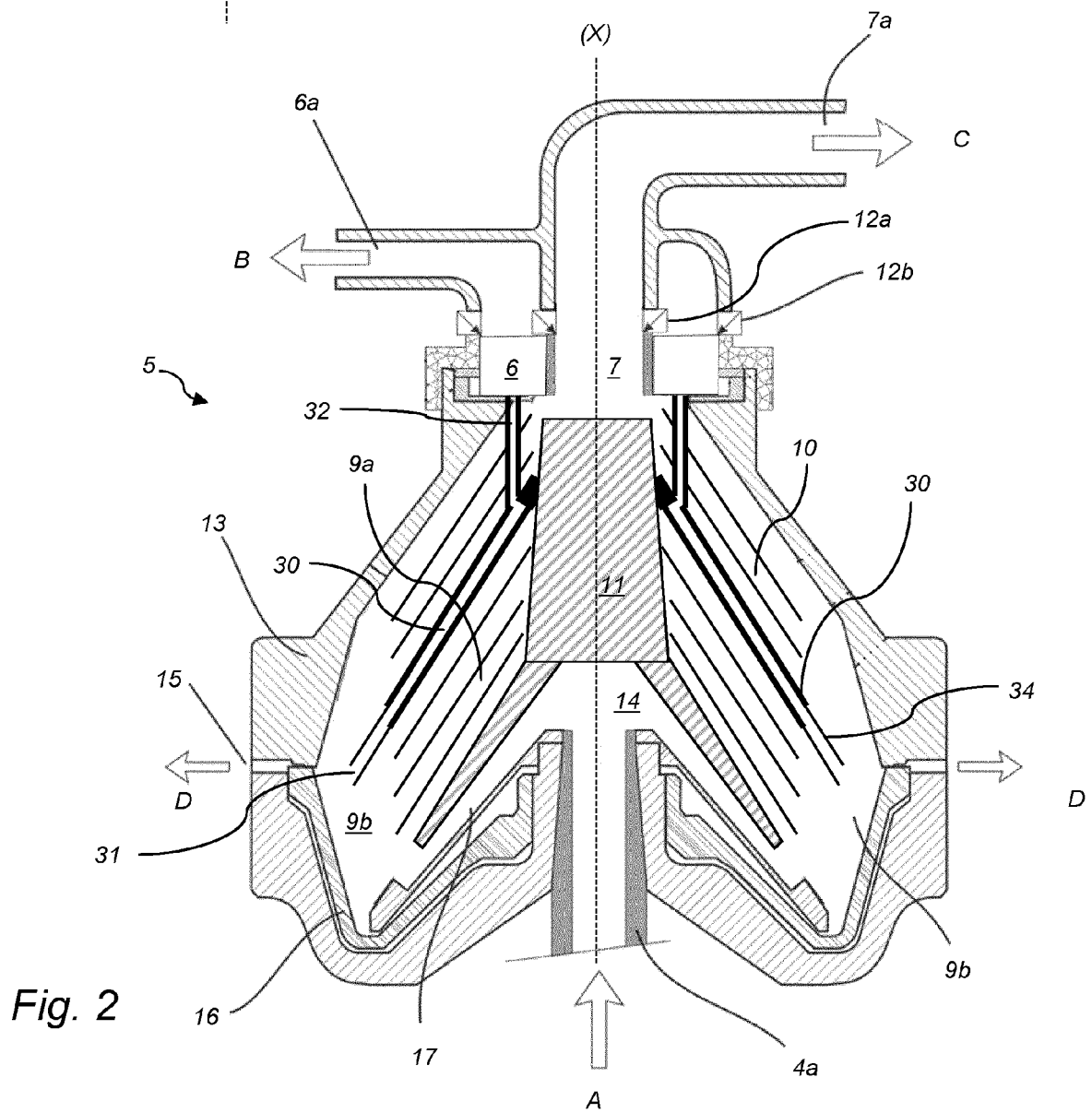
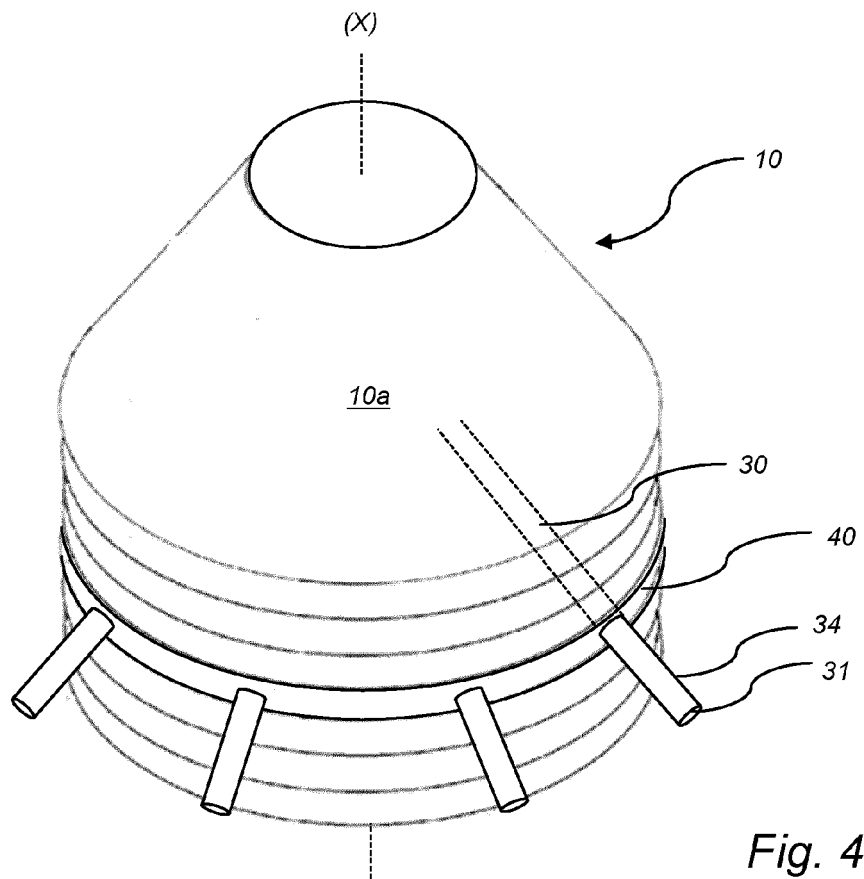
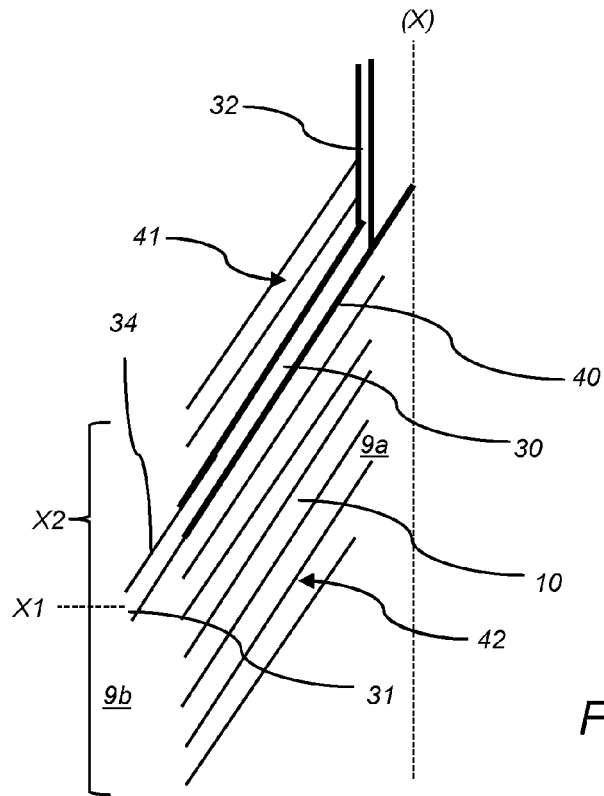


Fig. 2



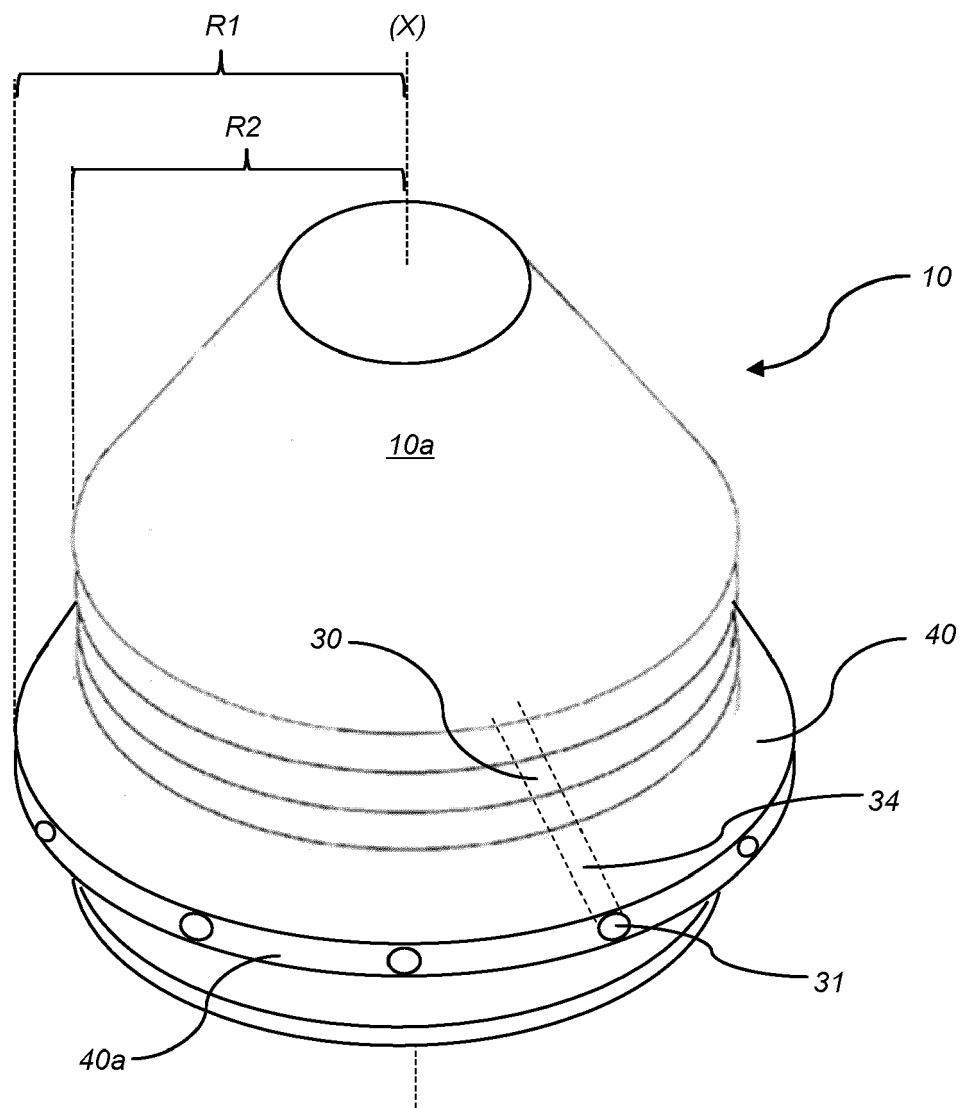


Fig. 5



EUROPEAN SEARCH REPORT

Application Number

EP 23 19 2563

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			B04B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 January 2024	Examiner Pössinger, Tobias
CATEGORY OF CITED DOCUMENTS		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	
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