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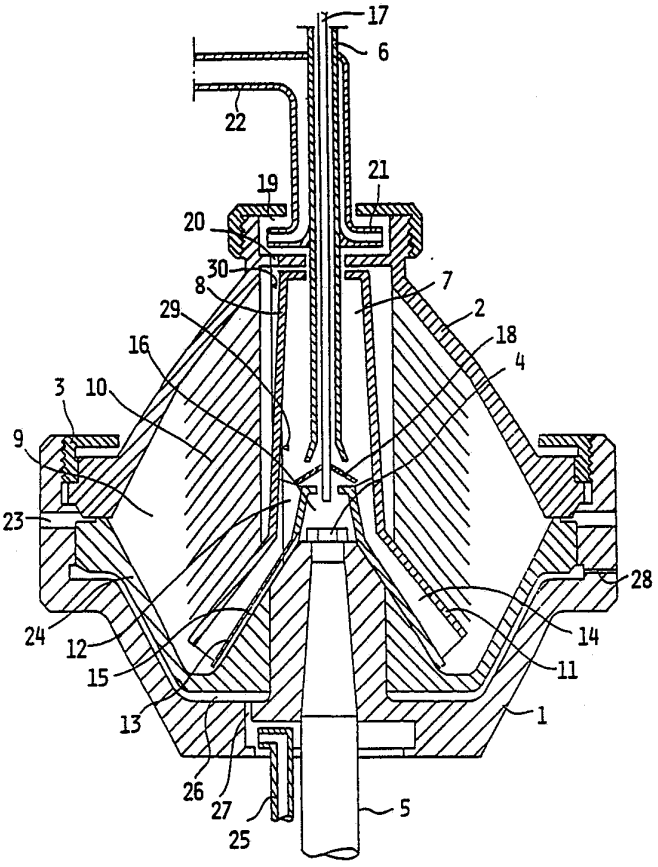
(54) Title: CENTRIFUGAL SEPARATOR WITH RECEIVING CHAMBER FOR ADDITIONAL LIQUID

(57) Abstract

In a centrifuge rotor having a separation chamber (9) and an upwardly open central inlet chamber (7) for a liquid mixture to be centrifugated, the inlet chamber (7) communicates with the separation chamber (9) through several inlet passages (14). For introduction of an additional liquid in the separation chamber (9) during rotor operation, which additional liquid has a density larger than that of the liquid present in the separation chamber (9), the rotor has a separate receiving chamber (16) confined centrally in the rotor and communicating with the separation chamber (9) through at least one channel (15) separate from said inlet passages (14). For avoiding that an emulsion is formed by the two different liquids, when additional liquid is introduced into the receiving chamber (16) through a stationary supply member (17), the walls delimiting the said channel (15) extend radially inwardly to a level inside the level, at which the liquid originally present in the rotor forms a free liquid surface in the channel (15). Thereby, the additional liquid will be brought to the same rotational speed as the rotor and the liquid present therein, before the two liquids get into contact with each other in the channel (15).

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## + DESIGNATIONS OF "SU"

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# CENTRIFUGAL SEPARATOR WITH RECEIVING CHAMBER FOR ADDITIONAL LIQUID

The present invention relates to a centrifugal separator for the separation of a liquid mixture into two components having different densities, which centrifugal separator comprises a rotor supported at the top of a vertical drive shaft and having a separation chamber and an inlet and two outlets, one central outlet and one peripheral outlet, for the respective mixture components, a stack of frusto-conical separation discs arranged in the separation chamber coaxially with the rotor, means forming centrally in the stack of separation discs an inlet chamber, which is open upwardly for receiving mixture to be separated and which through inlet passages communicates with the separation chamber, equipment for discharging the separated components out of the rotor through said outlets during rotation of the rotor, said equipment comprising first members arranged during operation of the rotor to maintain a free liquid surface at a predetermined radial level in the rotor inlet chamber and second members operable for intermittent opening and closing of the peripheral outlet, and means for introducing into the separation chamber an additional liquid having a density larger than that of the lighter one of the separated mixture components, said introducing means comprising stationary members for introducing the additional liquid centrally into the rotor and members connected with the rotor and forming a radially inwardly open receiving chamber in the rotor for receiving the additional liquid from the stationary members and at least one channel extending from the receiving chamber into the separation chamber separately from said inlet passages.

By means of a previously known centrifual separator of substantially this kind, described in DE-B-23 63 741, a liquid mixture may be separated into two different liquid components and a third component consisting substantially of solids. An

additional liquid having a density larger than that of the separated light liquid component may be introduced into the rotor either together with the liquid mixture or separately in order to displace separated light liquid component out of the separation chamber through the central outlet of the rotor for this liquid component. Normally, the additional liquid is of the same kind as the heavy liquid component separated in the rotor. In the previously known centrifugal separator the rotor has two central outlets for the respective separated liquid components. Both of these outlets are situated in the upper part of the rotor and are axially separated from each other, the outlet for separated heavy liquid component communicating with the radially outermost part of the separation chamber through an outlet channel situated above the stack of conical separation discs.

In order to avoid that additional liquid introduced into the rotor forms an emulsion in the rotor together with light liquid component separated therein it is previously known in a centrifugal separator of the kind shown in DE-B-23 63 741 to introduce the additional liquid through the central outlet of the rotor for the separated heavy liquid component. Thereby, the additional liquid may be brought to the same rotational speed as the rotor before it gets into contact with the separated light liquid component, which already rotates with the rotor speed within the separation chamber. Thus, the formation of an emulsion may be avoided in connection with the introduction of the additional liquid into the rotor, under the presumption that the outlet channel in the rotor, connecting the separation chamber with the central outlet of the rotor for separated heavy liquid component, is filled up with heavy liquid component.

Introduction of an additional liquid into a rotating centrifuge rotor is sometimes desirable even when the centrifuge

rotor has only one single central outlet for one separated liquid component of a mixture. Thus, it may be desirable to displace this liquid component radially inwardly and out of the separation chamber immediately before peripheral outlets of the rotor are opened for discharge of a separated heavier component of the mixture, for instance solids. Alternatively, or additionally, it may sometimes be desirable already at the beginning of a separating operation to introduce a small amount of additional liquid into the rotor, which shall form a layer in the radially outermost part of the separation chamber in order there to facilitate later discharge of separated heavy solids from the rotor through its peripheral outlet. There may be also other reasons for introduction of an additional liquid into a centrifuge rotor during operation, in connection with which the formation of an emulsion should be avoided between the additional liquid and a liquid already present within the rotor.

Attempts have been made to use a centrifuge rotor of the kind shown in DE-B-23 63 741 also in a case where only one liquid component is to be separated from a mixture and be discharged from the rotor through a central rotor outlet. In this case one of the central outlets of the centrifuge rotor has been used for the discharge of the separated liquid component, whereas the other central outlet has been used only for the introduction of an additional liquid into the separation chamber. However, during these attempts an undesired formation of an emulsion was obtained since, in connection with the introduction of the additional liquid into the rotor, separated liquid component was present in the radially inwardly open central chamber in the rotor, into which the additional liquid was introduced from a stationary tube or the like. It was not possible to prevent separated liquid component from flowing into this central chamber during the operation of the rotor.

Formation of an emulsion in connection with introduction of an additonal liquid into a centrifuge rotor during its operation can be substantially avoided if the additional liquid is introduced through completely closed supply means. Such means are expensive, however, and have been used hitherto only in connection with so called hermetically or semi-hermetically closed centrifuge rotors. In a centrifuge rotor of this kind the liquid mixture is introduced into the rotor without getting into contact with the surrounding atmosphere, usually through a channel extending through the rotor drive shaft. Examples of arrangements for the introduction of a liquid mixture and an additional liquid into a rotor through a hollow rotor drive shaft are shown in US-A-3,750,940 and WO 88/02663.

The object of the present invention has been to provide in connection with a so called open centrifuge rotor a means for introducing an additional liquid into the rotor separation chamber, which means is designed such that it will be cheap to produce and enable introduction of additional liquid into the rotor without formation of an emulsion therein. It should be possible to use the said means in a centrifuge rotor having only one central outlet for a separated liquid component.

This object can be obtained according to the invention in a centrifugal separator of the initially defined kind in a way such that the walls delimiting the afore-mentioned channel between the separation chamber and the said receiving chamber in the rotor extend radially inwardly past said predetermined radial level and are arranged positively to entrain in the rotor rotation additional liquid introduced into the receiving chamber through the stationary members, before the additional liquid gets into contact with separated liquid component. The supplied additional liquid will thus be acce-

lerated to the rotational speed of the rotor in the receiving chamber and in the radially innermost part of the said channel, before it meets the separated liquid component which is present in the channel at some distance from the receiving chamber.

For avoiding that solids entrained by liquid from the separation chamber into the said channel deposit on the channel walls and, thereby, jeopardize a free flow of additional liquid through the channel it is important that the walls delimiting the channel form an angle with the rotor axis at least in the part of the channel being situated radially outside of said predetermined level, up to which liquid from the separation chamber may reach at the longest.

Within the scope of the invention the centrifuge rotor may be arranged to receive additional liquid from said stationary members at different axial levels in the rotor. In a predetermined embodiment of the invention said receiving chamber is formed in the lower part of the inlet chamber, the stationary members extending into the rotor through the upper open end of the inlet chamber and further through the inlet chamber down to the receiving chamber. Thereby, no extra space has to be taken into account for the receiving chamber in the vicinity of the rotor outlet for the separated liquid component, and the rotor therefore can be given the smallest possible axial extension.

The invention is desribed in the following with reference to the accompanying drawing showing in fig 1 and 2 a preferred embodiment of the invention and in fig 3 an alternative embodiment of the invention.

Fig 1 shows a centrifuge rotor the rotor body of which comprises a lower part 1 and an upper part 2, which parts are

axially held together by means of a locking ring 3. A screw or a nut 4 keeps the rotor body fastened to the uppermost part of a vertical drive shaft 5.

A stationary inlet pipe 6 for a liquid mixture to be treated within the rotor extends from above axially into the rotor and opens in an inlet chamber 7. The inlet chamber 7 which is thus open axially upwardly is delimited centrally within the rotor by a slightly conical thin walled member 8 that is connected with the rotor body.

Between the member 8 and the rotor body parts 1 and 2 there is formed a separation chamber 9, in which there is situated a stack of frusto-conical separation discs 10 arranged coaxially with the rotor and axially spaced from each other. The separation discs turn their base portions downwardly towards the drive shaft 5.

The stack of separation discs 10 rests on a frusto-conical partition 11 formed in one piece with the lower part of the member 8 delimiting the inlet chamber 7. Through radially and axially extending wings 12, connected with the partition 11 and distributed around the rotor axis, the partition 11 rests on a hollow frusto-conical body 13, the upper part of which extends into the inlet chamber 7 immediately above the nut 4. Between the partition 11 and the body 13 a number of inlet passages 14 are delimited by means of the wings 12, said inlet passages connecting the inlet chamber 7 with the separation chamber 9.

The hollow fruso-conical body 13 rests on a central portion of the lower rotor body part 1 and has on its underside at least one radial groove 15. The cross sectional area of the groove is substantially unchanged along the length of the

groove and is substantially smaller than the cross sectional area of each of the inlet passages 14.

Between the nut 4 and the central upper part of the body 13 there is delimited a central receiving chamber 16 which through the channel formed by the groove 15 communicates with the separation chamber 9. The groove 15 has a width taking up only a small part of the circumference of the receiving chamber 16.

A narrow stationary tube 17 extends into and axially through the inlet pipe 6 to the central receiving chamber 16. The lowermost end portion of the tube 17 supports on its outside a conical flange or deflector 18, which is formed such that mixture introduced into the rotor through the inlet tube 6 is conducted into the inlet chamber 7 but is prevented from flowing into the receiving chamber 16.

In the upper part of the rotor body there is delimited a central outlet chamber 19 which through a passage 20 communicates with the separation chamber radially inside the separation discs 10. The passage 20 forms a central overflow outlet from the separation chamber 9 for a liquid separated therein.

A stationary outlet member 21, e.g. a so called paring disc, is arranged in the outlet chamber 19 for discharging separated liquid therefrom. The outlet member 21 is connected with an outlet conduit 22.

The lower rotor body part 1 has several ports 23 distributed around the rotor axis. These ports form peripheral outlets from the separation chamber, which may be kept closed or open during the rotation of the rotor. For this purpose, there is arranged within the rotor body an annular and axially movable valve slide 24, which in an upper position (shown in fig 1)

sealingly abuts against the upper rotor body part 2 in an area extending around the whole of the separation chamber 9 and in a lower position leaves a slot between itself and the upper rotor body part 2 in said area. In the lower position the separation chamber communicates with the ports 23, i.e. the peripheral outlets of the separation chamber are then open.

For operation of the valve slide 24 during rotation of the rotor hydraulic forces are used partly from liquid present in the separation chamber 9, partly from a separate operating liquid which can be supplied to the rotor body through a stationary supply pipe 25.

The valve slide 24 seals at its centre portion and at its peripheral portion radially against the lower rotor body part 1 and delimits therewith a so called closing chamber 26 for operating liquid. The closing chamber extends around the rotor axis and has at least one central supply channel 27 and at least one peripheral outlet channel 28 for operating liquid.

As long as operating liquid is supplied through the supply pipe 25 and the supply channel 27 the closing chamber 26 is kept filled with operating liquid. The outlet channel 28 is dimensioned so that this will be possible. The operating liquid by its pressure keeps the valve slide 24 in its upper position, so that the peripheral outlets 23 of the separation chamber are closed. When the peripheral outlets are to be opened, the supply of operating liquid through the supply pipe 25 is interrupted during a longer or shorter period. The closing chamber 26 then is drained completely or partly through the outlet channel 28, the valve slide 24 being pressed downwardly to its opening position by the pressure of liquid present in the separation chamber 9. When the closing

chamber is again filled with operating liquid, the valve slide 24 is pressed back to its closing position.

During operation of the rotor, when a liquid mixture is continuously supplied through the inlet pipe 6 and separated liquid is continuously removed through the outlet member 21, and the peripheral outlets 23 are closed, free liquid surfaces are formed in the various chambers of the rotor at the levels illustrated in fig 1 by small triangles. Thus, a free liquid surface is formed at 29 in the inlet chamber 7 and at 30 in the separation chamber 9.

From fig 2, showing an enlarged portion of fig 1, it can be seen that a free liquid surface is formed during rotor operation at 31 in the channel 15 that connects the receiving chamber 16 with the separation chamber 9. The liquid surface at 31 is situated at substantially the same radial level as the liquid surface at 29 in the inlet chamber 7, because the flow resistance in the inlet passages 14 is very small and no liquid flow takes place in the channel 15. The passages 14 and the channel 15 communicate with each other through the lower part of the separation chamber 9.

When after some time of operation of the centrifuge rotor a certain amount of solids in the form of a sludge has been separated in the radially outermost part of the separation chamber, the peripheral outlets 23 have to be uncovered during a short while so that the sludge can be thrown out of the separation chamber. So that separated liquid shall not be lost then through the peripheral outlets a certain amount of so called displacement liquid is introduced into the separation chamber 9, before the peripheral outlets are opened. This displacement liquid having a larger density than that of the liquid separated in the rotor is introduced through the supply pipe 17 into the receiving chamber 16. In the recei-

ving chamber 16 where entrainment members, e.g. in the form of wings or annular discs coaxial with the rotor, may be arranged the displacement liquid is gradually accelerated up to the rotational speed of the rotor. If not before so when the displacement liquid has entered the channel 15, it is thus caused to rotate with the same speed as the rotor. Only after this the displacement liquid gets into contact with the separated liquid present in the rotor, i.e. at the liquid surface 31 in the channel 15. The two different kinds of liquids will thus get into contact with each other in an area where both of them rotate with the same speed in the rotor, meaning that there is a minimum risk for the formation of an emulsion from the liquids.

The displacement liquid flows further into the separation chamber 9 through the channel 15. In the separation chamber 9 the displacement liquid collects at the periphery of the rotor radially outside the separation discs 10, and when gradually more displacement liquid is supplied the interface layer between this liquid and separated liquid moves radially inwardly in the separation chamber. The separated liquid is thus displaced towards the centre of the rotor and flows out through the outlet passage 20 and further through the outlet member 21 to the outlet conduit 22. During such displacement of the separated liquid out of the rotor the supply of mixture through the inlet pipe 6 may be interrupted, if desired.

When a sufficient amount of displacement liquid has been introduced into the rotor, the peripheral outlets 23 are uncovered during a short while, separated sludge and displacement liquid being thrown out therethrough. The channel 15 is then emptied of displacement liquid. When the peripheral outlets are again closed and normal operation of the centrifuge rotor is resumed, the channel 15 is filled with

separated liquid from the separation chamber 9 into the level 31 (fig 2).

In the above described embodiment of the invention the receiving chamber for displacement liquid is situated in the lower part of the rotor inlet chamber for mixture to be separated. In an alternative embodiment of the invention, which is to be described below with reference to fig 3, the receiving chamber for displacement liquid is, instead, situated above the inlet chamber for mixture to be separated.

Fig 3 shows a centrifuge rotor substantially of the same kind as the centrifuge rotor in fig 1. Means corresponding to each other in fig 1 and 3 have been given the same reference numerals, the letter a having been added in fig 3.

As can be seen from fig 3, there is inserted between the upper rotor body part 2a and the uppermost one of the separation discs 10a a body 13a having an annular central portion and a frusto-conical portion there-around. The frusto-conical portion has on its upper side, which abuts against the underside of the rotor body part 2, at least one radial groove 15a. The central annular portion of the body 13a delimits a radially inwardly open annular receiving chamber 16a. The groove 15a on the upper side of the body 13a forms a channel which connects the receiving chamber 16a with the separation chamber 9a. A channel 32 extends axially through the central portion of the body 13a and connects the separation chamber 9a with the passage 20a.

Axially through the inlet pipe 6a there is extending a narrower pipe 17a for displacement liquid. The pipe 17a is bent 90° at the level of the receiving chamber 16a and extends out through the wall of the inlet pipe 6a for introduction of displacement liquid into the receiving chamber 16a.

In connection with normal operation of the rotor there is formed at 31a a free liquid surface in the channel formed by the groove 15a, i.e. radially outside the receiving chamber 16a.

The working mode intended for the centrifuge rotor according to fig 3 is the same as that for the centrifuge rotor in fig 1 and 2. Thus, in both cases all of the limiting walls of the groove or the channel 15 and 15a, respectively, extend radially inside the level 31 and 31a, respectively, at which a free liquid surface is formed during normal operation of the rotor. Thereby, displacement liquid introduced into the receiving chamber 16 and 16a, respectively, will safely be brought to the same rotational speed as the rotor before it gets into contact with liquid having been separated in the rotor and being present in the groove or the channel 15 and 15a, respectively. As mentioned before there may be several grooves or channels 15.

As can be seen from fig 1 (and fig 3) there is formed at 29 in the inlet chamber 7 a free liquid surface which is situated somewhat radially inside of the free liquid surface at 30 in the separation chamber 9. The radial difference between the levels of these liquid surfaces depends substantially on the flow resistance encountered by separated liquid at its radial flow through the stack of separation discs 10.

It has been mentioned above that separate entrainment members in the form of wings, e.g. similar to the wings 12 in fig 1 and 2, may be arranged in the receiving chamber 16. Several wings of this kind distributed around the rotor axis may extend in a particular embodiment of the invention radially and axially in an annular space all the way from the receiving chamber 16 to the separation chamber 9 and, thus, deli-

mit between themselves channels corresponding to the channels 15 and 15a in fig 1 and fig 3, respectively.

Claims

1. Centrifugal separator for separation of a liquid mixture into at least two components having different densities, comprising

- a rotor (1,2) which is supported at the top of a vertical drive shaft (5) and which has a separation chamber (9) and an inlet (6) and two outlets, one central outlet (21) and one peripheral outlet (23), for the respective separated mixture components,

- a stack of frusto-conical separation discs (10) arranged in the separation chamber (9) coaxially with the rotor,

- means (8) forming centrally in the stack of separation discs (10) an inlet chamber (7) which is open upwardly for receiving mixture to be separated and communicating through inlet passages (14) with the separation chamber (9),

- equipment for discharging the separated components from the rotor through said outlets during rotation of the rotor, said equipment comprising first members (20) arranged during the rotor operation to maintain a free liquid surface at a predetermined radial level (29) in the inlet chamber (7) of the rotor and second members (24) arranged for intermittent opening and closing of the peripheral outlet (23), and

- means for introducing into the separation chamber (9) an additional liquid having a density larger than that of the lighter one of the separated mixture components, said introducing means comprising stationary members (17) for introducing the additional liquid centrally into the rotor and members (13) connected with the rotor and forming a

radially inwardly open receiving chamber (16) within the rotor for receiving the additional liquid from the stationary members (17), at least one channel (15) extending from the receiving chamber (16) into the separation chamber (9) separately from said inlet passages (14),

c h a r a c t e r i z e d i n

that the walls delimiting said channel (15) extend radially inwardly past said predetermined radial level (29) and are arranged positively to entrain in the rotor rotation additional liquid introduced into the receiving chamber (16) through the stationary members (17), before the additional liquid gets into contact with separated light mixture component.

2. Centrifugal separator according to claim 1, c h a r a c t e r i z e d i n

- that the frusto-conical separation discs (10) are arranged with their base portions facing downwardly towards the drive shaft (5),

- that the channel (15) extending between the receiving chamber (16) and the separation chamber (9) is formed below the stack of separation discs (10), and

- that the stationary members (17) for introducing additional liquid into the rotor extend into the inlet chamber (7) through the upper open end thereof.

3. Centrifugal separator according to claim 1 or 2, c h a r a c t e r i z e d i n that the receiving chamber (16) in the rotor is formed in the lower part of the inlet

chamber (7) and constitutes an upwardly open space which otherwise is separated from the inlet chamber (7).

4. Centrifugal separator according to claim 3, c h a r a c h t e r i z e d i n that a stationary pipe (17) for the introduction of additional liquid into the rotor extends into said space through the upper open end of the inlet chamber (7).

5. Centrifugal separator according to any one of the preceding claims, c h a r a c t e r i z e d b y a stationary inlet pipe (6) arranged for the introduction of a mixture into the inlet chamber (7) of the rotor at a first axial level in the rotor and a further pipe (17) extending through the inlet pipe (6) and arranged for introducing additional liquid at an axially lower level in the rotor.

6. Centrifugal separator according to claim 1 or 2, c h a r a c t e r i z e d i n that the extension of the channel (15) around the rotor axis, i.e. the width of the channel, constitutes only a small part of the extension of the receiving chamber (16) in the same direction.

7. Centrifugal separator according to claim 1 or 2, c h a r a c t e r i z e d i n that the rotor has several channels (15) for introducing into the separation chamber (9) additional liquid received from said stationary member (17), which channels (15) are distributed around the rotor axis and are delimited between several wings extending radially and axially in the rotor.

8. Centrifugal separator according to claim 7, c h a r a c t e r i z e d i n that the wings extend radially inwardly into the receiving chamber (16).

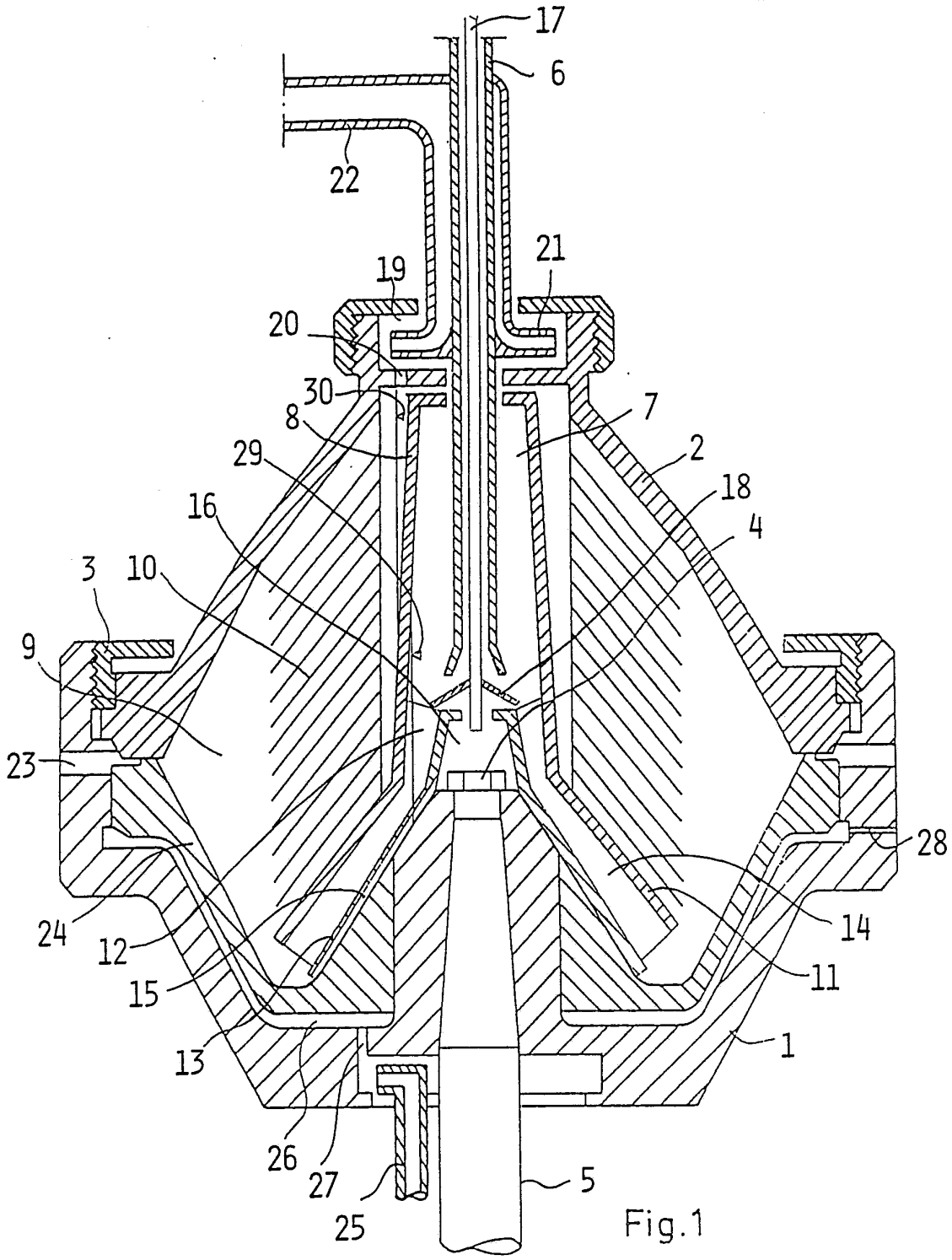
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Fig.1

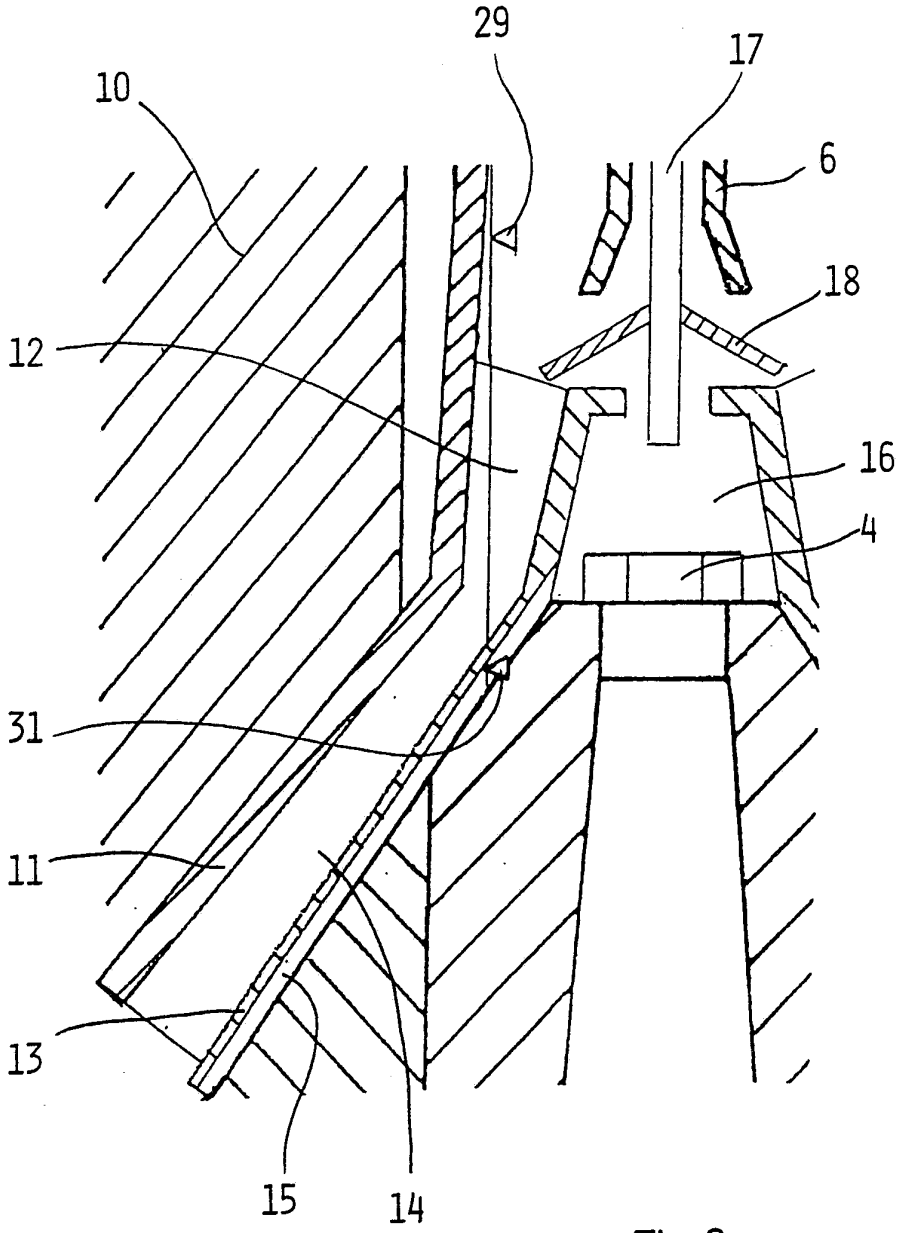


Fig. 2

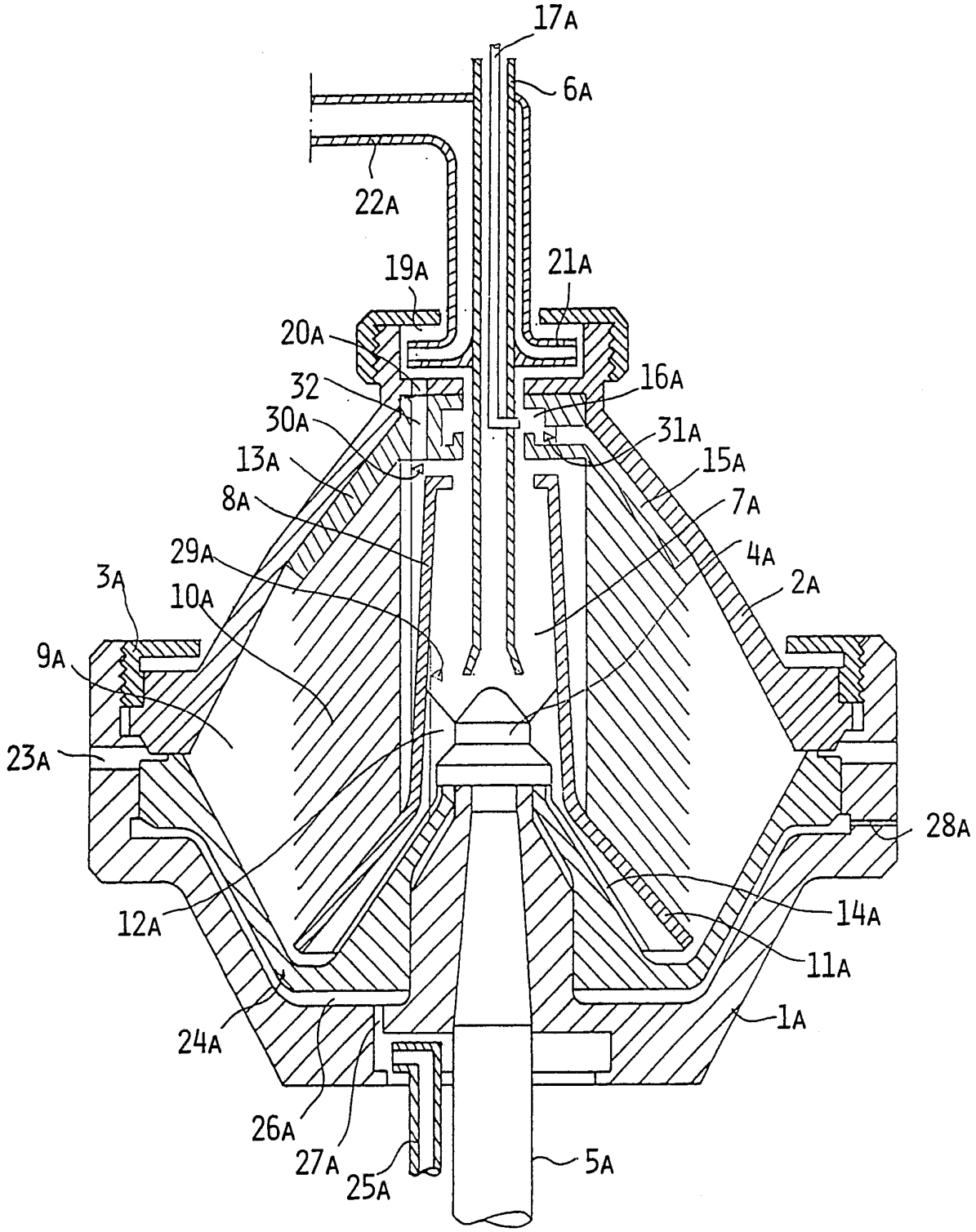
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Fig.3

# INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 91/00674

**I. CLASSIFICATION OF SUBJECT MATTER** (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: B 04 B 1/14, 11/06

**II. FIELDS SEARCHED**

Minimum Documentation Searched[7]

| Classification System | Classification Symbols |
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Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

**III. DOCUMENTS CONSIDERED TO BE RELEVANT**[9]

| Category * | Citation of Document,[11] with indication, where appropriate, of the relevant passages[12] | Relevant to Claim No.[13] |
|---|---|---|
| A | US, A, 4840612 (PALLMAR) 20 June 1989, see abstract; figure 1 -- | 1 |
| A | US, A, 3938734 (WILKE) 17 February 1976, see abstract; figure 1 -- | 1 |
| A | US, A, 1921181 (H.W. FAWCETT) 8 August 1933, see figure 1 -- | 1-8 |
| A | US, A, 1866638 (H.W. FAWCETT) 12 July 1932, see figure 1 -- | 1-8 |
| A | US, A, 1411782 (S.H. HALL) 4 April 1922, see the whole document -- | 1-8 |

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**IV. CERTIFICATION**

| Date of the Actual Completion of the International Search | Date of Mailing of this International Search Report |
|---|---|
| 16th January 1992 | 1992 -01- 13 |
| **International Searching Authority** | **Signature of Authorized Officer** |
| SWEDISH PATENT OFFICE | Åsa Fransson |

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

| Category * | Citation of Document, with indication, where appropriate, of the relevant passages | Relevant to Claim No |
|---|---|---|
| A | DE, A1, 3147613 (KLÖCKNER-HUMBOLDT-DEUTZ AG) 9 June 1983, see figure 1 -- | 1-8 |
| A | DE, A, 1140144 (WESTFALIA SEPARATOR A.G.) 22 November 1962, see the whole document -- | 1-8 |
| A | GB, A, 366703 (AKTIEBOLAGET SEPARATOR) 11 February 1932, see figure 1 -- | 1-8 |

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# ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/SE 91/00674

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 30/11/91 The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

| Patent document cited in search report | Publication date | Patent family member(s) | | Publication date |
|---|---|---|---|---|
| US-A- 4840612 | 89-06-20 | EP-A-B- | 0300618 | 89-01-25 |
| | | JP-A- | 1027655 | 89-01-30 |
| | | SE-B-C- | 458507 | 89-04-10 |
| | | SE-A- | 8702612 | 88-12-25 |
| US-A- 3938734 | 76-02-17 | DE-A- | 2363741 | 75-07-31 |
| | | FR-A-B- | 2255109 | 75-07-18 |
| | | GB-A- | 1491036 | 77-11-09 |
| | | JP-A- | 50095862 | 75-07-30 |
| US-A- 1921181 | 33-08-08 | BE-A- | 380341 | 00-00-00 |
| | | FR-A- | 718207 | 00-00-00 |
| US-A- 1866638 | 32-07-12 | DE-C- | 596797 | 00-00-00 |
| | | FR-A- | 703950 | 00-00-00 |
| | | GB-A- | 330958 | 00-00-00 |
| | | GB-A- | 344464 | 00-00-00 |
| US-A- 1411782 | 22-04-04 | NONE | | |
| DE-A1- 3147613 | 83-06-09 | NONE | | |
| DE-A- 1140144 | 62-11-22 | NONE | | |
| GB-A- 366703 | 32-02-11 | NONE | | |