

COMMONWEALTH OF AUSTRALIA

Patents Act 1952-1969

DECLARATION IN SUPPORT OF A CONVENTION
APPLICATION FOR A PATENT OR PATENT OF ADDITION

(1) Here
insert (in
full) Name of
Company.

In support of the Convention Application made by⁽¹⁾.....
Alfa-Laval Separation AB

(2) Here
insert title
of Invention.

(hereinafter referred to as the applicant) for a Patent

for an invention entitled:⁽²⁾.....
METHOD AND APPARATUS FOR REDUCTION OF THE
PRESSURE IN A LIQUID MIXTURE

(3) Here
insert full Name
and Address
of Company
official
authorized
to make
declaration.

I,⁽³⁾ Ingemar Clivemo
of Backsvalevägen 30
S-140 32 Grödinge, Sweden

do solemnly and sincerely declare as follows:

1. I am authorised by the applicant for the patent
to make this declaration on its behalf.

(4) Here
insert basic
Country or
Countries
followed by
date or dates
and basic
Applicant or
Applicants.

2. The basic application as defined by Section 141 of the Act was
made in⁽⁴⁾.....
on the 28th day of November 19 86, by
Alfa-Laval Separation AB
~~on the~~ ~~xx day~~ of ~~xx 19~~ ~~xx~~ by

(5) Here
insert (in
full) Name
and Address
of Actual
Inventor or
Inventors.

3.⁽⁵⁾ Kjell Klintenstedt
Sjöängsvägen 16
S-132 00 Saltsjö-Boo
Sweden

is/are the actual inventor of the invention and the facts upon which the applicant
is entitled to make the application are as follow:

The applicant is the assignee of the said inventor

4. The basic application referred to in paragraph 2 of this Declaration
was.....the first application made in a Convention country in
respect of the invention the subject of the application.

DECLARED at Tumba, Sweden
this 9th day of February 1989

161 *L. M. ...*

(12) PATENT ABRIDGMENT (11) Document No. AU-B-83386/87
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 600784

(54) Title
METHOD AND APPARATUS FOR REDUCTION OF THE PRESSURE IN A LIQUID MIXTURE

International Patent Classification(s)
(51)⁴ E21B 043/34 G05D 016/00

(21) Application No. : 83386/87

(22) Application Date : 16.11.87

(87) WIPO Number : WO88/03984

(30) Priority Data

(31) Number	(32) Date	(33) Country
8605117	28.11.86	SE SWEDEN

(43) Publication Date : 16.06.88

(44) Publication Date of Accepted Application : 23.08.90

(71) Applicant(s)
ALFA-LAVAL SEPARATION AB

(72) Inventor(s)
KJELL KLINTENSTEDT

(74) Attorney or Agent
WATERMARK MELBOURNE

(56) Prior Art Documents
US 4326863
US 4626237

(57) Claim

i. A method of reducing pressure in a liquid mixture of hydrocarbon compounds, characterized in
- that the liquid mixture is supplied into a chamber formed within a rotating vessel such that the liquid mixture is supplied to the chamber, the liquid mixture being supplied to the vessel with a predetermined pressure at an area at or adjacent to a rotational axis of the vessel and being conducted further through a channel radially outward in the vessel to said first radial level in a way such that the pressure of the liquid mixture will not be substantially lower than said predetermined pressure, and the pressure of the liquid mixture, when it reaches said first radial level, will be substantially lower than it would be if the liquid mixture in the channel would be allowed to flow freely therein and simultaneously be substantially entrained in the rotation of the vessel,

- that the liquid mixture supplied to the chamber is brought in rotation therein by means of the vessel,
- that a free liquid surface of the rotating liquid mixture in the chamber is maintained at a second level radially inside said first level,
- that a gas pressure lower than said predetermined pressure is maintained in a liquid free part of the chamber,
- that liquid is removed from the chamber at a level radially inside said first level, and
- that gas is removed from the liquid free part of the chamber.

5. Apparatus for for reducing pressure in a liquid mixture from a predetermined pressure, characterized by

- a rotatable vessel defining a chamber,
- means for rotation of the vessel,
- an inlet device for supplying a liquid mixture into the chamber at a first radial level therein, said device defining at least one channel extending from an area at or adjacent to a rotational axis of the vessel to said first radial level, said device further being arranged to prevent such a pressure increase in the liquid mixture in the channel that would be a consequence of allowing the liquid mixture to flow freely in the channel or channels and simultaneously be completely entrained is the rotation of the vessel,
- members connected with the vessel and arranged for entraining liquid mixture in the chamber in the rotation of the vessel,
- means for maintaining a free liquid surface of the liquid mixture in the chamber at a second level radially inside said first level, - means for discharging liquid mixture

(11) AU-B-83386/87
(10) 600784

-3-

from the chamber at a level radially inside said first level,

- means for discharging gas from a liquid free part of the chamber, and
- equipment for maintaining a gas pressure in the liquid free part of the chamber that is lower than said predetermined pressure.

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION

600784



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 :

E21B 43/34, G05D 16/00

A1

(11) International Publication Number:

WO 88/ 03984

(43) International Publication Date:

2 June 1988 (02.06.88)

(21) International Application Number: PCT/SE87/00535

(22) International Filing Date: 16 November 1987 (16.11.87)

(31) Priority Application Number: 8605117-4

(32) Priority Date: 28 November 1986 (28.11.86)

(33) Priority Country: SE

(71) Applicant (for all designated States except US): ALFA-LAVAL SEPARATION AB [SE/SE]; Box 500, S-147 00 Tumba (SE).

(72) Inventor; and

(75) Inventor/Applicant (for US only): KLINTENSTEDT, Kjell [SE/SE]; Sjöängsvägen 16, S-132 00 Saltjö-Boo (SE).

(74) Agent: CLIVEMO, Ingemar; Alfa-Laval AB, Box 500, S-147 00 Tumba (SE).

(81) Designated States: AT (European patent), AU, BE (European patent), BJ (OAPI patent), BR, CF (OAPI patent), CG (OAPI patent), CH (European patent), CM (OAPI patent), DE (European patent), DK, FR (European patent), GA (OAPI patent), GB (European patent), IT (European patent), JP, KR, LU (European patent), ML (OAPI patent), MR (OAPI patent), NL (European patent), NO, SE (European patent), SN (OAPI patent), SU, TD (OAPI patent), TG (OAPI patent), US.

Published

With international search report.

A.O.I.P. 21 JUL 1988

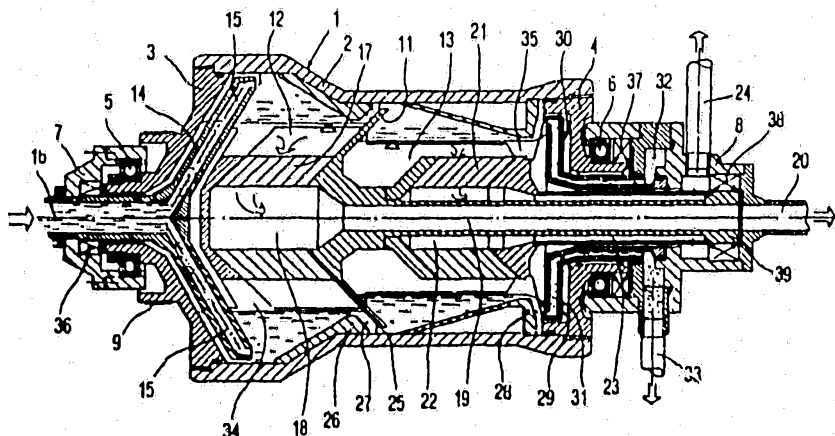
AUSTRALIAN

16 JUN 1988

PATENT OFFICE

This document contains the amendments made under Section 49 and is correct for printing.

(54) Title: METHOD AND APPARATUS FOR REDUCTION OF THE PRESSURE IN A LIQUID MIXTURE



(57) Abstract

In connection with reduction of the pressure of newly produced oil, i.e. a mixture of hydrocarbon compounds, this conventionally is performed stepwise, a momentary pressure drop occurring at each stage. According to the invention it is suggested that oil is caused to flow radially inward in a chamber (12), which is formed by a rotating vessel (1) and which is only partly filled with rotating oil, whereby the pressure drop in the oil can occur relatively slowly. A free liquid surface is maintained in the chamber (12), and a certain gas pressure is maintained in the liquid free part thereof, while evaporated hydrocarbon compounds are removed through a central gas outlet (18). By means of a special inlet device (14; 3a, 4ⁿ) it is prevented that the pressure in the oil, when it is on its way through the channel (15; 41) radially outward in the vessel (1) to the level, from which it is to flow radially inward, increases in the way that would happen if the oil would be allowed to flow freely in the channel and simultaneously be completely entrained in the rotation of the vessel.

Method and apparatus for reduction of the pressure in a liquid mixture.

The present invention relates to a process for reduction of the pressure in a liquid mixture of hydrocarbon compounds. Such a process is to be found in connection with oil production, when oil flows up of a drill hole with an overpressure which is often
5 very large, for instance in the order of 75-100 bar. The composition of the oil may vary from one oil source to another. For instance the following relatively easily volatile hydrocarbon compounds may be present in the oil: methane, ethane, propane, butane, isobutane, pentane, isopentane and hexane.

10 If the pressure in newly produced oil is reduced momentarily to substantially atmospheric pressure, a large part of the easily volatile hydrocarbon compounds therein will be evaporated. For several reasons this is not desirable. It has proved, however,
15 that the amount of hydrocarbon compounds being evaporated in connection with reduction of the oil pressure may be reduced substantially, if the pressure reduction is performed stepwise. Thus, in practice a method is used in which the pressure reduction is performed in 3-5 steps. Between the pressure
20 reductions, which are performed momentarily in that oil is passed through throttles, the oil is caused to flow through a container in which it exposes a free liquid surface towards a space which contains evaporated hydrocarbon compounds at a thoroughly determined pressure. The evaporated hydrocarbon
25 compounds are removed continuously from the respective containers without the pressures therein being reduced below the predetermined pressures.

30 It is considered that if the pressure reduction of the oil could be performed in the described manner in even more and smaller steps, even more oil would remain in a liquid form. The additional cost for equipment for reducing the oil pressure in more than 3-5 steps has been considered higher than the profit
35 possible to obtain, however.

The object of the present invention is to provide a new method and an apparatus for reducing the pressure in newly produced oil, i.e. in a liquid mixture of hydrocarbon compounds, enabling that a larger part of the oil can be maintained in a liquid form to acceptable costs.

Accordingly, the present invention provides a method of reducing pressure in a liquid mixture of hydrocarbon compounds, characterized in

- that the liquid mixture is supplied into a chamber formed within a rotating vessel such that the liquid mixture is supplied to the chamber, the liquid mixture being supplied to the vessel with a predetermined pressure at an area at or adjacent to a rotational axis of the vessel and being conducted further through a channel radially outward in the vessel to said first radial level in a way such that the pressure of the liquid mixture will not be substantially lower than said predetermined pressure, and the pressure of the liquid mixture, when it reaches said first radial level, will be substantially lower than it would be if the liquid mixture in the channel would be allowed to flow freely therein and simultaneously be substantially entrained in the rotation of the vessel,
- that the liquid mixture supplied to the chamber is brought in rotation therein by means of the vessel,
- that a free liquid surface of the rotating liquid mixture in the chamber is maintained at a second level radially inside said first level,
- that a gas pressure lower than said predetermined pressure is maintained in a liquid free part of the chamber,
- that liquid is removed from the chamber at a level radially inside said first level, and
- that gas is removed from the liquid free part of the chamber.



By this invention it is possible to avoid the liquid mixture being subjected to momentary pressure drops. Instead, the pressure in the liquid mixture may be reduced relatively slowly, while a free liquid surface of the liquid mixture is maintained in contact with evaporated hydrocarbon compounds at a desired pressure and at a desired temperature. Within the scope of the invention several chambers of the described kind may be coupled in series, gradually lower gas pressures being maintained in the chambers.

The pressure in the liquid mixture may be reduced by bringing the liquid mixture to flow radially inward in a rotating vessel, i.e. by subjecting it to a gradually decreasing centrifugal force. Further, according to the invention, the liquid mixture on its way to the treatment chamber in the vessel should be prevented from being influenced by the rotation of the vessel in the same way as the liquid mixture which is already present within the chamber. In other words it has to be prevented that the pressure in the liquid mixture, when it is on its way radially outward in the vessel, increases in the way that would happen if the liquid mixture would be allowed to flow freely and simultaneously be entirely entrained in the rotation of the vessel. In order to avoid that the liquid mixture is influenced in this way by centrifugal forces on its way into the treatment chamber of the vessel, i.e. before it is introduced into the chamber at said first radial level, the liquid mixture may be supplied in different ways.

According to one example of performing the method according to the invention the liquid mixture may be conducted into the chamber through a channel in a stationary member, which extends centrally into the rotating vessel and further radially outward therein via the liquid free part of the chamber and into the liquid body rotating in the chamber.



According to another example of performing the method according to the invention the liquid mixture may be conducted into the treatment chamber through means rotatable together with the vessel and forming a substantially annular channel extending from an area near the rotational axis of the vessel to said first radial level in the chamber, said channel being substantially free of entrainment members, so that the liquid mixture flowing through the channel during the rotation of the vessel is only insignificantly entrained in the rotation of the vessel.

The present invention also provides apparatus for reducing pressure in a liquid mixture from a predetermined pressure, characterized by

- a rotatable vessel defining a chamber,
- means for rotation of the vessel,
- an inlet device for supplying a liquid mixture into the chamber at a first radial level therein, said device defining at least one channel extending from an area at or adjacent to a rotational axis of the vessel to said first radial level, said device further being arranged to prevent such a pressure increase in the liquid mixture in the channel that would be a consequence of allowing the liquid mixture to flow freely in the channel or channels and simultaneously be completely entrained is the rotation of the vessel,
- members connected with the vessel and arranged for entraining liquid mixture in the chamber in the rotation of the vessel,
- means for maintaining a free liquid surface of the liquid mixture in the chamber at a second level radially inside said first level,



3b

- means for discharging liquid mixture from the chamber at a level radially inside said first level,
- means for discharging gas from a liquid free part of the chamber, and
- equipment for maintaining a gas pressure in the liquid free part of the chamber that is lower than said predetermined pressure.

5

10

Preferred embodiments of the present invention are hereinafter described with reference to the accompanying drawings, in which figure 1 shows a

15

20

25

30

35

SKP:EK(12.37)



~~free of entrainment members, so that the liquid mixture flowing~~
through the channel during the rotation of the vessel is only
insignificantly entrained in the rotation of the vessel.

- 5 The invention is described more closely in the following with
~~reference to the accompanying drawing, in which fig. 1 shows a~~
rotatable vessel being a part of an apparatus according to the
invention, fig. 2 shows a modified inlet device in a rotatable
vessel according to fig. 1, and fig. 3 schematically shows the
10 whole apparatus according to the invention.

In fig. 1 there is shown a vessel 1 of a rotational symmetrical
shape comprising a surrounding wall 2 and two end walls 3 and 4.
By means of bearings 5 and 6 the vessel is rotatably supported
15 by two stationary support members 7 and 8. Via a driving device
9 the vessel is rotatably coupled to a driving motor 10
(fig. 3).

By an annular partition 11 within the vessel 1 the interior
20 thereof is divided in two chambers 12 and 13. In the chamber 12
there is placed an annular stationary inlet member 14, which has
several separate inlet channels 15 extending from the rotational
axis of the vessel to the vicinity of the surrounding wall 2 of
the vessel, where they open into the chamber 12. The inlet
25 member 14 at its centre has a cylindrical part, extending out of
the vessel 1 and having a central inlet channel 16, with which
all of the channels 15 are communicating.

Within the chamber 12 the vessel 1 supports centrally a stack
30 of conical discs 17 arranged coaxially with the vessel at some
axial distance from each other. The discs 17 surround a free
space 18, which through the disc interspaces communicates with
the chamber 12 and through a first gas outlet channel 19
communicates with a first gas outlet 20 in the stationary
35 supporting member 8.



Within the chamber 13 the vessel 1 supports centrally a further stack of conical discs 21 similar to the discs 17 in the chamber 12. The discs 21 surround a free space 22, which through the disc interspaces communicates with the chamber 13 and through a second gas outlet channel 23 communicates with a second gas outlet 24 in the supporting member 8.

The chambers 12 and 13 communicate with each other via an annular gap 25, which is formed between the surrounding wall 2 of the vessel and the partition 11. The slot 25 is situated at a level in the vessel 1 radially inside of the openings of the inlet channels 15 in the chamber 12.

On its inside in the chamber 12 the surrounding wall 2 supports an annular threshold member 26. The radially innermost portion of this threshold member is situated close to and radially somewhat inside of the connecting slot 25 between the chambers 12 and 13. Between the threshold member 26 and the partition 11 there is formed an annular passage 27.

In the chamber 13 the surrounding wall 2 of the vessel supports a further annular threshold member 28. The radially innermost portion of this threshold member is situated at a level radially inside of the slot 25. Between the threshold member 28 and the end wall 4 of the vessel there is formed an annular groove 29, which is open radially inward. Out into the groove 29 there is extending a stationary annular outlet member 30 arranged coaxially with the vessel 1. The outlet member 30, which is connected with the supporting member 8, has one or more outlet channels 31. These extend from one or more openings in the outlet member 30 at the area of the groove 29 radially inward and further out of the vessel 1 to an outlet chamber 32 in the supporting member 8. An outlet conduit 33 is connected to the supporting member 8.

In the chamber 12 the member supporting the conical discs 17 is supported radially by the surrounding wall 2 of the vessel through several radially and axially extending wings 34, which are evenly distributed around the rotational axis of the vessel. These wings also form entrainment members in the chamber 12, so that the liquid mixture supplied to the chamber is given the rotational movement of the vessel. Similar wings 35 are present in the chamber 13.

For sealing of the chambers 12 and 13 from the surrounding of the vessel there are sealing members 36 between the supporting member 7 and the end wall 3, sealing members 37 between the supporting member 8 and the end wall 4 and sealing members 38 between the supporting member 8 and a central pipe 39 forming the above said gas outlet channel 19 from the chamber 12.

In fig. 2 there is shown an alternative embodiment of the inlet device of the vessel 1 for liquid mixture. Details in fig. 2 which have identical counterparts in fig. 1 have the same reference numerals as in fig. 1. Details in fig. 2, which have counterparts in fig. 1 but which as to their form are somewhat modified, have the same reference numerals as in fig. 1 with the addition of letter a.

The inlet device in fig. 2 comprises a conical partition 40 which through wings 34a is connected with the surrounding wall 2 of the vessel and, thereby, is arranged to rotate with the vessel 1. Between the end wall 3a of the vessel and the partition 40 there is formed an annular channel 41. The channel 41 communicates at the vessel axis with a central channel 42 formed by a cylindrical portion of the end wall 3a and in turn communicating with an inlet channel 16a, which is defined by the supporting member 7a.

In fig. 3 an apparatus according to the invention is shown schematically. Thus the rotatable vessel 1 is shown with its driving device 9, 10, its inlet channel 16 for liquid mixture, the gas outlets 20 and 24 and the outlet conduit 33 for liquid mixture.

The gas outlet 20 contains a control device 43 of a conventional kind for maintaining of a certain predetermined gas overpressure in the chamber 12 of the vessel. The gas outlet 24 contains a similar control device 44 for maintaining of a predetermined lower gas overpressure in the other chamber 13 of the vessel.

The liquid outlet conduit 33 contains a counter pressure device 45, by means of which a desired counter pressure may be set for the liquid flow out through the outlet member 30.

The apparatus according to the invention operates in the following manner with an inlet device in the vessel 1 of the kind shown in fig. 1. It is assumed that the vessel 1 is rotating and that the inlet channel 16 is connected to an overpressure source for a liquid mixture of hydrocarbon compounds.

With the pressure it has in the inlet channel 16 the liquid mixture is conducted further through the radial channels 15 and out into the chamber 12 near the surrounding wall 2 of the vessel. In this part of the chamber 12 the liquid mixture is given the same rotational speed as the vessel 1 by means of the wings 34. Between the wings 34 the liquid mixture flows radially inward and axially in the chamber 12, passes over the threshold member 26 and leaves the chamber 12 via the slot 27. When the liquid mixture enters the chamber 13 it flows further on between the wings 35 radially inward and axially towards the outlet member 30. In the chamber 13 the threshold member 28 forms an

overflow outlet for the liquid mixture, before it enters the groove 29. Through the channels 31 in the stationary member 30 the liquid mixture leaves the chamber 13. By means of the counter pressure device 45 (fig. 3) the counter pressure in the outlet conduit 33 is set such that all the liquid mixture flowing over into the groove 29 will be discharged out through the outlet member 30 without causing the free liquid surface in the groove 29 to move radially inside of the threshold member 28.

Hereby, the threshold member 28 will maintain a free liquid surface in the chamber 13 at the same level as its radially innermost portion. The pressure from a liquid column, which will thereby be present within the chamber 13 radially inside of the connecting slot 25 between the chambers 12 and 13, as well as the overpressure from the gas (evaporated hydrocarbons) present in the chamber 13 and acting on the free liquid surfaces therein, will determine the position of the free liquid surface formed in the chamber 12. The counter pressure in the slot 25 from the chamber 12 is constituted by the overpressure of the gas (evaporated hydrocarbons), which is present in the liquid free part of the chamber 12, and the pressure of the liquid column formed in the chamber 12 between the free liquid surfaces therein and the slot 25.

The liquid mixture having been supplied to the vessel 1 via the inlet channel 16 will maintain substantially its pressure while it is flowing through the channels 15 and into the chamber 12. The pressure of the rotating liquid in the chamber 12 near the openings of the channels 15 therein will thus be adjusted such that it substantially corresponds to the pressure of the liquid mixture in the inlet channel 16. If said pressure of the rotating liquid is too high, the liquid mixture can not flow into the chamber 12. If the pressure is too low, a pressure drop may arise in the liquid mixture on its way through the channels

15, resulting in an undesired evaporation of hydrocarbons in these channels.

After the liquid mixture has entered the chamber 12 it flows
5 radially inward and axially towards the passage 27. During this
course the liquid mixture is subjected to a gradual pressure
drop, part of its content being evaporated and leaving the
vessel through the central part of the chamber 12. Possibly
10 entrained liquid drops are separated in the passages between the
conical discs 17 and are thrown back to the free liquid surface
in the chamber 12.

Still entrained in rotation by the wings 34, which extend even
through the passage 27, the liquid mixture flows further on
15 through the passage 27 and the slot 25 into the radially
outermost part of the chamber 13. In the slot 27 the pressure
is somewhat increasing in the liquid mixture, but in the chamber
13 it is decreasing again, when the liquid mixture flows
radially inward and axially toward the outlet member 30.
20 A further part of the liquid mixture is then evaporated in the
chamber 13 and is discharged via its liquid free part from the
vessel 1.

After its passage of the threshold member 28 the liquid mixture
25 will go on rotating in the groove 29 entrained by the wings 35
which extend into a part of the groove. The pressure in the
rotating liquid mixture as well as the gas pressure in the
chamber 13 are accomplishing a liquid transport radially inward
in the channels 31 of the stationary outlet member 30 and further
30 out through the outlet member 32 and the outlet conduit 33.
Possibly the outlet member 30 may be formed as a paring member
in the groove 29, so that even the movement of the liquid
mixture in the peripheral direction of the groove may be used
for the liquid transport through the outlet channels 31.

The inlet device according to fig. 2 operates in the following manner.

5 The liquid mixture entering through the channel 16a with a predetermined overpressure flows further on through the annular channel 41 into the chamber 12a. In the channel 41 thin border layers of the liquid mixture will be caused to rotate by the end wall 3a of the vessel and the partition 40, whereas the main part of the liquid will not be given any substantial rotational movement. It is thus possible even by means of this inlet device to maintain substantially the same overpressure in the liquid mixture during its flow from the central inlet channel 16a into the chamber 12a, where the liquid mixture is rotating with the vessel 1.

15 For accomplishing the best possible flow conditions, when the liquid mixture flows into the chamber 12 or 12a, respectively, different arrangement can be used. For instance, at an inlet device according to fig. 1 the openings of the inlet channels 16 into the chamber 12 may be turned in the rotational direction of the vessel 1. At an inlet device according to fig. 2 there can be arranged in the radially outermost part of the channel 41 a number of conical, annular discs - coaxial with the vessel 1 and rotatable therewith - which form between themselves relatively narrow annular passages for the incoming liquid mixture. The function of such discs is that they would successively increase the contact surface between the liquid mixture and rotating surfaces in the vessel for avoiding too heavy chocks at the acceleration of the liquid mixture to full rotational speed at the transfer between the channel 41 and the chamber 12a.

A rotatable vessel has been described above containing two chambers 12 and 13, in which there are maintained different gas pressures at the respective free liquid surfaces. This should

be seen as a further developement of a basic embodiment of the invention, in which the vessel contains only one chamber and one single outlet for evaporated hydrocarbon compounds. Since the chambers 12 and 13 communicate through the passage 27 and the slot 25, the chambers may be considered as one and the same chamber, however, concerning the treated liquid. Only concerning the evaporated hydrocarbon compounds the chambers 12 and 13 need be considered as separate.

10 Within the scope of the invention it is of course possible in this way to divide the interior of the vessel in even more chambers, gradually decreasing gas pressures being maintained therein.

15 It is also possible according to the invention to connect two or more vessels of the described kind in series, i.e. to connect the liquid outlet 33 of one vessel to the liquid inlet 16 of a subsequent vessel. For instance in this way the pressure in a liquid mixture may be reduced from 60 to 15 bar in a first vessel rotating with a certain speed, and from 15 to 5 bar in a second vessel having the same size but rotating with a lower speed.

A pressure reduction vessel of the kind here described may also be used as a centrifugal separator for separating from the supplied liquid mixture of hydrocarbon compounds for instance water and/or solids. The vessel in a case like that may be equipped with conical separation discs, like conventional centrifugal separators, and with members for continuous or intermittent discharge of substances thus separated.

As defined by the accompanying claims it should be prevented according to the invention that the pressure of the liquid mixture, that is flowing radially outward in the vessel through a channel to the treatment chamber inlet at said first radial

level, increases in the way which would happen if this liquid would be allowed to flow freely in the channel and simultaneously be completely entrained in the rotation of the vessel.

- 5 According to a special embodiment of the invention, which is not shown in the drawing, this is obtainable in the following alternative way.

At an arrangement according to fig. 2 several frusto-conical
10 discs may be arranged coaxially in the annular channel 41, connected with the vessel 1 for rotation therewith. The distance between these discs may be made so small that the liquid mixture, which is introduced centrally in the disc interspaces, as completely entrained by the discs but is prevented from
15 flowing freely in the interspaces, whereby it will be subjected to a substantial dynamic pressure drop on its way towards the surrounding wall 2 of the vessel. Such a dynamic pressure drop may also be accomplished by members formed in a different way.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of reducing pressure in a liquid mixture of hydrocarbon compounds, characterized in
- that the liquid mixture is supplied into a chamber formed within a rotating vessel such that the liquid mixture is supplied to the chamber, the liquid mixture being supplied to the vessel with a predetermined pressure at an area at or adjacent to a rotational axis of the vessel and being conducted further through a channel radially outward in the vessel to said first radial level in a way such that the pressure of the liquid mixture will not be substantially lower than said predetermined pressure, and the pressure of the liquid mixture, when it reaches said first radial level, will be substantially lower than it would be if the liquid mixture in the channel would be allowed to flow freely therein and simultaneously be substantially entrained in the rotation of the vessel,
 - that the liquid mixture supplied to the chamber is brought in rotation therein by means of the vessel,
 - that a free liquid surface of the rotating liquid mixture in the chamber is maintained at a second level radially inside said first level,
 - that a gas pressure lower than said predetermined pressure is maintained in a liquid free part of the chamber,
 - that liquid is removed from the chamber at a level radially inside said first level, and
 - that gas is removed from the liquid free part of the chamber.



2. Method according to claim 1, characterized in that the liquid mixture is supplied at the first radial level in the chamber by means of a stationary member extending through the liquid free part of the chamber.

3. Method according to claim 1, characterized in that the liquid mixture is supplied from an area near the rotational axis of the vessel to the first radial level through an annular channel formed by members rotating with the vessel.

4. Method according to any one of the preceding claims, characterized in that the free liquid surface in the chamber is maintained at said second level by means of an overflow outlet.

5. Apparatus for for reducing pressure in a liquid mixture from a predetermined pressure, characterized by
- a rotatable vessel defining a chamber,

- means for rotation of the vessel,

- an inlet device for supplying a liquid mixture into the chamber at a first radial level therein, said device defining at least one channel extending from an area at or adjacent to a rotational axis of the vessel to said first radial level, said device further being arranged to prevent such a pressure increase in the liquid mixture in the channel that would be a consequence of allowing the liquid mixture to flow freely in the channel or channels and simultaneously be completely entrained is the rotation of the vessel,



- members connected with the vessel and arranged for entraining liquid mixture in the chamber in the rotation of the vessel,
- means for maintaining a free liquid surface of the liquid mixture in the chamber at a second level radially inside said first level, - means for discharging liquid mixture from the chamber at a level radially inside said first level,
- means for discharging gas from a liquid free part of the chamber, and
- equipment for maintaining a gas pressure in the liquid free part of the chamber that is lower than said predetermined pressure.

6. Apparatus according to claim 5, characterized in that the inlet device comprises a stationary member which extends axially into the vessel at the rotational axis thereof and radially outward within the vessel to said first level in the chamber.

7. Apparatus according to claim 5, characterized in that the inlet device comprises means rotatable with the vessel and forming a substantially annular channel which extends from an area near the rotational axis of the vessel to the said first radial level in the chamber and which is substantially free of entrainment members, so that liquid mixture flowing through the channel during the rotation of the vessel is only insignificantly entrained in the rotation.



8. Apparatus according to claim 5, characterized by means forming an overflow outlet from the chamber and constituting both part of said liquid discharge means and part of said means for maintaining of a free liquid surface in the chamber.

9. Apparatus according to claim 5, characterized in

- that the vessel defines a first said chamber and a second said chamber,
- that said first chamber has an inlet for the liquid mixture at the first radial level, an outlet for the liquid mixture at a level radially inside the first level, and an outlet for gas from a part of the first chamber which is free of liquid during rotation of the vessel,
- that the other second chamber has an inlet for the liquid mixture, an outlet for the liquid mixture at a level radially inside the level of the inlet to said second chamber and an outlet for gas from a part of the second chamber which is free of liquid during rotation of the vessel,
- that the outlet for the liquid mixture of said first chamber communicates with the inlet of said second chamber,
- that a first equipment is arranged to maintain a predetermined first overpressure of the gas in the liquid free part of the first chamber,
- that a second equipment is arranged to maintain a predetermined lower second overpressure of the gas in the liquid free part of the second chamber, and



- that means is arranged to maintain a free liquid surface at a predetermined level in at least one of the first and second chambers.

DATED this 22nd day of May, 1990

ALFA-LAVAL SEPARATION AB

WATERMARK

Patent & Trademark Attorneys,
"The Atrium",
290 Burwood Road,
Hawthorn,
Victoria, 3122,
AUSTRALIA.

SKP:EK(1.37)



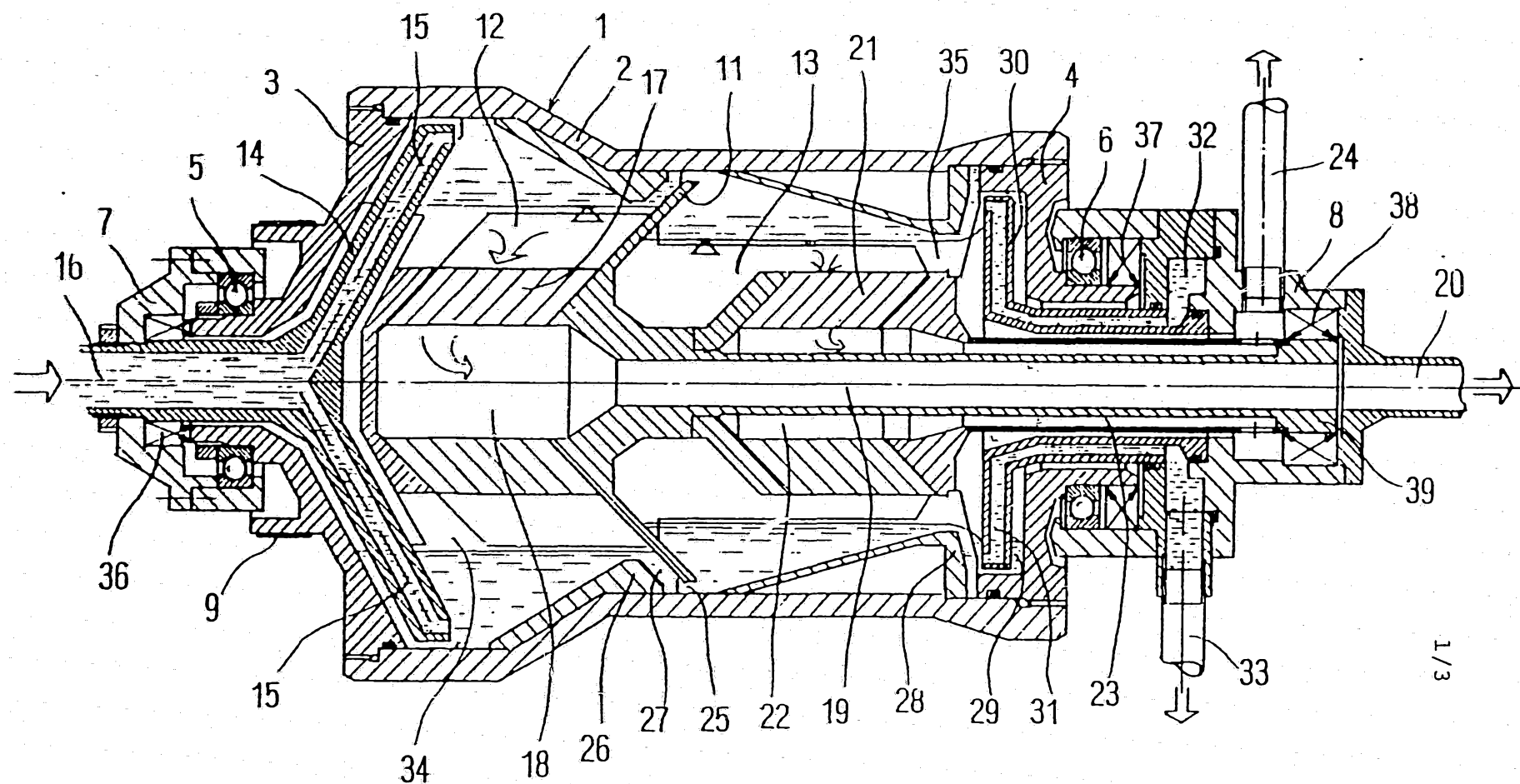


Fig. 1

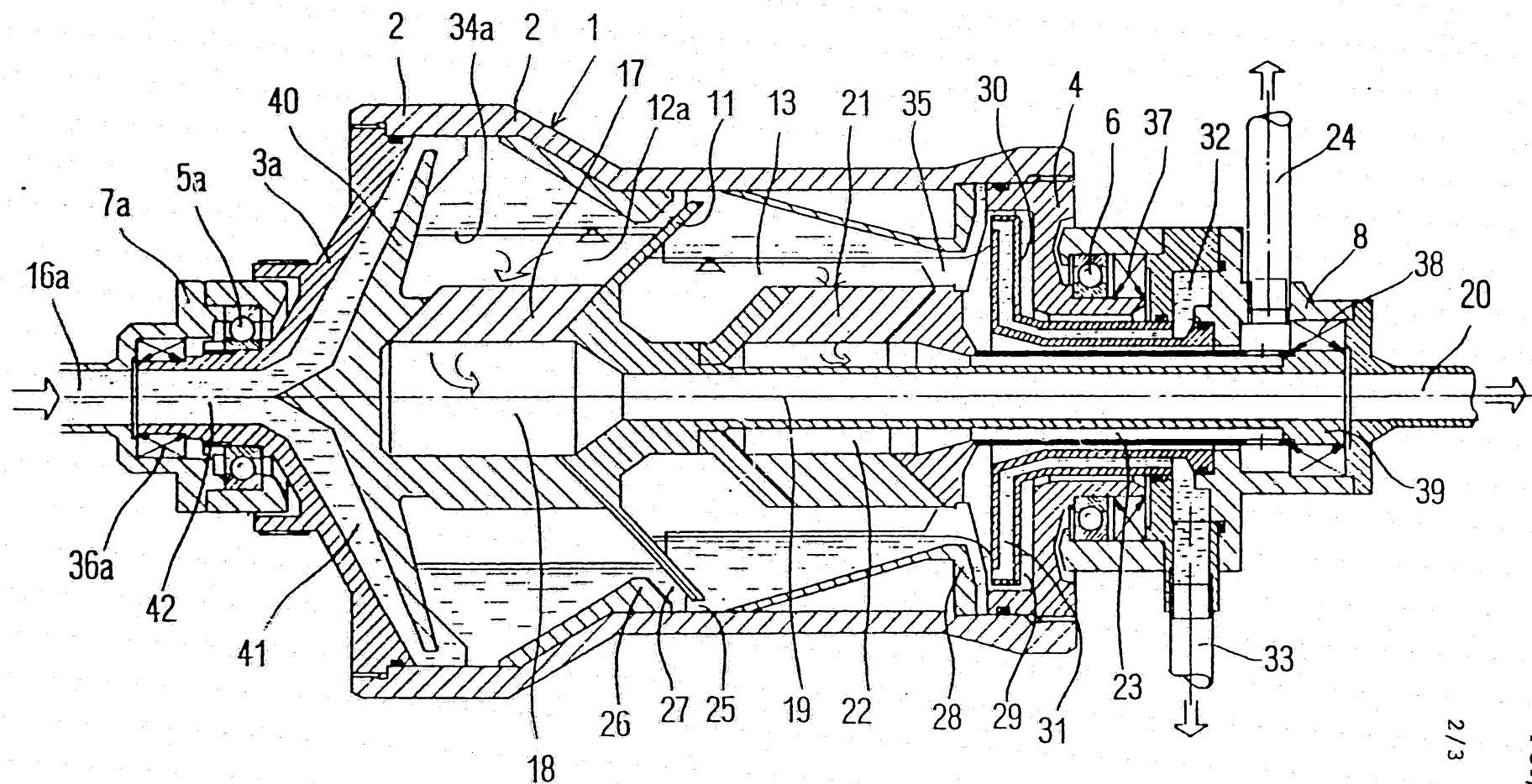


Fig. 2

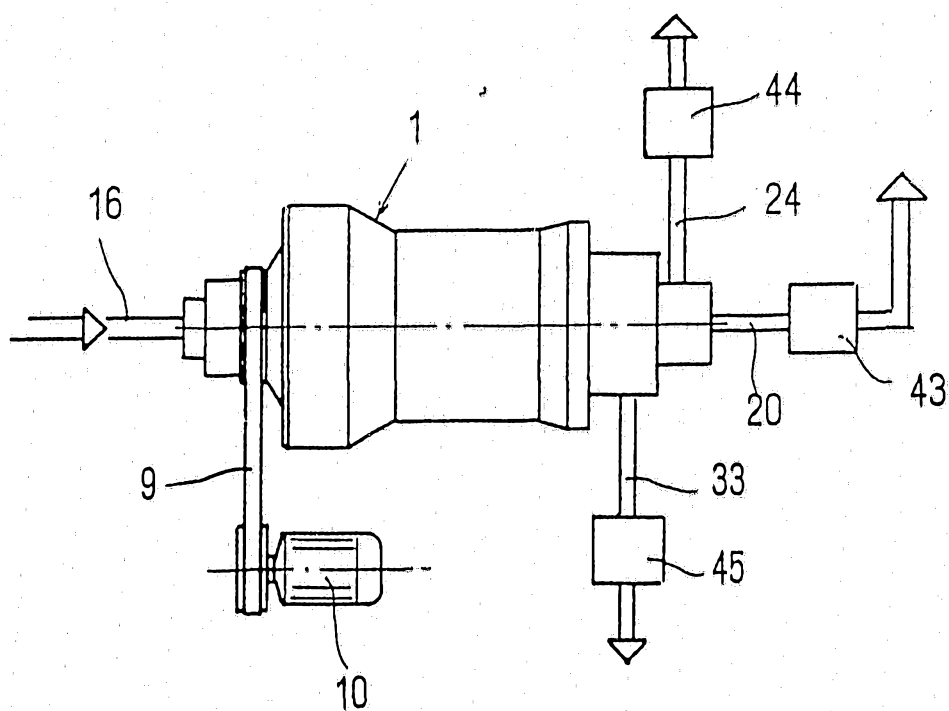
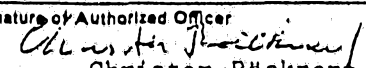


Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE87/00535

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC 4		
E 21 B 43/34, G 05 D 16/00		
II. FIELDS SEARCHED		
Minimum Documentation Searched 7		
Classification System	Classification Symbol(s)	
IPC 4	E 21 B 21/00, /06, 33/12, 43/00, /12, /18, /34; B 04 B 1/00, 15/00, /04; B 67 D 5/34; G 05 D 16/00, /08, /14	
US C1	137: 82, 84, 89, 102, 155, 171, 176; .../...	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *		
SE, NO, DK, FI classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT *		
Category *	Citation of Document, 11 with indication, where appropriate, of the relevant passages 12	Relevant to Claim No. 13
A,P	US, A, 4 626 237 (GALLOWAY Jr) 2 December 1986	
A	EP, A1, 0 044 466 (GEOSOURIE INC) 27 January 1982	
A	EP, A1, 0 082 630 (IMPERIAL CHEMICAL INDUSTRIES PLC) 29 June 1983	
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>* Special categories of cited documents: 10</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"A" document member of the same patent family</p> </div> </div>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
1988-02-22	1988-02-24	
International Searching Authority	Signature of Authorized Officer	
Swedish Patent Office	 Christer Bäcknert	

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

II

Fields searched (cont)

US Cl 166: 317-322;
 417: 112-117

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This international Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the international Searching Authority did not invite payment of any additional fee.

Remark on Protest

- ☐ The additional search fees were accompanied by applicant's protest.
☐ No protest accompanied the payment of additional search fees.