Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2612022 C 2014/08/19

(11)(21) **2 612 022**

(12) **BREVET CANADIEN**
CANADIAN PATENT

(13) **C**

(86) **Date de dépôt PCT/PCT Filing Date**: 2006/05/31
(87) **Date publication PCT/PCT Publication Date**: 2006/12/21
(45) **Date de délivrance/Issue Date**: 2014/08/19
(85) **Entrée phase nationale/National Entry**: 2007/12/13
(86) **N° demande PCT/PCT Application No.**: EP 2006/005172
(87) **N° publication PCT/PCT Publication No.**: 2006/133804
(30) **Priorité/Priority**: 2005/06/14 (DE10 2005 027 553.2)

(51) Cl.Int./Int.Cl. *B04B 11/08* (2006.01), *B04B 1/20* (2006.01), *B04B 11/02* (2006.01), *B04B 13/00* (2006.01)

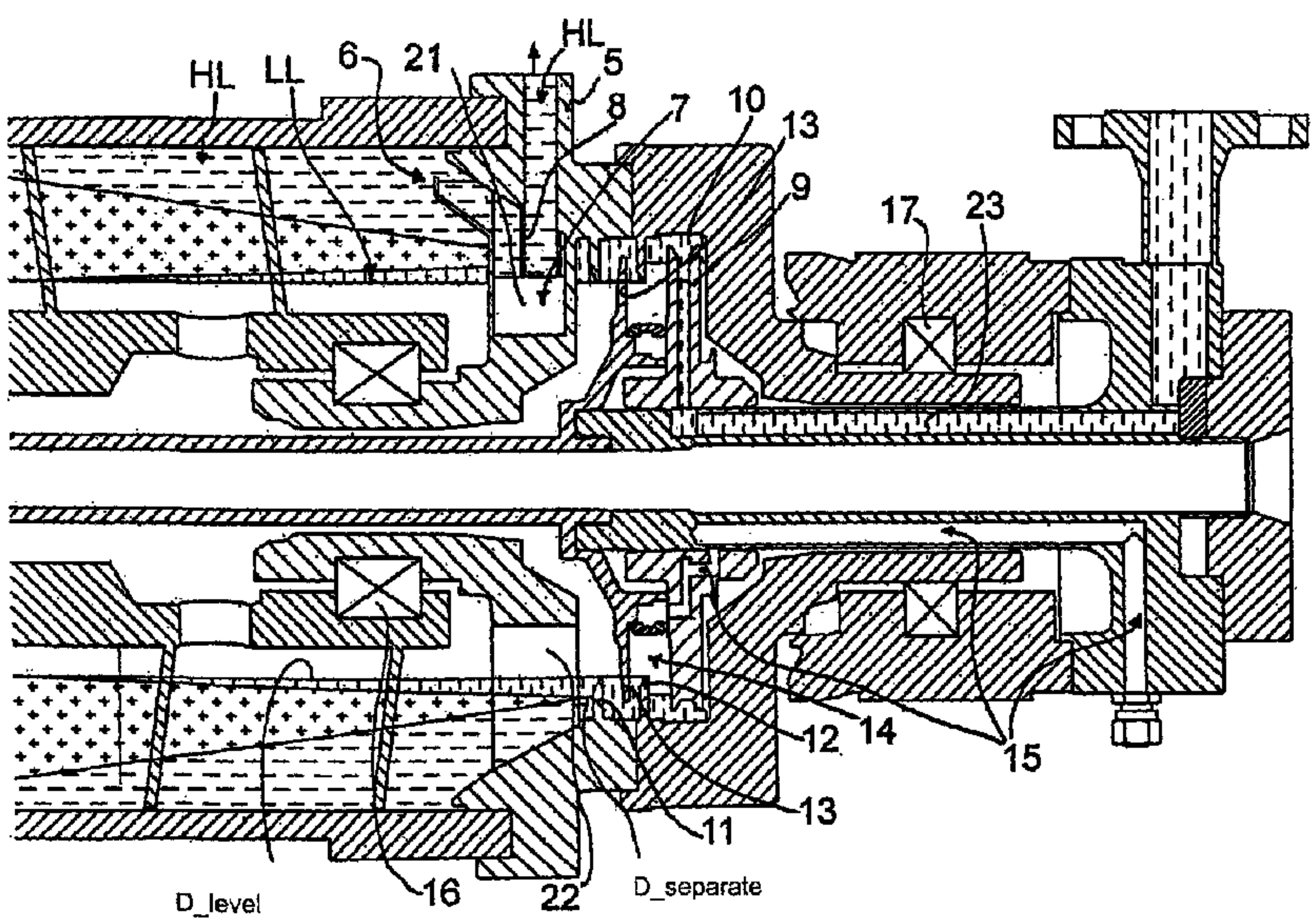
(72) **Inventeurs/Inventors**:
SUDHUES, WOLF-DIETHARD, DE;
HARTMANN, TORE, DE;
HORBACH, ULRICH, DE

(73) **Propriétaire/Owner**:
GEA MECHANICAL EQUIPMENT GMBH, DE

(74) **Agent**: FETHERSTONHAUGH & CO.

(54) Titre : CENTRIFUGEUSE A VIS SANS FIN, A BOL PLEIN ET A TROIS PHASES, ET PROCEDE POUR REGULER LE PROCESSUS DE SEPARATION

(54) Title: THREE-PHASE SOLID BOWL SCREW CENTRIFUGE AND METHOD OF CONTROLLING THE SEPARATING PROCESS



(57) **Abrégé/Abstract**:
A three-phase solid bowl screw centrifuge has a rotatable drum (1) and a screw (2) arranged in the drum (1). In this case, at least one solid material discharge is arranged at one axial end of the drum (1) and at least two or more liquid outlets for liquid phases of different densities - a lighter liquid phase and a heavier liquid phase - are arranged at its other axial end. The one liquid outlet also has a skimmer disc and the other liquid outlet is formed as an overflow weir, the skimmer disc being preceded by two regulating discs (11, 12) of the same inside diameter, which extend radially from the outside inwards and between which there enters a siphon disc (13), which in the skimming chamber (10) extends from the inner circumference of the latter outwards. This has the effect of forming an annular chamber (14), which is assigned a means for changing the pressure in the annular chamber (14).

ABSTRACT

A three-phase solid bowl screw centrifuge has a rotatable drum (1) and a screw (2) arranged in the drum (1). In this case, at least one solid material discharge is arranged at one axial end of the drum (1) and at least two or more liquid outlets for liquid phases of different densities - a lighter liquid phase and a heavier liquid phase - are arranged at its other axial end. The one liquid outlet also has a skimmer disc and the other liquid outlet is formed as an overflow weir, the skimmer disc being preceded by two regulating discs (11, 12) of the same inside diameter, which extend radially from the outside inwards and between which there enters a siphon disc (13), which in the skimming chamber (10) extends from the inner circumference of the latter outwards. This has the effect of forming an annular chamber (14), which is assigned a means for changing the pressure in the annular chamber (14).

THREE-PHASE SOLID BOWL SCREW CENTRIFUGE AND METHOD OF CONTROLLING THE SEPARATING PROCESS

The invention relates to a three-phase solid bowl screw centrifuge (three-phase decanter) and to a process for controlling the separating process by means of such a centrifuge.

With respect to the state of the art, the following documents are mentioned: U.S. Patent Document US 3 623 656, International Patent Document WO 03/074 185 A1, German Patent Documents DE 195 00 600 C1, DE 102 23 802 A1, DE 38 22 983 A1, International Patent Document WO 02/062483 A1 and German Patent Document DE 26 17 692 A1.

U.S. Patent Document US 3 623 656 shows a three-phase decanter by means of which two liquid phases and one solid phase can be discharged from the drum. When the machine is stopped, the liquid outlets can be adjusted by a conversion.

International Patent Document WO 03/074 185 A1 shows a three-phase decanter by means of which also two liquid phases and one solid phase can be discharged from the drum. The outflow quantity of the heavier liquid phase can be adjusted by a weir.

German Patent Document DE 38 22 983 A1 illustrates a three-phase decanter by means of which also two liquid phases and one solid phase can be discharged from the drum, one liquid phase being discharged through a weir and the other being discharged through a skimmer disk.

German Patent Documents DE 195 00 600 C1 and DE 102 23 802 A1 indicate two-phase decanters where the liquid is discharged by means of a skimmer disk from a chamber.

International Patent Document WO 02/062483 A1 shows a method of operating a solid bowl screw centrifuge.

German Patent Document DE 26 17 692 A1 discloses a solid bowl screw centrifuge having several disk stacks consisting of separating disks and several screw areas.

In the case of three-phase separating decanters, as a rule, conversion parts are available for the adaptation to the respective product characteristics or for the adaptation of the process to the respective situations.

If, for example, during the process of obtaining olive oil in a three-phase operation, the product characteristics of the olive change from the start to the end of the harvest, it may be necessary to stop the processing, to remove the rotor and to install other regulating disks and/or regulating tubes. This is time-consuming and cost-intensive.

It has been suggested to regulate the heavier phase by means of a non-rotating throttle disk arranged outside the drum and to discharge the lighter phase by means of a skimmer disk. Although this construction has been successful, it requires at least the use of a displaceable throttle disk from a constructive point of view.

However, by varying the throttling at the skimmer disk alone, the process cannot be sufficiently adjusted to the product characteristics, in order to avoid a conversion.

With respect to the above, an embodiment of the invention relates to reducing the constructive expenditures for creating a three-phase decanter that is easily adaptable to changing product characteristics and of indicating an advantageous method for its operation.

Accordingly, there is provided a three-phase solid bowl screw centrifuge having a. a rotatable drum and a screw arranged in the drum, b. at one axial end of the drum, at least one solid material discharge and, at the other axial end of the drum, at least two liquid outlets for liquid phases of different densities - a lighter liquid phase (LL) and a heavier liquid phase (HL), c. one of the at least two liquid outlets having a skimmer disk arranged in a centripetal chamber, and the other of the at least two liquid outlets being constructed in the fashion of an overflow, characterized in that d. two regulating disks, being disposed in front of the skimmer disk, which extend radially from the outside toward the inside and between which a siphon disk dips which extends in a skimmer chamber from an interior circumference of the skimmer chamber toward the exterior of the skimmer chamber, e. so that an annual chamber is formed during an operation, between the siphon disk and the skimmer disk as axial boundaries, an inside radius of the lighter liquid phase and an inside shell in the skimmer chamber, f. into which annular chamber at least one fluid pipe leads for changing the pressure in the annular chamber, in order to change at least one of a separating zone and a pool depth in the drum.

There is also provided a three-phase solid bowl screw centrifuge comprising: a rotatable drum; a screw arranged in the drum; a solid material discharge located at a first axial end of the drum; two liquid outlets located at a second axial end of the drum, a first of the liquid outlets being for a lighter liquid phase and a second of the liquid outlets being for a heavier liquid phase; one of the liquid outlets including a skimmer disk arranged in a skimmer chamber and the other of the liquid outlets formed as an overflow; two regulating disks located in front of the skimmer disk and which disks extend radially from an outside of the drum toward an inside of the drum; a siphon disk extends between the regulating disks and into the skimmer chamber from an interior circumference of the skimmer chamber to an exterior circumference of the skimmer chamber; an annular chamber is formed during an operation and is located between the siphon disk and the skimmer disk, the siphon and skimmer disks acting as axial boundaries for an axial area, and the annular chamber is further located between an inside radius of the lighter liquid phase in the drum and an inner wall of the skimmer chamber in the axial area; and a fluid feed pipe leading into the annular chamber to change a pressure on the annular chamber and to change at least one of a separation zone between the lighter and heavier phases and a pool depth in the drum.

A feed pipe and a removal pipe for feeding fluid to the chamber and removing it from the chamber may also be provided.

As a result of a change of pressure in the annular chamber - as required, in connection with a throttling effect onto the skimmer disk - the separating zone in the drum can easily be shifted, which also results in a change of the liquid level. A conversion, which would otherwise be required as a result of changes of the characteristics of the product, as a rule, can be eliminated by utilizing the given regulating range. The constructive expenditures for providing the annular chamber are low.

The annular chamber preferably has a fluid pipe for feeding a fluid, particularly a gas, into the annular chamber, as a device for changing the pressure in the annular chamber.

The overflow for the other phase can be implemented by radial discharge pipes, which penetrate the drum shell or the drum lid.

This basic construction can be implemented particularly in two variants: In one variant, the heavier liquid phase is discharged through the discharge pipe and the lighter liquid phase is discharged through the skimmer disk, and in the other variant, the lighter liquid phase is discharged through the discharge pipe and the heavier liquid phase is discharged through the skimmer disk. Both variants permit a good controlling of the process but result in different regulating characteristics.

The invention also provides a process for operating a three-phase solid bowl screw centrifuge as described above, by which the regulating of the separating operation in the drum takes place in a very simple manner by changing the pressure in the annular chamber as the manipulated variable. This variant is preferred because a simple and good regulating of the separating operation becomes possible.

There is also provided a method of operating a three-phase solid bowl centrifuge, the method steps comprising: providing a three-phase solid bowl centrifuge including: a rotatable drum; a screw arranged in the drum; a solid material discharge for a solid phase located at a first axial end of the drum; two liquid outlets located at a second axial end of the drum, a first of the liquid outlets being for a lighter liquid phase and a second of the liquid outlets being for a heavier liquid phase; one of the liquid outlets including a skimmer disk arranged in a skimmer chamber and the other of the liquid outlets formed as an overflow; two regulating disks located in front of the skimmer disk and which disks extend radially from an outside of the drum toward an inside of the drum; a siphon disk extends between the regulating disks and into the skimmer chamber from an interior circumference of the skimmer chamber to an exterior circumference of the skimmer chamber; an annular chamber is formed during in operation and is located between the siphon disk and the skimmer disk, the siphon disk and skimmer disks acting as axial boundaries for an axial area, and the annular chamber is further located between an inside radius of the lighter liquid phase in the axial area and an inner wall of the skimmer chamber in the axial area; a fluid feed pipe leading into the annular chamber to change a pressure on the annular chamber and to change at least one of a separation zone between the lighter and heavier phases and a pool depth in the drum; operating the centrifuge in a separating operation; and controlling the separating operation by changing a pressure in the annular chamber.

As an alternative, it is also conceivable that the regulating of the separating operation in the drum takes place by changing the rotational speed of the drum as the manipulated variable.

Particularly preferably, the regulating of the separating operation in the drum takes place as a function of the concentration in the solid phase or in one or both discharged liquid phases as the controlled variable.

The invention is also particularly suitable for the phase separation when obtaining hydrometals, such as cobalt, nickel, copper.

Particularly when obtaining hydrometals, such as cobalt, nickel, copper, the emulsion formation cannot be avoided during the extraction. The extraction as well as the emulsion consists of three phases - an organic phase, an aqueous phase and solids -. The open sedimentation tanks of the extraction are susceptible to contamination from the air. These different dust concentrations lead to a density difference of the individual phases in the emulsion. The decanter according to the invention provides a remedy here.

In order to meet these dynamic process demands, the separating diameter within the decanter can be adapted on-line by means of an increase of pressure into the annular chamber.

As a result, the emulsion is cleanly separated into three phases. The use of a centrifuge according to the invention for the emulsion separation when obtaining hydrometals, such as cobalt, nickel, copper, therefore offers considerable advantages.

In the following, embodiments of the invention and their advantages will be explained in detail by means of embodiments with reference to the drawing.

Figure 1 is a sectional view of a first three-phase solid bowl screw centrifuge according to the invention;

Figure 2 is a schematic sectional view of a partial area of the solid bowl centrifuge from Figure 1 in a first operating condition;

Figure 3 is a schematic sectional view of a partial area of the solid bowl centrifuge from Figure 1 in a second operating condition;

Figure 4 is a diagram for illustrating the operating behavior and the controllability of separating and clarifying processes by means of the solid bowl centrifuge of Figure 1 according to the invention;

Figure 5 is a sectional view of a second three-phase solid bowl screw centrifuge according to the invention;

Figure 6 is a schematic sectional view of a partial area of the solid bowl centrifuge from Figure 5 in a first operating condition;

Figure 7 is a schematic sectional view of a partial area of the solid bowl centrifuge from Figure 5 in a second operating condition;

Figure 8 is a diagram for illustrating the operating behavior and the controllability of separating and clarifying processes by means of the solid bowl centrifuge of Figure 5 according to the invention.

Figures 1 and 5 illustrate parts of three-phase solid bowl screw centrifuges which have a rotatably disposed (bearing 17) drum 1 - here, with a horizontal axis of rotation - and a rotatable screw 2 which is arranged in the drum 1 and has a screw body 3, on which a circulating screw blade 4 is arranged. During the operation, the drum 1 and the screw 2 rotate at different rotational speeds n, m about the same axis of rotation (at the diameter D_0). A bearing 16 is arranged between the drum 1 and the screw body 3. The second bearing of the screw is situated on the solids side (not shown here).

As a rule, the drum 1 as well as the screw 2 tapers at its one end, for example, conically. At the tapering end of the drum 1, a solids discharge 24 is arranged for the solid phase S transported to this end of the drum 1 by the screw; whereas two liquid phases LL and HL - a lighter and a heavier liquid phase - which can be mutually separated in the centrifugal field, are discharged from the drum 1 in the area of the opposite cylindrical end of the drum 1, which is closed by a drum lid 5.

For example, in the transition area to the tapering section, a baffle plate 18 can be arranged on the screw body 3.

As an example, an inlet pipe 19 extends here from the cylindrical end of the drum 1 into the drum. This inlet pipe 19 leads into a distributing device 20 by way of which the product is guided into the drum 1.

The drum lid 5 has several breakthroughs or openings 21, 22 axially penetrating the drum lid. Preferably between four and eight such openings are formed on a circle of a defined diameter in the drum lid 5 and are distributed along the circumference.

Some of these openings - in the following called first openings 21 - are constructed in the form of recesses closed on one side (or in the manner of pocket holes) and are used for discharging the heavier liquid phase HL, and some of these openings - in the following called second openings 22 - are used for discharging the lighter liquid phase LL.

For the implementation, a separating-plate-like separating weir 6 is disposed in front of some of the openings - the first openings 21 -, which separating weir 6 is in each case further developed and arranged such that only the heavy phase is discharged by way of the outer radius of this separating weir 6 in all provided operating conditions. In contrast, the second openings 22 have no such separating weir.

To this extent, the constructions of Figures 1 and 5 are identical.

However, the difference between Figures 1 and 5 is that the areas of the decanter 1 arranged behind the first and the second openings are quasi "exchanged", or the separating weir is situated in front of the openings leading to the skimmer disk 9.

This will be explained in detail in the following.

According to Figure 1, the heavier liquid phase - collecting radially farther to the outside - is guided by way of the separating weir 6 on the drum lid in each case into a discharge space 7 adjoining the separating weir 6 along a portion of the circumference of the separating weir 6 - which discharge space 7 is formed here by the openings 21 themselves -. Discharge pipes 8 in each case penetrating the drum shell project into the discharge spaces 7, the inner radius, to which the respective discharge pipe 8 extends, also determining the discharge radius for the heavier liquid phase HL.

During the operation or during a running process, this discharge radius for the heavier phase HL is not variable, but it can be changed or pre-adjusted when the drum 1 is stopped by exchanging the discharge pipe 8 or small tube for one of a different length.

In contrast, the discharge of the lighter liquid phase LL, after the passage through the second openings 22, takes place by means of a skimmer disk 9 which is arranged in a skimmer chamber 10 connected in front of the drum shell, which skimmer chamber 10 axially adjoins the drum interior and its inside diameter is equal to or -preferably - smaller than the inside diameter of the drum 1 in its cylindrical area. The light liquid phase LL is discharged from the drum through this skimmer disk 9 and a discharge duct 23 adjoining this skimmer disk 9.

Toward the drum interior - see also Figures 2 and 3 - in the skimmer chamber 10, two regulating disks 11, 12 of the same inside diameter are disposed in front of the skimmer disk, which regulating disk 11, 12 extend radially from the outside toward the inside, and a siphon disk 13 dips between these two regulating disks 11, 12, which extends in the skimmer chamber 10 from its inner circumference to the outside and whose outside diameter is situated on a larger radius relative to the axis of rotation D of the drum 1 than the inside diameter of the two regulating disks 11, 12.

The regulating disk 11 facing the separating weir defines an overflow diameter for the light liquid phase LL.

Between the siphon disk 13 and the skimmer disk 9 as the axial boundaries, the inner radius of the lighter liquid phase in this axial area and the inner shell or inner wall of the skimmer chamber 10 in this area, an annular chamber 14 is thereby formed during the operation.

A fluid feeding pipe 15, through which a fluid, such as a gas, can be guided from the outside into the annular chamber 14, leads into this annular chamber 14.

In this manner, it becomes possible to change the pressure in the annular chamber 14, which also causes a change of the radius of the lighter liquid phase and thus has an effect on the separating diameter in the drum 1. It thereby becomes easily possible to influence these two quantities - the pool depth (inside radius of the drum minus the radius at the line D - level position; for example, in Figure 3), and the separating zone between the lighter and the heavier phase - during the operation only by influencing or changing the pressure in the annular chamber 14.

As a result of the selection of the diameter of the regulating disks 11, 12 or their exchange, the overflow diameter of the lighter phase can be pre-adjusted.

When the pressure in the annular chamber 14 is increased, the liquid level to the center (pool depth) rises in the drum interior. Analogously, the separating zone diameter is displaced farther toward the outside (compare Figures 2 and 3).

As a result, the layer thickness of the lighter phase (broken vertical line) becomes greater and the flow-off velocity becomes lower (longer sedimentation time). The degree of clarification of the lighter phase is thereby increased or becomes better.

Since the separating zone moves toward the outside, the degree of clarification of the heavier phase (horizontal broken line) has the tendency to become poorer. The crosswise hatching indicates a mixed phase area or a separating zone area.

For the most part, the outflow pressure of the lighter phase (skimmer disk pressure) can be varied independently of the chamber pressure.

When, for example, the concentration of the heavy phase (or mixed phase) increases, the pressure in the annular chamber 14 rises in order to shift the separating zone in the drum interior farther toward the outside to a greater radius. As a rule, this causes a greater layer thickness and a better degree of clarification of the lighter phase or a better phase separation.

The above-described behavior tendency is also indicated in the diagram of Figure 4.

The diagram shows the diameters of the outflow for the light and the heavy liquid phases as well as the level D_ position in the drum 1, and the separating diameter D_separate, as a function of the pressure in the annular chamber 14.

The diagram of Figure 4 shows the behavior at a constant rotational speed. Because of the change of pressure, the liquid filling in the drum 1 is not constant. In each case, D indicates the diameter in the drum on both sides of the axis of rotation. The diameters D_pipes (diameter discharge pipes) and D_separating weir are each kept constant during the operation, although they are variable per se (by an exchange). The inside diameter of the drum and the inside diameter of the solids discharge, as a rule, are also not variable by a conversion. The diameter on which the separating zone is situated (separating diameter) increases with the pressure. In contrast, the liquid level D_level position falls inversely proportionally to the pressure.

Figures 2 and 3 schematically illustrate the conditions in the drum at different pressures.

It is also conceivable to fixedly define a pressure in the annular chamber 14 during the operation and then achieve a change of the separating diameter in the drum only by changing the rotational drum speed. This change of the rotational speed can take place, for example, as a function of a concentration measurement of the product inflow or outflow.

However, in the case of this type of control, the regulating range is smaller and can also only be used if a changing of the rotational drum speed during the operation is permissible. The diameter of the separating zone will then increase with the rotational speed (not shown here).

Figure 5 illustrates another embodiment. Here, the heavier liquid phase is discharged by way of the regulating disk arrangement and the skimmer disk 9, and the lighter liquid phase is discharged by way of the discharge pipe 8, which is achieved in that there the separating-plate-like separating weir is in each case arranged in front of the continuous two openings 26 which are open on both sides. The separating weir 6 thereby guides the heavy liquid phase HL to the skimmer disk, whereas the lighter phase is discharged by way of the discharge pipes 8 in the first openings 25 which are of a pocket hole type or are closed at one end.

In the annular chamber 14, the pressure thereby acts upon the heavier liquid phase.

When the pressure in the annular chamber 14 is increased in the embodiment, on the drum side of the siphon disk 13, the inside diameter of the heavier phase shifts to the center, and the separating zone diameter shifts farther toward the interior or is reduced. This has the result that the layer thickness of the lighter phase LL becomes smaller and that the outflow velocity is increased. The degree of clarification of the lighter phase is thereby reduced. Figure 6 shows the higher-pressure condition, and Figure 7 shows the condition after a lowering of pressure in the annular chamber 14.

Since the separating zone moves farther toward the inside, in contrast, the degree of clarification of the heavier phase becomes better.

The concentration distribution of any of the discharged phases, for example, is preferably used as the controlled variable.

When, for example, the pressure of the heavy liquid phase rises in the light liquid phase, the pressure is reduced in order to shift the separating zone in the drum interior farther toward the outside to a larger radius. As a rule, this causes a larger layer thickness and a better degree of clarification of the lighter phase.

Figure 8 illustrates the corresponding control behavior by means of an example analogous to Figure 4. The different diameters are again entered as a function of the pressure in the annular chamber 14.

Here, it is also conceivable to fixedly define a pressure in the annular chamber 14 during the operation and to achieve a change of the separating diameter in the drum solely by changing the rotational speed of the drum. This change of the rotational speed can take place, for example, as a function of a concentration measurement of the product inflow or outflow.

However, in the case of this type of the control, the control range is smaller and can also be used only when a changing of the rotational drum speed during the operation is permitted.

List of Reference Symbols

Drum	1
Screw	2
Screw body	3
Screw blade	4
Drum lid	5
Separating weir	6
Discharge space	7
Discharge pipe	8
Skimmer disk	9
Skimmer chamber	10
Regulating disks	11, 12
Siphon disk	13
Annular chamber	14
Fluid feed pipes	15
Bearing	16, 17
Baffle plate	18
Inlet pipe	19
Distributing device	20
Openings	21, 22
Discharge duct	23
Solids outlet	24
Openings	25, 26
Liquid phases	LL, HL
Solids phase	S
Rotational speeds	n, m

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A three-phase solid bowl screw centrifuge having

a. a rotatable drum (1) and a screw (2) arranged in the drum (1),

b. at one axial end of the drum (1), at least one solid material discharge and, at the other axial end of the drum (1), at least two liquid outlets for liquid phases of different densities - a lighter liquid phase (LL) and a heavier liquid phase (HL),

c. one of the at least two liquid outlets having a skimmer disk (9) arranged in a centripetal chamber, and the other of the at least two liquid outlets being constructed in the fashion of an overflow,

characterized in that

d. two regulating disks (11, 12), being disposed in front of the skimmer disk (9), which extend radially from the outside toward the inside and between which a siphon disk (13) dips which extends in a skimmer chamber (10) from an interior circumference of the skimmer chamber toward the exterior of the skimmer chamber,

e. so that an annual chamber (14) is formed during an operation, between the siphon disk (13) and the skimmer disk (9) as axial boundaries, an inside radius of the lighter liquid phase and an inside shell in the skimmer chamber (10),

f. into which annular chamber (14) at least one fluid pipe leads for changing the pressure in the annular chamber, in order to change at least one of a separating zone and a pool depth in the drum.

2. The three-phase solid bowl screw centrifuge according to Claim 1, characterized by the at least two liquid outlets being first and second axial openings (21, 22; 25, 26) in a drum lid, and a separating-plate-type separating weir being assigned to one of the first and the second openings.

3. The three-phase solid bowl screw centrifuge according to Claim 2, characterized in that at least one of the first and second axial openings (21, 22; 25, 26) is constructed as a pocket hole closed at one axial end in the fashion of a chamber.

4. The three-phase solid bowl screw centrifuge according to any one of Claims 2 to 3, characterized by the separating weir (6) being formed such that the heavier liquid phase is guided into at least one discharge space (7) in which at least one discharge pipe (8) penetrating the drum shell is inserted as the overflow.

5. The three-phase solid bowl screw centrifuge according to any one of Claims 2 to 4, characterized by an arrangement of the separating weir such that the lighter liquid phase is guided to the skimmer disk (9) during the operation.

6. The three-phase solid bowl screw centrifuge according to any one of Claims 2 to 3, characterized by an arrangement of the separating weir (6) such that the lighter liquid phase is guided into a discharge space (7), in which a

discharge pipe (8) penetrating the drum shell is inserted as the overflow.

7. The three-phase solid bowl screw centrifuge according to any one of the Claims 2 to 4, characterized by an arrangement of the separating weir such that the heavier liquid phase is guided to the skimmer disk (9) during the operation.

8. The three-phase solid bowl screw centrifuge according to any one of Claims 1 to 7, characterized in that the skimmer disk (9) is arranged in the skimmer chamber (10) which axially adjoins the drum interior and whose inside diameter is at most equal to the inside diameter of the drum (1) in its cylindrical area, and in that the two regulating disks (11, 12) and the siphon disk (13) are disposed in front of the skimmer disk (9) in the skimmer chamber (10).

9. The three-phase solid bowl screw centrifuge according to claim 8, characterized in that the skimmer disk (9) has an inside diameter smaller than the inside diameter of the drum (1)) in its cylindrical area.

10. The three-phase solid bowl screw centrifuge according to any one of the Claims 2 to 7, characterized in that a plurality of first and second axial openings (21, 22) are arranged in the drum lid on an imaginary circle and distributed along a circumference of the drum lid, a separating weir being assigned to each second opening.

11. The three-phase solid bowl screw centrifuge according to any one of Claims 1 to 10, wherein the two regulating disks (11, 12) are of an identical inside diameter.

12. The three-phase solid bowl screw centrifuge according to any one of Claims 2 to 7, wherein the plurality of first and second axial openings comprises in the range of four to eight openings.

13. A process for operating a three-phase solid bowl screw centrifuge according to any one of Claims 1 to 12, characterized in that the controlling of the separating operation in the drum takes place by changing the pressure in the annular chamber (14).

14. The process for operating a three-phase solid bowl screw centrifuge according to any one of Claims 1 to 12, characterized in that the controlling of the separating operation in the drum comprises changing the rotational speed of the drum.

15. The process according to Claim 13 or 14, characterized in that the controlling of the separating operation in the drum takes place as a function of the concentration distribution in at least one of the phases.

16. Use of a centrifuge according to any one of Claims 1 to 12 for the three-phase separation of an emulsion which is formed when obtaining hydrometals.

17. The use of Claim 16, in which the hydrometals include at least one of cobalt, nickel and copper.

18. A three-phase solid bowl screw centrifuge comprising:

a rotatable drum;

a screw arranged in the drum;

a solid material discharge located at a first axial end of the drum;

two liquid outlets located at a second axial end of the drum, a first of the liquid outlets being for a lighter liquid phase and a second of the liquid outlets being for a heavier liquid phase;

one of the liquid outlets including a skimmer disk arranged in a skimmer chamber and the other of the liquid outlets formed as an overflow;

two regulating disks located in front of the skimmer disk and which disks extend radially from an outside of the drum toward an inside of the drum;

a siphon disk extends between the regulating disks and into the skimmer chamber from an interior circumference of the skimmer chamber to an exterior circumference of the skimmer chamber;

an annular chamber is formed during an operation and is located between the siphon disk and the skimmer disk, the siphon and skimmer disks acting as axial boundaries for an axial area, and the annular chamber is further located between an inside radius of the lighter liquid phase in the drum and an inner wall of the skimmer chamber in the axial area; and a fluid feed pipe leading into the annular chamber to change a pressure on the annular chamber and to change at least one of a separation zone between the lighter and heavier phases and a pool depth in the drum.

19. The three-phase solid bowl screw centrifuge according to Claim 18, wherein the first and second liquid outlets are axial openings in a drum lid, and a separating-plate-type separating weir is assigned to one of the first and axial second openings.

20. The three-phase solid bowl screw centrifuge according to Claim 19, wherein one or more of the openings is constructed as a chamber, or a pocket hole closed at one axial end.

21. The three-phase solid bowl screw centrifuge according to Claim 19 or 20, wherein the separating weir is situated such that the heavier liquid phase is guided by way of the separating weir into at least one discharge space in which at least one discharge pipe penetrating the drum shell is inserted as the overflow.

22. The three-phase solid bowl screw centrifuge according to Claim 19, 20 or 21, wherein an arrangement of the separating weir is such that the lighter liquid phase is guided to the skimmer disk during the operation.

23. The three-phase solid bowl screw centrifuge according to Claim 19 or 20, wherein an arrangement of the separating weir is such that the lighter liquid phase is

guided into the discharge space, in which a discharge pipe penetrating the drum shell is inserted as the overflow.

24. The three-phase solid bowl screw centrifuge according to Claim 19, 20 or 21, wherein an arrangement of the separating weir is such that the heavier liquid phase is guided to the skimmer disk during the operation.

25. The three-phase solid bowl screw centrifuge according to any one of Claims 18 to 24, wherein the skimmer chamber axially adjoins a drum interior, and an inside diameter of the skimmer chamber is smaller than the inside diameter of the drum in a cylindrical area of the drum, and the two regulating disks and the siphon disk are disposed in front of the skimmer disk in the skimmer chamber.

26. The three-phase solid bowl screw centrifuge according to any one of Claims 19 to 22, further including at least two first liquid outlets and two second liquid outlets, each of the outlets formed as axial openings and arranged in a drum lid in a circular fashion and distributed along a circumference, of the drum lid, and a separating weir is assigned to each second opening.

27. The centrifuge of any one of Claims 18 to 26, wherein the two regulating disks have identical inside diameters.

28. The centrifuge of any one of Claims 18 to 27, wherein the skimmer chamber axially adjoins a drum interior and an inside diameter of the skimmer chamber is equal to the

inside diameter of the drum in a cylindrical area of the drum, and in the two regulating disks and the siphon disk are disposed in front of the skimmer disk in the skimmer chamber.

29. A method of operating a three-phase solid bowl centrifuge, the method steps comprising:

providing a three-phase solid bowl centrifuge including:

a rotatable drum;

a screw arranged in the drum;

a solid material discharge for a solid phase located at a first axial end of the drum;

two liquid outlets located at a second axial end of the drum, a first of the liquid outlets being for a lighter liquid phase and a second of the liquid outlets being for a heavier liquid phase;

one of the liquid outlets including a skimmer disk arranged in a skimmer chamber and the other of the liquid outlets formed as an overflow;

two regulating disks located in front of the skimmer disk and which disks extend radially from an outside of the drum toward an inside of the drum;

a siphon disk extends between the regulating disks and into the skimmer chamber from an interior circumference of the skimmer chamber to an exterior circumference of the skimmer chamber;

an annular chamber is formed during in operation and is located between the siphon disk and the skimmer disk, the siphon disk and skimmer disks acting as axial boundaries for an axial area, and the annular chamber is further located between an inside radius of the lighter liquid phase in the axial area and an inner wall of the skimmer chamber in the axial area;

a fluid feed pipe leading into the annular chamber to change a pressure on the annular chamber and to change at least one of a separation zone between the lighter and heavier phases and a pool depth in the drum;

operating the centrifuge in a separating operation; and

controlling the separating operation by changing a pressure in the annular chamber.

30. The method according to Claim 29, including the step of changing the rotational speed of the drum.

31. The method according to Claim 29 or 30, wherein the controlling of the separating operation in the drum is a function of the concentration distribution in at least one of the phases.

32. The method of Claim 29, 30 or 31, wherein the separating operation includes an emulsion which is formed when obtaining hydrometals.

33. The method of Claim 32, wherein the hydrometals include cobalt, metal and copper.

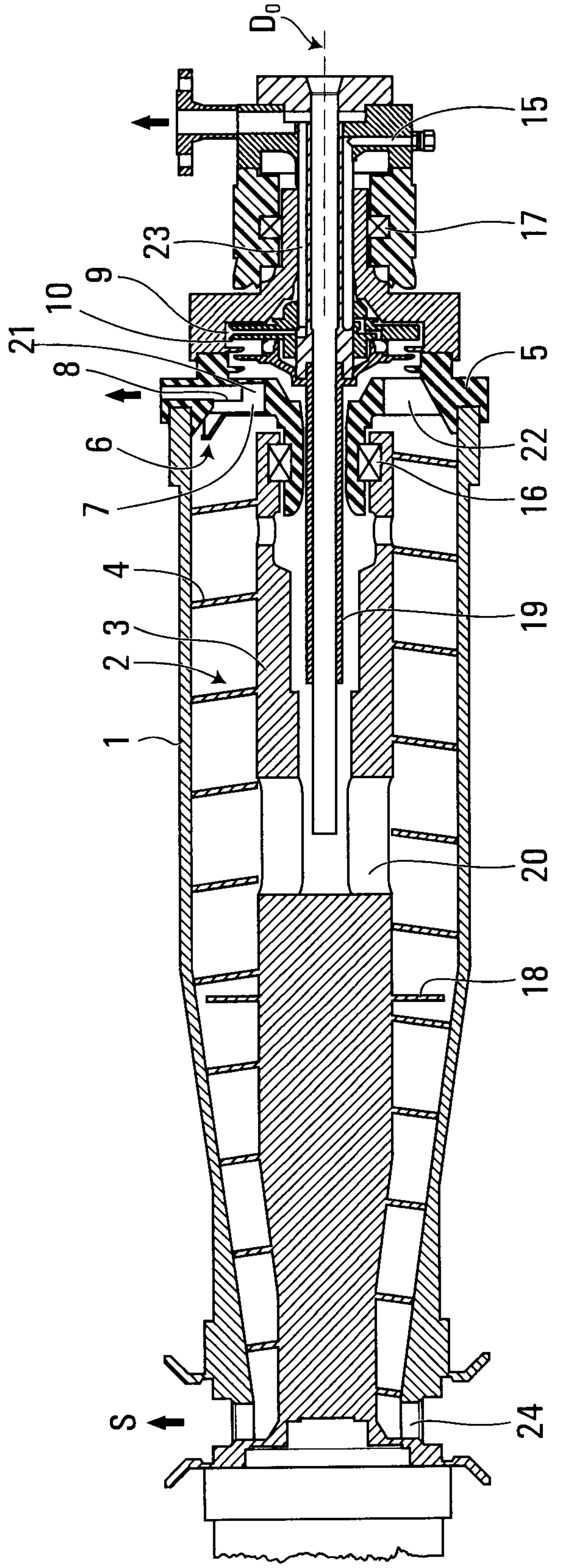


FIG. 1

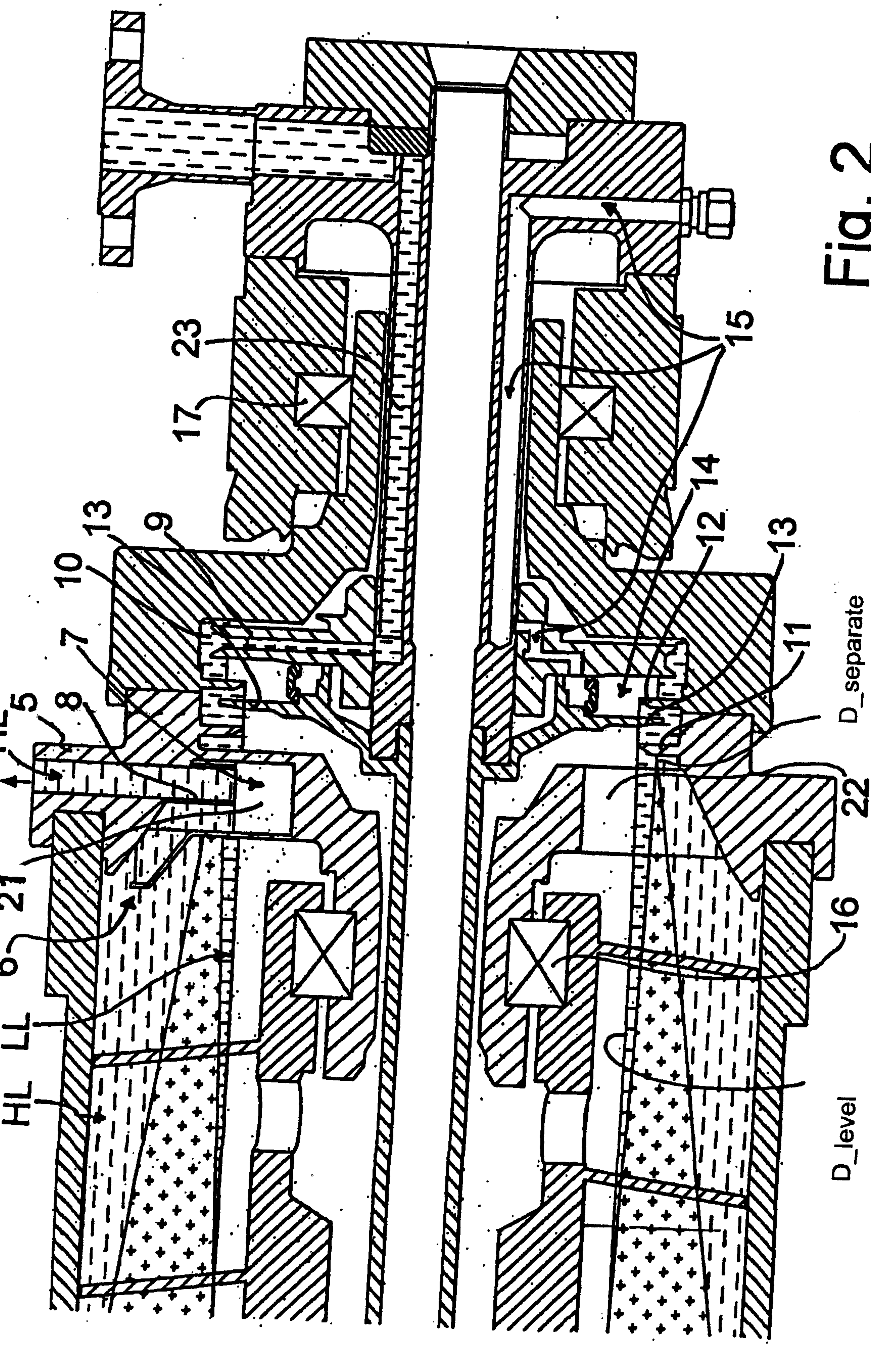

HL
5
8
7
10
13
9
23
17
15
14
12
13
11
D_separate
22
16
D_level
HL
LL
6
21

Fig. 2

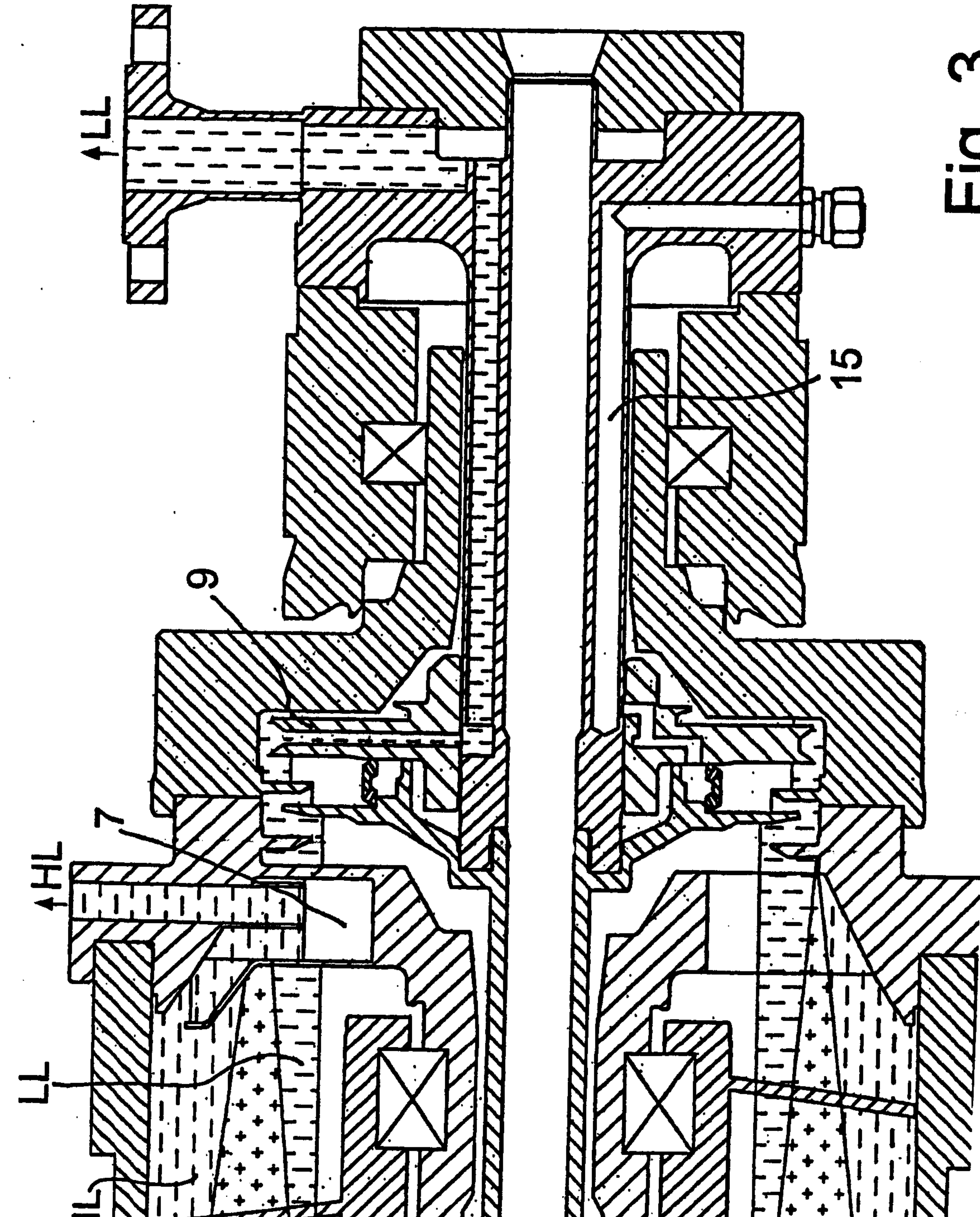


Fig. 3

Separating Decanter

Pneumatic Control of the Level Position of the Light Phase

and Thereby Control of the Separating Diameter

Liquid Filling in the Drum not Constant

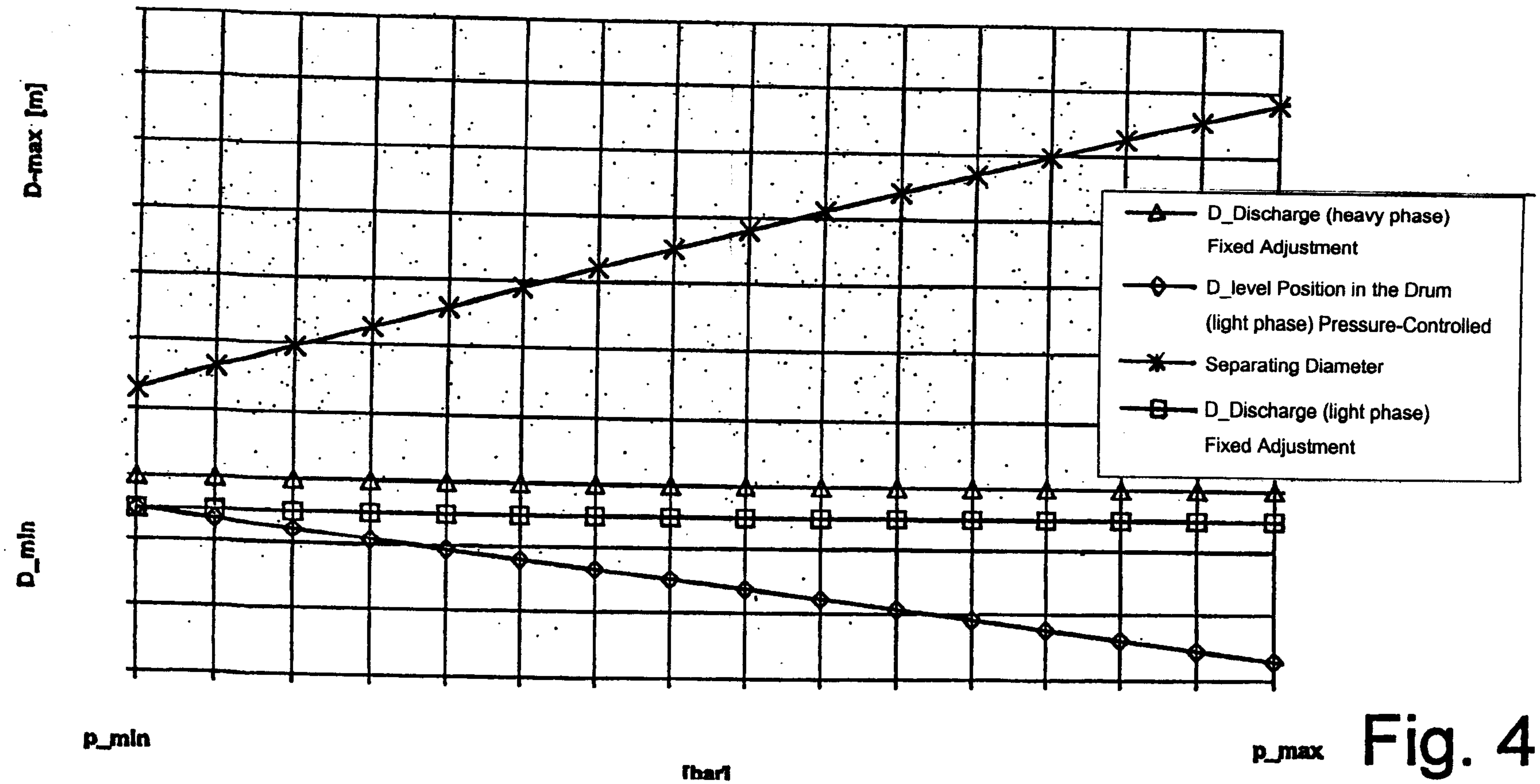


Fig. 4

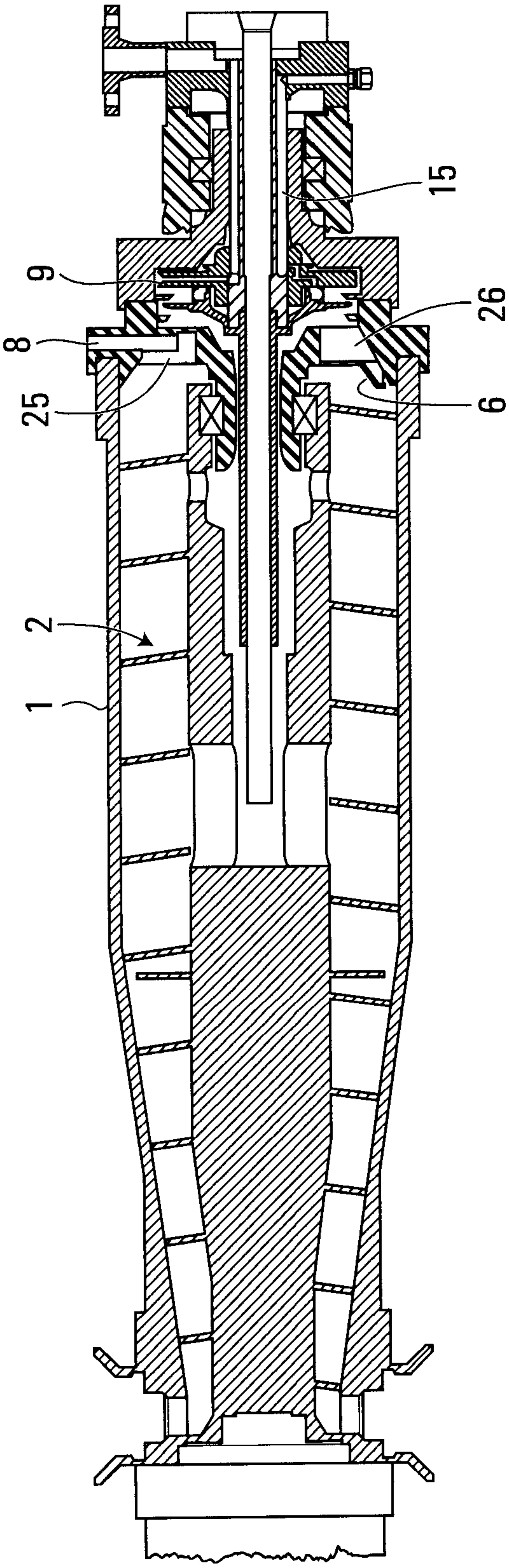


FIG. 5

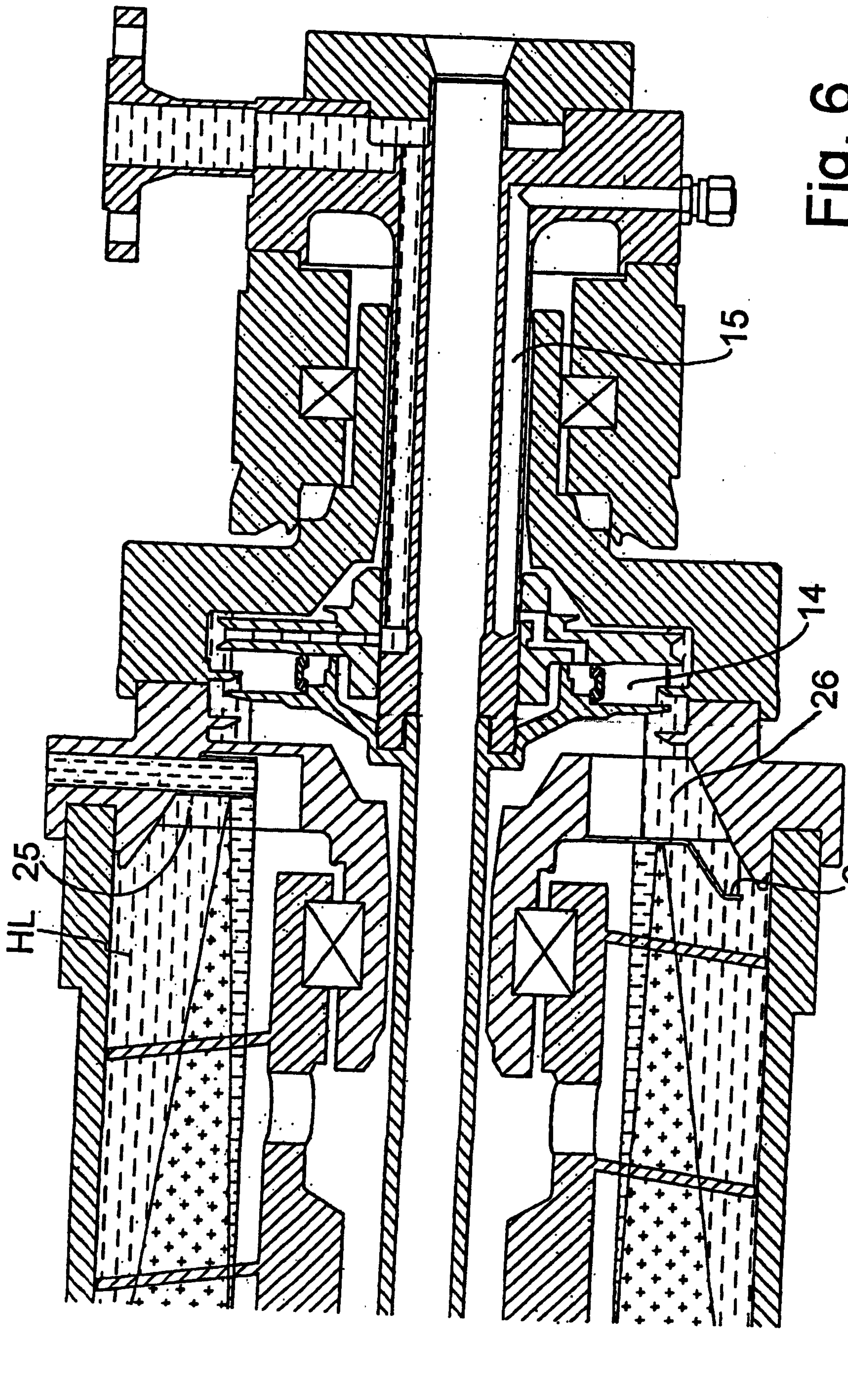


Fig. 6

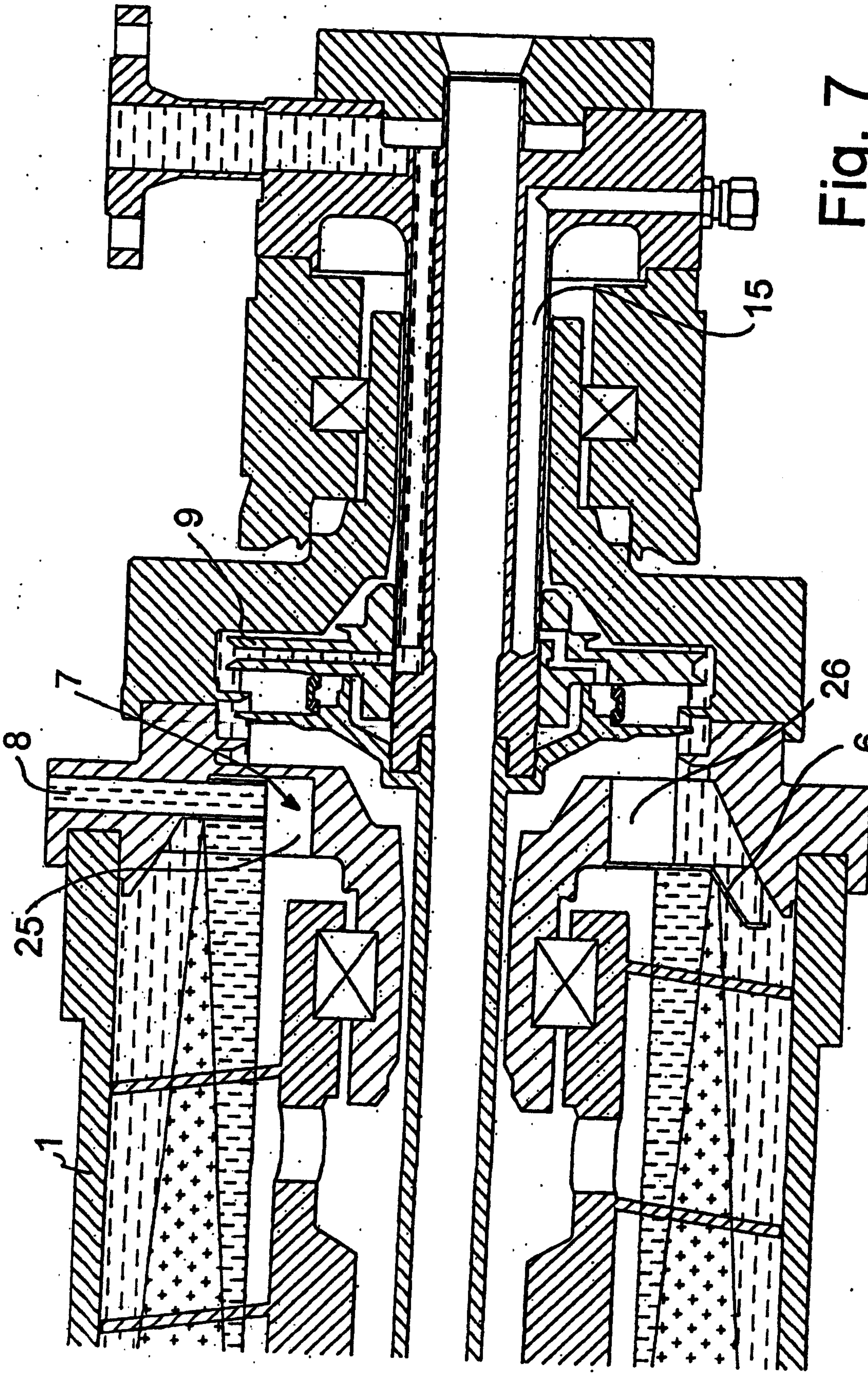


Fig. 7

Separating Decanter
Pneumatic Control of the Level Position of the Heavy Phase
and Thereby Control of the Separating Diameter
Liquid Filling in the Drum Constant

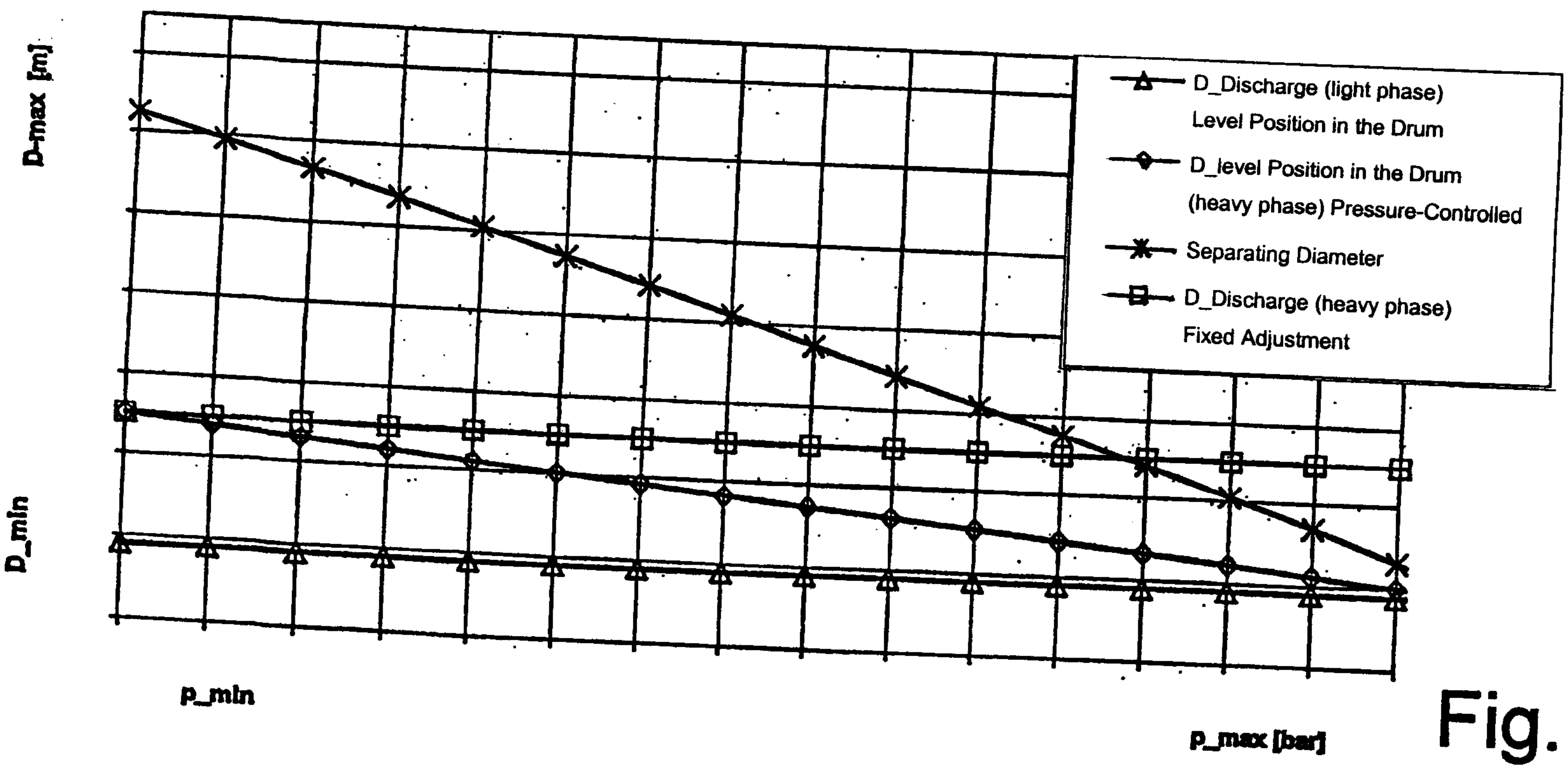
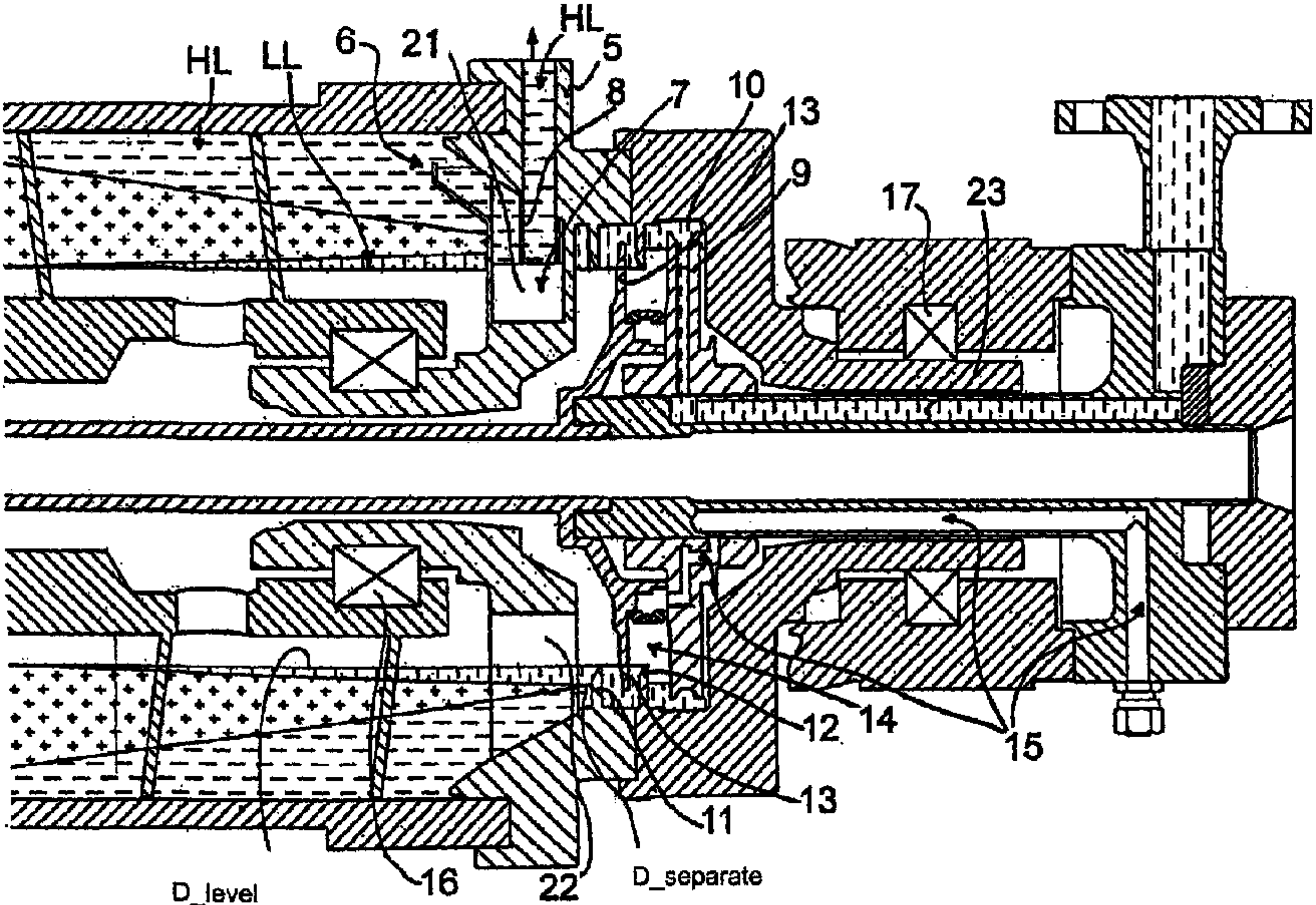


Fig. 8


HL
LL
6
21
HL
5
8
7
10
13
9
17
23
12
14
15
13
11
D_level
16
22
D_separate