AUSTRALIA

Patents Act 1990

NOTICE OF ENTITLEMENT

We, **SCHERING AKTIENGESELLSCHAFT**, of Müllerstrasse 170/78, Postfach 65 03 11, W-1000 Berlin 65, Germany, the Applicant in respect of Application No. 42595/93 state the following:

1. Schering Aktiengesellschaft is the Nominated Person in respect of the application.

2. The actual inventors of the invention, the subject of the application, are Christoph Donner, Stephan Sokolowsky and Lothar Reinke.

3 The Nominated Person, Schering Aktiengesellschaft, is entitled to the grant of a patent in respect of the application because the said Nominated Person derived title to the invention from the actual inventors by virtue of the terms of their employment.

4. The Nominated Person is entitled to claim priority from the basic application listed in the declaration under Article 8 of the PCT because (i) the Nominated Person is the Applicant in respect of the application listed in the declaration under Article 8 of the PCT and (ii) the said application was the first application made in a Convention country in respect of the invention the subject of the application.

Dated this 6th day of August, 1996.

SCHERING AKTIENGESELLSCHAFT
By Its Patent Attorneys
DAVIES COLLISON CAVE

JAMES G SIELY, RPAA

AU9342595

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FLUIDIZED-BED FERMENTER

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C12M 001/40

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(56) Prior Art Documents
EP 258611
WO 88/08825

(57) Claim

1. Fluidized-bed fermenter characterized by an inverted cone-shaped fermentation space (1) with truncated cone frustum, with two feed pipes (2 and 3), of which one (2) is arrange vertically aligned to the cone vertex and the second (3) nonvertically aligned to the shell of the cone in 0.02 to 0.3 times the height of the fermentation space and a sedimentation space (6) above fermentation space (1), which has one or two drainpipes (7 and 8).

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(81) Bestimmungsstaaten: AU, CA, HU, JP, US, europäisches Patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

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Mit internationalem Recherchenbericht.

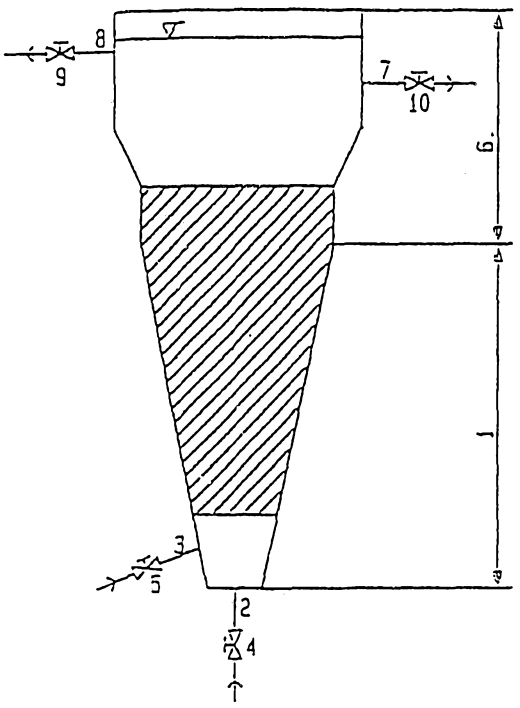
672208

(54) Title: FLUIDIZED-BED FERMENTER

(54) Bezeichnung: WIRBELSCHICHTFERMENTER

(57) Abstract

Disclosed is a fluidized-bed fermenter which is characterized by an inverted-cone-shaped fermentation space (1) with two feed lines (2 and 3) optionally fitted with control valves (4 and 5), one (2) of the feed lines being fitted vertically in the apex of the cone and the second (3) being fitted at an angle to the vertical in the wall of the cone at 0.1 to 0.3 times the height of the fermentation space. The fermenter is further characterized by a sedimentation space (6), located above the fermentation space (1), with one or two discharge lines (7 and 8) optionally fitted with control valves (9 and 10).



(57) Zusammenfassung

Es wird ein Wirbelschichtfermenter beschrieben, der gekennzeichnet ist durch einen auf der Spitze stehenden kegelförmigen Fermentationsraum (1) mit zwei gegebenenfalls mit Steuerventilen (4 und 5) versehenen Zuführungsleitungen (2 und 3), von denen die eine (2) vertikal ausgerichtet in der Kegelspitze und die zweite (3) nicht vertikal ausgerichtet im Kegelmantel in der 0,1 bis 0,3-fachen Fermentationsraumhöhe angeordnet ist und einen oberhalb des Fermentationsraums (1) befindlichen Sedimentationsraum (6), welcher ein oder zwei gegebenenfalls mit Steuerventilen (9 und 10) versehene Abflußleitungen (7 und 8) besitzt.

Fluidized-Bed Fermenter

The invention relates to a fluidized-bed fermenter, which is characterized by an inverted cone-shaped fermentation space (1) with two feed pipes (2 and 3) optionally provided with control valves (4 and 5), of which one (2) is placed vertically aligned to the cone vertex and the second (3) is nonvertically aligned to the shell of the cone in 0.02 to 0.3 times the height of the fermentation space and a sedimentation space (6) above fermentation space (1), which has one or two drainpipes (7 and 8) optionally provided with control valves (9 and 10).

The special design of the fluidized-bed fermenter according to the invention results in that a turbulent flow prevails in its fermentation space (1), if the liquid to be fermented is fed simultaneously by vertical and horizontal feed pipes (2 and 3). This flow then merges in sedimentation space (6) in a quasi-laminar flow. If such a continuously-fed fermenter is inoculated with a microorganism culture, the latter forms pelletlike agglomerates after a growth phase because of the turbulent flow, agglomerates which are suspended in the fluidized bed of fermentation space (1) and sink again in sedimentation space (6). Because of these circumstances, the fluidized-bed fermenter according to the invention is substantially better suited for continuous fermentation of large amounts of liquid over a long period than is the case in previously known fluidized-bed fermenters, such as, for example, the device described in European Patent Specification EP-B-0258611. Consequently, the fluidized-bed fermenter according to the invention is especially

suitable, for example, for biological waste-water or ground-water treatment.

The design of the fluidized-bed fermenter according to the invention is determined essentially by the type of microorganism cultures, which are to be used in it. If these are microorganism cultures which sediment relatively quickly, such as, for example, microorganism-immobilizates, as they are described in International Patent Application WO 88/08825, or fungi cultures, fluidized-bed fermenters with a fermentation space (1) and sedimentation space (6) of relatively small height are preferably used. In relatively poorly sedimenting microorganism cultures, as bacteria cultures generally are, fluidized-bed fermenters with relatively large fermentation space (1) and sedimentation space (6) are preferred. But it is not necessary that for every microorganism culture used, a specially configured fermenter be used; a continuous fermentation generally can also be achieved in fluidized-bed fermenters according to the invention not optimally configured for the special case by a corresponding adjustment of the intake rates of the liquids to be fermented by vertical and nonvertical feed pipes (2 and 3).

Generally, the fluidized-bed fermenter according to the invention is to be configured so that the upper diameter of fermentation space (1) is 0.1 to 0.8 times as large as its height. These numerical values do not take into consideration that the fermentation space normally has a truncated cone frustum, which is suitable for the reason alone that the fermenter can be more easily cleaned.

It has already been mentioned that nonvertically-aligned feed pipe (3) is arranged in the shell of the cone in 0.02 to 0.3 -- especially 0.05 to 0.15 -- times the height of fermentation space, in which two feed pipes are aligned so that in putting the fermenter in operation, a fluidized bed is produced in the fermentation space. Nonvertically-aligned feed pipe (3) can be arranged horizontally, so that the straight horizontal line pointing from the intake opening of this pipe to the axis of the fermentation space crosses this axis. But to produce a readily reproducible turbulent flow, it is suitable that the longitudinal axis of the nonvertically-aligned pipe and the straight horizontal lines pointing from the intake opening of this pipe to the axis of the fermentation space form an angle in the vertical line and/or the horizontal line, which does not exceed the value of 70° in the vertical line and the value of 60° in the horizontal line. If this feed pipe (3) is arranged directed vertically upward, the angle is preferably 10° to 60° (especially 30° to 40°), if the pipe is vertical but arranged directed downward, the angle suitably has a value between 10° and 60° (especially 20° to 45°). If feed pipe (3) optionally in addition is arranged horizontally offset, the angle is preferably 5° to 60° and especially 20° to 45°.

It is obvious to one skilled in the art that the terms "horizontal" and "vertical" are not to be understood in the mathematical sense, but that the feed pipes can deviate within the usual tolerances from an exact horizontal or vertical arrangement. Generally, feed pipes (2 and 3) are provided with

usual control valves (4 and 5) and are connected by a common pipe with a storage vessel intended to accommodate the solution to be fermented.

It has already been mentioned that the fluidized-bed fermenter according to the invention has a sedimentation space (6) above fermentation space (1), which has one or preferably two drainpipes (7 and 8) optionally provided with control valves (9 and 10).

This sedimentation space (6) can be configured so that it represents a continuation without a transition of the cone-shaped fermentation space; on the other hand, it can also be configured, for example, so that it consists of one or two cylindrical components optionally provided with a conical enlargement. In this case, it can be dimensioned so that its upper diameter is 1 to 3 times (especially 1.5 to 2.5 times) the upper diameter of fermentation space (1). Sedimentation space (6) is preferably dimensioned so that it has 0.2 to 0.5 times the height of fermentation space (1). Sedimentation space (6) has one or preferably two drainpipes optionally provided with control valves (9 and 10). Two drainpipes are suitable, if it is intended to return a part of the fermented liquid to the fermentation cycle to dilute the liquid to be fermented to the extent that a practically complete conversion of the substrates contained in it can be achieved. In this case, the drainpipe used for the recycling is suitably arranged somewhat lower (preferably 20 to 40% below the upper drainpipe) than the pipe used for the drainage.

Just as in the case of conventional fermenters, the fluidized-bed fermenter according to the invention can also be provided with the usual auxiliary devices, which make possible tempering, pH control, aeration and/or sterilization of the contents of the fermenter. It can be produced the same way as conventional fermenters made of glass and/or noncorroding metal.

Based on the drawings, the invention is to be explained in more detail.

There are shown in:

Figure 1 a longitudinal section through a fluidized-bed fermenter according to the invention,

Figure 2 a cross section through the fluidized-bed fermenter of figure 1 at the level of plane A-B,

Figure 3 a longitudinal section through a fluidized-bed fermenter with built-in tempering, aerating and sterilizing device,

Figure 4 a diagrammatic representation of a fermentation unit with a fluidized-bed fermenter according to the invention and

Figure 5 a diagrammatic representation of a fermentation unit with two fluidized-bed fermenters connected in series.

The fluidized-bed fermenter represented in figure 1 is intended for treatment of waste water with bacteria cultures. It consists of cone-shaped fermentation space (1) with truncated cone frustum, sedimentation space (6) as well as feed pipes (2 and 3) provided with control valves (4 and 5) and drainpipes (7 and 8) provided with control valves (9 and 10). Fermentation

space (1) has a height of 2300 mm and an upper diameter of 600 mm. Vertical pipe (2) feeds into it and nonhorizontal pipe (3), which is sloped vertically upward and forms an angle of 35° with the horizontal line, at a height of 230 mm. Sedimentation space (6) is arranged on the upper edge of fermentation space (1). This sedimentation space consists of two cylindrical components provided with a conical enlargement, is closed on top and has an upper diameter of 1300 mm and a total height of 1300 mm. (Hatched area 12 of figure 1 is to symbolize the area in which the bacteria culture is whirled. The space identified with number 16 is to symbolize the largely bacteria-free space.) Below the upper cover, two drainpipes (7 and 8) are attached facing one another, of which one pipe (8), used to discharge the fermentation broth, is arranged 250 mm below the upper cover of the sedimentation space, and pipe (9) used as the return is arranged 600 mm below. The fermenter is produced from stainless steel. It can be seen from Fig. 2 that nonvertical feed pipe (3) with the straight line pointing from its intake opening to the fermentation axis forms an angle α of 35°.

The fluidized-bed fermenter represented in Figure 3 has the same design as that described in Figure 1, but it has in addition a circular incoming air pipe (13), provided with nozzles, present tight on the bottom; a superheated steam pipe (14), which can be used to sterilize the contents of the fermenter; and a double shell (15) enclosing the fermentation space to accommodate the tempering liquid.

The fermentation unit diagrammatically represented in Figure 4 basically consists of a fluidized-bed fermenter, as explained in Figure 1, and a return pipe (17) provided with a metering pump (22) as well as a feed pipe for feeding additives (19) controlling the pH, a feed pipe for feeding H_2O_2 as oxygen donor (20), a feed pipe for feeding nutrient medium (21) and a feed pipe for feeding waste water (18), return pipe which is connected by a branching with feed pipes (2 and 3).

1 m^3 of waste water and the reflux, concentrated with nutrient medium and adjusted to pH = 7, are fed hourly by feed pipe (18) to the fermenter inoculated with a bacteria-mixed culture isolated from the corresponding waste-water sludge, and control valves (4 and 5) of feed pipes (2 and 3) are adjusted so that a stable fluidized bed with constant microorganism density results in the fermenter after the conclusion of the growth phase (about 2 to 6 weeks). Then, 1 m^3 of purified waste water is removed hourly from the fermenter by one drainpipe (7) while 7 to 14 m^3 of purified waste water is returned to the cycle per hour by other drainpipe (8) to dilute the fed waste water or ground water.

With this fermentation unit, it is possible to purify, continuously per hour, 1 m^3 of waste water, which is contaminated with tetrahydrofuran, diethyl ether and diisopropyl ether, over several months, so that it contained at most 5% of the above-mentioned contaminants.

Finally, the fermentation unit diagrammatically represented in Figure 5 can be mentioned, which is distinguished basically

from the device sketched in Figure 4 in that it has two fermentation units (23 and 24), which in principle have the same design as the unit represented in Fig. 4, in which drainpipe 32 discharging from unit 24 is used to feed waste water or ground water to fermentation unit 23. This unit can be adjusted by corresponding adjustment of the control valves, so that the fermenters are connected in parallel or in series.

It is obvious to one skilled in the art that the fluidized-bed fermenters according to the invention can be used not only for waste-water or ground-water treatment. Possible applications of these fermenters follow, for example, also in the continuous fermentative production of water-soluble alcohols, acids or carbohydrates, such as, for example, ethanol, acetic acid, citric acid, galactose, L-sorbose, the microbial synthesis of amino acids, such as glutamic acid, the production of antibiotics, or the microbiological transformation of steroids.

Reference numerals, in parenthesis, are employed in the ensuing claims. It is to be understood that, in each instance of such use, the numerals are solely for the purpose of illustration, and therefore should not be limitatively construed.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Fluidized-bed fermenter characterized by an inverted cone-shaped fermentation space (1) with truncated cone frustum, with two feed pipes (2 and 3), of which one (2) is arrange vertically aligned to the cone vertex and the second (3) nonvertically aligned to the shell of the cone in 0.02 to 0.3 times the height of the fermentation space and a sedimentation space (6) above fermentation space (1), which has one or two drainpipes (7 and 8).

2. Fluidized-bed fermenter according to claim 1, characterized in that the upper diameter of fermentation space (1) is 0.1 to 0.8 times as large as its height.

3. Fluidized-bed fermenter according to claim 1 or 2, wherein the feed pipes (2 and 3) and the drain pipes (7 and 8) are respectively provided with control valves (4 and 5), (9 and 10).

4. Fluidized-bed fermenter according to any one of claims 1 to 3, wherein the vertically-aligned feed pipe (2) and the nonvertically-aligned feed pipe (3) are arranged so that in putting the fermenter in operation, a fluidized bed is produced in the fermentation space.

5. Fluidized-bed fermenter according to claim 4, wherein the angle between the longitudinal axis of the nonvertically-aligned feed pipe (3) and that of the straight horizontal line pointing from the intake opening of this feed pipe to the axis of the fermentation space does not exceed 70° in the vertical line and 60° in the horizontal line.

6. Fluidized-bed fermenter according to any one of claims 1 to 5, wherein the sedimentation space (6) consists of one or two cylindrical components provided with a conical enlargement.

7. Fluidized-bed fermenter according to claim 6, wherein the upper diameter of the sedimentation space (6) is 1 to 3 times the upper diameter of the fermentation space (1).

8. Fluidized-bed fermenter according to claim 6 or 7, wherein the sedimentation space (6) has 0.2 to 0.5 times the height of the fermentation space (1).

9. A process for the treatment of waste-water or ground-water wherein the waste-water or ground-water being treated is fed into a fluidized-bed fermenter according to any one of the preceding claims.

DATED this 6th day of August, 1996.

SCHERING AKTIENGESELLSCHAFT
By Its Patent Attorneys
DAVIES COLLISON CAVE

Abstract

A fluidized-bed fermenter is described, which is characterized by an inverted cone-shaped fermentation space (1) with two feed pipes (2 and 3) optionally provided with control valves (4 and 5), of which one (2) is vertically aligned to the cone vertex and the second (3) is nonvertically aligned to the shell of the cone in 0.1 to 0.3 times the height of the fermentation space and a sedimentation space (6) above fermentation space (1), which has one or two drainpipes (7 and 8) optionally provided with control valves (9 and 10).

[Key to Figures:]

Fig. 4:

Umlauf = circulation

Zulauf = feed

Fig. 5:

Ablauf = discharge

Umlauf = circulation

Zulauf = feed

Fig. 6:

Zeichnung zur Zusammenfassung = drawing for the abstract

42595/93

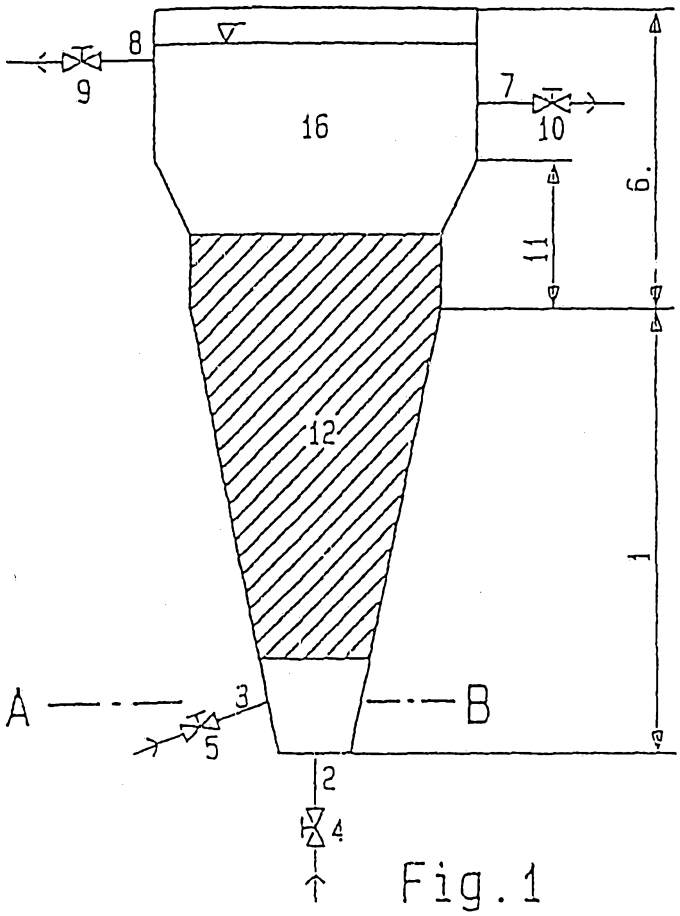


Fig. 1

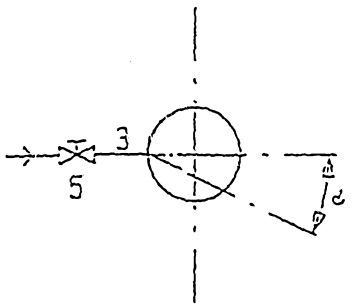


Fig.2

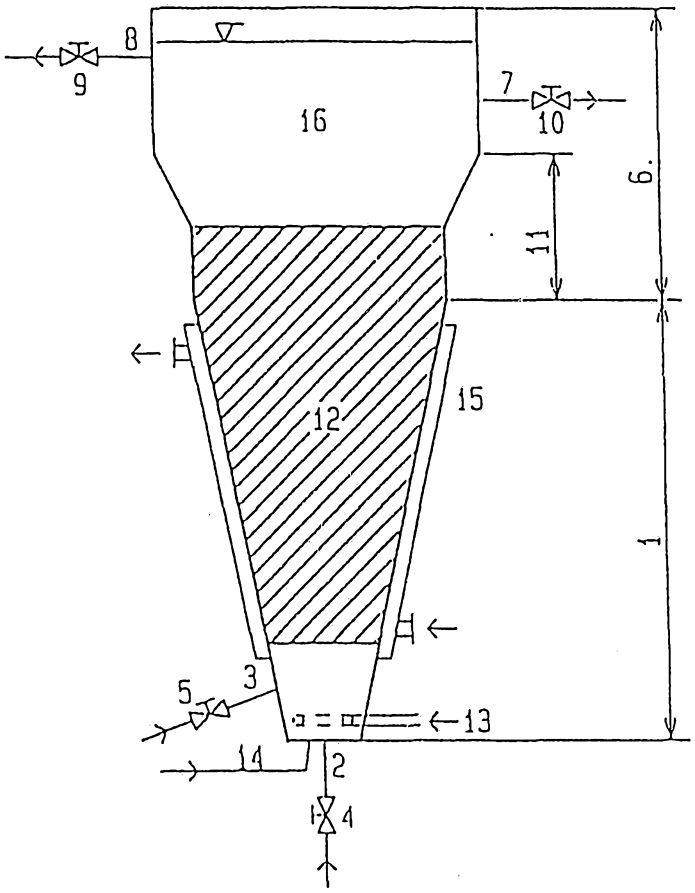


Fig.3

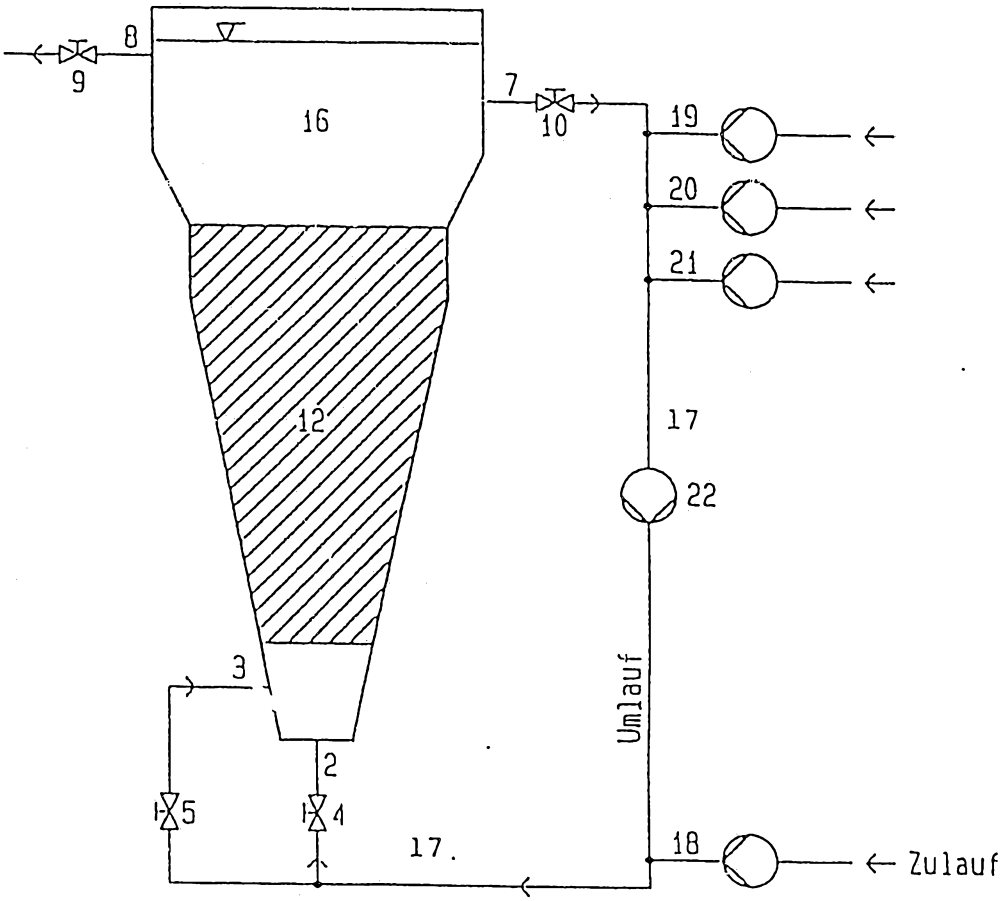
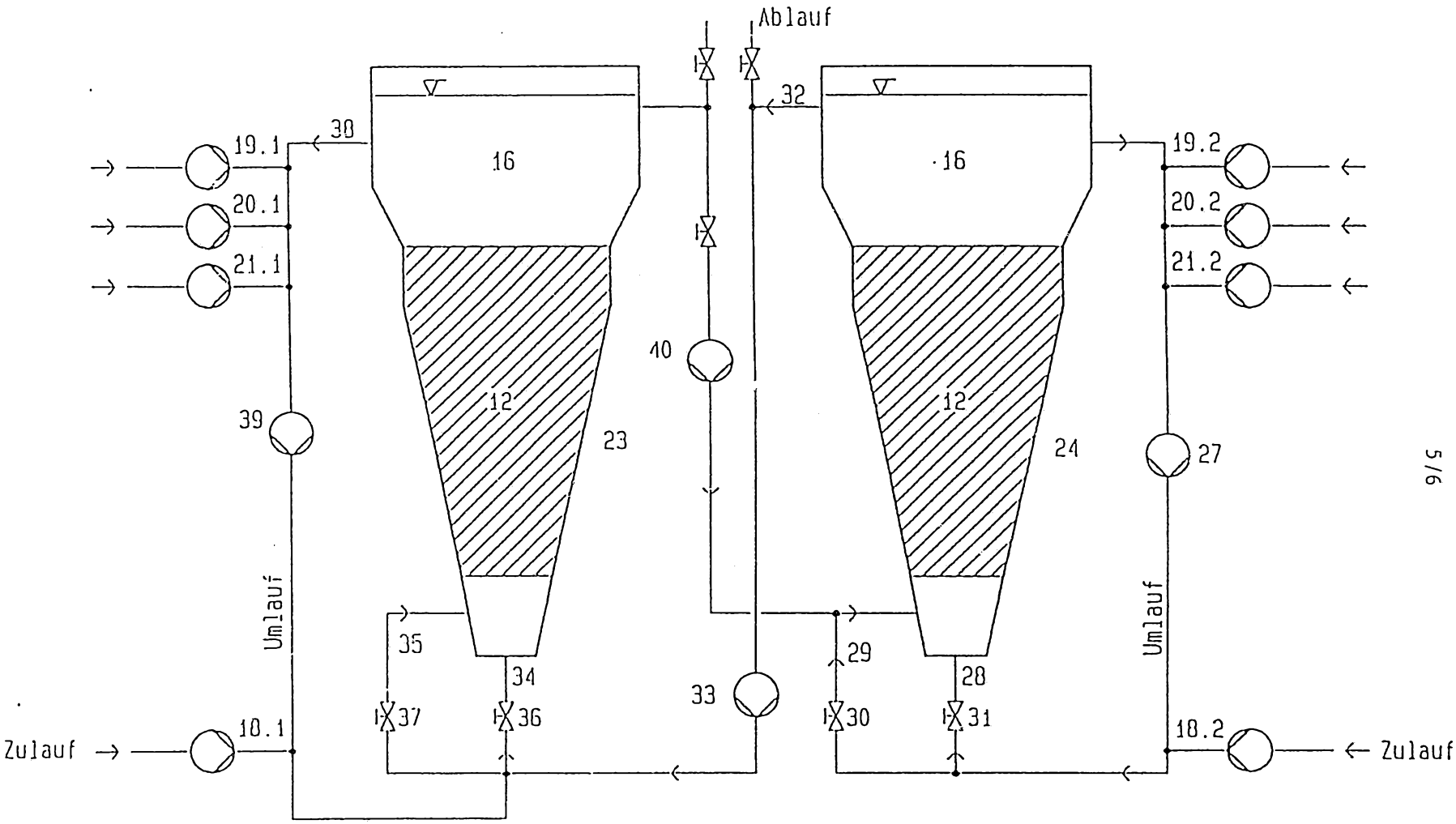


Fig.4


Ablauf
32
30
19.1
20.1
21.1
16
16
19.2
20.2
21.2
40
12
12
39
23
24
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Umlauf
Umlauf
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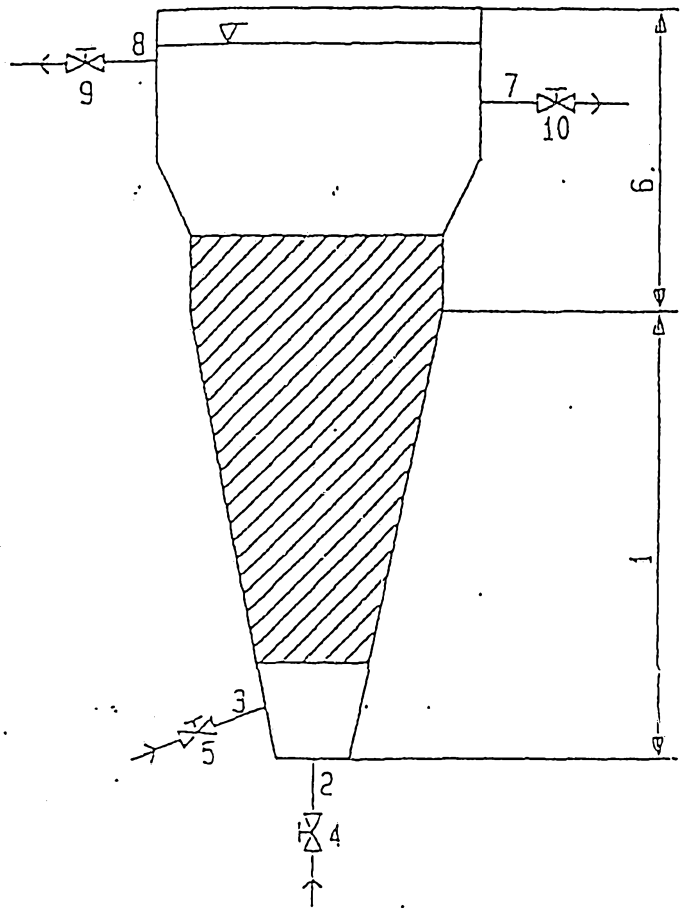
18.1
18.2
Zulauf
Zulauf

Fig.5

Zeichnung zur Zusammenfassung



INTERNATIONAL SEARCH REPORT

International application No.
PCT/DE 93/00414

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.[5] C02F3/12; C02F3/28; C12M1/40

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl.[5] C02F; C12M; B01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	BE, A, 900 159 (REGION WALLONNE) 5 November 1984 see page 4, line 18 - line 30 see page 7, line 26 - line 33	1,4,7,9
Y	FR, A, 2 102 216 (ESSO RESEARCH AND ENGINEERING COMPANY) 7 April 1972 see page 7, line 12 - line 17	1,4,7,9
A	DE, A, 4 011 649 (VEB ENERGIEKOMBINAT ERFURT) 14 February 1991 see claim 1	1,3,4
A	EP, A, 0 433 139 (ATOCHEM) 19 June 1991 see example 1a	1,6,9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 July 1993 (29.07.93)	11 August 1993 (11.08.93)
Name and mailing address of the ISA/ European Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

DE 9300414
SA 72965

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 European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
BE-A-900159	05-11-84	None		
FR-A-2102216	07-04-72	CA-A-	965366	01-04-75
		DE-A,C	2138107	17-02-72
		GB-A-	1357220	19-06-74
		NL-A-	7110877	15-02-72
		US-A-	3654140	04-04-72
DE-A-4011649	14-02-91	None		
EP-A-0433139	19-06-91	FR-A-	2655974	21-06-91
		AU-A-	6813690	20-06-91

INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen PCT/DE 93/00414

I. KLASSIFIKATION DES ANMELDUNGSGEGENSTANDS (bei mehreren Klassifikationssymbolen sind alle anzugeben)[6]

Nach der Internationalen Patentklassifikation (IPC) oder nach der nationalen Klassifikation und der IPC

Int.Kl. 5 C02F3/12; C02F3/28; C12M1/40

II. RECHERCHIERTE SACHGEBIETE

Recherchierter Mindestprüfstoff [7]

Klassifikationssytem	Klassifikationssymbole
Int.Kl. 5	C02F ; C12M ; B01J

Recherchierte nicht zum Mindestprüfstoff gehörende Veröffentlichungen, soweit diese unter die recherchierten Sachgebiete fallen [8]

III. EINSCHLAGIGE VEROFFENTLICHUNGEN [9]

Art.°	Kennzeichnung der Veröffentlichung [11], soweit erforderlich unter Angabe der maßgeblichen Teile [12]	Betr. Anspruch Nr.[13]
Y	BE,A,900 159 (REGION WALLONNE) 5. November 1984 siehe Seite 4, Zeile 18 - Zeile 30 siehe Seite 7, Zeile 26 - Zeile 33	1,4,7,9
Y	FR,A,2 102 216 (ESSO RESEARCH AND ENGINEERING COMPANY) 7. April 1972 siehe Seite 7, Zeile 12 - Zeile 17	1,4,7,9
A	DE,A,4 011 649 (VEB ENERGIEKOMBINAT ERFURT) 14. Februar 1991 siehe Anspruch 1	1,3,4
A	EP,A,0 433 139 (ATOCHEM) 19. Juni 1991 siehe Beispiel 1a	1,6,9

° Besondere Kategorien von angegebenen Veröffentlichungen [10] :

"A" Veröffentlichung, die den allgemeinen Stand der Technik definiert, aber nicht als besonders bedeutsam anzusehen ist

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"X" Veröffentlichung von besonderer Bedeutung; die beanspruchte Erfindung kann nicht als neu oder auf erfinderischer Tätigkeit beruhend betrachtet werden

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"&" Veröffentlichung, die Mitglied derselben Patentfamilie ist

IV. BESCHEINIGUNG

Datum des Abschlusses der internationalen Recherche	Absendedatum des internationalen Recherchenberichts
29.JULI 1993	11. 08. 93
Internationale Recherchenbehörde	**Unterschrift des bevollmächtigten Bediensteten**
EUROPAISCHES PATENTAMT	GONZALEZ Y ARIAS M.

Formblatt PCT/ISA/210 (Blatt 2) (Januar 1985)

ANHANG ZUM INTERNATIONALEN RECHERCHENBERICHT ÜBER DIE INTERNATIONALE PATENTANMELDUNG NR.

DE 9300414
SA 72965

In diesem Anhang sind die Mitglieder der Patentfamilien der im obengenannten internationalen Recherchenbericht angeführten Patentdokumente angegeben.
Die Angaben über die Familienmitglieder entsprechen dem Stand der Datei des Europäischen Patentamts am 29/07/93
Diese Angaben dienen nur zur Unterrichtung und erfolgen ohne Gewähr.

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