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CA 2640749 C 2011/05/17

(11)(21) **2 640 749**

(12) **BREVET CANADIEN**
CANADIAN PATENT

(13) **C**

(86) **Date de dépôt PCT/PCT Filing Date:** 2006/11/30
(87) **Date publication PCT/PCT Publication Date:** 2007/06/14
(45) **Date de délivrance/Issue Date:** 2011/05/17
(85) **Entrée phase nationale/National Entry:** 2008/07/30
(86) **N° demande PCT/PCT Application No.:** EP 2006/011516
(87) **N° publication PCT/PCT Publication No.:** 2007/065596
(30) **Priorité/Priority:** 2005/12/05 (DE10 2005 057 977.9)

(51) **Cl.Int./Int.Cl.** *B01J 4/00* (2006.01), *B01F 3/04* (2006.01), *B01J 19/24* (2006.01)
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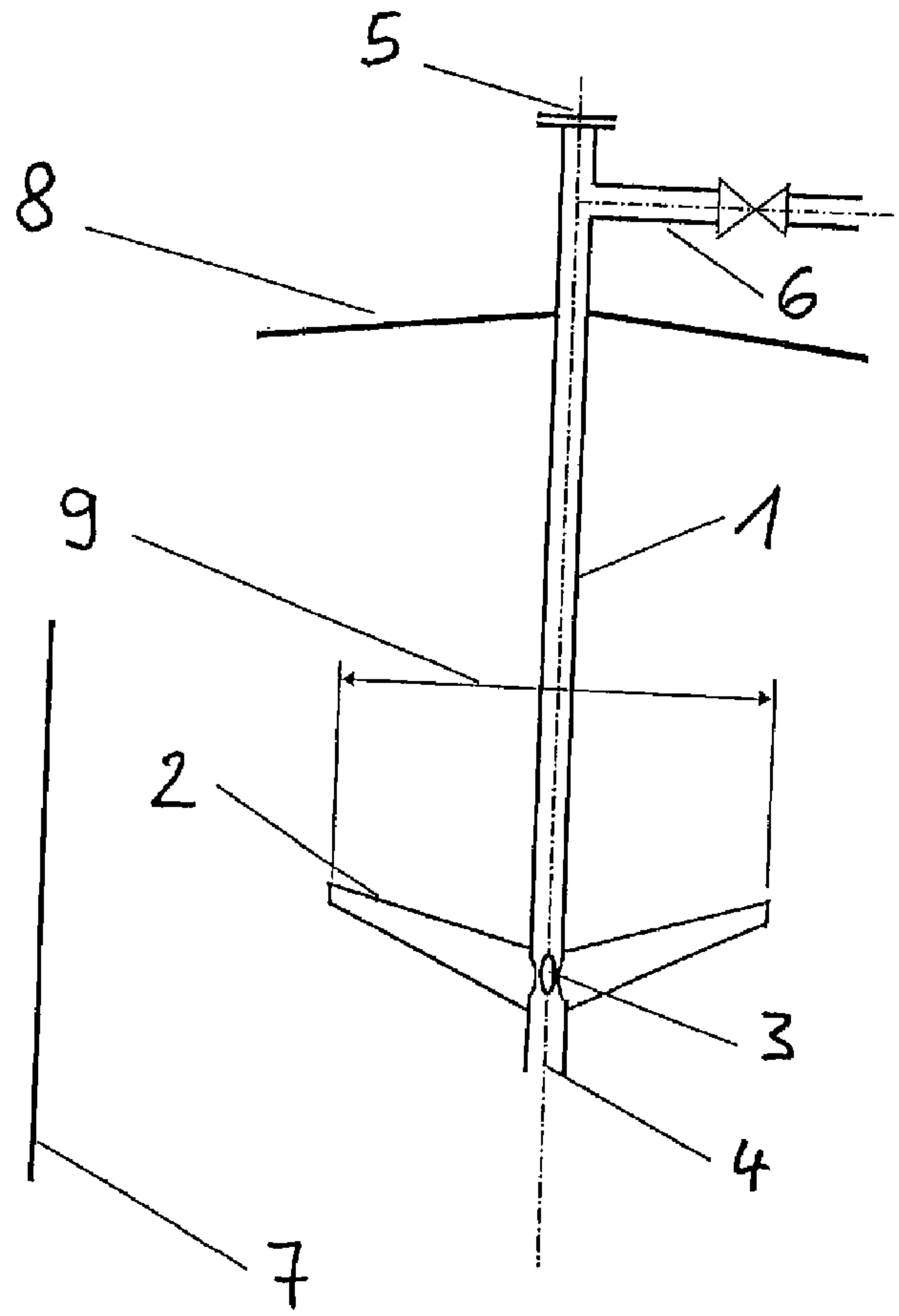
(54) **Titre :** REACTEUR EN BOUCLE DOTE D'UNE REPARTITION DE GAZ ANTI-COLMATAGE
(54) **Title:** LOOP REACTOR WITH CLOG-RESISTANT GAS DISTRIBUTION



(57) **Abrégé/Abstract:**
The invention relates to a loop reactor having a guide device (7) arranged in the interior of the loop reactor for circulating the reactor contents. The guide device (7) has at least one central gas feed device (1) with gas distributor devices (2) mounted thereon for gas

(57) Abrégé(suite)/Abstract(continued):
introduction into the guide device (7). Such loop reactors are used, for example, as biogas reactors for treating biological wastes or renewable raw materials. It is proposed to design the gas distributor devices (2) as gas guiding elements open at the bottom, which are arranged above gas outlet orifices (3) of the central gas feed device (1).

CA 02640749 2008-07-30

(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

(19) Weltorganisation für geistiges Eigentum
Internationales Büro

PCT

(43) Internationales Veröffentlichungsdatum
14. Juni 2007 (14.06.2007)

(10) Internationale Veröffentlichungsnummer
WO 2007/065596 A1

(51) Internationale Patentklassifikation:
B01J 4/00 (2006.01) ***B01F 3/04*** (2006.01)
B01J 19/24 (2006.01)

(21) Internationales Aktenzeichen: PCT/EP2006/011516

(22) Internationales Anmeldedatum:
30. November 2006 (30.11.2006)

(25) Einreichungssprache: Deutsch

(26) Veröffentlichungssprache: Deutsch

(30) Angaben zur Priorität:
10 2005 057 977.9 5. Dezember 2005 (05.12.2005) DE

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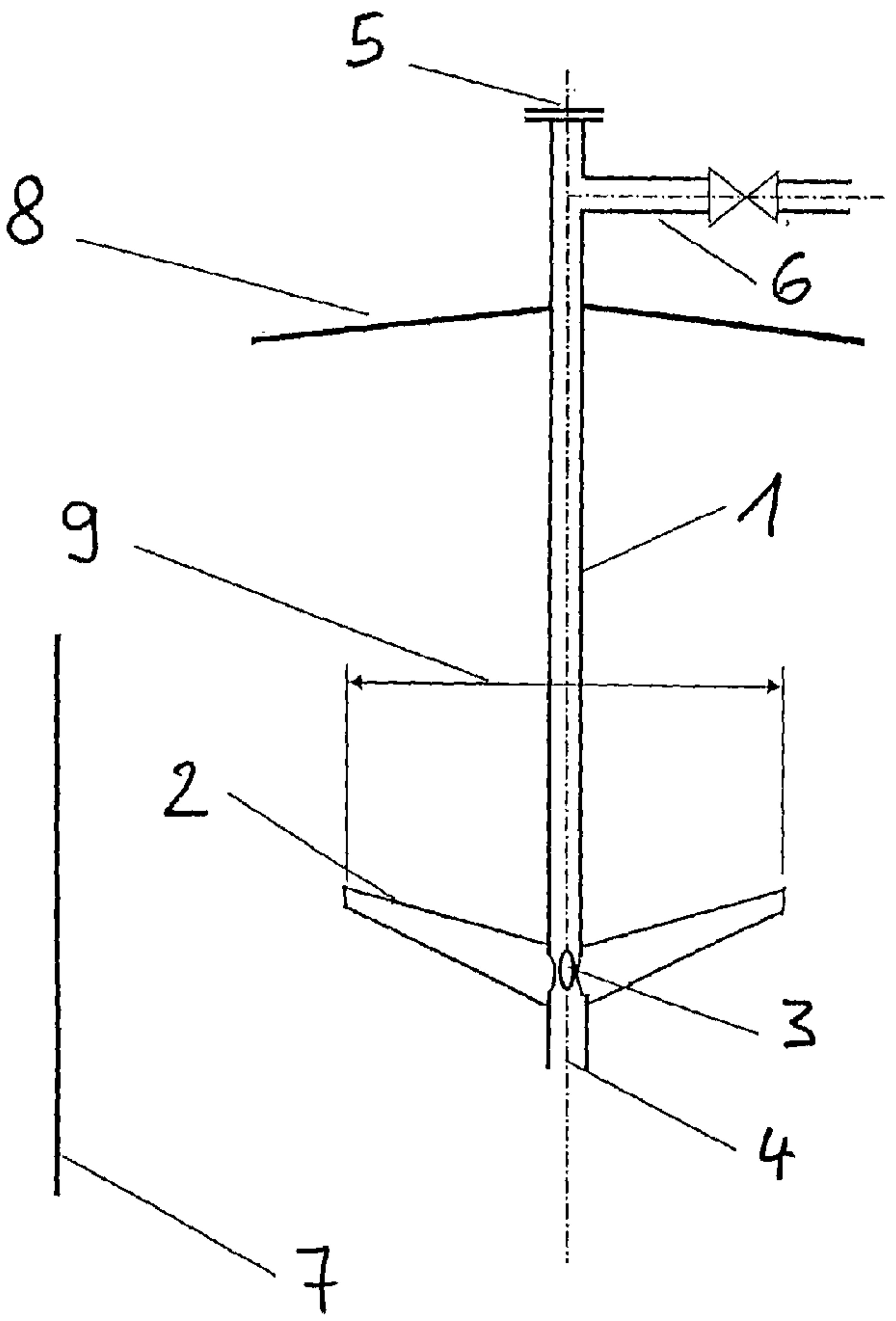
[Fortsetzung auf der nächsten Seite]

(54) Title: LOOP REACTOR WITH BLOCKAGE-RESISTANT GAS DISTRIBUTION

(54) Bezeichnung: SCHLAUFENREAKTOR MIT VERSTOPFUNGSRESISTENTER GASVERTEILUNG



(57) Abstract: The invention relates to a loop reactor having a guide device (7) arranged in the interior of the loop reactor for circulating the reactor contents. The guide device (7) has at least one central gas feed device (1) with gas distributor devices (2) mounted thereon for gas introduction into the guide device (7). Such loop reactors are used, for example, as biogas reactors for treating biological wastes or renewable raw materials. It is proposed to design the gas distributor devices (2) as gas guiding elements open at the bottom, which are arranged above gas outlet orifices (3) of the central gas feed device (1).

(57) Zusammenfassung: Die Erfindung betrifft einen Schlaufenreaktor mit einer im Innenraum des Schlaufenreaktors angeordneten Leiteinrichtung (7) zur Umwälzung des Reaktorinhalts. Die Leiteinrichtung (7) weist mindestens eine zentrale Gaszufuhreinrichtung (1) mit daran angebrachten Gasverteileinrichtungen (2) zum Gaseintrag in die Leiteinrichtung (7) auf. Derartige Schlaufenreaktoren werden z.B. als Biogasreaktoren zur Behandlung von Bioabfällen oder nachwachsenden Rohstoffen eingesetzt. Es wird vorgeschlagen, die Gasverteileinrichtungen (2) als nach unten offene Gasleitelemente auszubilden, die oberhalb von Gasaustrittsöffnungen (3) der zentralen Gaszufuhreinrichtung (1) angeordnet sind.

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FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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Veröffentlicht:

— *mit internationalem Recherchenbericht*

Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

Description

Loop reactor with clog-resistant gas distribution

The invention relates to a loop reactor having a guide means disposed in the interior of the loop reactor for circulating the reactor contents, the guide means having at least one central gas supply means with gas distribution means attached thereto for feeding gas into the guide means.

Loop reactors are often used in process engineering. In this case, liquid or flowable media are treated in a reactor with circulation of the reactor contents. The reactor contents are routed from bottom to top through a central guide means, e.g., a vertical guide pipe, into the interior of the reactor, and flow down again outside the guide pipe. For induction of the upward flow in the guide pipe, a gas is fed into the lower area of the guide pipe. The reactor contents are thus circulated in the form of a loop flow in the reactor.

Such loop reactors with internal loops are used as fully mixed anaerobic suspension reactors, in particular for biogas recovery from suspensions containing biodegradable substances, e.g., biowaste or renewable raw materials. The principle is described in e.g., among others, CH 31 67 67, DE 197 25 823 A1. In this case, immersed biogas is blown into the bottom of the central guide pipe. The reduced density of the sunken mixture in the guide pipe relative to the external liquid level yields a pressure difference in the liquid that induces upward flow in the guide pipe. The injected biogas is to be distributed as uniformly as possible with bubbles as fine as possible over the guide pipe cross-section in order to assure efficient mixture formation.

For small-diameter guide pipes, a gas-supplying ring line from which gas emerges inside on the guide pipe periphery via holes is often placed on the outside. For larger-diameter guide pipes, this principle is unfavorable, since distribution over the cross-section is not achieved. Central feed nozzles on the bottom of the reactor under the guide pipe entry are likewise unfavorable for large fermentation reactors, since they do not significantly contribute to the driving pressure difference for gas feed nozzles located lower than roughly 14 m below the liquid surface due to the static pressure. The compressor rating for charging of the gas at the correspondoing depth must however be applied.

For these reasons, for large reactors, lances immersed from the reactor roof are often inserted for supplying the biogas preferably between 7 m and 12 m below the liquid level. In this case, according to the prior art there are two alternatives with the advantages and disadvantages described below:

One alternative calls for the use of a central gas supply pipe with 3 to 7, preferably 5, gas distributor pipes of smaller diameter added to the lower end. The gas distributor pipes ensure gas emergence from the desired component circuit within the guide pipe and are thus designed to provide for an efficient mixture formation. This system has the advantage that a large-caliber supply pipe can be used for the gas, which can made resistant to bending and vibration over a great immersion length. In pratice however, the laterally outgoing distributor pipes of small diameter are disadvantageous and can clog over the medium-term with incrustations and caking in highly-concentrated suspensions, e.g. digested sludges. The gas emergence that takes place asymmetrically from the still unclogged pipes leads to disruptions of the sensitive hydraulic system.

In the other alternative, individual lances that are routed downwards are used separately on a component circuit. The latter offer a better cleaning possibility, since they can be cleaned from the reactor roof over the entire length up to the gas exit. A problem however arises from inadequate mechanical stability due to the smaller individual pipe diameter relative to dynamic stresses and the shear forces imposed by floating parts in operation.

The present invention is based on the task of designing the gas supply and gas distribution means in loop reactors so as to ensure resistance to buckling and bending on the one hand and an efficient distribution of gas on the other, accompanied by a low tendency to clog.

This task is solved in accordance with the invention in that the gas distribution means are designed as gas conducting elements open at the bottom and arranged above the gas exit openings of the central gas supply means.

Existing designs assume routing the gas via pipes to the exit point. According to the invention, however a design is proposed that has at least one central gas supply means that can comprise, for example, a stable central middle pipe that extends under the level of the liquid up to the desired introductory depth in the loop reactor. The gas distribution from this central gas supply means to the desired discharge component circuit in the guide means takes place in contrast to the prior art, not via distributor pipes, but rather via gas guide elements that are open on the bottom and that cannot clog. Preferably, the gas guide elements are designed as sheets bent in a semicircle and open on the bottom. The central gas supply means is suitably designed as a vertical supply pipe that extends under the liquid level provided in loop reactor. Preferably the gas guide elements are attached to the outside of this supply pipe. For example, they can be welded to the supply pipe when the supply pipe is made of metal and the gas guide elements are made as sheets bent in a semi-circle]. Depending on the individual case, three to seven, usually a preferred five, gas guide elements at the height of the gas exit openings distributed over the pipe periphery can be attached to the supply pipe . The gas exit openings in the supply pipe then enable the gas passage under the gas guide elements. The latter are preferably tilted upward at an angle of between 5 degrees and 45 degrees to the horizontal, whereby a tilt angle of between 10 degrees and 20 degrees is especially advantageous. The buoyancy forces cause the gas to flow under the preferably convexly arched gas guide element to the outer edge, where it separates as a chain of bubbles. The gas guide elements suitably have lateral guide surfaces which are elongated downward in the area around the gas discharge openings of the central gas supply means. As a result, this prevents the gas from emerging laterally under the gas guide elements in the area of the turbulent gas passage. The gas thus reliably follows the guide contour of the gas guide elements.

After the large-space reactor circulation flow starts, the velocity of the streaming liquid in the guide means, which is process-specific between 0.5 m per second and roughly 1.4 m per second, supports the gas flow under the gas guide elements and stabilizes the formation of a desired small-diameter bubble spectrum of between 10 mm and about 30 mm by the shear forces on the separation edges of the contour. At the same time, the liquid gas flow along the gas guide elements has a self-cleaning effect, in which the beginnings of caking and incrustations are washed off.

The essential advantages of the device according to the invention comprise especially in the durability and clogging resistance of the gas supply system, which in particular enables economical continuous operation in the treatment of high-solids suspensions. The use of a central gas supply means that can be designed as a stable central pipe in conjunction with the gas guide elements attached thereto and open to the bottom results overall in a gas supply system with high resistance to buckling and bending. The central gas supply means can be easily cleaned by, e.g., inserting a pipe brush or a high-pressure cleaning head. The gas guide elements open to the bottom cannot clog, so that altogether the maintenance cost for the gas charging system can be minimized.

The invention is suitable for all conceivable loop reactors in which the reactor contents are circulated via a guide means that is supplied with a gas for forming a propulsion jet. Especially advantageous the invention can be used in biogas reactors for the treatment of suspensions containing biodegradable substances, in which e.g., biowastes or renewable raw materials are fermented. In particular due to the high solids content of the suspension to be treated, an increased risk of clogging exists for the gas supply system in the treatment of renewable raw materials in biogas reactors. The invention offers important advantages in this respect.

The following will make reference to the embodiment depicted schematically in the figures in describing the invention in greater detail:

Shown are:

Figure 1 shows a cross-section of a gas supply system for a loop reactor.

Figure 2 shows a detailed view of a gas guide element.

Figure 1 shows an extract from a loop reactor which can be used, for example, as a fully-mixed anaerobic suspension reactor for treatment of biowastes or renewable raw materials. In the extract of the loop reactor the guide means 7 designed as a guide pipe for forming the interior loop flow in the loop reactor is shown. In guide pipe 7, there is a central supply pipe 1 for introducing gas into the guide pipe 7. The supply pipe 1 is introduced as a lance from overhead through the reactor roof 8 . Underneath the intended liquid level in the loop reactor, the supply pipe 1 has gas exit openings 3 configured as holes. In this area, gas guide elements 2, which are designed as semi-circular bent sheets and open on the bottom, are welded to the supply pipe 1. Gas distribution takes place from the central supply pipe 1 to the desired discharge component 9 in the guide pipe 7 through these gas distribution elements. In doing so, the gas exit openings 3 in the central supply pipe 1 enable gas passage under the gas guide elements 2, which are bent upwards at an angle of 10 to 20 degrees. The buoyancy forces cause the gas to flow under the convexly-arched gas guide element to the outer edge where it separates as a chain of bubbles. In so doing, the liquid gas flow along the gas guide elements 2 has a self-cleaning effect, in which it washes off the beginnings of caking and incrustations.

The central supply pipe 1 and the area of the gas discharge openings 3 under the gas guide elements 2 are easily cleaned in operation. In addition, the central supply pipe 1 open at the bottom is extended 100 mm to 300 mm under the gas exit openings 3 as a guide section 4. The supply pipe 1 ends in known fashion above the reactor roof 8 in a blind flange *5*, under which the gas supply 6 into the supply pipe 1 is joined laterally. During cleaning, this line can be closed off from the gas system by a valve. A cleaning element can then be introduced via the removed blind flange entry *5*, e.g. in the form of a pipe brush or a high-pressure cleaning head, and can be lowered into the area of the gas exist openings 3. In this way blockages can be reliably removed mechanically or hydraulically. During the cleaning, there is no significant discharge of gas from the central supply pipe 1, since the lower area is securely closed off by the liquid level of the loop reactor. The guide section 4 on the central supply pipe 1, which is open to the bottom, prevents the cleaning element from getting stuck at the height of the gas exit openings 3 during operation. Dislodged solids do not accumulate in the supply pipe 1, but rather sink through the lower opening into the reactor fluid. Gas does not escape here during operation since the static liquid column forces the forced gas to flow out of the gas exit openings 3 disposed higher under the gas guide elements 2.

Figure 2 shows a detailed view of a gas guide element. This is here a convex bent sheet that is open to the bottom. In the area of the gas exit opening 3, the lateral guide surfaces 10 of the gas guide element are elongated and extend downward. This prevents the gas from discharging laterally under the gas guide element 2 in the area of the turbulent gas passage through the gas exit opening 3. The gas thus reliably follows the guide contour of the gas element 2.

CLAIMS:

1. An anaerobic loop reactor being designed as a biogas reactor for the treatment of suspensions containing biodegradable substances, comprising a guide means located in the interior of said loop reactor for circulating the reactor contents, wherein the guide means has at least one central gas supply means with gas distribution means attached thereto for feeding gas into the guide means, and wherein the gas distribution means are designed as gas guide elements configured as sheets bent in a semicircle open to the bottom, which are bent upwards to the horizontal and are arranged above the gas exit openings of the central gas supply means, and that the gas distribution means are attached to the central gas supply means at the height of the gas exit openings distributed over the periphery of the central gas supply means.

2. The loop reactor according to claim 1, wherein the central gas supply means is configured as a vertical supply pipe which extends under the liquid level provided in the loop reactor.

3. The loop reactor according to claim 2, wherein the gas guide elements are attached to the outside of the supply pipe.

4. The loop reactor according to claim 3, wherein three to seven gas guide elements are provided.

5. The loop reactor according to any one of claims 1 to 4, wherein the gas guide elements are bent upwards at an angle of between 5 degrees and 45 degrees to the horizontal.

6. The loop reactor according to any one of claims 1 to 5, wherein the gas guide elements have lateral guide surfaces which are downwardly elongated in the area around the gas exit openings of the central gas supply means.

7. The loop reactor according to any one of claims 1 to 6, wherein the biodegradable substances are biowastes or renewable raw materials.

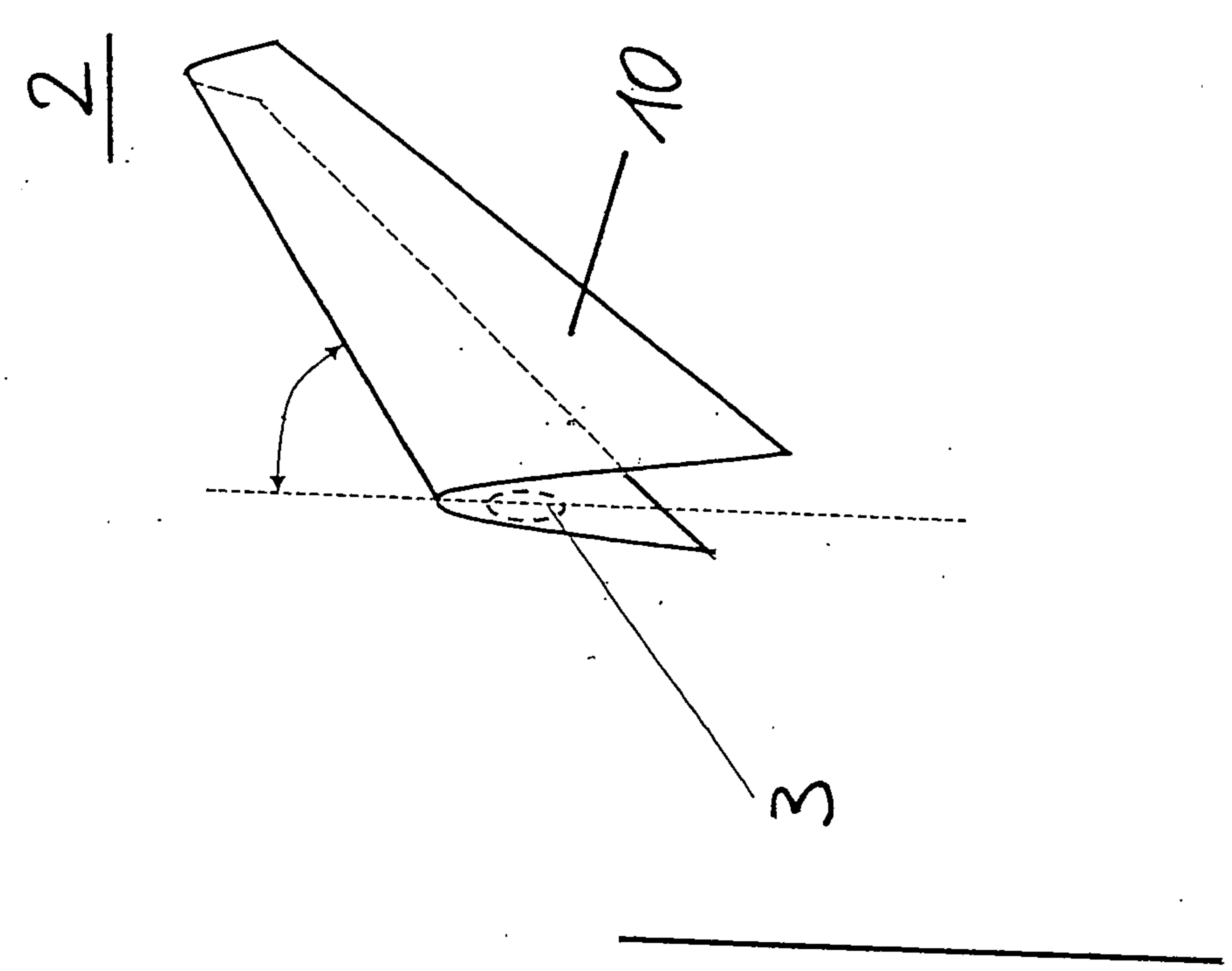


Fig. 2

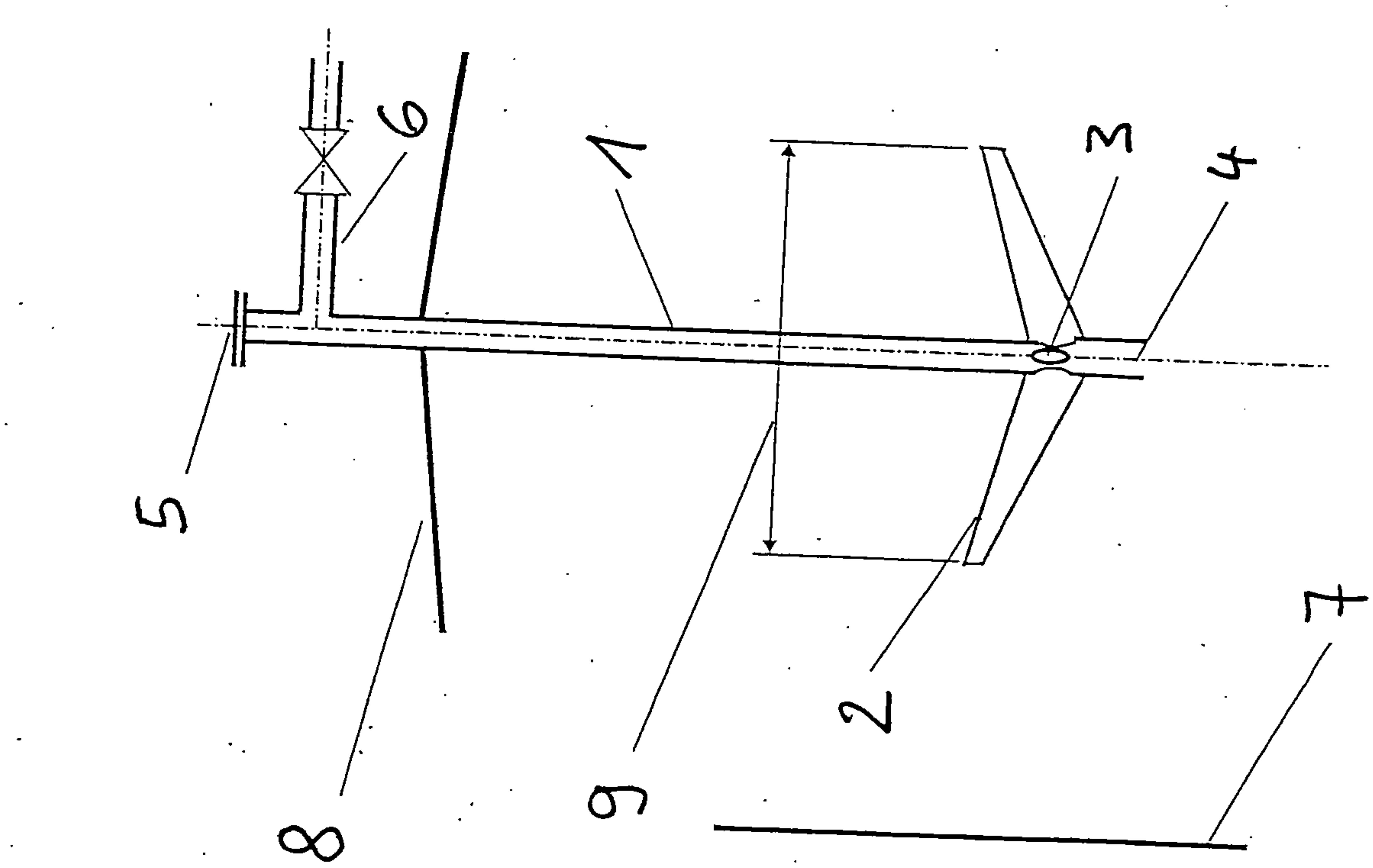
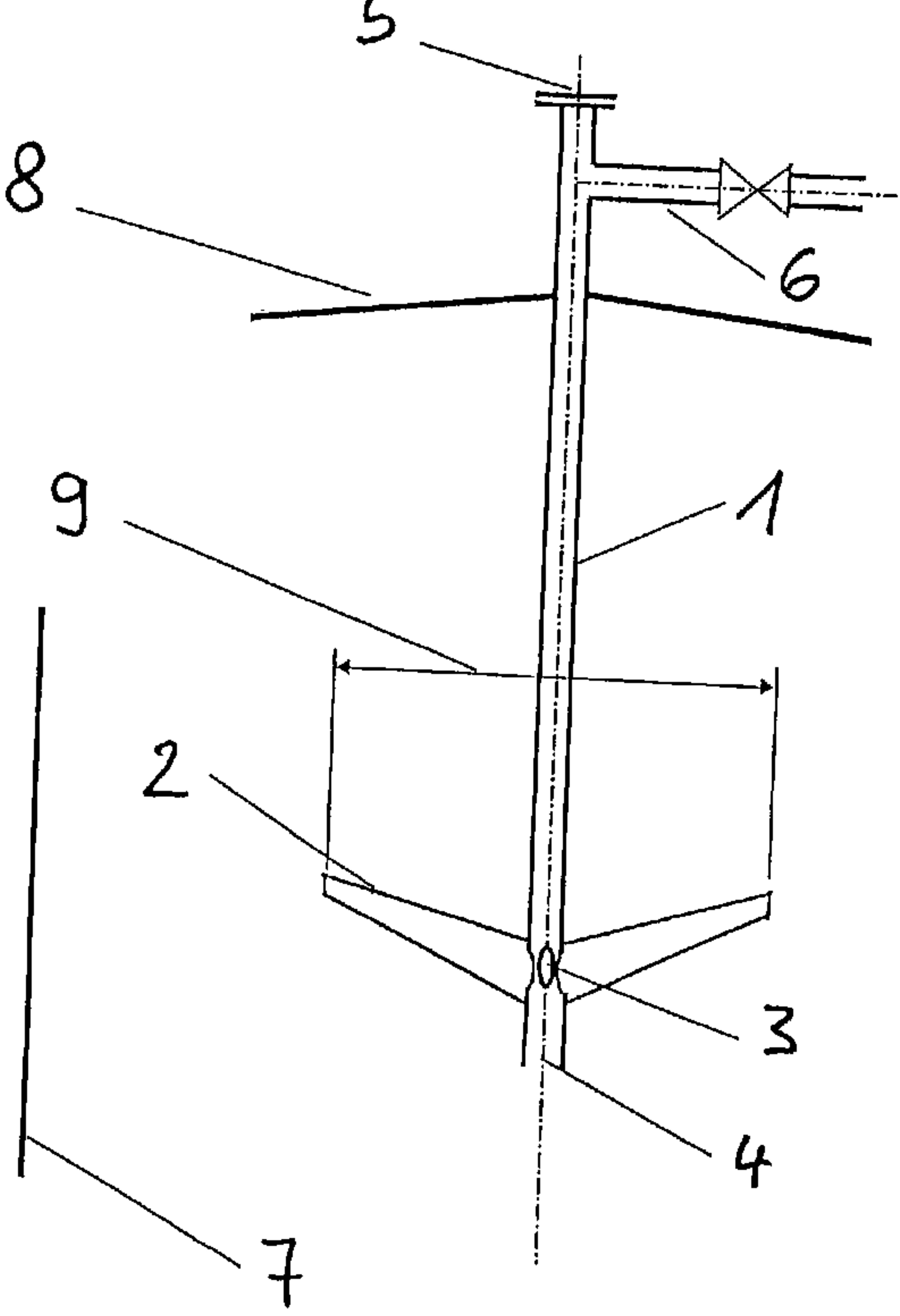


Fig. 1



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