

RECIRCULATING MECHANICAL AERATOR**FIELD OF INVENTION****REPLACED SHEETS SG**

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This invention pertains to a device, namely a mechanical aerator, and its application for the transfer of air or oxygen or any gas mixture into water or a liquid-solid mixture (here also called liquor or slurry).

This invention would be particularly suited to the waste water treatment industry where there is a need to supply dissolved oxygen to biological wastewater treatment systems. In general, it may be used in any application where an increased dissolved oxygen level would be beneficial in any water borne aerobic treatment process.

BACKGROUND OF THE INVENTION

Aeration is necessary in aerobic biotreatment processes to supply the oxygen required for biooxidation of the organic contaminants in the wastewater and maintain a minimum dissolved oxygen level in the bioreactor. Aeration in such treatment systems can account for as much as 60% of the total energy consumption. In order to save energy, and hence reduce operating costs, efficient aeration systems play a key role.

Currently a number of aeration systems are commercially available. These may be divided into 3 broad areas: (a) air diffusers; (2) mechanical aerators without an air supply; (3) mechanical aerators with an air supply. The air diffusers depend on an external air supply being forced through perforated discs or membranes. The latter break the air into small bubbles which enhance air-liquid contact and dissolution of oxygen into the water. Mechanical aerators without an air supply are often surface aerators which breakup the water surface and hence also achieve better air-liquid contact than is possible naturally. The third group are often submerged aerators with air supplied from an outside source. Air and water is intimately mixed in the aerator. This enhances transfer of oxygen into the water. The third group is also of increasing interest because, with the air supply cutoff, such aerators can then serve as mixers. Where wastewater treatment involves nitrification and denitrification, the capability of the aeration system to provide mixing without aeration would be a useful one. Diffuser systems are often not applicable where intermittent aeration is practised as biomass clogging of the diffuser pores would occur.

A number of aerator types belonging to the third type has been reported in the literature. T. Ide (appearing in *Water Treatment Engineering*, 2nd Ed., Gihoto Publishers, 1990, pp 248~257) describes an aerator where air is released towards an impeller with vertical and flat blades. Water is simultaneously forced by the impeller downwards to the bottom of the aerator. Water and air is mixed in the mixing chamber where the impeller is located and then released into the main body of water.

US Patent No. 4925598 (1990) describes an aerator where air is supplied to the rotor from where it is discharged from openings. The air-sewage mixture is forced down and out through stator ducts. US Patent No. 5045202 (1991) describes an equipment where the impeller is used to create a highly agitated mixture of air and waste in a collector.

In the three examples described the impellers or rotor served to mix the air-sewage mixture intimately while also prolonging the contact time between the two. The size of the air bubbles so produced would obviously have an important contribution to the efficiency of the aerator system. While the processes disclosed by US Patents 4925598 and 5045202 represent advancements in oxygen transfer in wastewater treatment, they are relatively complex and cumbersome and may not be suited to communities which require simpler and cheaper equipment.

OBJECT AND SUMMARY OF THE INVENTION

An object of the present invention is to provide a means, i.e. use of the recirculating aerator, to supply oxygen to a wastewater.

Another object is to provide an aerator which can provide mixing to the contents of a bioreactor when aeration is not required.

It is still another object of this invention to provide a combination of aeration and mixing which will provide efficient oxygen transfer at water levels as low as 1m. This will allow for installations with very limited headroom or in shallow vessels or ponds or in retrofitting of existing wastewater treatment plants to achieve greater aeration efficiency and hence treatment capacity.

In the above respect, the invention is sufficiently compact and simple such that only minor modifications need be made to the existing facilities. Simplicity in equipment construction also facilitates installation and maintenance in areas where skilled operators are lacking.

It is still another object of this invention to provide mixing and eliminate problems of odours in wastewater collection systems such as pump sumps and buffer tanks by providing sufficient dissolved oxygen to inhibit anaerobic degradation.

The above, along with other objectives and advantages of this invention, will become apparent from the following more detailed description when viewed in conjunction with the accompanying drawings and illustrative embodiments.

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BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a fragmentary view of the aerator.

FIG. 2 is a cross-sectional view taken through the motor, rotor, impeller and release chamber.

FIG. 3 is a sectional view taken substantially along line A-A of FIG. 2.

FIG. 4 is a sectional view taken substantially along line B-B of FIG. 2.

FIG. 5 is a sectional view taken substantially along line L-L of FIG. 4.

FIG. 6 is a sectional view taken substantially along line C-C of FIG. 2.

FIG. 7 is a sectional view taken substantially along line D-D of FIG. 2.

FIG. 8 is an elevational view of a form of the aerator mounted in a wastewater treatment reactor.

DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

The invention is further explained with reference to the above drawings.

FIG. 1 provides an exploded view of the aerator showing the components it comprises while FIG. 2 provides a cross-sectional view. Air is supplied to the unit via an air supply inlet 1 located towards the base of the aerator 2. This inlet passes through the release chamber shell 14 and is connected to the annular air distributor 3. The distributor rests on the aeration chamber base 5. Located in this chamber is also the aeration chamber inlet/outlet 15. Air is released into the aeration chamber 4 where the impeller 7 is located. The impeller is located

above the release chamber 13. An aeration chamber cover 6 rests on the aeration chamber base with the impeller located in between. A rotor shaft 8 connects the impeller to the variable speed motor 10 by way of the connector 9. The motor is mounted on the support plate 11. The support plate can be connected to the aeration chamber cover by downward directed support legs 12.

The latter ensures an even distribution as the air is released. As the air rises it is mixed into the liquor drawn into the aeration chamber by the impeller 7. The gas-liquor mixture is intimately mixed and forced downwards towards the aeration chamber base 5. This produces a backpressure. The gas-liquor mixture escapes from the aeration chamber through the release chamber 13 and is directed downwards to what may be a dispersion box with tangentially mounted baffles. The latter conducts the gas-liquor mixture away from the immediate vicinity of the aerator, so that the aeration effect may be extended to a wider area. For purposes of a surface mounting in packaged aerobic biofilm reactors, the dispersion box may be omitted. The gas-liquid stream would then be jetted down the narrow reactor.

Although the drawings show the impeller diameter to be greater than that of the aeration chamber base, this can be adjusted such that the diameter of the top opening of the aeration chamber cover 6 is the same as that of the aeration chamber base 5. The ratio of the diameter of the aeration chamber base 5 to the release chamber 13 is between 4:1 to 3:1. The clearance between the impeller 7

and the top of the release chamber 13 is about 3 to 5 cm. The ratio of the height of the aeration chamber 4 to its diameter may vary from 1:1 to 2:1.

As is seen in FIG. 3, B'-B' (FIG. 4) and L'-L' (FIG. 5) sections, three blades are mounted on the shaft 8. Each blade is mounted such that it is at 45° to the horizontal, L'-L' section. The blades have a sharp leading edge and rotate on the horizontal plane. In operation the impeller 7 is rotated in the horizontal plane about the shaft 8. The sharp blades not only draw mix liquor into the aeration chamber 4 and mix the liquid with the gas but also serve to cut organic solids drawn in the aerator into smaller particles.

The construction of the annular air distributor 3 is shown in FIG. 6. This is located within the aeration chamber base 5. Its exact location within the aeration chamber base may however be varied and may be placed as far down as the bottom of the aeration chamber base 5. FIG. 7 shows how the release chamber 13 is supported within the release chamber shell 14.

In operation, the aerator is placed in a reactor of mixed liquor to be aerated. The aerator 2 may be placed on the reactor's floor 18 or mounted from the top. (FIG. 8). Air is supplied by a blower 22, regulated by a flowmeter 23 and through a pipe leading to the air inlet 1. The impeller is driven by a variable speed or fixed speed motor included in the operating unit 2. Rotating speeds may range from 275 to 1200 rpm and may be controlled by the dissolved oxygen sensor 19 and meter 20. A continuous record of dissolved oxygen levels may be

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obtained with the recorder 21. The oxygen transfer efficiency of the unit is influenced by both the impeller's rotating speed and rate of air supply. The air-liquid mixture is forced out of the aerator in a downward direction in top mounted units. For a unit mounted on the floor or a reactor, the air-liquid mixture is forced into the dispersion box and then horizontally out.

By employing the apparatus of the present invention, it is possible to increase the efficiency of oxygen transfer. The following results were obtained from laboratory tests.

Performance of the aerator in comparison with diffusers (air = 1 L min⁻¹
water depth = 45 cm)

Speed, rpm	KLa, h ⁻¹	OR, g O ₂ h ⁻¹	OTE, %	Remarks
510	17.20	3.64	21.13	Aerator
692	29.58	6.26	36.35	
940	54.04	11.44	66.40	
1043	72.76	15.41	89.41	
-	3.96	0.84	4.86	Ceramic diffuser
	29.74	6.61	36.65	Ceramic diffuser with O ₂

Note: KLa = Oxygen transfer coefficient
OR = Oxygen transfer rate
OTE = Oxygen transfer efficiency



WE CLAIM

1. An apparatus for the aeration of the mixed (solid-liquid) liquor or slurry of a bioreactor comprising

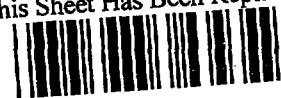
an impeller housed within an aeration chamber in which gas and slurry or suspension is mixed and released into the bioreactor through a release chamber from which the gas -liquid or gas-suspension mixture is directed downwards towards the bottom of the bioreactor when the aerator is top mounted and used in biofilm reactors, or, is directed down through the release chamber and out through the dispersion box when the aerator is bottom mounted in reactors such as the suspended growth bioreactors;

an annular gas distributor positioned in the aeration chamber base around the release chamber to allow air or any gas or mixture of gases to be introduced into the said aeration chamber;

and where typically,

the diameter of the aeration chamber base is three to four times larger than the diameter of the release chamber,

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the height of the aeration chamber is up to twice the diameter of the said aeration chamber, and

the impeller with blades angled at between 30 to 60 degrees to the axis of rotation and sharpened on the leading edges is driven by a variable speed motor with speeds variable from 0 to 1200 rpm.

2. The process of aerating a liquid or liquid-solid suspension with selected air, or a gas or a mixture of gases using the apparatus as in claim 1.

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ABSTRACT

An apparatus for feeding some gas, such as air or oxygen, into the mixed liquor of a bioreactor is described. The apparatus is formed of an impeller and an annular air/gas distributor housed within an aeration chamber. The liquid is drawn into the aeration chamber by the rotating impeller and is mixed with air released from the annular air distributor. The gas and liquid mixture is directed downwards towards the bottom of the bioreactor when the aerator is top mounted and used in biofilm reactors. For bottom mounted aerators used in suspended growth bioreactors, the gas-liquid mixture is directed down through the release chamber and out through the dispersion box. The apparatus is used in a continuous process which increases the transfer of oxygen into water, wastewater or slurries, providing efficient oxygen diffusion in shallow liquid levels (down to 0.45m) by establishing strong agitation and a higher pressure zone within the aeration chamber.

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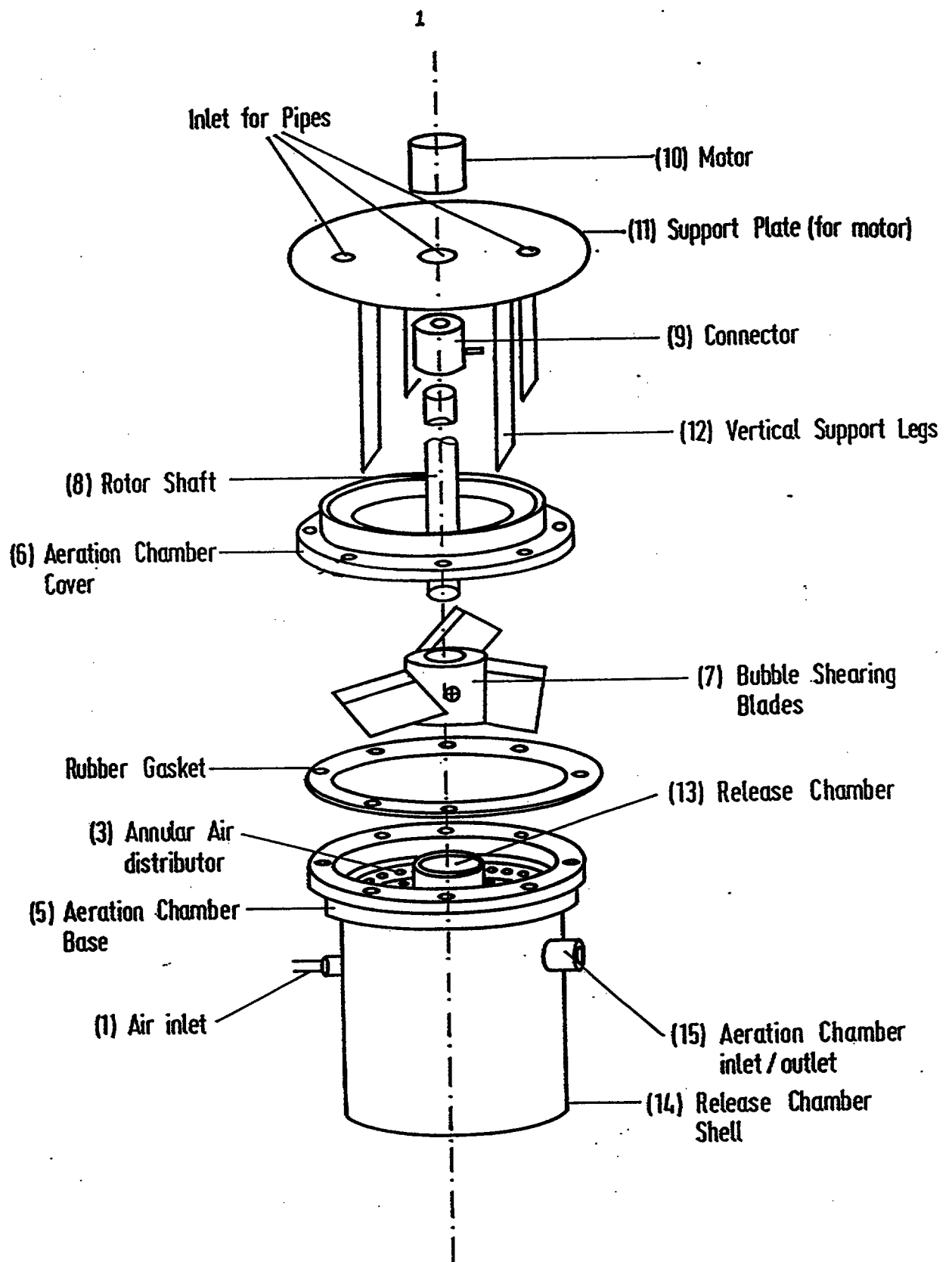


FIG. 1

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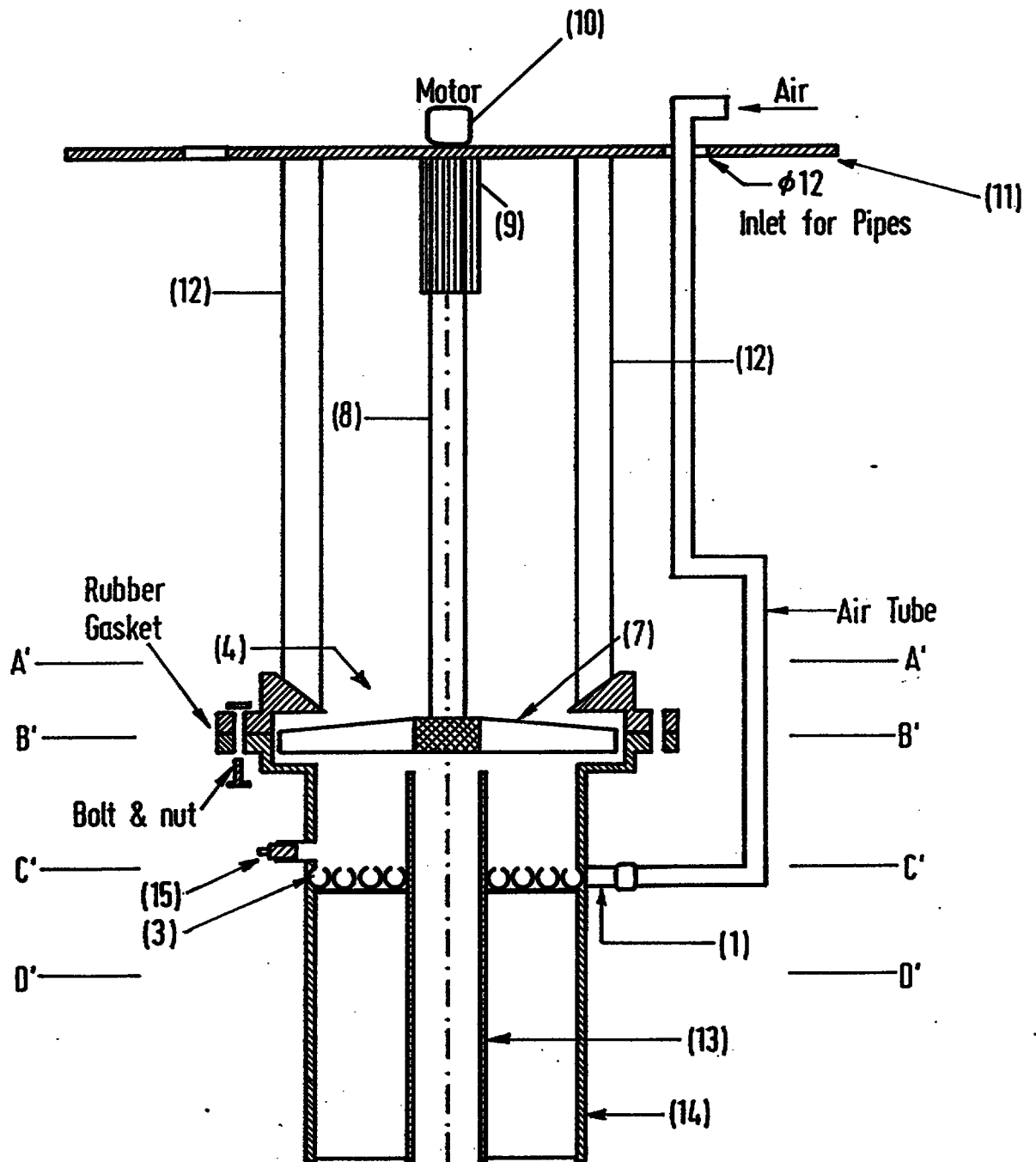
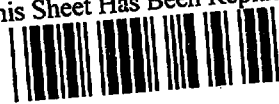


FIG. 2

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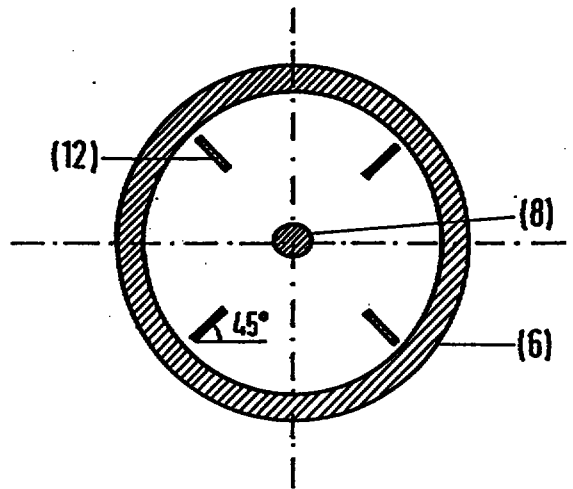


FIG. 3

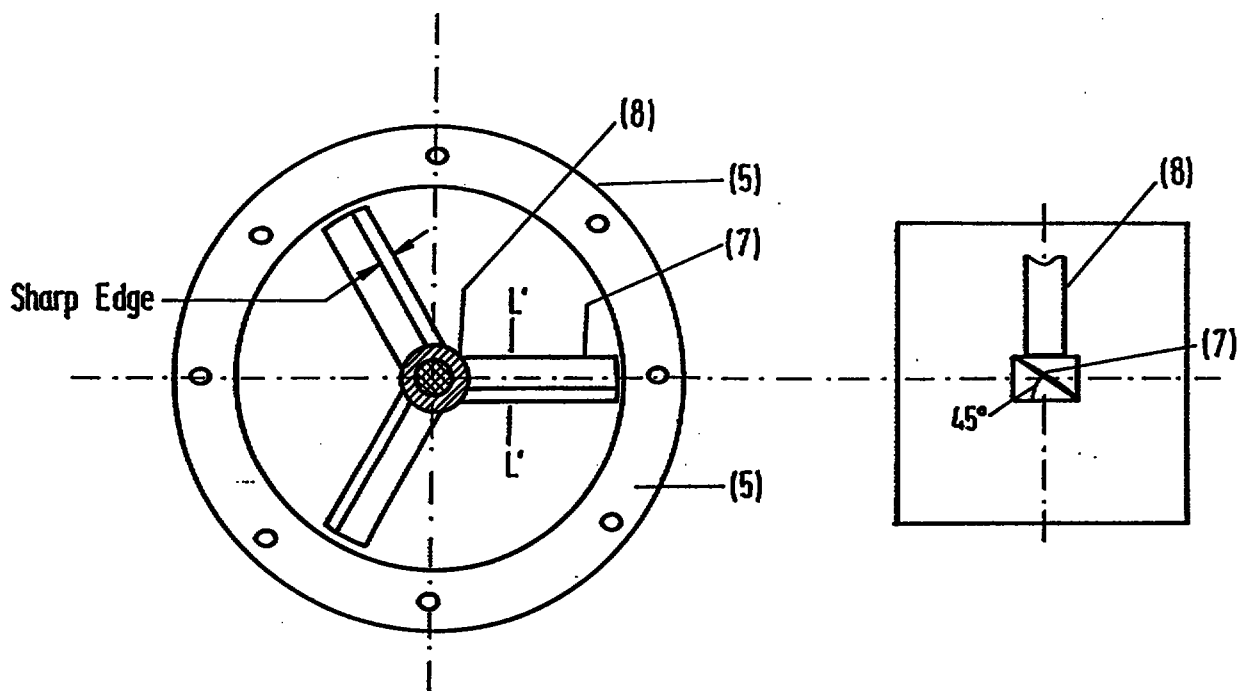


FIG. 4

FIG. 5

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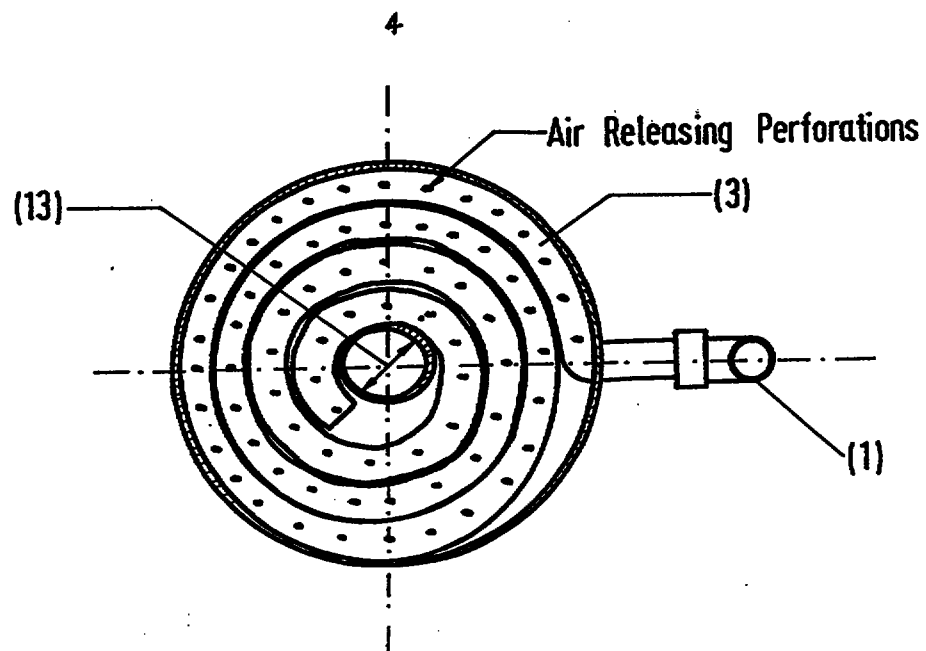


FIG. 6

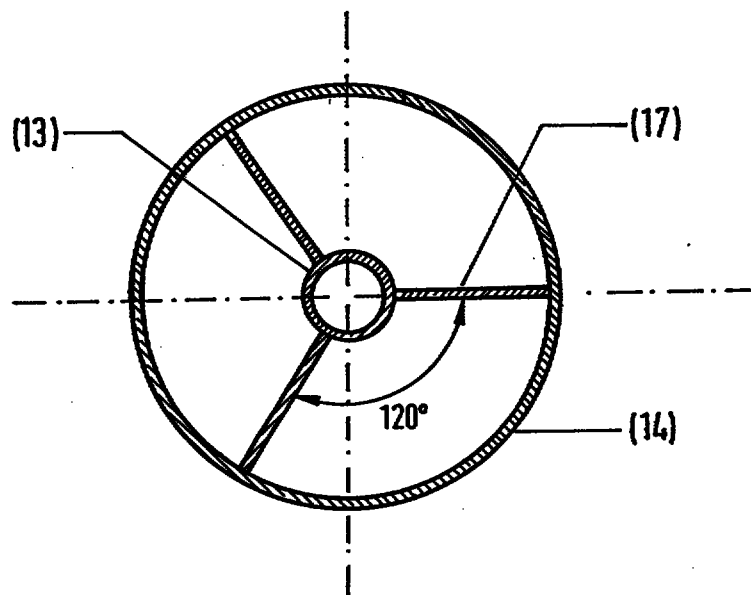


FIG. 7

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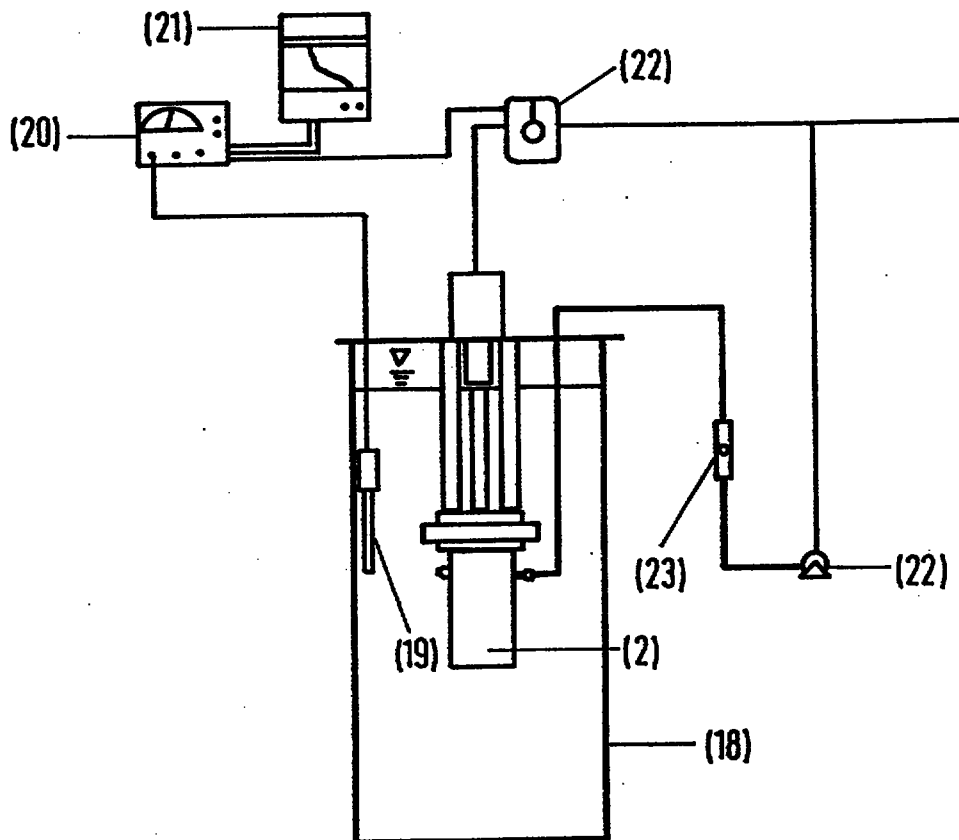


FIG.8

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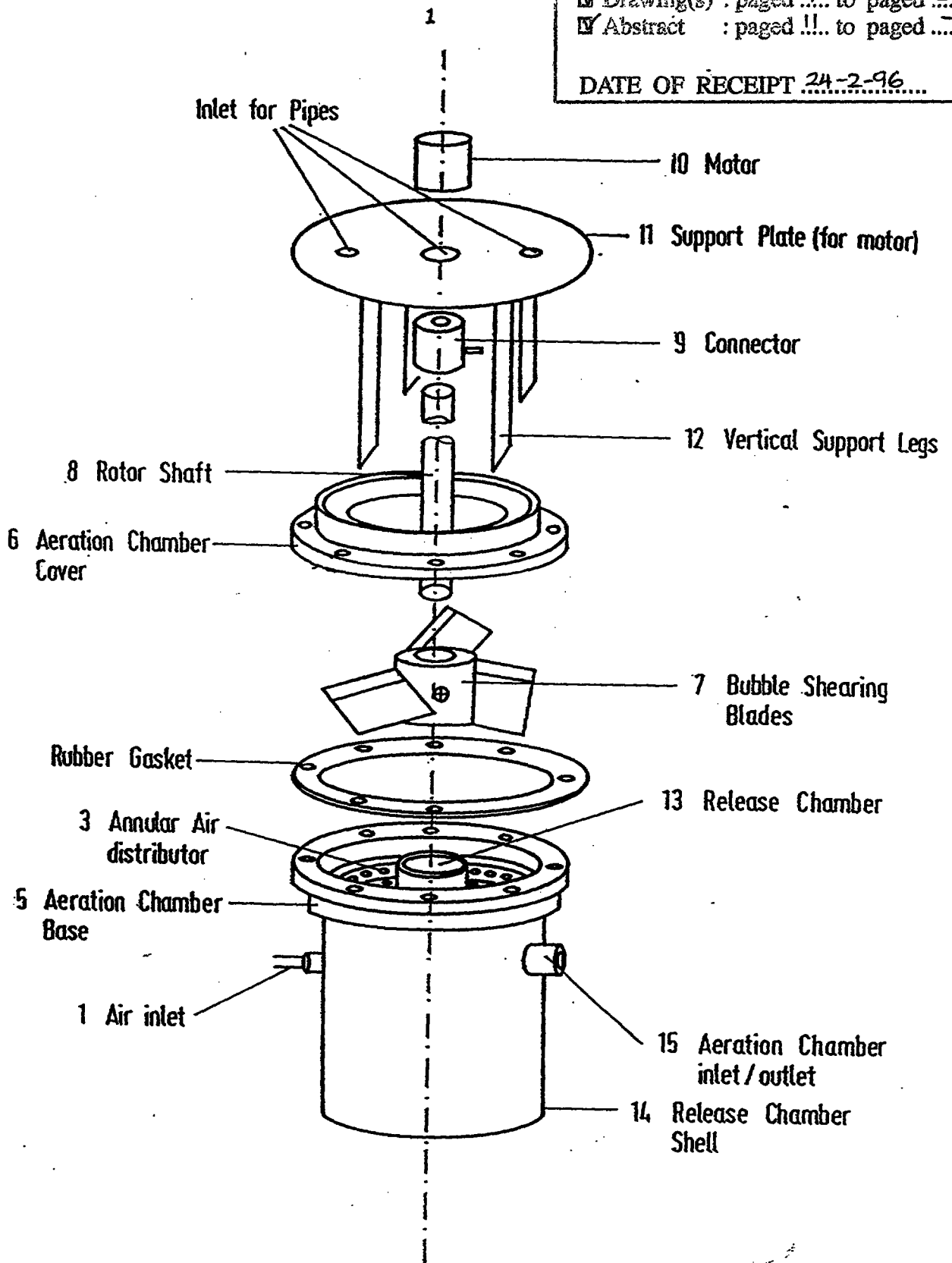


FIG.1

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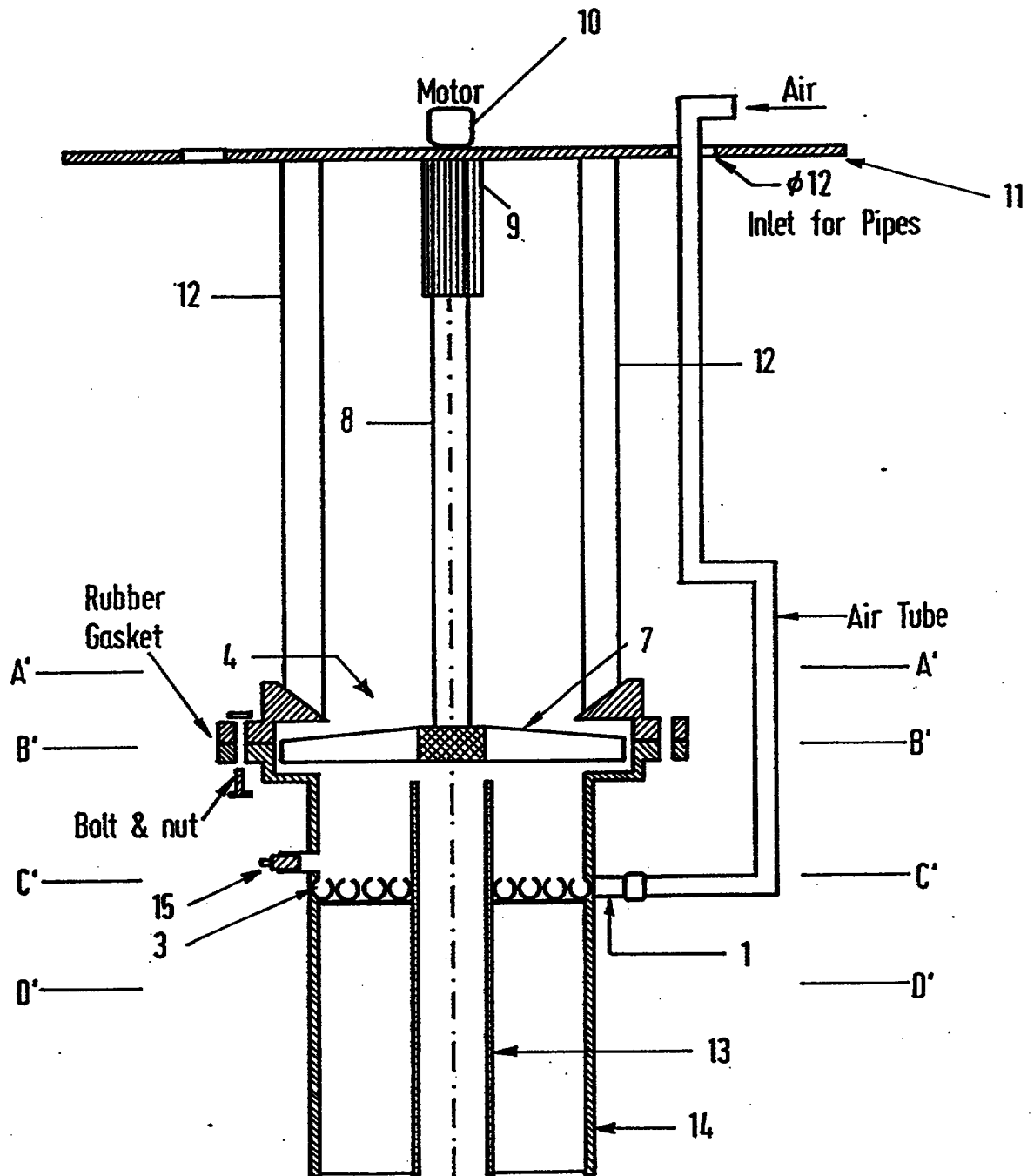


FIG. 2

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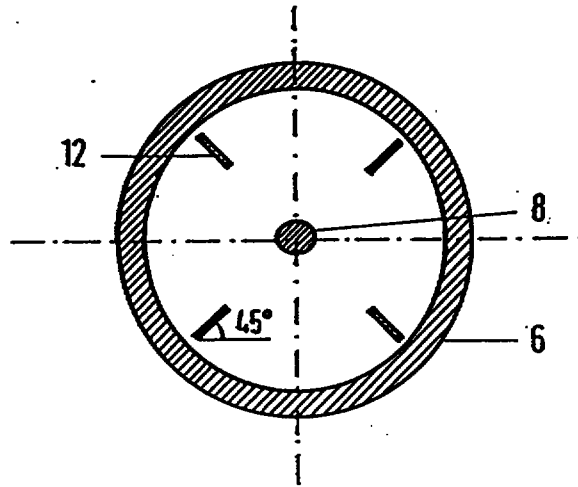


FIG. 3

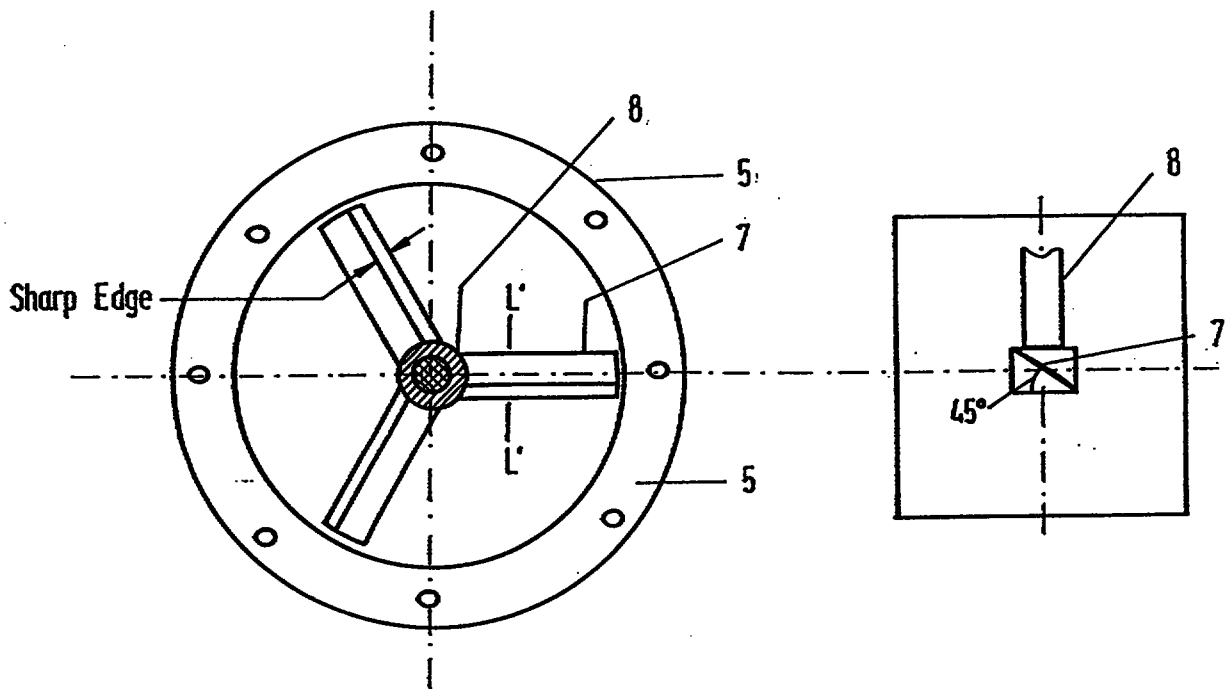


FIG. 4

FIG. 5

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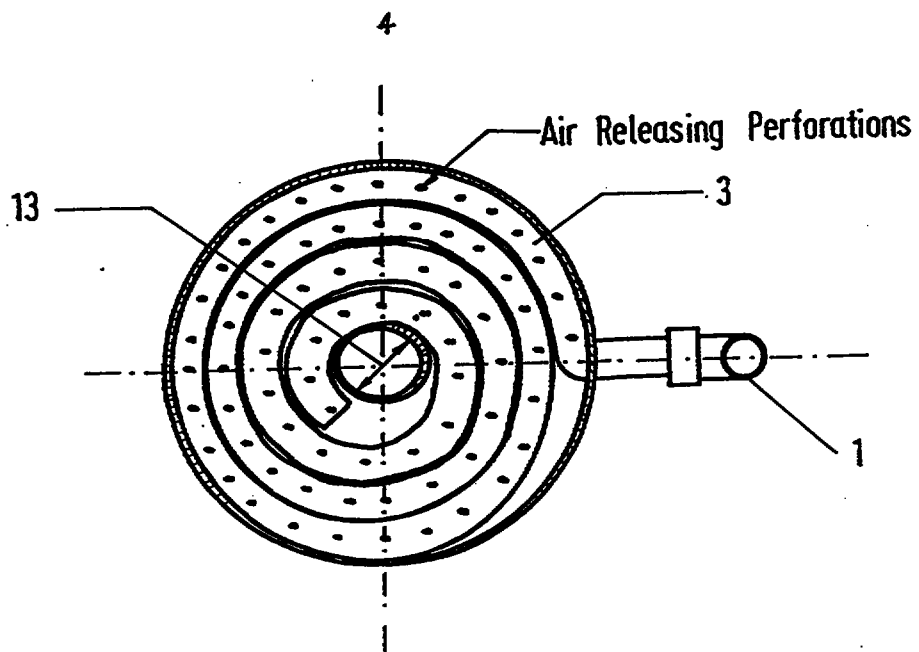


FIG. 6

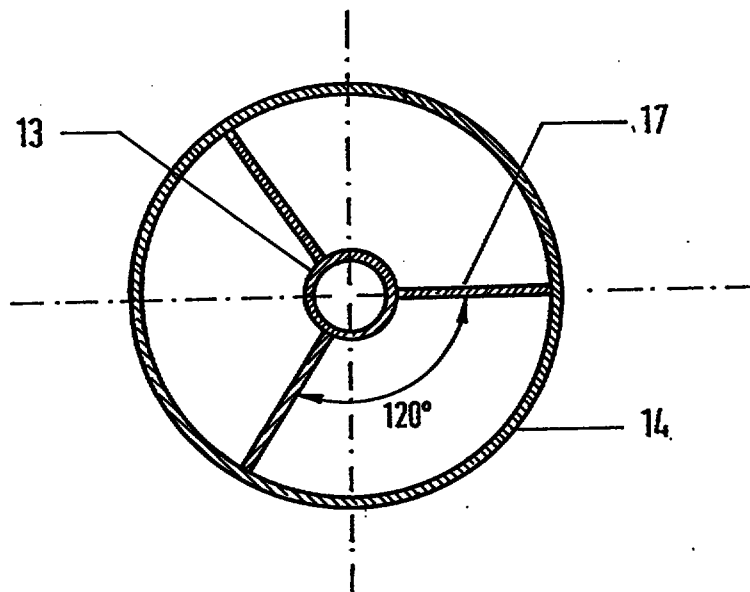


FIG. 7

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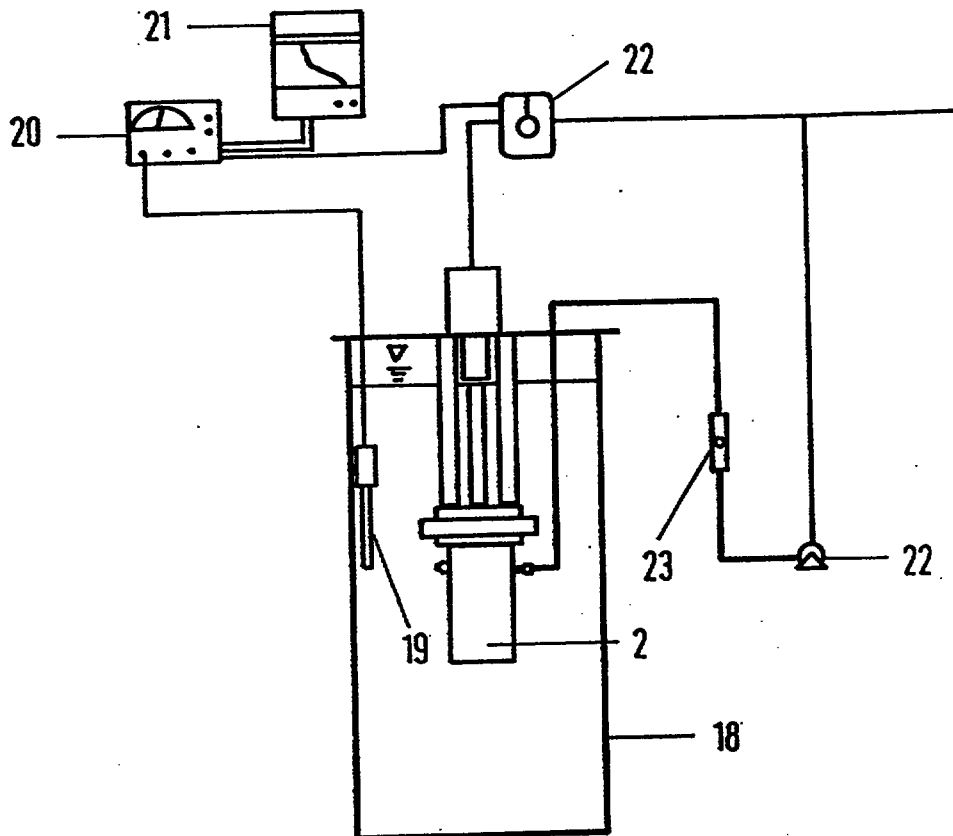


FIG. 8

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ABSTRACT

A recirculating mechanical aerator for feeding some gas, such as air or oxygen, into the mixed liquor of a bioreactor is described (Fig. 8). The apparatus is formed of an impeller and an annular air/gas distributor housed within an aeration chamber. The liquid is drawn into the aeration chamber by the rotating impeller and is mixed with air released from the annular air distributor. The gas and liquid mixture is directed downwards towards the bottom of the bioreactor when the aerator is top mounted and used in biofilm reactors. For bottom mounted aerators used in suspended growth bioreactors, the gas-liquid mixture is directed down through the release chamber and out through the dispersion box. The apparatus is used in a continuous process which increases the transfer of oxygen into water, wastewater or slurries, providing efficient oxygen diffusion in shallow liquid levels (down to 0.45m) by establishing strong agitation and a higher pressure zone within the aeration chamber.

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CLAIMS

1. An apparatus for aeration of a fluid medium, the apparatus comprising an aeration chamber, a distributor for introducing an aeration medium into said chamber, an impeller positioned above said distributor, a discharge chamber positioned within the aeration chamber having an inlet adjacent the impeller and an outlet below the distributor, the distributor and aeration chamber being located around the discharge chamber, the impeller forcing fluid medium downwards into the aeration chamber against the upward flow of aeration medium, the aerated fluid medium passing through the inlet of the discharge chamber to the outlet thereof.
2. An apparatus according to Claim 1, wherein the aeration chamber and discharge chamber are coaxially positioned with the distributor forming a substantially fluid tight barrier therebetween.
3. An apparatus according to Claim 1 or 2, wherein the diameter of the aeration chamber is between three and four times the diameter of the discharge chamber.
4. An apparatus according to Claim 1, 2 or 3, wherein the distributor comprises a spirally coiled pipe with a plurality of spaced apertures along the length thereof for discharge of the aeration medium.
5. An apparatus according to any preceding claim, wherein the aeration chamber and discharge chamber comprise coaxial cylinders the ends of which are positioned beneath the impeller, the distributor comprising a planar spirally coiled pipe with discharge apertures mounted on an annular support plate extending between the aeration chamber and discharge chamber below the ends thereof.

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6. An apparatus according to any one of the preceding claims 2 to 5, wherein the aeration chamber and the discharge chamber are formed by casings extending below the distributor, the part of the casings extending below the distributor comprising at least 50% of the overall length of the casings.
7. An apparatus according to any one of the preceding claims 2 to 6, wherein the aeration chamber and the discharge chamber comprise casings extending the same distance beneath the distributor.
8. An apparatus according to any one of the preceding claims, wherein the aeration chamber is formed by a casing extending below the distributor and serving to support the discharge chamber.
9. An apparatus according to any preceding claim, wherein the height of the aeration chamber is twice the diameter.
10. An apparatus according to any preceding claim, wherein the impeller blades have cutting leading edges and the pitch angle thereof is between 30° and 60° .
11. An apparatus according to any preceding claim wherein the impeller is driven by a variable speed motor.
12. An apparatus according to any preceding claim, wherein the ends of the impeller blades are embraced by a casing integral with the aeration chamber casing.
13. An apparatus according to Claim 12, wherein the impeller casing has a greater diameter than the aeration chamber casing.

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14. An apparatus according to any preceding claim, wherein the height of the discharge chamber is between three to four times the diameter thereof.
15. An apparatus according to any preceding claim, wherein the outlet of the discharge chamber includes baffles to produce lateral deflection of the aerated fluid medium discharged therefrom.
16. A method for the aeration of a fluid medium wherein the fluid medium is directed downwardly by an impeller against an upward counterflow of aeration medium distributed from the base of an aeration chamber, the aerated fluid medium in the chamber being discharged through an outlet adjacent the hub of the impeller and at the top of the aeration chamber.
17. An apparatus for the purposes herein disclosed constructed and arranged to function substantially as described herein and as shown in the accompanying drawings.
18. A method for aeration of a fluid medium carried out substantially as herein described and illustrated.

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