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(54) **METHOD AND APPARATUS FOR FEEDING GAS OR GAS MIXTURE INTO LIQUID.**

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Description

The present invention relates to a method for feeding gas or gas mixture into liquid, in which method a preferably vertical tube is arranged in a liquid contained in a tank or equivalent space, and the liquid is made to flow through the tube from top to bottom by means of a liquid transport device placed in the pipe and provided with an impeller, and gas is conducted into the liquid after the impeller, when seen in the flowing direction.

The present invention also relates to an apparatus for feeding gas or gas mixture into liquid, the said apparatus comprising a tube which is installed preferably vertically in a liquid containing tank or equivalent, which tube is provided with a liquid inlet and a liquid outlet, and inside which tube there is arranged a liquid transport device provided with an impeller and a gas feeding device located in the tube below the impeller when seen in the flowing direction, through which gas feeding device gas is fed into the liquid flow, and which impeller makes the liquid and the liquid and gas mixture to flow through the tube downwards, i.e. from top to bottom.

In a prior art method, gas or gas mixture is blown onto the bottom of a liquid containing tank, wherefrom it rises in bubbles directly and rapidly to the surface of the liquid and is thereafter discharged into the environment. In this case only a small portion of the gas is transferred into the liquid, wherefore it is necessary to blow gas into the liquid continuously and in large quantities. With this method, energy consumption tends to rise immoderately high while the gas transfer efficiency remains poor.

In another improved method, gas or gas mixture is blown onto the bottom of a liquid containing tank, and the gas bubbles rising from the bottom are mixed into the liquid by means of a rapidly rotating flat blade turbine agitator. By employing this method, the gas transfer efficiency can be somewhat improved, but energy consumption with respect to the transferred quantity of gas still remains high.

The Finnish Patent Publication No. 35233 introduces a method and apparatus for aerating liquid effluents in the process of biological treatment. According to this method, water is made to flow within the tank at one or several spots through a cylindrical tube from top to bottom, essentially in vertical direction, first to the vicinicty of the tank bottom and subsequently sideways. Air is mixed into the water flowing downwards in the tube so that the water and the air mixed therein both flow downwards together. According to one modification of the method, the flowing of the water downwards in the tube and the mixing of the air therein are carried out by means of an impeller, pulsator or the like, and air is conducted through a tubular pipe either to above or below the impeller.

As regards energy consumption, the above described method is more advantageous than other prior art methods. It is not necessary to press air, or any gas, against a high liquid pressure down to the tank bottom, which procedure requires a lot of energy, but the mixture of air, water or gas and liquid is pumped deeper down by aid of the impeller, so that the energy consumption remains relatively low.

This method, however, also has its drawbacks. The impeller, pulsator or the like also sets the surrounding water and/or air and water mixture in a turbulent motion while in operation. As a consequence, the air bubbles contained in the water or fed therein after the impeller may, as being lighter than water, be separated towards the vicinity of the centre axis of the tube and even be combined into large bubbles. Irrespective of the manner in which air is fed in, a homogeneous distribution of air into the water flowing in the tube is prevented. As a result, the air transfer efficiency in the liquid decreases.

Another apparatus for the aeration of liquid effluents which is an application of the above described method is introduced in the British Patent Publication No. 1 421 668. The said apparatus comprises an elongate chamber at the upper end of a tube, in which chamber there are arranged an impeller, a blade wheel or the like, air feeding means and baffle plates. The tube is narrower than the chamber and extends in the flow direction downwards, towards the bottom of the chamber. Air is admitted into the liquid effluent within the chamber, where the impeller agitates the water and the air, and pushes the mixture downwards into the subsequent tube. In the inner walls of the chamber, both above and below the impeller, there are arranged planar baffle plates which are positioned parallel to the longitudinal axis of the pipe. The purpose of the said baffle plates is to prevent the air and water mixture agitated by the impeller from assuming turbulent motion and to convert its motion so that it is directed axially downwards.

Among the drawbacks of the method of the said British patent it is pointed out that the impeller or the like is arranged to rotate in the gas and liquid mixture. An effective and profitable liquid transport, with respect to energy consumption, is achieved only when the impeller operates in liquid alone. Another remarkable drawback is the fact that the said baffle plates do not fulfil their indicated function. The baffle plates located below the impeller are installed in the inner wall of the chamber near to the bottom thereof, at the juncture of the chamber and the tube. These baffle plates and the impeller do not have any clearly defined mutual connection which would be essential for the prevention of turbulent currents.

The object of the present invention is to realize an improved method and apparatus for feeding gas or gas mixture into liquid wherein the drawbacks of the above described methods and apparatuses are eliminated.

The method of the invention is defined by claim 1. As for the apparatus of the invention, it is characterized by the features enlisted in the patent claim 6.

With respect to the feeding efficiency of gas mixture into liquid, it is essential that a maximum amount of gas is mixed to the liquid, that the gas is distributed homogeneously in the liquid and that only a minimum amont of energy is consumed in the operation. In the method and apparatus of the present invention, these aspects are taken into account in an optimal fashion.

By matching the impeller blades and the guide baffles with each other in a manner explained in the claim 1, the turbulent motion created by the impeller can be effectively attenuated. Thus the kinetic energy bound in the turbulent motion of the liquid is converted into kinetic energy of the flow which is directed parallel to the tube axis.

By adjusting the impeller and the baffles so that the direction of the liquid flow leaving the impeller blade is approximately parallel to the tangent of the baffle intake edge, there is achieved a new method for attenuating turbulence, which method is much more effective than when using prior art methods.

After attenuating turbulent currents in the above described manner, it is possible to feed into the liquid flow, now proceeding mainly in the tube direction, remarkably larger quantities of gas than before.

A substantial increase in the gas quantities is, however, only achieved in favourable conditions. In order to create such conditions, first the impeller is fitted inside the tube so that the rotating area of the impeller covers at least 80% of the cross-sectional area of the tube, and secondly, the baffles are fitted in the tube so that they extend, in the direction of the tube radius, over the whole rotating area of the impeller. If the first requirement is not fulfilled, liquid flows in the tube at an irregular velocity, and part of the large quantity of gas fed into the liquid may escape upwards through the annular aperture left between the tips of the impeller blades and the tube casing, which may critically disturb both the liquid transport and the feeding of gas into the liquid. According to the second requirement, the guide baffles extend over the whole cross-sectional area of the tube, and their influence in the flowing liquid at each specific spot in the tube is equally strong. As the intake edges of the baffles extend near to the trailing edges of the impeller blades, the influence of the matching operation is most effective, and turbulent currents are not formed in the liquid.

The feeding of gas into the flow is carried out immediately after the liquid flow has been directed and the current flows mainly parallel to the tube.

In the following the invention and its advantages are described in detail with reference to the appended drawings, where

Figure 1 is a schematical and partially cross-sectional illustration of a preferred embodiment of the invention for feeding gas into liquid,

Figure 2 is a schematical illustration of how the impeller blade and the baffle designed for directing the liquid flow are matched;

Figure 3 shows the section A—A of the apparatus of Figure 1, seen in the direction of the tube axis, and

Figure 4 shows the section B—B of the apparatus of Figure 1.

Figure 1 is an illustration of the apparatus of the invention designed particularly for feeding air into water, but it is obvious that the apparatus is suited for feeding any gas or gas mixture into liquid.

In Figure 1, the pontoons 11 are arranged to support the apparatus in a water tank. The apparatus comprises the cylindrical tube 1, which is located advantageously vertically in the water tank. The tube is provided with at least one water inlet 2 and at least one water outlet 3. Inside the tube, on the axis D—D, there is fitted the impeller 4 which makes the water flow through the tube 1 in the direction C from top to bottom, i.e. in through the inlet 2 and out through the outlet 3. After the impeller 4, seen in the flowing direction, the tube 1 comprises the guide baffles 5 and the gas feeding device 6. The guide baffles 5 are located radially and mainly parallel to the tube 1. The discharge openings of the gas feeding device 6 are connected to the inside of the tube, at the earliest stage with respect to the flowing direction on such a horizontal plane in the tube where the liquid already flows mainly in the tube direction D—D. In this embodiment, the gas feeding device 6 is connected to the air blower 9. The feeding device 6 can, however, also be connected to an oxygen container or other vessel or device transferring or producing oxygen.

On the raft 10, which floats in the water supported by the pontoons 11, there is installed the motor 8 and the air blower 9. The motor 8 is connected to the fulcrum 42 of the impeller 4 by means of the axis 7. The air blower 9 is connected by means of pipes 12 or hoses to the air feeding device 6 which is located in the tube 1.

The impeller 4 is provided with two or more blades 41, which are attached symmetrically around the fulcrum 42 of the impeller. The measures of the impeller 4 are arranged in a generally known fashion so that the difference in pressure over the impeller, at each separate spot thereof is equally great during operation. Thus the impeller 4 is capable of pushing water in the tube 1 with equal power over the whole rotating area of the impeller. In this case the rotating area of the impeller is defined as the area of the circle drawn by the tips of the impeller blades 41 while in rotation, the distance of the said tips from the centre axis being r_1.

In practice the form of the blade 41 of the impeller 4 is such that the angle α between the tangent E of the trailing edge 41a of the blade (Figure 2) and the rotating plane P—P of the impeller 41 changes as a function of the distance r (Figure 1). This is due to the fact that while the impeller is in rotation, the circumferential speed at separate points of the trailing edge 41a of the blade 41 at the distance r changes: near the tip of the blade 41 the circumferential speed is high and

the trailing angle α of the blade is small, whereas near the fulcrum 42 of the impeller the circumferential speed is low and the trailing angle α is large.

The angle α of the trailing edge 41a of the blade 41 determines the angle at which the water leaves the blade 41. Let's observe Figure 2 which illustrates the cross-section of the blade 41 and the baffle 5 for instance at the distance r from the impeller axis in Figure 1. The impeller rotating direction is marked P_p and the direction of the impeller axis is marked P_a, the latter being parallel to the axis D—D of the tube 1.

The circumferential speed vector of the impeller blade 41 is referred to as $\bar{v}_p$, and $\bar{v}_1$ represents such a speed vector of the water which is parallel to the tube axis D—D and describes the direction and power of the water flow before the impeller when seen in the flowing direction C. When the vector $\bar{v}_1$ is divided into two components, i.e. $\bar{v}_{1E}$ parallel to the tangent E of the blade 41 and $\bar{v}_{1p}$ parallel to the circumferential speed vector $\bar{v}_p$ of the impeller, and the circumferential speed vector $\bar{v}_p$ of the impeller is taken into account, the resulting vector is $\bar{v}_2$ which approximately represents the speed and direction of the water flow leaving the blade 41. The angle of departure of the water flow, with respect to the rotating plane P—P, is marked with β.

The impeller 4 and the baffles 5 are matched with each other so that the direction of the water flow leaving the blade 41 of the impeller 4, roughly parallel to the direction of the vector $\bar{v}_2$, is equal to the direction F of the tangent of the intake edge 51a of the baffle 5. This means that the baffles 5 are, at least at the end 51 which is first on the impeller side when seen in the tube direction D—D, members with an advantageously curved surface as is seen for example in Figure 2. The tangent G of the trailing edge 52a of the baffle 5 is parallel to the tube axis D—D. Thus the turbulent flow caused by the impeller and represented by the vector $\bar{v}_2$ is rectified by means of the baffles 5 so that it becomes parallel to the tube axis D—D, as is illustrated by means of the arrows H in Figure 2.

The baffles 5 can also be realized as members parallel to the axis D—D, i.e. to the tube 1. This embodiment is illustrated by dotted lines in Figure 2. In this case the first end 51′ of the baffle 5 at the impeller side is straight and parallel to the other end 52. While employing a baffle of this type, the liquid flow leaving the impeller blade 41 hits the baffle at a certain angle 90°-β with respect to the axis D—D, the size of which angle 90°-β also depends on each separate point on the blade and the baffle, i.e. it is a function of the distance r. This results in turbulent flows, and the turbulence does not attenuate as easily as in the case of the curved baffle described above.

The impeller 4 is fitted within the tube 1 so that the ratio between the rotating area πr^2 of the impeller 4 and the cross-sectional area πR^2 of the tube, where R is the inner radius of the tube 1, is $\geqq 0{,}8$. This arrangement prevents back flows in the tube periphery and thus increases the efficiency.

In order to make the baffles 5 fulfil their function as well as possible, their vertical width is roughly equal to the tube radius R. Moreover, the greatest distance h_1 between the impeller 4 and the baffles 5 in the tube direction should be shorter than the maximum height h_p of the impeller (Figure 1).

In the above described embodiment, the gas feeding device 6 is formed of at least one member 61 with a blade-like profile. On the sides of this member, advantageously on its downwards curved parts and/or on its trailing edge, there are located discharge openings 62 at short intervals from each other. The device 6 is connected to the air blower 9 or equivalent by means of the pipe 12 or the like.

At least one blade-like member 61 of the air feeding device 6 is placed at an interval from the baffles 5, when seen in the flow direction and advantageously so that the blade-like member 61 are located in between the imaginable continuations of the guide baffles 5 parallel to the tube axis, preferably in the middle of the said areas as is shown in Figure 4. In that case the blade-like members 61 also serve as members which stabilize the flow. By employing this arrangement, air can be fed homogeneously into the water flow on the whole cross-sectional area of the tube.

The distance h_2 of the blade-like members 61 of the air feeding device 6 from the baffles 5 in the direction D—D of the axis of the tube 1 is shorter than the length h_s of the baffles 5 in the direction of the axis of the tube 1. The blade-like members 61 can also be positioned between the baffles 5. One viable solution is to leave out the blade-like members 61 and to feed the air into the water flow through the guide baffles 5.

Claims

1. A method for feeding gas or gas mixture into liquid, in which method a preferably vertical tube is arranged in a liquid contained in a tank or equivalent space and the liquid is made to flow in the tube from top to bottom by means of a liquid transport device which is fitted within the tube and provided with an impeller, and gas is conducted into the liquid after the impeller when seen in the flowing direction, and the turbulent motion of the liquid created by the impeller is attenuated by placing guide baffles after the impeller in the tube, which guide baffles are positioned radially and mainly parallel to the tube, characterized in that the tube is provided with a substantially constant cross-section, the baffles are fitted in the tube so that they extend, in the direction of the tube radius, substantially over the whole rotating area of the impeller and their upper edge is in close vicinity of the impeller, and that all the gas is fed into the liquid at the earliest stage, with respect to the flowing direction, after the turbulent motion has been attenuated and the liquid flows mainly in the tube direction.

2. The method of claim 1 for feeding gas or gas mixture into liquid, characterized in that the impeller and the baffles are matched so that the direction of the water flow leaving the impeller blade is approximately parallel to the tangent of the intake edge of the baffle.

3. The method of claim 1 or 2 for feeding gas or gas mixture into liquid, characterized in that the impeller is placed in the tube so that the rotating area of the impeller covers at least 80% of the cross-sectional area of the tube.

4. The method of claim 3 for feeding gas or gas mixture into liquid, characterized in that gas is fed into the liquid in the area left between the baffles or their imaginable continuations and so that the gas flow is directed into the liquid mainly in the direction of the liquid flow.

5. The method of claim 3 for feeding gas or gas mixture into liquid, characterized in that gas is fed into the liquid through the baffles and so that the gas flow is directed into the liquid mainly in the direction of the liquid flow.

6. An apparatus for feeding gas or gas mixture into liquid, comprising a tube (1), installed preferably in a vertical position in a liquid containing tank or equivalent and provided with a liquid inlet (2) and outlet (3) and within which tube there is fitted a liquid transport device provided with an impeller (4) and thereafter, when seen in the flowing direction, a gas feeding device (6) through which gas is fed into the liquid flow, and which impeller (4) is employed for making the liquid and the liquid and gas mixture flow through the tube from the top to bottom, and between the impeller (4) and the gas feeding device (6) there are located baffles (5) which are positioned radially and mainly parallel to the tube (1), characterized in that the tube is provided with a substantially constant cross-section, the baffles (5) are fitted in the tube (1) so that they extend, in the direction of the tube radius, substantially over the whole rotating area of the impeller (4) and their upper edge is in close vicinity of the impeller (4), and that the discharge openings of said gas feeding device (6) are connected to the inside of the tube (1), at the earliest stage, with respect to the flowing direction, on the plane perpendicular to the axis (D—D) of the tube (1) where the liquid already flows mainly in the direction (D—D) of the tube (1), and means (9, 12) are provided for feeding gas through said feeding device (6).

7. The apparatus of claim 6 for feeding gas or gas mixture into liquid, characterized in that the baffles (5) are curved at the end (51) which is first on the impeller side, when seen in the direction of the tube (1), and preferably parallel to the axis (D—D) of the tube (1) at the other end (52) on the outlet side, and that the tangent (E) of the inner surface of the blade, imagined at a point of the trailing edge (41a) of each blade (41) of the impeller (4), which tangent determines the direction ($\bar{v}_2$) of the water flow leaving the said point, and the tangent (F) imagined at each respective point of the impeller-side intake edge (51a) of each baffle (5) are matched with each other so that the direction ($\bar{v}_2$) of the water flow leaving the impeller blade (41) is approximately parallel to the tangent (F) of the intake edge (51a) of the blade (5), the said two points being located at an equal distance (r) from the tube axis (D—D) with respect to the cross-sectional plane of the tube.

8. The apparatus of claim 6 or 7 for feeding gas or gas mixture into liquid, characterized in that the ratio between the rotating area (πr^2) of the impeller (4) and the cross-sectional area (πR^2) of the tube (1) is $\geqq 0{,}8$.

9. The apparatus of claim 6, 7 or 8 for feeding gas or gas mixture into liquid, characterized in that the width of the baffles (5) in the plane vertical to the axis (D—D) of the tube (1) is preferably roughly equal to the tube radius (R) and that the greatest distance (h_1) between the impeller and the baffles in the pipe direction is shorter than the maximum height (h_p) of the impeller.

10. The apparatus of claim 8 or 9 for feeding gas or gas mixture into liquid, characterized in that the gas feeding device (6) is formed of at least one member (61) with a blade-like profile, on the sides of which member, preferably on the downwards curving parts and/or at the trailing edge, there are located discharge openings (62) at certain intervals from each other, and that the said gas feeding device (6) is connected to a gas blower or the like by means of a pipe (12) or equivalent member.

11. The apparatus of claim 8, 9 or 10 for feeding gas or gas mixture into liquid, characterized in that the distance (h_2) of the blade-like members (61) of the gas feeding device (6) from the baffles (5) in the direction of the axis (D—D) of the tube (1) is shorter than the length (h_s) of the baffles (5) in the tube direction.

Patentansprüche

1. Ein Verfahren zum Zuführen von Gas oder einer Gasmischung in eine Flüssigkeit, bei welchem Verfahren ein bevorzugt vertikales Rohr in einer in einem Tank oder einem vergleichbaren Raum enthaltenden Flüssigkeit angeordnet ist, und mittels einer innerhalb des Rohres angeordneten und ein Flügelrad aufweisenden Flüssigkeits-Transporteinrichtung bewirkt wird, daß die Flüssigkeit im Rohr von oben nach unten strömt, und Gas bei Betrachtung in Strömungsrichtung hinter dem Flügelrad in die Flüssigkeit eingeleitet wird, und die vom Flügelrad erzeugte turbulente Bewegung der Flüssigkeit durch Anordnen von Leitplatten in dem Rohr hinter dem Flügelrad gedämpft wird, wobei die Leitplatten radial und im wesentlichen parallel zum Rohr angeordnet sind, dadurch gekennzeichnet, daß das Rohr einen im wesentlichen konstanten Querschnitt aufweist, daß die Leitplatten im Rohr so angeordnet sind, daß sie sich in Richtung des Rohrradius im wesentlichen über den gesamten Rotationsbereich des Flügelrades erstrecken und ihre obere Kante in enger Nachbarschaft des Flügelrades liegt, und daß die gesamte Gas-

menge bezüglich der Strömungsrichtung am frühestmöglichen Stelle in die Flüssigkeit eingeleitet wird, nachdem die turbulente Bewegung abgeschwächt worden ist und die Flüssigkeit im wesentlichen in Rohrrichtung strömt.

2. Das Verfahren nach Anspruch 1 zum Zuführen von Gas oder einer Gasmischung in eine Flüssigkeit, dadurch gekennzeichnet, daß das Flügelrad und die Leitplatten einander angepaßt sind, so daß die Richtung der den Flügelrad-Flügel verlassenden Waserströmung ungefähr parallel zur Tangente der Zuströmkante der Leitplatte ist.

3. Das Verfahren nach Anspruch 1 oder 2 zum Zuführen von Gas oder einer Gasmischung eine Flüssigkeit, dadurch gekennzeichnet, daß das Flügelrad so im Rohr angeordnet ist, daß der Rotationsbereich des Flügelrades wenigstens 80% der Querschnittsfläche des Rohrs abdeckt.

4. Das Verfahren nach Anspruch 3 zum Zuführen von Gas oder einer Gasmischung in eine Flüssigkeit, dadurch gekennzeichnet, daß Gas in dem zwischen den Leitplatten oder deren gedachten Verlängerungen Verbleibenden Bereich in die Flüssigkeit eingeleitet wird und so daß die Gasströmung im wesentlichen in Richtung der Flüssigkeitsströmung in die Flüssigkeit geleitet wird.

5. Das Verfahren nach Anspruch 3 zum Zuführen von Gas oder einer Gasmischung in eine Flüssigkeit, dadurch gekennzeichnet, daß Gas durch die Leitplatten hindurch in die Flüssigkeit so eingeleitet wird und so daß die Gasströmung im wesentlichen in Richtung der Flüssigkeitsströmung in die Flüssigkeit geleitet wird.

6. Eine Vorrichtung zum Zuführen von Gas oder einer Gasmischung in eine Flüssigkeit, mit einem Rohr (1), welches vorzugsweise in einer vertikalen Stellung in einem flüssigkeitsenthaltenden Tank oder einem Äquivalent installiert und mit einem Flüssigkeitseinlaß (2) und -auslaß (3) versehen ist, und wobei innerhalb des Rohres eine Flüssigkeits-Transporteinrichtung angeordnet ist, die ein Flügelrad (4) und, bei Betrachtung in Strömungsrichtung, danach eine Gas-Zufuhreinrichtung (6) aufweist, mittels welcher Gas in die Flüssigkeitsströmung eingeleitet wird, und wobei das Flügelrad (4) verwendet wird, um zu bewirken, daß die Flüssigkeit und die Flüssigkeits- und Gasmischung durch das Rohr von oben nach unten strömen, und wobei zwischen dem Flügelrad (4) und der Gas-Zufuhreinrichtung (6) Leitplatten (5) angeordnet sind, welche radial und im wesentlichen parallel zum Rohr (1) angebracht sind, dadurch gekennzeichnet, daß das Rohr (1) einen im wesentlichen konstanten Querschnitt aufweist, daß die Leitplatten (5) im Rohr (1) so angeordnet sind, daß sie sich in Richtung des Rohrradius im wesentlichen über den gesamten Rotationsbereich des Flügelrades (4) erstrecken und ihre obere Kante sich in enger Nachbarschaft des Flügelrades (4) befindet, und daß die Auslaßöffnungen der genannten Gas-Zufuhreinrichtung (6) bezüglich der Strömungsrichtung an der frühestmöglichen Stelle an die Innenseite des Rohrs (1) in der zur Achse (D—D) des Rohres (1) senkrechten Ebene angeschlossen sind, wo die Flüssigkeit bereits im wesentlichen in der Richtung (D—D) des Rohres (1) strömt, und wobei Mittel (9, 12) zum Zuführen durch die genannte Zufuhreinrichtung (6) vorgesehen sind.

7. Die Vorrichtung nach Anspruch 6 zum Zuführen von Gas oder einer Gasmischung in eine Flüssigkeit, dadurch gekennzeichnet, daß die Leitplatten (5) an dem Ende (51), welches sich bei Betrachtung in Richtung des Rohres (1) als erstes auf der Flügelradseite befindet, gebogen und am anderen Ende (52) auf der Auslaßseite vorzugsweise parallel zur Achse (D—D) des Rohres (1) sind, und daß die gedachte Tangente (E) der Innenfläche des Flügels an einem Punkt der nachlaufenden Kante (41a) jedes Flügels (41) des Flügelrads (4) die Richtung ($\bar{v}_2$) der den genannten Punkt verlassenden Wasserströmung bestimmt, und die gedachte Tangente (F) an jedem einzelnen Punkt der flügelradseitigen Einlaßkante (51a) jeder Leitplatte (5) einander angepaßt sind, so daß die Richtung ($\bar{v}_2$) der den Flügelradflügel (41) verlassenden Wasserströmung ungefähr parallel zur Tangente (F) der Einlaßkante (51a) des Flügels (5) ist, wobei die genannten zwei Punkte in einer gleichen Entfernung (r) von der Rohrachse (D—D) bezüglich der Querschnittsebene des Rohres angeordnet sind.

8. Die Vorrichtung nach Anspruch 6 oder 7 zum Zuführen von Gas oder einer Gasmischung in eine Flüssigkeit, dadurch gekennzeichnet, daß das Verhältnis zwischen der Rotationsfläche (πr^2) des Flügelrades (4) und der Querschnittsfläche (πR^2) des Rohres (1) $\geqq 0{,}8$ ist.

9. Die Vorrichtung nach Anspruch 6, 7 oder 8 zum Zuführen von Gas oder einer Gasmischung in eine Flüssigkeit dadurch gekennzeichnet, daß die Breite der Leitplatten (5) in der vertikal zur Achse (D—D) des Rohres (1) verlaufenden Ebene vorzugsweise ungefähr gleich dem Rohrradius (R) ist, und daß der größte Abstand (h_1) zwischen dem Flügelrad und den Leitplatten in Rohrrichtung kleiner als die größte Höhe (h_p) des Flügelrades ist.

10. Die Vorrichtung nach Anspruch 8 oder 9 zum Zuführen von Gas oder einer Gasmischung in eine Flüssigkeit, dadurch gekennzeichnet, daß die Gaszufuhreinrichtung (6) aus wenigstens einem Element (61) mit einem flügelähnlichen Profil gebildet ist, wobei auf den Seiten des Elementes, vorzugsweise auf den nach unten gebogenen Teilen und/oder an der nachlaufend angeordneten Kante, Auslaßöffnungen (62) in bestimmten Abständen voneinander angeordnet sind, und daß die genannte Gaszufuhreinrichtung (6) mittels einer Röhre (12) oder einem vergleichbaren Element an ein Gasgebläse oder dergl. angeschlossen ist.

11. Die Vorrichtung nach Anspruch 8, 9 oder 10 zum Zuführen von Gas oder einer Gasmischung in eine Flüssigkeit, dadurch gekennzeichnet, daß der Abstand (h_2) der flügelähnlichen Elemente (61) der Gaszufuhreinrichtung (6) von den Leitplatten (5) in Richtung der Achse (D—D) des

Rohres (1) kürzer als die Länge (h_s) der Leitplatten (5) in Rohrrichtung ist.

Revendications

1. Procédé pour introduire un gaz ou un mélange de gaz dans un liquide, selon lequel on dispose un tube de préférence vertical dans un liquide contenu dans un réservoir au dans un espace équivalent et on amène le liquide à circuler dans le tube depuis la partie supérieure jusqu'à la partie inférieure au moyen d'un dispositif d'entraînement du liquide, qui est monté à l'intérieur du tube et comporte un rotor, et on introduit un gas dans le liquide en aval du rotor, lorsqu'on regarde dans la direction d'écoulement, et le déplacement turbulent du liquide, créé par le rotor, est atténué moyennant la mise en place de chicanes de guidage en aval du rotor à l'intérieur du tube, lesquelles chicanes sont disposées radialement en étant sensiblement parallèles au tube, caractérisé en ce que le tube possède une section transversale sensiblement constante, que les chicanes sont montées dans le tube de manière à s'étendre, dans la direction radiale du tube, sensiblement sur toute la zone de rotation du rotor et que leur bord supérieur est à proximité directe du rotor, et que la totalité du gaz est introduite dans le liquide au stade le plus précoce, en rapport avec la direction d'écoulement, une fois que le déplacement turbulent s'est atténué et que le liquide circule principalement dans la direction du tube.

2. Procédé selon la revendication 1 pour introduire un gaz ou un mélange de gas dans un liquide, caractérisé en ce que le rotor et les chicanes sont adaptés de telle sorte que la direction de l'écoulement d'eau quittant la pale du rotor est approximativement parallèle à la tangente du bord d'entrée de la chicane.

3. Procédé selon la revendication 1 ou 2, pour introduire un gaz ou un mélange de gas dans un liquide, caractérisé en ce que le rotor est disposé dans le tube de manière que la zone de rotation du rotor occupe au moins 80% de la surface en coupe transversale du tube.

4. Procédé selon la revendication 3, pour introduire un gaz ou un mélange de gas dans un liquide, caractérisé en ce qu'on introduit le gaz dans le liquide, dans la zone subsistant entre des chicanes ou leurs prolongements imaginables, et ce de telle sorte que l'écoulement de gaz est dirigé dans le liquide principalement dans la direction d'écoulement du liquide.

5. Procédé selon la revendication 3 pour introduire un gaz ou un mélange de gas dans un liquide, caractérisé en ce qu'on introduit le gaz dans le liquide au moyen des chicanes et ce de telle sorte que l'écoulement de gaz est dirigé dans le liquide principalement dans la direction d'écoulement du liquide.

6. Dispositif pour introduire un gaz ou un mélange de gaz dans un liquide, comprenant un tube (1) installé de préférence dans une position verticale dans un réservoir contenant le liquide ou dans un espace équivalent, et comportant une entrée (2) et une sortie (3) pour le liquide et à l'intérieur duquel se trouve intallé le dispositif d'entraînement du liquide comportant un rotor (4), en aval duquel est disposé, lorsqu'on regarde dans la direction d'écoulement, le dispositif (6) d'introduction du gaz, au moyen duquel un gaz est introduit dans l'écoulement de liquide, lequel rotor (4) est utilisé pour amener le liquide et le mélange du liquide et du gaz à circuler dans le tube de la partie supérieure à la partie inférieure, des chicanes (5), qui sont disposées radialement et principalement parallèlement au tube (1), étant situées entre le rotor (4) et le dispositif (6) d'introduction du gaz, caractérisé en ce que le tube possède une section transversale sensiblement constante, les chicanes (5) sont montées dans le tube (1) de manière à s'étendre dans la direction radiale du tube, sensiblement sur la totalité de la zone de rotation du rotor (4) et leur bord supérieur étant situé au voisinage immédiat du rotor (4), et que les ouvertures de refoulement dudit dispositif (6) d'introduction du gaz sont raccordées à l'intérieur du tube (1), au stade le plus précoce, en rapport avec la direction d'écoulement, dans le plan perpendiculaire à l'axe (D—D) du tube (1), dans lequel le liquide circule déjà essentiellement dans la direction (D—D) du tube (1), et qu'il est prévu des moyens (9, 12) pour réaliser l'introduction du gaz au moyen dudit dispositif (6) d'introduction du gaz.

7. Dispositif selon la revendication 6 servant à introduire un gaz ou un mélange de gaz dans un liquide, caractérisé en ce que les chicanes (5) sont recourbées au niveau de l'extrémité (51), qui est la première du côté du rotor, lorsqu'on regarde dans la direction du tube (1), et sont de préférence parallèles à l'axe (D—D) du tube (1) au niveau de l'autre extrémité (52) du côté de la sortie, et que la tangente (E) à la surface intérieure de l'aube, tracée de façon imaginaire en un point du bord arrière (41A) de chaque pale (41) du rotor (4) et déterminant la direction ($\bar{v}_2$) de l'écoulement d'eau quittant ledit point, et la tangente (F) tracée de façon imaginaire en chaque point respectif du bord d'entrée (51a), situé du côté du rotor, de chaque aube (5) sont adaptées l'une à l'autre de manière que la direction ($\bar{v}_2$) de l'écoulement d'eau quittant la pale (41) du rotor est approximativement parallèle à la tangente (F) au bord d'entrée (51a) de la pale (5), lesdits deux points étant situés à une même distance (r) de l'axe (D—D) du tube dans le plan en coupe transversale de ce tube.

8. Dispositif selon la revendication 6 ou 7 pour introduire un gaz ou un mélange de gaz dans un liquide, caractérisé en ce que le rapport entre la surface en rotation (πr^2) du rotor (4) et la surface en coupe transversale (πR^2) du tube (1) est $\geqq 0{,}8$.

9. Dispositif selon la revendication 6, 7 ou 8 pour introduire un gaz ou une mélange de gaz dans un liquide, caractérisé en ce que la largeur des chicanes (5) dans le plan perpendiculaire à l'axe (D—D) du tube (1) est de préférence approximativement égale au rayon (R) du tube et que la

distance maximale (h_1) entre le rotor et les chicanes dans la direction du tube est inférieure à la hauteur maximale (h_p) du rotor.

10. Dispositif selon la revendication 8 ou 9 pour introduire un gaz ou un mélange de gaz dans un liquide, caractérisé en ce que le dispositif (6) d'introduction du gaz comporte au moins un élément (61) possédant un profil en forme de pale, et que sur les côtés de cet élément de préférence sur les parties courbes descendantes et/ou sur le bord arrière, il est prévu des ouvertures de refoulement (62) situées à certains intervalles les unes des autres, et que ledit dispositif (6) d'introduction du gaz est raccordé à une soufflerie à gaz ou analogue au moyen d'une canalisation (12) ou d'un élément équivalent.

11. Dispositif selon la revendication 8, 9 ou 10 pour introduire un gaz ou un mélange de gaz dans un liquide, caractérisé en ce que la distance (h_2) des éléments en forme de pales (61) du dispositif (6) d'introduction du gaz à partir des chicanes (5) dans la direction de l'axe (D—D) du tube (1) est inférieure à la longueur (h_s) des chicanes (5) dans la direction du tube.

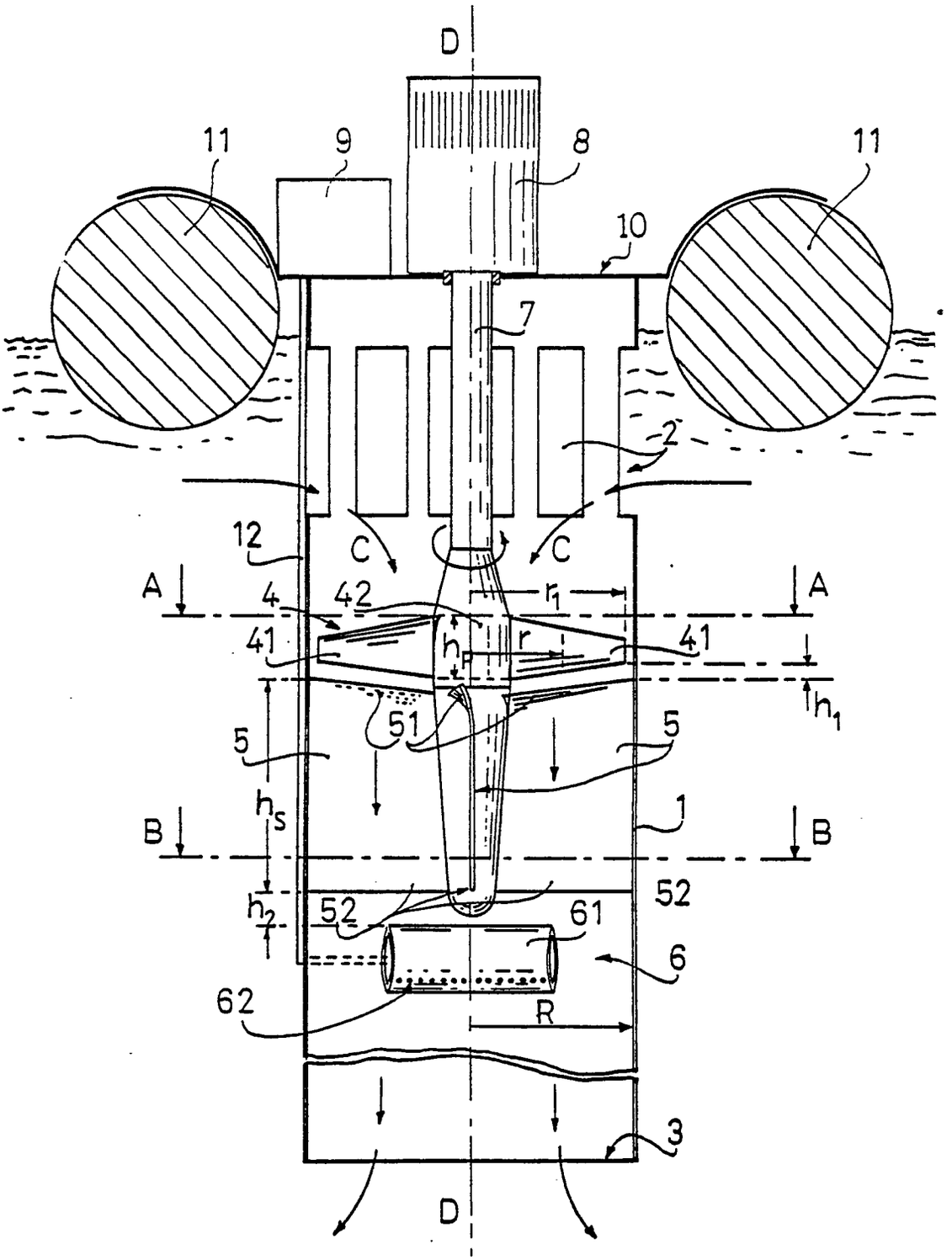

D
11
9
8
11
10
7
2
12
C
C
A
4
42
r_1
A
41
h_r
r
41
h_1
5
51
5
h_s
B
1
B
52
h_2
52
61
6
62
R
3
D

FIG. 1

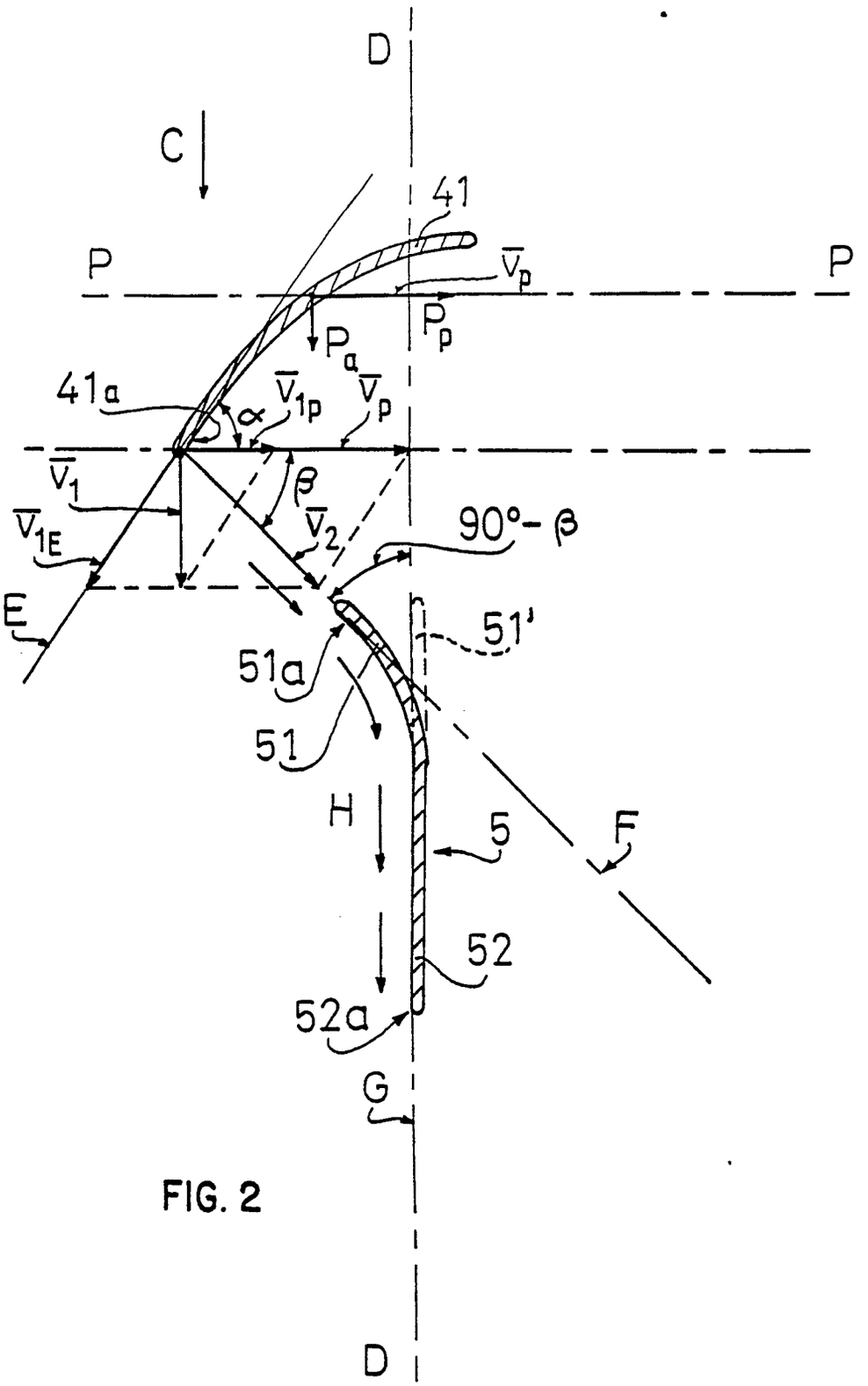

D
C
41
P
P
$\overline{V}_p$
P_p
P_a
41a
$\overline{V}_{1p}$
$\overline{V}_p$
α
$\overline{V}_1$
β
$\overline{V}_{1E}$
$\overline{V}_2$
90°- β
E
51'
51a
51
H
5
F
52
52a
G
D

FIG. 2

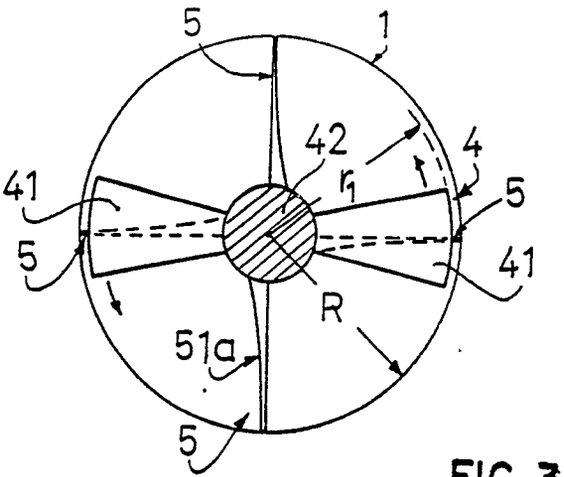


FIG. 3

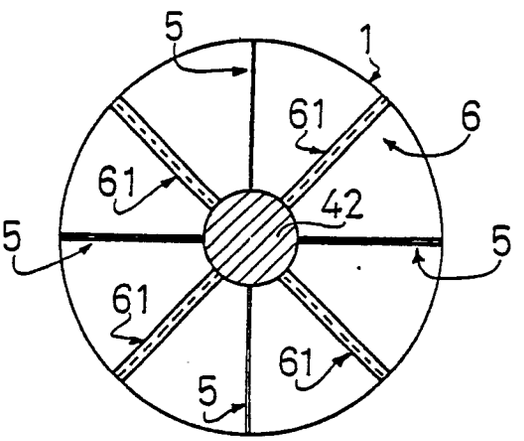


FIG. 4