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(54) APPARATUS FOR MIXING GASES INTO LIQUIDS WHICH TEND TO FROTH

(71) We, BUCHER - GUYER AG MASCHINENFABRIK, a Swiss Company of CH 8166 Niederweningen, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an apparatus for mixing gas, e.g. air, with liquids which tend to froth, particularly although not exclusively apparatus for aeration of sewage coming from livestock establishments and charged with organic substances.

The expressions "aeration" and "air" are here used to refer to any gaseous medium which is to be admixed with any liquid concerned in the present context. Similarly, the expression "air pipe" is to be understood as meaning a pipe for a gaseous medium. The following remarks therefore deal with a case of aeration not only for the sake of simplicity, but also because this is a frequent, if not the most frequent application of the apparatus described above. It is solely for the same reason that the aeration of sewage highly charged with organic substances, particularly from livestock establishments, will mainly be discussed.

In the aeration (or treatment with gas) of sewage for the biological (or chemical) purification of the latter it is well known that considerable frothing occurs, which cannot be controlled even with considerable effort and expense, for example using froth skimmers, froth barriers, oversize tanks, and the like.

According to the present invention there is provided apparatus for mixing gas into liquid; a passage for flow of liquid to the rotor; including a bladed rotor immersible in the liquid and an inlet pipe for the gas to extend in use from above the surface of the liquid to the rotor; and support means to support the inlet pipe at a position dependent on the liquid level so that in use its inlet end is maintained substantially at a predetermined distance above the surface of the liquid which predetermined distance corresponds to a maximum desired thickness of froth on the liquid, froth in excess of this thickness passing into the inlet pipe and down to the rotor to be mixed with the liquid fed to the rotor. Consequently the inlet of the gas inlet pipe gradually penetrates into the froth when the layer of froth grows beyond its permissible thickness, so that it is no longer feed gas alone but partly froth, in some cases considerable amounts of froth and in the extreme case even froth alone, that is drawn in and fed to the rotor. Since frothing is proportionate to the aeration of the liquid, it is clear that an apparatus of this kind has a self-regulating action.

Embodiments of the invention are illustrated by way of example diagrammatically in the accompanying drawings, in which:

Figure 1 shows an aeration apparatus partly in axial section;

Figure 2 is a section on the line II—II;

Figure 3 shows an apparatus which corresponds basically to that shown in Figure 1, but which has a modified support and an auxiliary air pipe; and

Figures 4 and 5 show a modified embodiment similar to that of Figures 1 and 2 respectively.

According to Figure 1, the bladed rotor 1 provided on both sides with blades is mounted on the shaft 2 of the submersible motor 3, which in turn is disposed inside a liquid feed pipe 4 having its mouth in the region of the lower side of the bladed rotor and is fastened to the pipe 4 at 5. By means of a web 6 the liquid pipe 4 is joined to a funnel-shaped air pipe 7 whose lower end has its outlet in the region of the upper side of the bladed rotor. The connection of the air pipe 7 — which hereinbelow will be referred to as "air funnel" for the sake of clarity — to the liquid feed pipe 4 is reinforced by a slightly angled support 8 of T-shaped cross-section, which is joined by webs 9 to the air funnel and liquid pipe. The bottom two webs serve to hold the motor 3. In this way, a constructional unit is formed which comprises primarily the air funnel and the mounting of the rotor 1 (obviously also including the drive motor 3),

and in addition also the liquid feed pipe 4.

At the bottom end of the pipe 4 is provided an outwardly directed flange 10 which on its lower side carries support feet 11. The latter are intended to rest on the bottom 12 of the tank (not otherwise shown) in certain circumstances, for example when the amount of liquid contained therein is small. With a normal level of liquid in the tank — the level is indicated at 13 — this however is not the case, because an annular float 14 that is to say a floating belt, is disposed in the air funnel 7. This floating belt naturally also forms part of the support of the apparatus.

As is obvious, the apparatus must be secured against rotation. The necessity of measures serving this purpose is indicated in the form of a lug 15 at the end of the part 8. The other parts of the support illustrated or described are also given by way of indication, particularly as the support may be modified in many respects. The only essential point is that it should fulfil its purpose of always keeping the inlet of the air funnel 7 at a distance above the liquid level 13 which corresponds approximately to the permissible thickness of the froth layer. Accordingly the support may have other floats or, as shown in Figure 3, may additionally (or optionally exclusively) be provided with a suspension given the general reference 15^1 and provided with a counterweight 16. It is obvious that one or more suspension springs could equally well be used, that is to say in general terms a suspension having an energy storage means providing an upwardly directed force. The floats and/or the suspension serve to hold the apparatus in equilibrium in the desired position. This equilibrium however is destroyed when the blade wheel is put into operation, since a downwardly directed force component occurs through the drawing-in of the liquid. This force component is however balanced through the fact that — in contrast to the stationary state — the air funnel is emptied and consequently acts itself to provide support, acting as a buoyant body. For this reason alone it is advantageous — although not indispensable — for the air pipe to be in the form of a funnel.

The mode of operation of the apparatus can be seen from what has been stated so far, and therefore will only be briefly recapitulated. When the layer of froth designated 17 in Figures 1 and 3 reaches its maximum permissible thickness, that is to say the upper edge of the air funnel 7, froth enters through the inlet of the latter (see 18), passes to the rotor, and is mixed into the liquid again. In the present case however a regulating function is also combined with this action, since in proportion to the amount of foam returned to the liquid a smaller amount of air can be drawn in. Frothing is thereby checked. In the extreme case the air funnel 7 becomes full of froth, so that the supply of fresh air to the rotor is completely suppressed. This state continues until frothing declines and the layer of froth 17 is reduced.

In certain cases, for example in the case of closed tanks (see Figure 3), it may be necessary on the one hand for a reduced amount of air still to be supplied to the rotor when the air funnel 7 has been filled with froth, and on the other hand to supply a certain amount of fresh air to the rotor in all circumstances. As already stated, this need may arise in the case of a closed tank owing to the fact that the tank space above the liquid is mainly filled with gases passing out of the latter. With this in mind the embodiment shown in Figure 3 provides an auxiliary air pipe 19, which has one end in the region of the air intake side of the rotor and the other end in the atmosphere. As indicated at 20 and 21, the auxiliary air pipe may at the same time form part of a vertical guide arrangement for the apparatus. In order to avoid undesirable soiling of the auxiliary air pipe, it is advantageous to provide at its bottom end a valve 22, 23 which prevents liquid from rising in the pipe in the stationary state.

The embodiments illustrated are not only advantageous because of their self-regulating facility and therefore indirectly because of the optimum aeration achieved in the particular conditions prevailing, but also because of the arrangement of the motor driving the blade wheel in the liquid, particularly inside the liquid feed pipe 4, which forms around the drive motor an annular passage through which the liquid is fed to the blade wheel. The transfer of heat from the drive motor to the liquid results in a very substantial increase of the utilisation of energy. This is also ensured with a low level of liquid, because the supports 11 disposed on the lower side of the flange 10 keeps the inlet of the liquid feed pipe 4 free in all circumstances and at the same time prevent the flange 10 from adhering by suction to the bottom of the tank when the level of liquid is low.

Finally, mention should be made of the streamlined form of the connecting web 6 which can be seen in Figure 2. Apart from the mechanical aspect, the purpose of this web is to prevent straw stalks and other foreign bodies, which have a tendency to coil up, from being caught on the part 8.

Reference has already been made above to numerous modifications which may be made. Here it will simply be added that in certain circumstances the air funnel 7 may not simply be provided with a floating belt

but could itself be in the form of a floating body and made for example of expanded plastics material. The utilisation of the submersible aerator in annular tanks, for example "oxidation pits", requires that it shall provide an additional conveying action. This can be achieved by deflecting the outgoing jet of air-liquid mixture in a determined direction by means of a deflector plate.

The extent to which the air and liquid are mixed can in addition be substantially increased if the mixture flowing out of the rotor is guided over a certain distance in a turbulence tube 24 (see Figures 4 and 5). This tube allows a defined direction of flow to be achieved at the same time. The tube thus also serves for circulating the medium, for example in an elongated tank, or for example also for transporting the medium through a wall into a neighbouring tank or into the open. It is preferable for the turbulence tube to have its mouth in the lower third of the tank.

It is also conceivable for the conveying action to be switched on only intermittently, for example for emptying the tank.

WHAT WE CLAIM IS:—

1. Apparatus for mixing gas into liquid, including a bladed rotor immersible in the liquid; a passage for flow of liquid to the rotor; an inlet pipe for the gas to extend in use from above the surface of the liquid to the rotor; and support means to support the inlet pipe at a position dependent on the liquid level so that in use its inlet end is maintained substantially at a predetermined distance above the surface of the liquid which predetermined distance corresponds to a maximum desired thickness of froth on the liquid, froth in excess of this thickness passing into the inlet pipe and down to the rotor to be mixed with the liquid fed to the rotor.

2. Apparatus according to claim 1 wherein the rotor and the inlet pipe are supportet by the support means.

3. Apparatus according to claim 1 or claim 2 wherein the axis of the rotor is vertically disposed and the inlet pipe feeds gas to the upper side of the rotor and the passage is provided by a feed pipe which feeds liquid to the lower side of the rotor.

4. Apparatus according to claim 3 including driving means to rotate the bladed rotor, the driving means being located in and supported by the feed pipe, the feed pipe being supported by the said support means.

5. Apparatus according to claim 3 or claim 4 wherein the feed pipe extends in a downwards direction and includes support feet at its lower end.

6. Apparatus according to claim 5 wherein the support feet are attached to the lower side of a radially outwardly extending flange at the said lower end of the pipe.

7. Apparatus according to any one of the preceding claims wherein the support means includes a suspension for the inlet pipe provided with energy storage means.

8. Apparatus according to any one of the preceding claims wherein the support means includes a float.

9. Apparatus according to any one of the preceding claims wherein the inlet pipe is funnel-shaped, narrowing towards the rotor.

10. Apparatus according to claim 9 as appedant to claim 8, wherein the float is in the form of a belt around a circumference of the funnel.

11. Apparatus according to any one of the preceding claims including an auxiliary gas inlet pipe having a lower end inside the first inlet pipe and extending from above the level of the inlet end of the first inlet pipe so as to maintain gas flow to the rotor if froth fills the first inlet pipe.

12. Apparatus according to claim 11 wherein the auxiliary inlet pipe serves to position the inlet pipe and the immersible parts of the apparatus with respect to a vertical axis.

13. Apparatus according to claim 11 or claim 12 wherein a valve is located at the end of the auxiliary pipe in the vicinity of the rotor.

14. Apparatus according to any one of the preceding claims including outlet guide means at a radial side of the rotor.

15. Apparatus according to claim 14 wherein the outlet guide means is a turbulence pipe.

16. Apparatus according to any one of the preceding claims including a tank to hold the liquid.

17. Apparatus according to claim 16 as appendant on claim 15 wherein the outlet end of the turbulence pipe is located in the lower third portion of the tank.

18. Apparatus according to claim 16 as appendant to claim 15 including a second tank into which the turbulence pipe leads.

19. Apparatus according to claim 16, as appendant to any one of claims 11 to 13, wherein the tank has a cover and the auxiliary inlet pipe extends through the cover so as to be open to fresh air.

20. Apparatus substantially as herein described with reference to Figs. 1 and 2, Fig. 3 or Figs. 4 and 5 of the accompanying drawings.

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3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG. 1

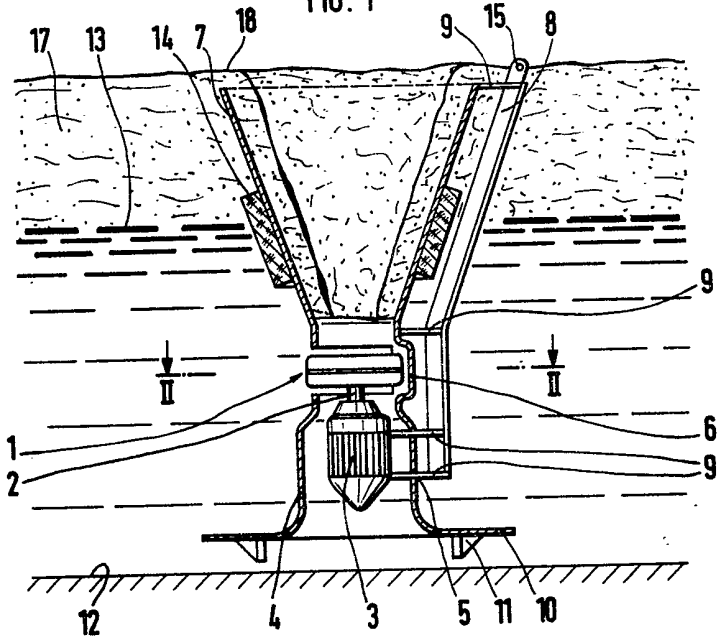
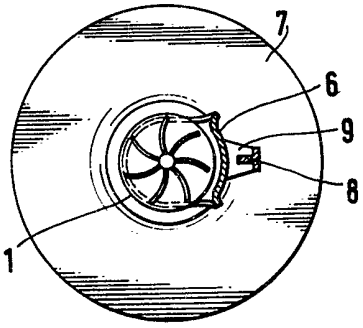


FIG. 2



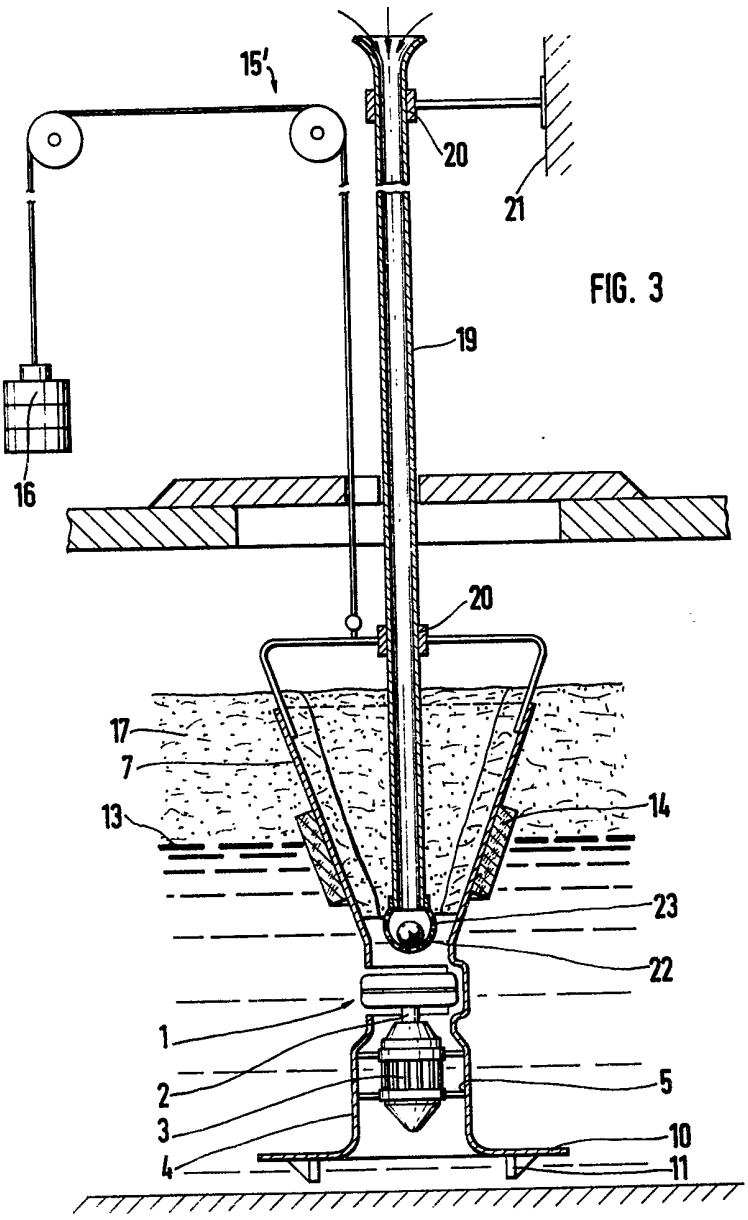


FIG. 3

FIG. 4

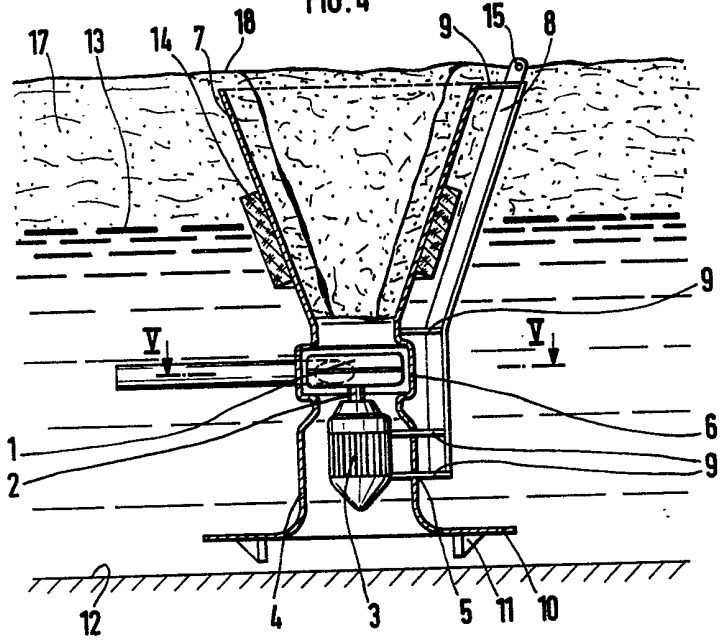


FIG. 5