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(54) Fluid mixing system

(57) A fluid mixing system (2) is provided for a tank (8) containing a first fluid material (10). The system comprises an inlet (4) and an outlet (14) for a second fluid material (28). The inlet (4) and outlet (14) define a flexible interface section (16) therebetween for the second fluid material (28). The flexible interface section (16) contacts the first fluid material (10) and is adapted to flex when the second fluid (28) flows therethrough, thereby mixing the first fluid material (10) in the tank (8).

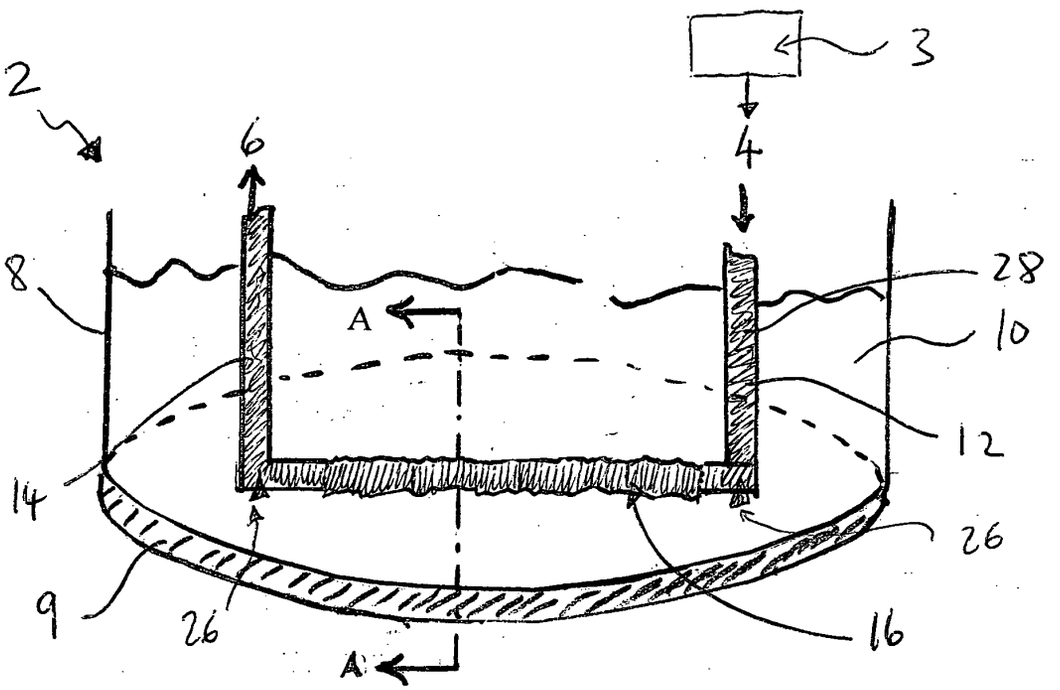

FIGURE 1

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Description

[0001] The present invention relates to fluid mixing systems and particularly, although not exclusively, to fluid mixing systems for use in waste water treatment. The invention extends to methods for mixing fluid.

[0002] Waste water, normally in the form of sewage, is processed in containers known as digesters. Processing of the sewage includes microbial decomposition in the digester and, in most digesters, the sewage is mixed to improve the rate of digestion. Sewage mixing may be achieved by pneumatic mixers located in the digester and arranged to eject gas throughout the sewage, thereby producing and entraining a flow of fluid within the digester to cause mixing. The gas ejected from the pneumatic mixer used to cause the mixing often consists of bio-gas, for example, methane MO_x and/or SO_x gases. An alternative way of mixing sewage is to use mechanical stirrers in the digester.

[0003] Problems associated with use of pneumatic mixers using bio-gases, are that there is a tendency for microorganisms to become over-populated within the sewage. Problems associated with mechanical stirrers are the constant risk of mechanical failure, the need for constant supervision and maintenance, and their expense.

[0004] It is an aim of embodiments of the present invention to provide a fluid mixing system, which does not consist of complex machinery and therefore does not need constant supervision and maintenance. In addition, there is a requirement to provide a fluid mixing system in which any direct contact between a fluid being mixed and a fluid doing the mixing, is removed.

[0005] According to a first aspect of the present invention, there is provided a fluid mixing system for a tank containing a first fluid material, the system comprising an inlet and an outlet for a second fluid material, which inlet and outlet define a flexible interface section therebetween for the second fluid material, wherein the flexible interface section contacts the first fluid material and is adapted to flex when the second fluid flows therethrough, thereby mixing the first fluid material in the tank.

[0006] Preferably, the interface section comprises a conduit arranged between the inlet and outlet.

[0007] The system may be a waste fluid mixing system. The first fluid material may comprise a mixture of fluid material and solid material. The mixture may comprise waste water or sewage. The first fluid material may comprise a volatile fluid. The first fluid material may comprise a liquid, for example, water, chemicals, paint, glue.

[0008] Preferably, the system is portable and is adapted to be inserted in to any tank containing fluid, which requires mixing. Advantageously, the system may be quickly inserted in to a tank to mix a fluid, and quickly removed when required.

[0009] Preferably, the first fluid material is isolated from the second fluid material. By the term "isolated", we mean the first and second fluid materials do not come in to contact with each other. Advantageously, and preferably, the system is substantially non-mechanical, and is adapted to create turbulence in the first fluid material without direct contact between the first and second fluid materials. Advantageously, and preferably, the first fluid material is not contaminated by the second fluid material.

[0010] Preferably, the system comprises a second fluid material feed source, which may be located externally from the tank. The second fluid material is preferably supplied to the flexible mixing means under pressure, and preferably, in pulses. Preferably, the system comprises a pump adapted to pressurise, and preferably, pulse the second fluid material. The system may comprise a pneumatic mixer located at the inlet, which mixer is operable to entrain a flow of the second fluid material into and through the flexible interface section.

[0011] The second fluid material may comprise liquid or gas. The second fluid material may comprise water, steam, air, Bio-gas, for example, methane, NO_x and/or SO_x gases, or mixtures thereof. Preferably, the system comprises temperature control means adapted to heat and/or cool the second fluid material. For example, the second fluid material may comprise hot or cold water. Advantageously, the system may be used to mix and also control the temperature of the first fluid material.

[0012] The flexible interface section may extend through or adjacent the first fluid material.

[0013] Preferably, the flexible interface section is adapted to be located towards a base of the tank, and preferably substantially at the base thereof. Preferably, the flexible interface section is impermeable to the first and second fluid materials.

[0014] In a first embodiment, the flexible interface section may comprise a passageway, which extends between the inlet and outlet. The flexible interface section may comprise tubing, which may be corrugated. The tubing may be plastic.

[0015] Preferably, the inlet is adapted to extend downwardly substantially adjacent one side of the tank and, preferably the outlet is adapted to extend upwardly substantially adjacent an opposite side of the tank. Preferably, the inlet is attached to a first end of the flexible interface section, and preferably the outlet is attached to a second end of the flexible interface section. The inlet and outlet may comprise tubing.

[0016] Preferably, the inlet and preferably, the outlet are adapted to be secured to a side or base of the tank. Preferably, portions of the interface section remote from the sites of attachment with the inlet and outlet are not attached to the tank. Alternatively, or additionally, the system may comprise submersion means adapted to weigh the inlet and outlet and, preferably the flexible interface section, down to the base of the tank. The submersion means may comprise a weight attached to the system. The system may be adapted to submerse and maintain itself at the base of the container due to the

weight of the second fluid material flowing through the flexible interface section.

[0017] Preferably, the interface section is adapted to flex and move within the first fluid material, as the second fluid material flows therethrough. Preferably, said flexing occurs substantially transverse to the direction of flow of the second fluid material through the mixing means. Preferably, said flexing adopts a wave motion, which is dependant on the depth of immersion of the flexible interface section.

[0018] Advantageously, and preferably, securing or weighting down, the inlet and outlet to the side or base of the tank ensures that the maximum amount of force from the second fluid flowing through the interface section is actually imparted into the flexing of the conduit. This results in optimum mixing of the first fluid material, which is in close proximity to the flexing conduit. The flexing conduit establishes currents and turbulence in the tank, which results in the first fluid material being mixed.

[0019] In a second embodiment, the flexible interface section may comprise a sheet of material, which is preferably adapted to extend substantially across the tank, preferably at the base thereof. Preferably, the system comprises a plurality of inlets, which are preferably located on one side of the tank. Preferably, the system comprises a plurality of outlets, which are preferably located in an opposite side of the tank. Preferably, the sheet is secured below the first fluid material and, preferably above the inlets and outlets. Preferably, the flexible interface section in the second embodiment is formed between the sheet, and the base and sides of the tank. Preferably, the sheet is secured to the tank such that the first fluid material cannot mix with the second fluid material, and vice versa. Preferably, the sheet is impervious.

[0020] In a third embodiment, the flexible interface section may comprise a diaphragm, which is preferably adapted to extend substantially across the tank, preferably at the base thereof. Preferably, the diaphragm is substantially planar and preferably, elongated. The diaphragm may have a substantially flattened balloon shape. Preferably, the diaphragm comprises a plurality of inlets on one side thereof, and preferably, a plurality of outlets on an opposite side thereof. Preferably, the diaphragm is adapted to be placed at the base of the tank, preferably, substantially below the first fluid material.

[0021] Preferably, the diaphragm comprises submersion means adapted to weigh the diaphragm down to the base of the tank. The submersion means may comprise a weight attached to the diaphragm. The submersion means may comprise a plate which is sufficiently heavy to weight the diaphragm down to the base of the tank. Alternatively, the diaphragm may be adapted to submerse and maintain itself at the base of the tank due to the weight of the second fluid material flowing therethrough. Preferably, the flexible conduit of the third embodiment is the diaphragm. Preferably, the diaphragm is impervious.

[0022] The invention extends to a waste water digester tank fitted with a fluid mixing system according to the above aspect.

[0023] According to another aspect of the present invention, there is provided a method of mixing a first fluid material in a tank, the method comprising passing a second fluid material along a flexible interface section which contacts the first fluid material so that the interface section flexes, thereby mixing the first fluid material in the tank.

[0024] Preferably, the interface section comprises a conduit arranged between an inlet and an outlet for the second fluid material.

[0025] The method may comprise mixing waste water or sewage, and may comprise pressurising the second fluid material, preferably by pumping. Preferably, the second fluid material may be pulsed. The second fluid material may be heated and/or cooled prior to being introduced through the conduit.

[0026] All of the features described herein may be combined with any of the above aspects, in any combination.

[0027] For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:-

Figure 1 shows a schematic perspective view of a first embodiment of a fluid mixing system;

Figure 2 shows a schematic view of the fluid mixing system along axis 'A-A' shown in Figure 1;

Figure 3 shows a schematic perspective view of a second embodiment of a fluid mixing system; and

Figure 4 shows a schematic perspective view of a third embodiment of a fluid mixing system.

[0028] Referring to Figures 1 and 2, there is shown a first embodiment of a fluid mixing system 2. The mixing system 2 consists of a tank or container 8 containing a first fluid 10. The container 8 is on a waste water treatment plant and contains waste water or sewage 10. A pump 3 is provided to pump a second fluid 28 in to a fluid inlet 4 of the system 2. If necessary, the pump 3 can be replaced by a pneumatic mixer. The second fluid is a gas, for example, air, or a biogas such as methane MO_x and/or SO_x. However, the second fluid 28 could also be a liquid, for example, water, in which case a reservoir (not shown) for storing a source of liquid 28 is required. Although not shown in the figures, the second fluid, be it either liquid or gas can be heated or cooled by a temperature control unit (not shown).

[0029] The pump 3 pumps the gas 28 in to the fluid

inlet 4, along fluid inlet tube 12 which extends from an upper region of the container 8, and down one side towards the base 9 of the container 8. The inlet tube 12 extends for a short distance along the base 9 of the container 8 and is connected to a flexible mixing tube 16, which extends from one side of the base 9 of the container 8 to the opposite side of the base 9 of the container 8, where it is attached to a fluid outlet tube 14. The fluid outlet tube 14 extends upwardly from the base 9 of the container 8 to the upper part of the container 8 on the opposite side to that of the inlet tube 12.

[0030] As shown in Figures 1 and 2, the lowermost parts of the fluid inlet tube 12 and the fluid outlet tube 14 are securely attached to the base 9 of the container 8 via attachment straps 26. However, the flexible mixing tube 16 is not secured to the base 9 of the container 8, such that it is able to flex and move about as will be described hereinbelow. In some cases, the system is not attached to the base 9, but is weighted down by the weight of the mixing tube 16 and the weight of the fluid flowing therethrough.

[0031] Referring to Figures 1 and 2, the fluid mixing system 2 is used as follows. A flow of air 28 through the mixing system 2 is set up by first initiating the pump 3, which creates a positive pressure through the lengths of tubing 12,16,14. The air 28 is pumped in to the fluid inlet 4, down the inlet tube 12 on one side of the container 8, through the flexible mixing tube 16 along the base of the container 8, up through the outlet tube 14 on the other side of the container 8, and out of the fluid outlet 6. The air 28 (or liquid) can then be recycled back to the fluid inlet 4, if required.

[0032] The attachment straps 26 ensure that that the inlet and outlet tubes 12,14 do not move as the air 28 flows therethrough. However, because the flexible mixing tube 16 is not strapped down to the base of the container 8, and because it is flexible, the flow of air 28 therethrough creates an internal wave-form action within the tube 16 which in turn causes the tube 16 to move about.

[0033] At a certain air pressure, a harmonic sound is produced in the tubing 16, which causes the flexible tube 16 to continually flex. Figure 2 shows the tube 16 flexing in directions indicated by arrows 'X' and 'Y', i.e. from one side of the container 8 to the other. The amount of flexing depends on the material from which the tube 16 is made, its length and also the pressure of the air 28 flowing therethrough.

[0034] The result of the tube 16 flexing from side to side in a regular pattern, is that the waste water 10 at the base 9 of the container 8 is mixed. The constant flexing of the flexible tube 16 at the base 9 causes turbulence and produces mixing currents throughout the container 8, which results in the waste water 10 throughout the container 8, including the upper regions thereof, being mixed. After a reasonable period of time, the constant flow of air 28 through the flexible tube 16 ensures that the waste water 10 in the container 8 is constantly mixed.

[0035] Referring to Figure 3, there is shown a second embodiment of a fluid mixing system 24. The system 24 consists of a container 8 containing waste water or sewage 10, underneath which is attached an impervious, thin, flexible, plastic sheet 22. The sheet 22 is sealed all of the way around the base 9 of the container 8 so that no waste water 10 is able to pass from the upper side to the underside of the sheet 22.

[0036] On one side of the container 8, there is provided a series of inlet apertures 18 through which gas or liquid, is introduced into the system. On the side of the container 8 opposite to that of the inlet apertures 18, there is provided a series of outlet apertures 20 through which the gas or liquid exits the system. A pump 3 is arranged to blow air through apertures 18 above the base 9 of the container 8 and underneath the waste water. It should be appreciated that the pump 3 could pump liquid through the inlet apertures 18 and underneath the sheet 22.

[0037] As air or liquid is continually pumped under the sheet 22, a rolling wave action is created in the sheet 22, as the gas moves in a direction as illustrated by arrow 'Z' in Figure 3. As the sheet 22 moves or undulates at the base 9 of the container 8, it creates a rolling wave action in the waste water 10 at the base 9 of the container 8, directly above the sheet 22, which causes mixing thereof. Mixing currents are generated in the water 10 which spread throughout the rest of the water 10 in the container 8, thereby causing the whole contents to be mixed.

[0038] Referring to Figure 4, there is shown a third embodiment of a fluid mixing system 38. The system 38 consists of a container 8 containing waste water or sewage 10, at the base 9 of which is placed an impervious, thin, flexible, plastic diaphragm 30. The diaphragm 30 is attached to a plate 36 which weighs it down to the base 9 of the container 8.

[0039] On one side of the diaphragm 30, there is provided a series of inlet apertures 32, each of which is attached by tubing 40 to the inlet tube 12. Gas or liquid, is pumped by a pump 3 through the inlet tube 12, through the tubing 40 and into the diaphragm 30. On the side of the diaphragm 30 opposite to that of the inlet apertures 32, there is provided a series of outlet apertures 34 through which the gas or liquid exits the diaphragm 30. The outlet apertures 34 are attached by tubing 40 to outlet tubing 14 and out of the system as in the previous embodiments.

[0040] As air or liquid is continually pumped into and through the diaphragm 30, a rolling wave action is created therein in a similar way to the sheet 22 in the second embodiment. As the diaphragm 30 moves or undulates at the base of the container 8, it creates a rolling wave action in the waste water 10 at the base of the container 8, directly above it, which causes mixing. Mixing currents are generated in the water 10, which spread throughout the rest of the water 10 in the container 8,

thereby causing the whole contents to be mixed.

[0041] Advantages of the fluid mixing systems 2,24,38 are that the waste water 10 is mixed without direct contact occurring between the waste water 10 being mixed and the mixing fluid, be it either gas or liquid carried within the mixing tube 16 of the first embodiment 2, underneath the flexible mixing sheet 22 of the second embodiment 24, or through the diaphragm 30 of the third embodiment. The advantage of this is that digestion of the waste water 10 proceeds without any of the deleterious effects which would occur if the gas/fluid 28 and waste water 10 were able to come in to direct contact with each other, for example, an increase in the population of microbes in the waste water 10. In addition, all three embodiments of the system 2,24 consist of very few moving parts. Hence, maintenance of any embodiment of the system is simple and cheap. Also, the first and third embodiments of the system are portable and can very easily by dropped in to the container 10 to mix the water 10, and then quickly removed when required.

[0042] The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

[0043] All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

[0044] Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

[0045] The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. A fluid mixing system for a tank containing a first fluid material, the system comprising an inlet and an outlet for a second fluid material, which inlet and outlet define a flexible interface section therebetween for the second fluid material, **characterised in that** the flexible interface section contacts the first fluid material and is adapted to flex when the second fluid flows therethrough, thereby mixing the first fluid material in the tank.

2. A fluid mixing system as claimed in claim 1, wherein the interface section comprises a conduit arranged between the inlet and outlet.

3. A fluid mixing system as claimed in claims' 1 or 2, wherein the first fluid material may comprise a mixture of fluid material and solid material.

4. A fluid mixing system as claimed in any one of the preceding claims, wherein the system is adapted to create turbulence in the first fluid material without direct contact between the first and second fluid materials.

5. A fluid mixing system as claimed in any one of the preceding claims, wherein the second fluid material is supplied to the flexible interface section under pressure.

6. A fluid mixing system as claimed in any one of the preceding claims, wherein the flexible interface section is impermeable to the first and second fluid materials.

7. A fluid mixing system as claimed in any one of the preceding claims, wherein the inlet is attached to a first end of the flexible interface section, and the outlet is attached to a second end of the flexible interface section.

8. A fluid mixing system as claimed in any one of the preceding claims, wherein the interface section is adapted to flex and move within the first fluid material, as the second fluid material flows therethrough, and the said flexing occurs substantially transverse to the direction of flow of the second fluid material through the mixing means.

9. A fluid mixing system as claimed in any one of the preceding claims, wherein the flexible interface section comprises a sheet of material, which is adapted to extend substantially across the tank, at the base thereof, the sheet comprising a plurality of inlets, which are located on one side of the tank and a plurality of outlets, which are located in an opposite side of the tank.

10. A fluid mixing system as claimed in any one of claims 1 to 9, wherein the flexible interface section comprises a diaphragm, which is adapted to extend substantially across the tank, at the base thereof.

11. A waste water digester tank fitted with a fluid mixing system according to any one of the preceding claims.

12. A method of mixing a first fluid material in a tank, the method comprising passing a second fluid material along a flexible interface section which contacts the first fluid material so that the interface section flexes, thereby mixing the first fluid material in the tank.

FIGURE 1

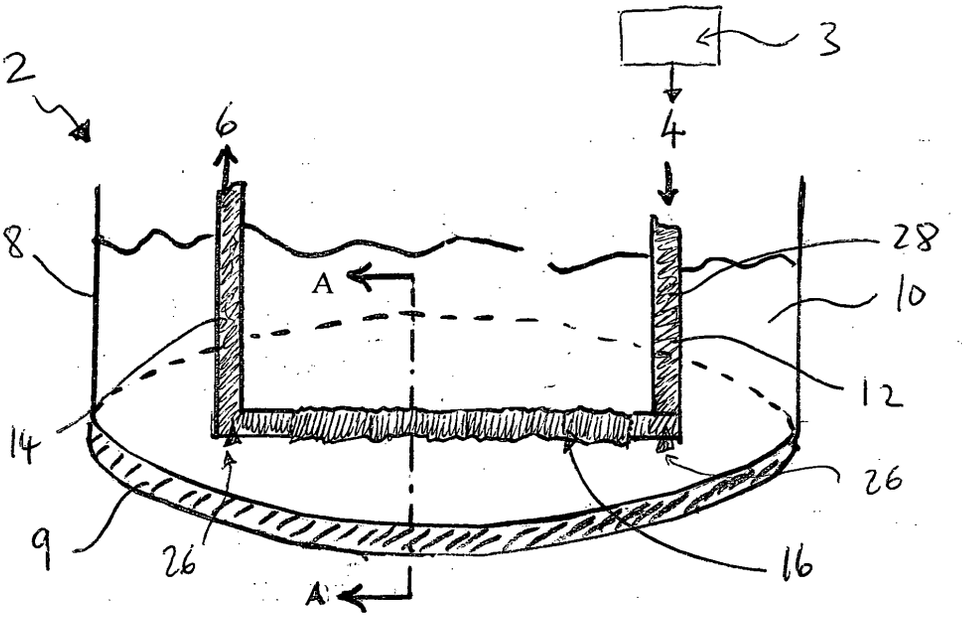


FIGURE 2

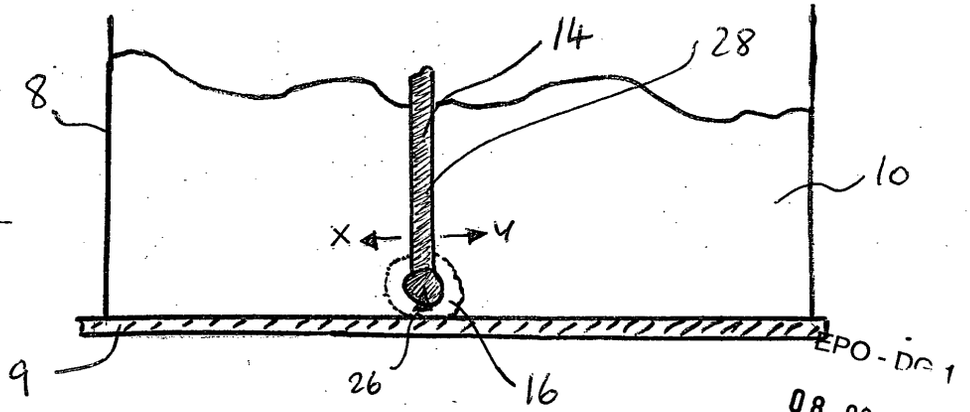


FIGURE 3

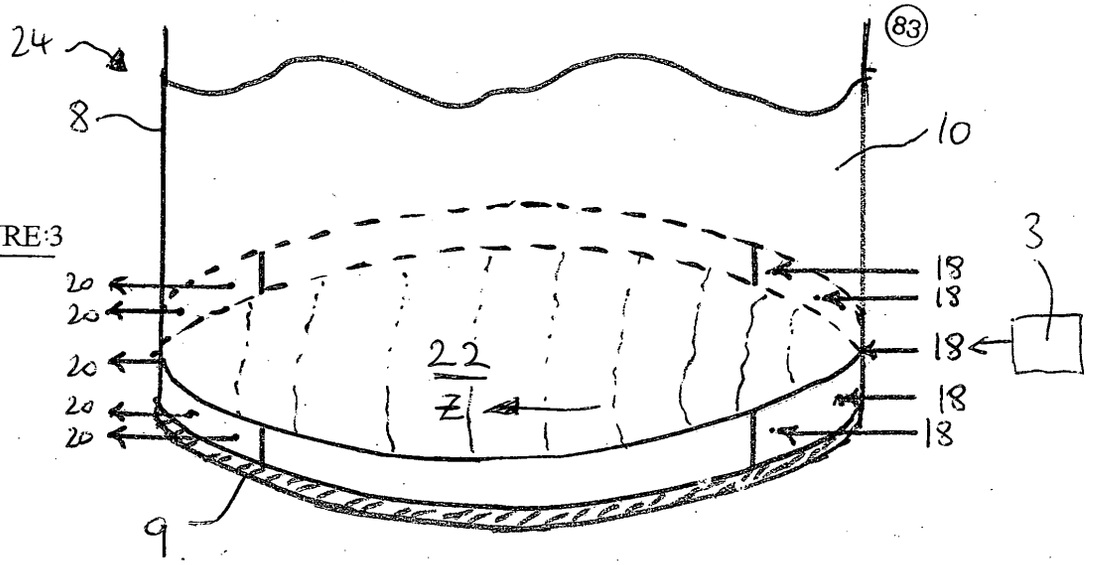
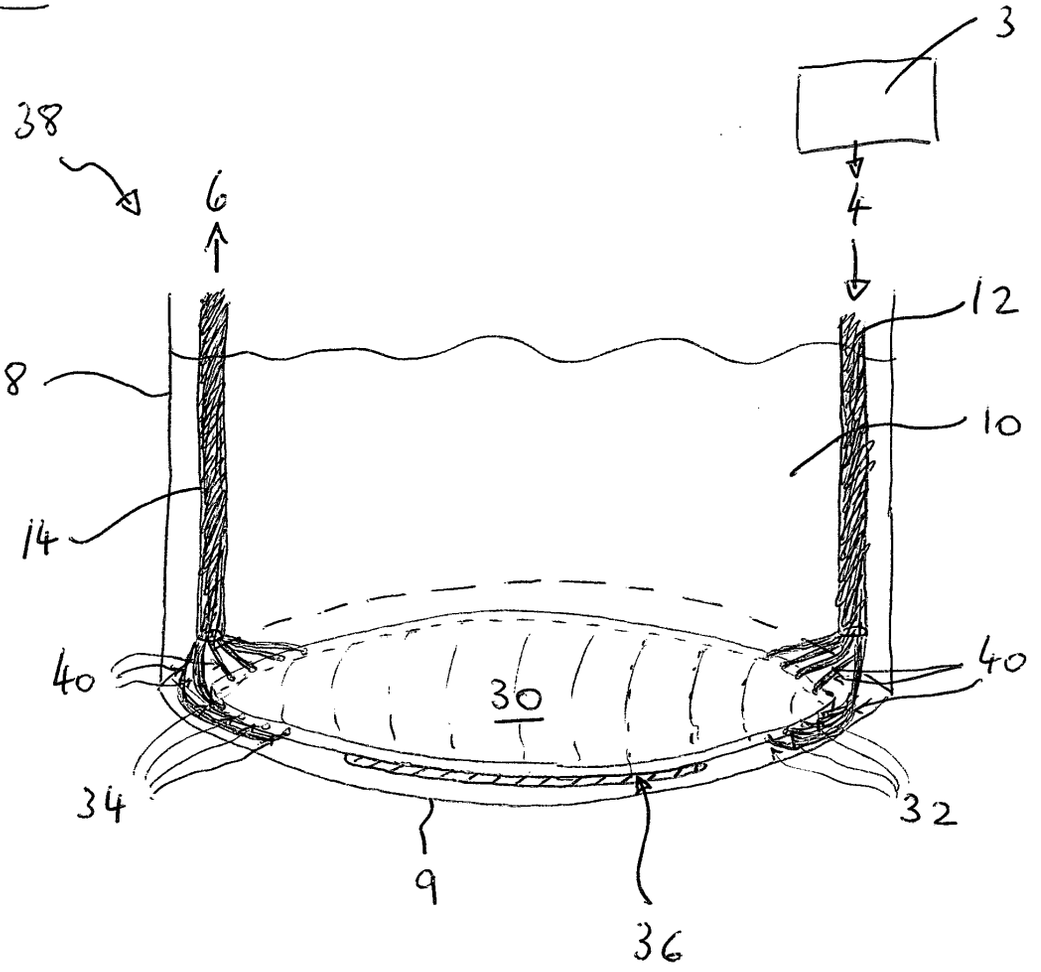


FIGURE: 4



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EUROPEAN SEARCH REPORT

Application Number
EP 04 25 4926

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	US 4 207 007 A (KARBACHINSKY VLADIMIR M ET AL) 10 June 1980 (1980-06-10) * column 3, line 62 - column 6, line 63 *	1,3-6, 11,12	B01F11/00
X	US 4 029 581 A (SNOW JOHN F ET AL) 14 June 1977 (1977-06-14) * column 2, line 50 - column 5, line 20; figures 1,2 *	1-3,5,6, 8,10-12	
A	BE 1 010 746 A (WOW COMPANY S A) 5 January 1999 (1999-01-05) * page 1 - page 2; claims 1,2; figures 1,2 *	1-12	
A	US 5 826 979 A (FOSS MILTON K) 27 October 1998 (1998-10-27) * abstract; figures 1,4,6 *	1-12	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			B01F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	29 November 2004	Muller, G

CATEGORY OF CITED DOCUMENTS

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29-11-2004

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