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(54) A system for rendering tanks safe

(57) A system for rendering tanks safe according to the invention comprises an outer tank or reservoir (1) to be rendered safe, and an inner tank (2) made of plastic material able to contain the polluting liquid, positioned within the outer tank (1) in such a way as to generate an inter-space (30) between them, an intake pipe (4) positioned inside the inter-space (30) and connected to intake means (40) to aspirate air from the inter-space and exhaust it into the external environment, a supply pipe (5) positioned inside the inter-space (30) and connected to the external environment to inject air from the exterior into the inter-space (30) in order to replenish the air aspirated by the intake pipe (4), and a vapour detection unit (6) comprising a vapour sensor (60) connected to the intake means (40) to detect the vapours aspirated from the inter-space (30) and accordingly to activate an audible/visual alarm (61).

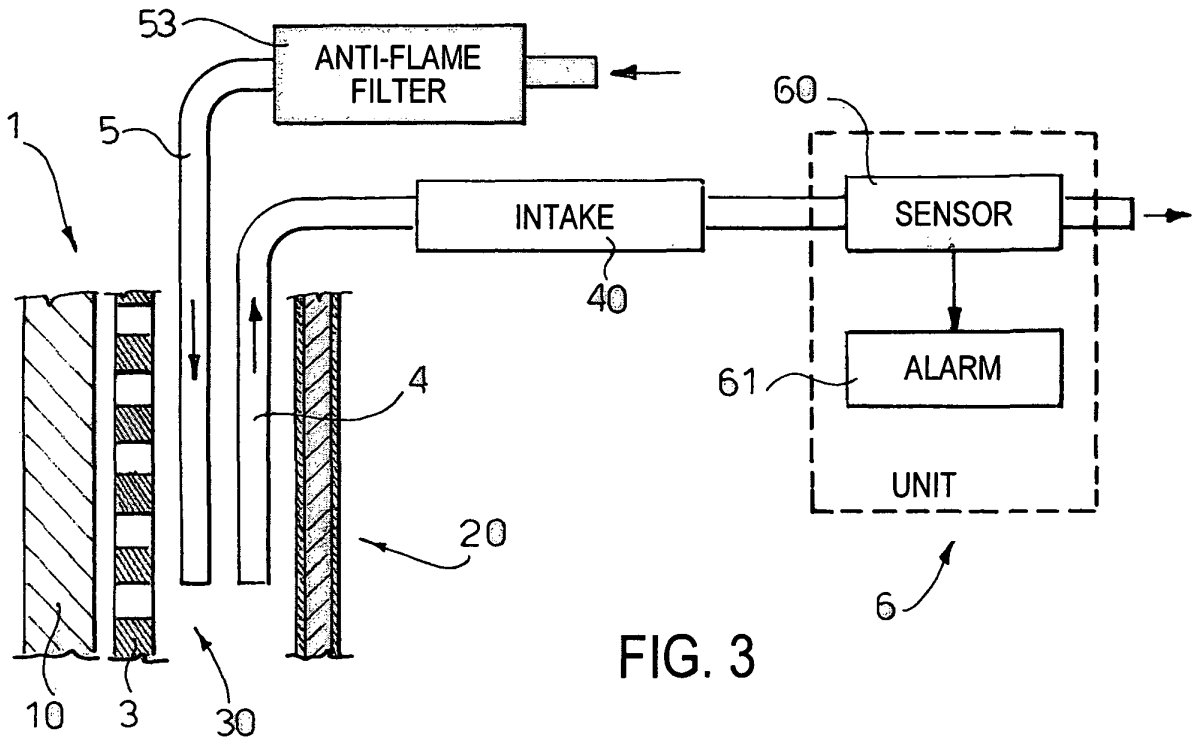

FIG. 3

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Description

[0001] The present invention relates to a system for rendering safe underground or non underground tanks or reservoirs for the storage of hazardous and polluting substances, e.g. fuels, combustible oils and the like.

[0002] Although hereafter specific reference shall be made to fuels, the safety system according to the invention can be applied to tanks for the storage of other types of hazardous and polluting substances.

[0003] As is well known in car service areas, in proximity to fuel distributors, large tanks for storing fuel are placed underground. At times it may occur that, due to ageing and deterioration, said tanks are subject to the leakage of fuel, which escapes into the surround ground, with the resulting pollution of the soil and of the surrounding waters and hence severe environmental damage.

[0004] To solve this drawback, double walled tanks are known, provided with monitoring and alarm system to detect and warn of any leaks. Such tanks have an inter-space between the two walls which is monitored by means of a system based on the pressure and vacuum generated within it. Said monitoring system is connected to an alarm system which emits an alarm signal to warn assigned operators who replace the double wall tank before the leaks involve the outermost part as well, with the consequent spillage of fuel.

[0005] Systems for restoring underground tanks are known, which require two to four days of time for installation. This translates into a long idle time of the facilities and consequent hardships and costs, especially when operating in car service stations.

[0006] An object of the present invention is to eliminate the drawbacks of the prior art, providing a system for rendering tanks safe that can be monitored to reveal the presence of leaks and that at the same time is economical and whose installation is simple to accomplish.

[0007] This object is achieved in accordance with the invention with the characteristics listed in the appended independent claim 1.

Another object of the present invention is to provide a method for rendering a tank safe that is efficient, effective and safe.

[0008] This object is achieved in accordance with the invention with the characteristics listed in the appended independent claim 14.

[0009] Advantageous embodiments of the invention are readily apparent from the dependent claims.

[0010] The system for rendering tanks safe according to the invention comprises an outer tank or reservoir to be rendered safe, and an inner tank made of plastic material able to contain the polluting liquid, positioned within the outer tank in such a way as to generate an inter-space between them.

[0011] An intake o suction pipe and a supply pipe are positioned within said inter-space formed between the two tanks. The intake pipe is connected to intake means to intake air from said inter-space and exhaust it into the external environment. The supply pipe is connected to the external environment to draw air from the exterior and inject it into said inter-space in such a way as to replenish the air aspirated by the intake pipe.

[0012] The system further comprises a vapour/gas detection unit comprising a vapour/gas sensor connected to said intake means to detect the vapours/gases aspirated from said inter-space. The vapour/gas sensor is electrically connected to an audible/visual alarm that is activated when the sensor detects the presence of vapours/gases in the air aspirated from said inter-space.

[0013] The advantages of the system according to invention are readily apparent, for it enables in simple and practical fashion to render safe an underground or external tank or reservoir.

[0014] Additional characteristics of the invention shall become more readily apparent from the detailed description that follows, referred to a purely exemplifying and hence not limiting embodiment thereof, illustrated in the accompanying drawings, in which:

Fig. 1 is a schematic perspective view, illustrating in exploded fashion an inner tank and an axial section of an external tank that needs to be rendered safe;
Fig. 1A is an enlarged sectional view, illustrating a portion of wall of the inner tank of Fig. 1
Fig. 2 is a schematic axial sectional view showing the inner tank positioned within the outer tank to obtain a double wall tank for rendering the outer tank safe;
Fig. 3 is a schematic view of a section of the double wall tank of Fig. 2, showing a supply pipe and an intake pipe connected to a leak detection unit; and
Fig. 4 is a block diagram showing the leak detection unit in its complete version.

[0015] With the aid of the figures, the system for rendering a tank safe according to the invention is described.

[0016] Figures 1 and 2 show an outer tank 1 to be rendered safe. The outer tank 1 has a body 10, generally made of metallic material, having a substantially cylindrical shape with the edges rounded.

[0017] In the upper part of the body 10 of the outer tank is provided a cylindrical opening 11 with vertical axis, commonly called manhole, whose purpose is to receive the nozzle of a refuelling pipe for injecting the fuel into the outer tank 1.

[0018] Into the outer tank 1 is inserted an inner tank 2 in such a way as to obtain a double wall tank.

[0019] In conformity with the length of the outer tank 1, the inner tank 2 can comprise one or more strips of plastic material 20 with their lateral edges sealed together, by high frequency sealing or heat sealing 21, in spots or continuous. A strip of the desired length is thereby obtained, which is rolled into a tubular shape and the superposed longitudinal edges are sealed longitudinally by high frequency sealing or heat sealing 22.

[0020] At the open circumferential ends of the tubular

shape thus obtained are fastened two circular bottoms 23 made of the same plastic material as the strips 20, by high frequency sealing or heat sealing 24. Alternatively to the circular bottoms 23, a longer tubular shape than the length of the tank can be provided, and each open circumferential end of the tubular shape can be closed in bag fashion by superposing the edges and high frequency sealing or heat sealing the superposed edges.

[0021] In the upper part of the inner tank 2 is obtained an opening around which is placed a cylindrical tang 25 destined to match with the manhole 11 of the outer tank 1 for the injection of the fuel into the inner tank 2.

The inner tank 2 is made with dimensions that are a few percentage points larger than the dimensions of the outer tank 1, to avoid mechanical stress, especially in the welded areas, due to a high pressure.

[0022] The material whereof the strips 20 and the bottoms 23 of the inner tank 2 is a multi-layer film (Fig. 1A) comprising three layers: an intermediate layer 26 constituted by a film of Nylon or polyamide and two surface layers 27 applied on both the faces of the intermediate layer of nylon 26.

[0023] Since it is difficult to seal the nylon film 26 with another nylon film, on it are applied the surface layers 27 constituted by a plastic material which can easily be sealed. Between the plastic materials of the surface layers 27, preferably materials based on polyurethane or polyurethane-polycarbonate or polycarbonate are used, which can be sealed by high frequency sealing or heat sealing.

[0024] In addition to assuring an easy sealing, such a multi-layer film assures excellent resistance to corrosion by fuels and the like.

[0025] Once the clean-up operations inside the outer tank 1 are completed along with any repairs to particularly damaged parts of the tank, a net made of plastic material 3 (Fig. 2) is positioned in the inner tank. The net 3 is fastened to the inner wall of the outer tank 1 by means of adhesive materials and/or magnets.

[0026] In this way, when the inner tank 2 is positioned in the outer tank 1, the net 3 is interposed between them generating an inter-space 30 between the inner surface of the outer tank and the outer surface of the inner tank. The net 3 performs a dual function: it protects the inner tank 2 from the roughness of the inner surface of the reservoir 1 and at the same time it is able to assure a minimum circulation of air flows within the inter-space 30 formed between the two tanks 1 and 2.

[0027] After positioning the net 3, into the outer tank 1 are inserted, through the manhole 11, an air intake or suction pipe 4, and an air supply pipe 5, as shown in Fig. 3. The intake pipe 4 is connected to intake means 40 able to aspirate the air through the intake pipe 4 from the inter-space 30 between the two tanks 1 and 2 and to expel it to the exterior. The supply pipe 5 is connected to the external environment to draw clean air and inject it into the inter-space 30 between the two tanks 1 and 2.

[0028] In this way, in the inter-space 30 between the two tanks 1 and 2, the air aspirated by the intake pipe 4 is replaced with clean air injected by the supply pipe 5. To prevent any saturation and vacuum formation effects in the inter-space 30, the supply pipe 5 can preferably have a greater flow rate than the intake pipe 4.

[0029] At the top of the supply pipe 5 is positioned a flame arresting filter 55 able to prevent the entry of flame igniting agents into the inter-space 30 between the two tanks.

[0030] The intake means 40 are connected to a vapour/gas detection unit 6 which in its simplest version comprises a sensor 60 able to detect the presence of vapours/gases, such as fuel vapours, and accordingly to send an alarm signal to a visual or sound alarm 61 which is activated.

[0031] The intake means 40 can be integrated in the detection unit 6 which will be equipped with other optional devices, as shall be described below with reference to Fig. 4.

[0032] After positioning the intake and supply pipes 4 and 5, the inner tank 2 is inserted in the outer tank 1, through the manhole 11. By means of a blower, the inner tank 2 is blown in such a way that it positions itself correctly in the outer tank 1. As shown in Fig. 2 inside the inner tank 2 are positioned straps 9 (circular bands, 4 mm thick and 6 cm wide) made of plastic material that is chemically resistant to hydrocarbons. The straps 9 serve the purpose of fastening the inner tank 2 in position on the plastic net 3 that is applied to the inner part of the outer tank 1.

[0033] In addition or alternatively to the straps 9, magnets protected by a barrier film can be provided, positioned in the inner tank 2 in such a way as to anchor themselves by magnetic retention to the metallic outer part of the outer tank 1.

[0034] Given the high resistance of the inner tank 2, during installation operations, the installer who has to work inside the inner tank 2 can wear normal shoes with rubber soles with no risk of damaging it.

[0035] On the bottom of the inner tank 2 is laid a carpet of nitrilic rubber 8 of adequate thickness and weight (Fig. 2). The rubber carpet 8 has the function of protecting the bottom of the inner tank 2 from rod beating operations for the periodic check of the fill level. The rubber carpet 8 also provides assurance that the inner tank 2 will not move during possible dregs aspirating operations.

[0036] At this point, the system is ready to the detection of any leak and consequent spillage of pollutants. If a through hole were generated in the wall of the inner tank, the fuel vapours would be released inside the inter-space 30 between the inner tank 2 and the outer tank 1.

[0037] These fuel vapours would immediately be aspirated by the intake pipe 4 and hence detected by the sensor 60 of the detection unit 6. Accordingly, the sensor 60 sends a first alarm signal to the alarm 61 which is activated. The sensor 60 is preferably calibrated in such a way as to send an alarm signal to start from the reaching of a threshold value equal to 3% of the LEL (low explosion

level).

[0038] Through the intake pipe 4, a quantity of about 0.5 litres of air per minute is conveyed to the detection unit 6. Fig. 4 shows a complete version of the detection unit 6. However, the basic fitting of the detection unit 6 comprises:

A) an intake and delivery pump 62,
B) a gas/vapour detection sensor 60,
C) an alarm 61,
D) a flow meter 63, and
E) a liquid blocking filter 64.

[0039] The intake and delivery pump 62 is preferably a membrane pump provided with an intake chamber 40 connected to the intake pipe 4 and a delivery chamber 50 connected to the sensor 60. The pump 62 is driven by an electric motor M separate from the intake and delivery chambers 40, 50. Instead of the motor M, the pump 62 can also be connected to a Venturi valve actuated by a compressor.

[0040] The sensor 60 is connected to the delivery chamber 50 of the pump 62 and it is a catalytic combustion sensor (pellistor) able to test in a few minutes the flow of air aspirated by the pump 62. The sensor 60 is able to detect the presence of any petrol or Diesel oil vapours, indicating a spill of pollutant from the inner tank 2. It must be considered that if the pollutant leaks out of the inner tank 2, it does not necessarily also leak out of the reservoir 1 and hence into the environment.

[0041] The sensor 60 is electrically connected to an alarm 61 provided with three indicator lights A1, A2, A3, e.g. red, corresponding to three different alarm levels (e.g. 3%, 5% and 10% of LEL or 10%, 20% and 30% of LEL, etc...). The third light A3 is also connected to an audible alarm, such as a buzzer.

[0042] The flow meter 63 is connected to the intake pipe 4 and it is calibrated to a flow of aspirated air of about 0.5 litres/min. The flow meter 63 is provided with visual monitoring and manual adjustment.

[0043] The liquid blocking filter 64 is connected to the intake pipe 4 and it is positioned at the input of the unit 6, to prevent liquids, such as water or fuel, from being aspirated from the inter-space 30 between the two tanks. The filter 64 is the type with float which blocks the passage of liquids through the intake pipe 4.

[0044] The unit 6 can be provided, in addition to the items listed above, also with the following components:

1) an anti-condensation filter (positioned on the outer wall of the unit),
2) a three-way electrical valve 65,
3) a flow switch 66,
4) a second alarm 67, and
5) a power supply blocking timer 69.

[0045] The principle of the interchangeability and equivalency between a unit fit out with the components A, B, C, D, E and one provided, in addition to them, also with those indicated under items 1), 2), 3), 4) and 5) applies.

[0046] The presence or absence of the components 1, 2, 3, 4 and 5 in addition to the components A, B, C, D, and E is dictated by prevalently commercial requirements, for it entails no substantial change either to the detection system or to the unit which always remains substantially the same and it does not change the safety levels or the ability of the unit to detect the presence both of petrol and of Diesel oil in the inter-space 30.

[0047] This latter characteristic in fact is not connected to the presence of additional accessories (as are those indicated under items 1, 2, 3, 4, and 5), but to the installation of a sensor 60 appropriately calibrated for detecting petrol or Diesel oil or otherwise to the presence of a sensor 60 for Diesel oil, able obviously to detect Diesel oil, but also petrol (the opposite instead is not possible: a sensor calibrated specifically for the detection of petrol is not able to signal the presence of Diesel oil in sufficiently short times).

[0048] Said sensor 60 has different degrees and combinations of detection: the range goes from 3% to over 100% of the LEL in order to assure ample opportunities for intervention well before a detonating concentration of hazardous gases is reached in the inter-space 30 between the two tanks 1 and 2.

[0049] The sensor 60 allows to adjust minimum drifts. The adjustment of the alarm thresholds will depend on the requirements of the system user and above all on the type of pollutant contained in the inner tank 2.

[0050] In the case of Diesel oil, a greater sensitivity of the sensor 60 will be necessary (the sensor will thus be calibrated directly to 3% of the LEL), because the chemical composition of Diesel oil entails, for equal environmental conditions, less volatility of its representative element (nonane, i.e. C9) with respect to the representative element of petrol (butane, i.e. C4). Instead, in the case of gasoline storage, the sensor 60 will have a higher input calibration (e.g. 10% of LEL).

[0051] The electrical valve 65 is of the three-way type and it comprises a first inlet 65a connected to the intake pipe 4, an outlet 65b connected to the pump 62 and a second auxiliary inlet 65c connected to the outside environment. The electrical valve 65 comprises a switching timer able to enable/disable the first inlet 65a or the second inlet 65c. The electrical valve 65 is electrically connected to the sensor 60 that sends a command signal to control the switching timer.

[0052] The flow switch 66 is connected to the intake pipe 4 and it is able to transform into an electrical signal a variation in the flow of air within the intake pipe 4. The flow switch 66 is electrically connected to a second visual/audible alarm 67 which comprises a yellow indicator light S1 and a buzzer. The second alarm 67 is activated when the flow switch 66 detects a flow variation in the intake pipe 4.

[0053] The power supply blocking timer 69 is electri-

cally connected to the sensor 60 and to the power supply of the motor M of the pump 62 and it is calibrated with a delay time set by the user. When the sensor 60 activates the third alarm A3, it simultaneously sends a command signal to the timer 69 which after the pre-set delay time removes the electrical power supply from the motor M of the pump.

[0054] The engineering of the unit 6 allows a series of advantages that are directly connected to efficiency and safety.

[0055] First of all, in case of spillage of pollutants from the inner tank 2, of consequent detection of the vapours/gases by the sensor 60 and of reaching of the third alarm threshold, to the visual alarm A3 (red indicator light), an audible alarm will be added as well (the buzzer of the alarm 61).

[0056] Immediately afterwards, the electrical valve 65 will switch the intake from polluted air coming from the first inlet 65a to clean air coming from the second inlet 65c in order to preserve and safeguard to operating condition of the sensor 60, which is thus ready for new monitoring operations. The air fouled by vapours aspirated by the intake pipe 4 could consume the sensitive element of the sensor 60.

[0057] After a certain number of minutes have elapsed (calibration from one minute to a few hours is possible), during which air is aspirated from the exterior, as is necessary to clean the sensor 60, the timer 69 sends a command signal to remove the power supply from the motor M of the pump 62 in order to increase the degree of safety in a suspicious situation, at risk of pollutant spillage.

[0058] It should be noted that the pump 62 can be replaced with a Venturi aspiration system in order to eliminate the presence, which is not dangerous in view of the area where the unit is positioned, of an electric motor M inside the unit itself.

[0059] Moreover, thanks to the presence of the liquid blocking filter 64 it is possible to prevent liquids from entering the intake pump 62. There could be both a spillage from the inner tank 2 of the fuel which would flood the inter-space 30 between the two tanks, and an entrance, through a hole of the outer reservoir 1 produced by free currents present in the ground, of water originating from the numerous water-bearing strata present in the subsoil.

[0060] In either case, the pump 62, through the intake pipe 4, would cause the liquid to rise to the unit 6. This liquid would first flood the filter 64 whose task is to block the liquid by means of a float system. At this point, the filter 64 would shut off, leading to a precipitous drop of the intake flow detectable through the simple observation of the graduated scale of the flow meter 63 or thanks to the concurrent action of the yellow fault indicator light S 1 and of the buzzer (audible alarm) of the alarm 67, activated by the flow switch 66.

[0061] At this point it would be sufficient to check the colour of the liquid contained in the liquid blocking filter 64 (which is appropriately transparent) to know whether it is water or fuel. Moreover, the confirmation in one sense or in another could be had by checking a display positioned on the door of the unit 6 (or, depending on the model, directly on the sensor 60). If all three red alarm/LEL indicator lights A1, A2, A3 are on, then a fuel spill is occurring. If, instead, the first two indicator lights A1 and A2 were not on, but only the third one A3 were on together with the yellow fault indicator light 67, then water would have entered the reservoir 1 and thus the inter-space 30 between the reservoir and the inner tank 2.

[0062] Summarising, in the case of hole, laceration or destructive wear of the wall 10 of the outer reservoir 1 there is no fuel spillage or contamination and the system detects any entrance of water into the inter-space 30 between the outer tank 1 and the inner tank 2.

[0063] On the other hand, in the case of hole, laceration or destructive wear of the wall of the inner tank 2 without any fuel spillage or contamination, but only release of fuel vapour into the inter-space 30, the system would activate the alarm system even if no substantial leak occurs. Although no substantial spillage of liquid outside the inner tank 2 has occurred, the sensor 60 will detect a presence of hydrocarbon vapours in the inter-space 30.

[0064] The present embodiment of the invention can be subject to numerous variations and modifications to its details by those skilled in the art, without thereby departing from the scope of the invention as expressed by the appended claims.

Claims

1. A system for rendering tanks safe comprising:

- an outer tank or reservoir (1) to be rendered safe,
- an inner tank (2) made of plastic material able to contain the polluting liquid, positioned within said outer tank (1) in such a way as to generate an inter-space (30) between them,
- an intake pipe (4) positioned in said inter-space (30) and connected to intake means (40) to intake air from said inter-space and exhaust it into the external environment,
- a supply pipe (5) positioned in said inter-space (30) and connected to the external environment to inject air from the exterior into said inter-space (30) in such a way as to replenish the air aspirated by the intake pipe (4),
- a vapour/gas detection unit (6) comprising a vapour/gas sensor (60) connected to said intake means (40) to detect the vapours/gases aspirated from said inter-space (30) and accordingly to activate an audible/visible alarm (61).

2. System as claimed in claim 1, **characterised in that** in said inter-space (30) between said inner tank (2) and said outer tank (1) is interposed a plastic net (3) which provides protection to the inner tank (2) and

at the same time minimises the flow of air in the inter-space (30).

3. System as claimed in claim 1 or 2, **characterised in that** the wall (20, 23) of said inner tank (2) is constituted by a multi-layer plastic film comprising an intermediate layer (26) constituted by a film of Nylon or polyamide and two surface layers (27) made of easily sealed plastic material, such as polyurethane or polyurethane-polycarbonate or polycarbonate.

4. System as claimed in any of the claims 2 through 4, **characterised in that** said intake means (40) are integrated in a membrane pump (62) positioned in said unit (6), wherein said membrane pump (62) is driven by an electrical motor (M) positioned distant from the intake and delivery chambers (40, 50) of the pump or said membrane pump (62) comprises a Venturi valve actuated by a compressor.

5. System as claimed in any of the previous claims, **characterised in that** said sensor (60) is a catalytic combustion sensor (pellistor) and it is calibrated in such a way as to send an alarm signal (61) to start from the reaching of a threshold value equal to about 3% of the LEL (low explosion level) of the detected vapour/gas.

6. System as claimed in any of the previous claims, **characterised in that** said alarm (61) comprises three indicator lights (A1, A2, A3) which are lighted when the sensor (61) exceeds corresponding pre-set threshold values and a buzzer which is activated when the sensor exceeds the pre-set maximum threshold value.

7. System as claimed in any of the previous claims, **characterised in that** said pump (62) is calibrated in such a way as to assure within the intake pipe (4) a flow of air having a flow rate of about 0.5 litres of air per minute.

8. System as claimed in any of the previous claims, **characterised in that** it comprises an anti-flame filter (55) positioned in said supply pipe (5) to prevent the entrance of agents able to ignite a spark into said inter-space (30) between the two tanks.

9. System as claimed in any of the previous claims, **characterised in that** it comprises liquid-blocking filter (64) positioned in said intake pipe (4) to prevent the intake of liquids from said inter-space (30) towards said detection unit (6) and said liquid-blocking filter (64) having a transparent wall to allow users to see the colour of the blocked liquid.

10. System as claimed in any of the previous claims, **characterised in that** said detection unit (6) comprises a flow meter (63) connected to said intake pipe (4) provided with visual monitoring and manual adjustment.

11. System as claimed in any of the previous claims, **characterised in that** said detection unit (6) comprises a flow switch (66) connected hydraulically to said intake pipe (4) and electrically to a second visual/audible alarm (67) to send an alarm signal, when it detects a flow variation in the intake pipe.

12. System as claimed in any of the previous claims, **characterised in that** said detection unit (6) comprises an electrical valve (65), which in turn comprises:

- a first inlet (65a) connected to the intake pipe (4),
- an outlet (65b) connected to said pump (62),
- a second auxiliary inlet (65c) connected to the external environment, and
- a switching timer electrically connected to the sensor (60) to switch the intake of air from the first inlet (65a) to the second inlet (65c), when the sensor (60) reaches a pre-set threshold value.

13. System as claimed in any of the previous claims, **characterised in that** said detection unit (6) comprises a power supply blocking timer (69) electrically connected to said sensor (60) and to the power supply of the pump (62), to shut off the power supply of the pump after a time interval set by the user to start when the sensor (60) reaches a pre-set threshold value.

14. Method for rendering tanks safe comprising the following steps:

- forming an inter-space (30) between an outer tank (1) to be rendered safe and an inner tank (2) that is to contain the polluting liquid,
- aspirating air from said inter-space (30) and replenishing the aspirated air in said inter-space,
- detecting the presence of vapours/gases in said air aspirated from said inter-space (30) and providing an alarm indication in the case of detection of vapours/gases of the polluting liquid contained in the inner tank (2).

15. Method as claimed in claim 14, **characterised in that** said alarm indication is triggered when a presence of vapours/gases exceeding a threshold value of about 3% of the LEL (low explosion level) is detected.

16. Method as claimed in claim 14 or 15, **characterised**

in that it further comprises the step of activating an alarm when a variation in the flow of air aspirated from inter-space (30) due to the presence of liquids in said inter-space (30) is detected.

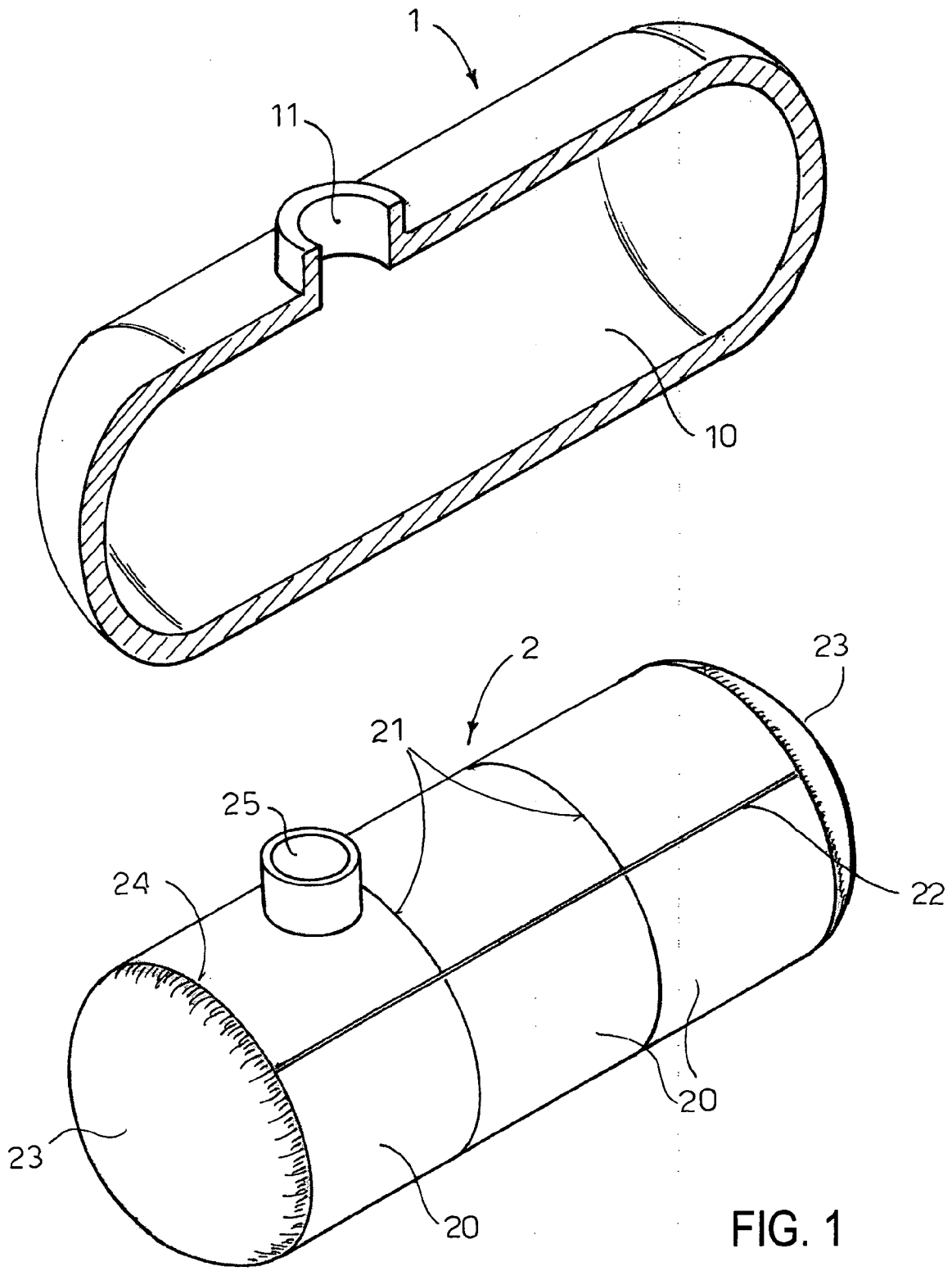


FIG. 1

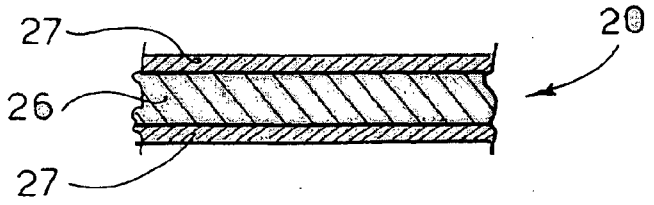
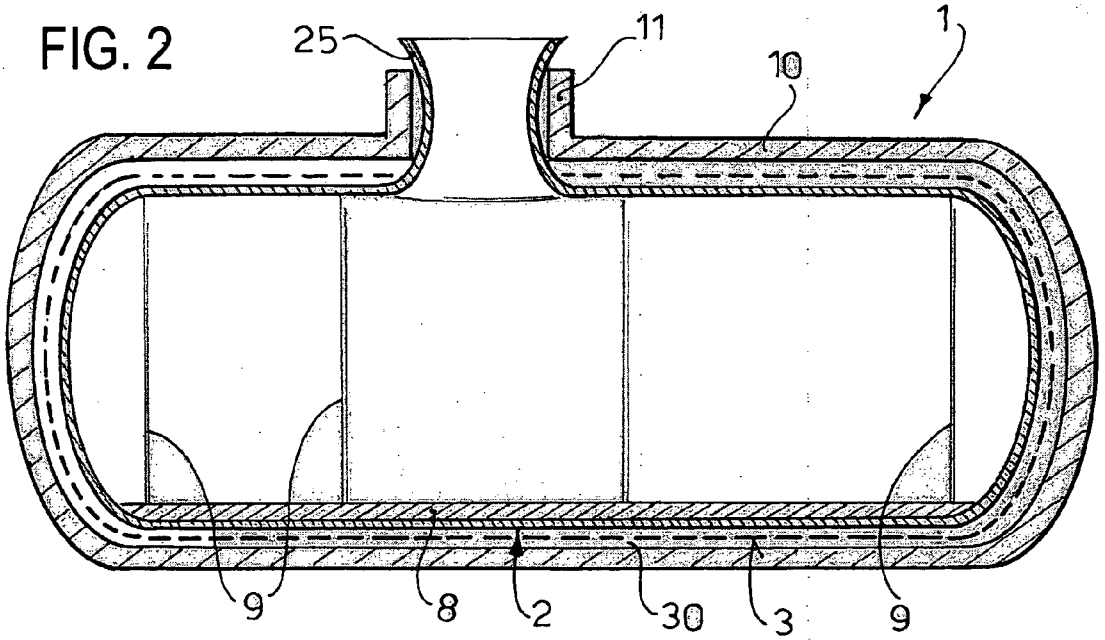


FIG. 1A

FIG. 2



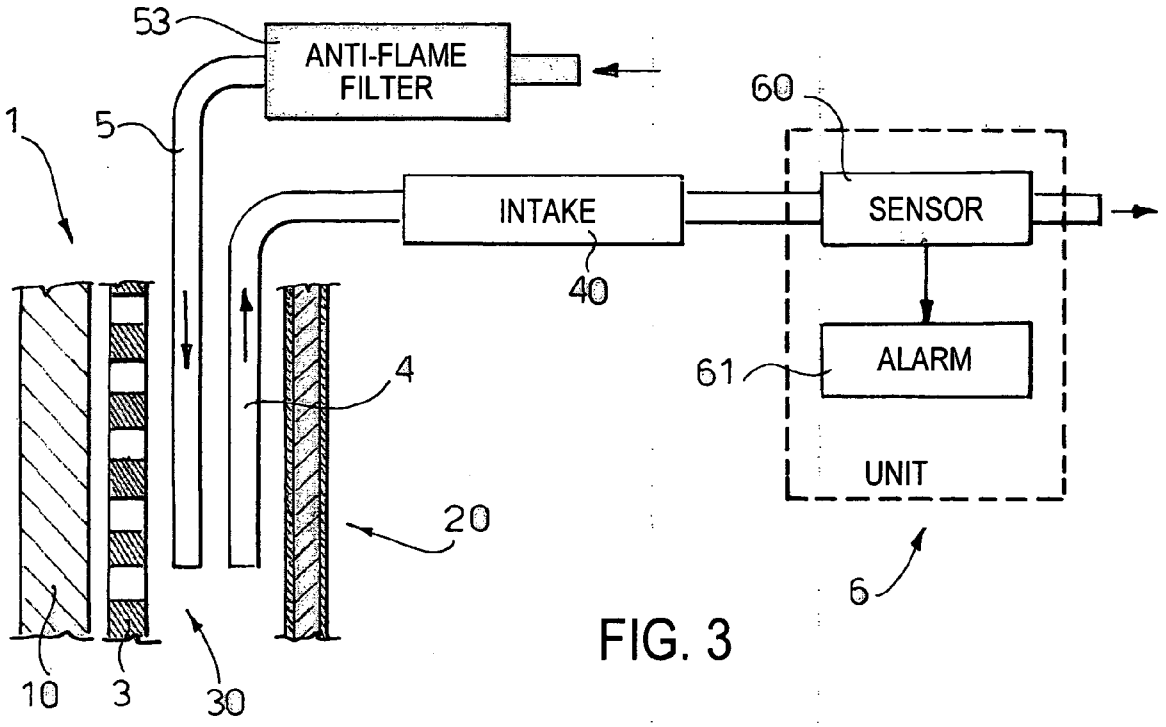


FIG. 3

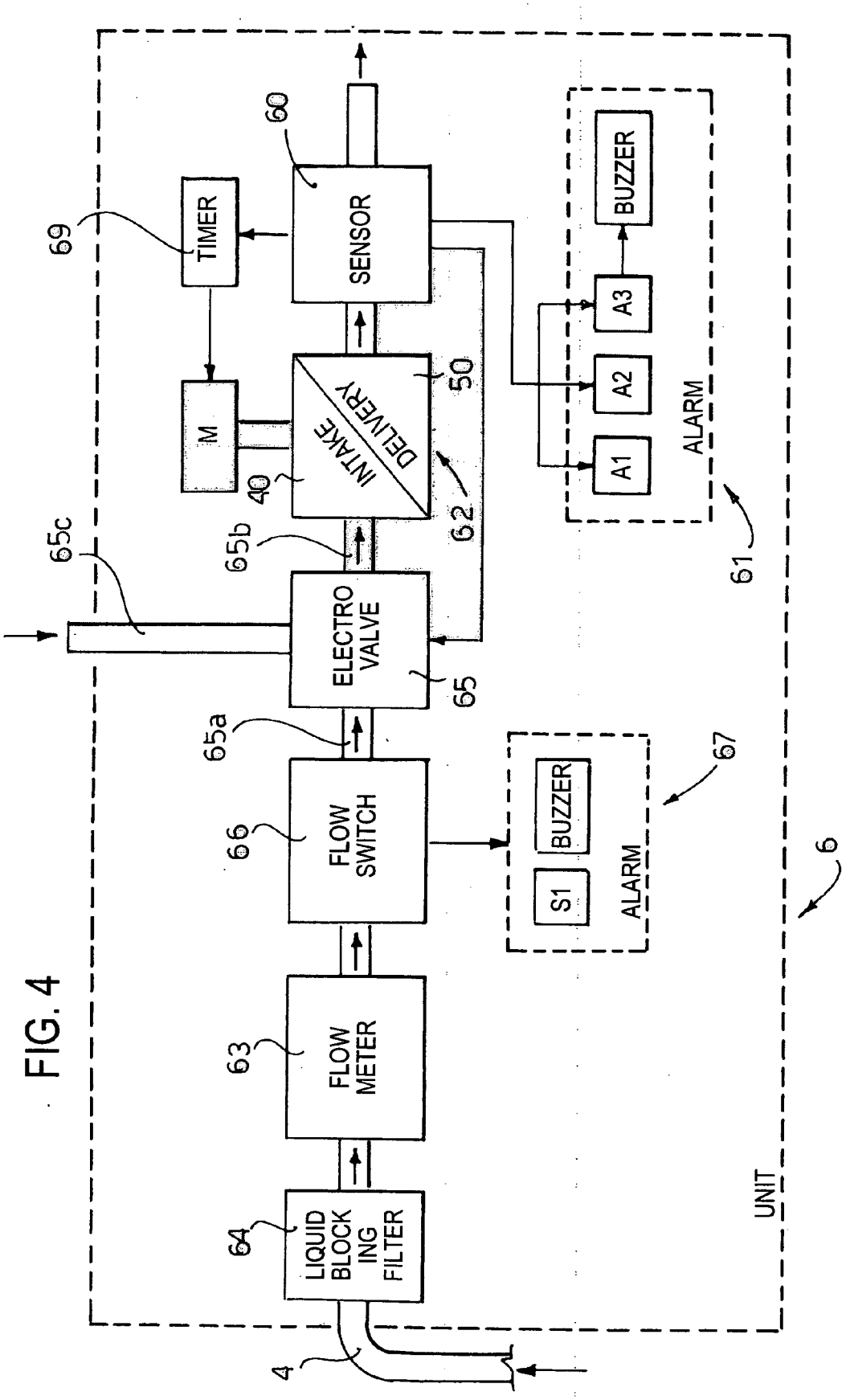

UNIT
6
4
LIQUID BLOCK ING FILTER
64
FLOW METER
63
FLOW SWITCH
66
ELECTRO VALVE
65
65a
65b
65c
INTAKE
DELIVERY
50
62
40
M
TIMER
69
SENSOR
60
ALARM
61
A1
A2
A3
BUZZER
ALARM
67
S1
BUZZER

FIG. 4