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(54) A METHOD OF CLEANING THE BOTTOM INTERSTITIAL SPACE AND/OR WALL INTERSTITIAL SPACE OF A STORAGE TANK

(57) The subject matter of the invention relates to a method of cleaning the bottom interstitial space (110) and/or wall interstitial space (120) of a storage tank (100; 200), in the event of a sealing failure in those spaces and penetration of a product (150) thereinto.

The method of cleaning consists in that a fluid is sucked in, in the case of low-pressure function of bottom interstitial space (110) and/or wall interstitial space (120), or forced in, in the case of high-pressure function of bottom interstitial space (110) and/or wall interstitial space (120), into those spaces. After filling those spaces with the fluid, the sucked-in or forced-in fluid, which has been mixed with a product (150) remaining in the bottom interstitial space (110) and/or wall interstitial space (120), is respectively sucked off or drained from those spaces. In the course of, respectively, sucking off or draining the fluid that was mixed with the product (150) a neutral gas is forced into the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200), and the concentration of explosive gases in the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (110; 200) is measured in a continuous manner.

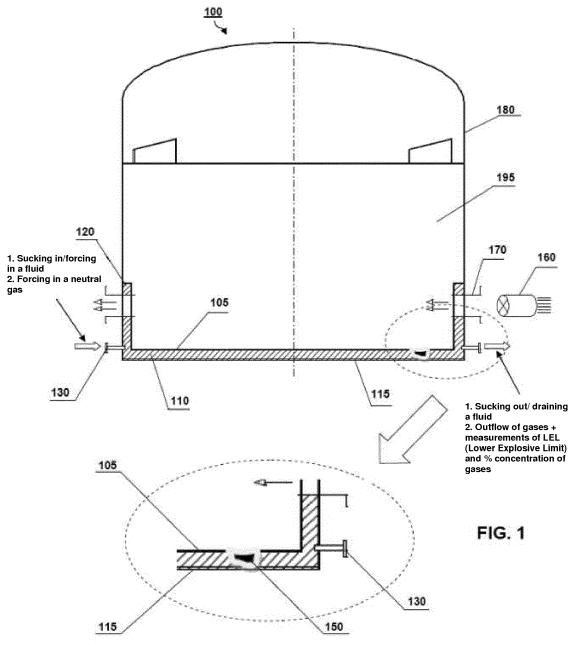

FIG. 1

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Description

Field of the Invention

[0001] The subject matter of the invention relates to a method of cleaning the bottom interstitial space and/or wall interstitial space of a storage tank designed in particular for the storage of liquid flammable, toxic and caustic materials.

Background of the Invention

[0002] Storage tanks, both underground and above ground storage tanks, should meet requirements concerning non-pressurized and low-pressure tanks designed in particular for the storage of liquid flammable, toxic and caustic materials. Such tanks must meet strict safety standards; namely, they must be, *inter alia,* equipped with monitoring and measurement devices signalling leakages of substances to the ground and ground waters. Moreover, rigorous safety requirements compel both the manufacturers and users of storage tanks to produce and use tanks having bottom interstitial spaces and/or wall interstitial spaces.

[0003] Such spaces should basically prevent penetration of liquid flammable, toxic and caustic materials directly to the ground and ground waters. They should thus form an additional protective space located at the bottom of a storage tank in the case of a bottom interstitial space, and an additional protective space located on the walls of a storage tank in the case of a wall interstitial space. These spaces are made during the construction of a storage tank or are added in the course of its operation. They are most frequently delimited by a secondary steel bottom or a secondary laminated bottom made of 3D mats and suitable resins.

[0004] Despite taking all due care and maintaining high quality safety standards, storage tanks with a bottom interstitial space and/or wall interstitial space are subject to damage due to sealing failure *(unsealing)* of said spaces. This may be caused by improper operation or by operational wear of the tank's parts when a sealing failure of the bottom interstitial space and/or wall interstitial space occurs a result of which a product in the form of a liquid inflammable, toxic and/or caustic material penetrates into those spaces.

[0005] If the presence of a product in detected in the bottom interstitial space and/or wall interstitial space of the storage tank, it is necessary to take actions in order to clean those spaces of a storage tank and subsequently repair them in order to seal them and permit further operation thereof.

Description of Prior Art

[0006] Considering the above-described problem in order to eliminate damage caused by sealing failure in the bottom interstitial space and/or wall interstitial space of a storage tank, there is provided a method of cleaning the bottom interstitial space and/or wall interstitial space of a storage tank in order to subsequently repair it and permit further operation thereof.

[0007] In the prior art there are known such solutions that relate to a method of cleaning storage tanks designed in particular for liquid flammable, toxic and caustic materials. However, said method of cleaning applies only to the interior of a water tank, called storage capacity or storage space of the storage tank, which method basically consists in that a product remaining in the storage tank is drained and subsequently the storage space of the storage tank is subjected to cleaning, washing and vaporization.

[0008] More specifically, the process consists in pumping out sediments from technological and clean-out hatches through conduits forced into a tank for forcing in sediments. If it is not possible to take off the covers of hatches due to remaining pumpable and unpumpable sediments, starting removing residuals from the tank is performed through open technological hatches of the main tank. After pumping out sediments to a level that makes it possible to fully open technological and clean-out hatches cleaning works are started using the addition of water (in the amount not greater than 2% of the volume of sediments) and polymers which fluidize the residuals of liquid flammable materials to the state allowing their easy pumping and which are added before and while sediments move towards the vicinity of suction hosts of screw pumps.

[0009] When removing pumpable, unpumpable and solid sediments from the inside of the tank has been finished, and a total lack of an explosive hazard area inside the tank has been confirmed, the whole surface is washed by means of hot-water high pressure washers with the addition of chemical substances making it possible to fully degrease the surfaces being washed.

[0010] In the prior art there are also known techniques of automatic cleaning of storage tanks that consist in dissolving accumulated sediments and cleaning large-size storage tanks. Since the majority of cleaning processes are automatized, the system makes it possible to eliminate the presence of workers inside the tanks, i.e. in the storage space, during the main operations of dissolving sediments until the moment when the operation of final cleaning and degreasing the storage tank and removing undissolved solid elements is performed. The final operations with the participation of workers in the working space are performed in the already safe space when the tank contains only trace amounts of carbohydrates and the surrounding atmosphere does not pose a threat to the life and health of people. Thanks to such solutions such systems fall within the category of "NON MAN ENTRY" systems.

[0011] Compared with traditional methods of manual cleaning and desludging storage tanks, the system of automatic cleaning is much more effective and safe for the health of workers. An essential feature of the system

is that the process is performed in a closed-circuit system without the necessity to expose the product in open containers outside a storage tank, which significantly reduces its adverse effect on the natural environment.

[0012] The above-described prior art solutions and, more broadly, solutions related to cleaning the storage space of a storage tank fail to provide an answer to the basic question: what measures should be taken while maintaining high safety standards in the process of cleaning the bottom interstitial space and/or wall interstitial space of a storage tank in the case the presence of a product is detected in those spaces due to sealing failure.

Essence of the Invention

[0013] Thus, the subject matter of the present invention relates to providing a method of cleaning the bottom interstitial space and/or wall interstitial space of a storage tank, designed in particular for the storage of liquid inflammable, toxic and caustic materials, which has been damaged due to sealing failure in the bottom interstitial space and/or wall interstitial space.

[0014] The method must, on the one hand, ensure high efficiency of the whole cleaning process, and on the other, guarantee high accuracy while maintaining strict safety standards.

[0015] To achieve the above purposes, the present invention provides a method of cleaning the bottom interstitial space and/or wall interstitial space of a storage tank in the event of a sealing failure in the bottom interstitial space and/or wall interstitial space of a storage tank, which method consist in that the emptied storage space of a storage tank is supplied in a continuous manner with fresh air through at least one inspection hatch thus ventilating the storage space of the storage tank by means of ventilators, the cleaning process being performed with the continuous monitoring of the storage space of the storage tank by means of sensors measuring the level of an explosive atmosphere and determining the concentration of carbohydrates as percentage with respect to the lower and upper explosive limit of gases and oxygen content in the storage space of the storage tank, as well as the minimum admissible concentration of toxic gases in the storage space of the storage tank. The method is characterized in that a fluid is sucked in, in the case of low-pressure function of bottom interstitial space and/or wall interstitial space, or forced in, in the case of high-pressure function of bottom interstitial space and/or wall interstitial space, into the bottom interstitial space and/or wall interstitial space, and subsequently, after filling the bottom interstitial space and/or wall interstitial space of a storage tank with the fluid, the sucked-in or forced-in fluid, respectively, which has been mixed with the product remaining in the bottom interstitial space and/or wall interstitial space, which product previously penetrated into the bottom interstitial space and/or wall interstitial space of the storage tank due to sealing failure, is respectively sucked off or drained from the bottom interstitial space and/or wall interstitial space. In the course of, respectively, sucking off or draining the fluid that was mixed with the product remaining in the bottom interstitial space and/or wall interstitial space a neutral gas is forced into the bottom interstitial space and/or wall interstitial space of the storage tank and the concentration of explosive gases in the bottom interstitial space and/or wall interstitial space of the storage tank is measured in a continuous manner. In the case the measurement is beyond the admissible range, the process of cleaning the bottom interstitial space and/or wall interstitial space of the storage tank is repeated until the concentration of explosive gases reaches the lower limit explosive limit.

[0016] Preferably, the fluid being, respectively, sucked into or forced into the bottom interstitial space and/or wall interstitial space of the storage tank is water or water with washing agents in the form of surfactants that react with the product, and corrosion inhibitors or reduced water vapour from a technological installation or a steam generator.

[0017] Preferably, the fluid is sucked, through at least one inspection stub pipe of the system monitoring leakages, into the bottom interstitial space and/or wall interstitial space of the storage tank by means of a pump, in particular a low-pressure pneumatic diaphragm pump or other Ex pump allowing suitable selection of low pressure within the rage from 0 to -1 bar.

[0018] Preferably, the liquid is forced, through at least one inspection stub pipe of the system monitoring leakages, into the bottom interstitial space and/or wall interstitial space of the storage tank by means of a pressure installation with a suitable pressure reducing valve allowing suitable selection of pressure within the rage from 0 to 1 bar.

[0019] Preferably, the fluid that has been mixed with the product remaining in the bottom interstitial space and/or wall interstitial space is sucked out through at least one inspection stub pipe of the system monitoring leakages from the bottom interstitial space and/or wall interstitial space of the storage tank by means of a pump, in particular a low-pressure pneumatic diaphragm pump or another Ex pump allowing suitable selection of low pressure within the rage from 0 to -1 bar.

[0020] Preferably, the fluid that has been mixed with the product remaining in the bottom interstitial space and/or wall interstitial space is drained through at least one inspection stub pipe of the system monitoring leakages from the bottom interstitial space and/or wall interstitial space of the storage tank by means of a pressure installation with a suitable pressure reducing valve allowing suitable selection of pressure within the rage from 0 to 1 bar.

[0021] Preferably, neutral gas is forced into the bottom interstitial space and/or wall interstitial space of the storage tank through at least one inspection stub pipe of the system monitoring leakages by means of gas regulators allowing suitable selection of pressure within the range from 0 to 1 bar, from bottle bundles or a cryogenic tank

or a nitrogen generator or a technological installation.

[0022] Preferably nitrogen is used as a neutral gas to eliminate the explosive atmosphere inside the bottom interstitial space and/or wall interstitial space of the storage tank.

[0023] Preferably, the process of cleaning the bottom interstitial space and/or wall interstitial space of the storage tank is repeated until the concentration of explosive gases reaches the lower explosive limit which is below 10% for all types of carbohydrate mixtures, below 4% for gaseous hydrogen, and oxygen content is below 5% for all types of gaseous mixtures.

[0024] Preferably, in the case where the process of cleaning the bottom interstitial space and/or wall interstitial space of the storage tank has been repeated at least twice and the concentration of explosive gases in the bottom interstitial space and/or wall interstitial space of the storage tank is outside the admissible range, inspection holes having 1 mm to 50 mm in diameter are drilled in the upper surface delimiting the bottom interstitial space and/or in the inner surfaces of walls delimiting the wall interstitial space in the amount from several to several tens depending of the size of the area of the bottom interstitial space and/or wall interstitial space of the storage tank, and/or the number of inspection stub pipes of the system monitoring leakages in the bottom interstitial space and/or wall interstitial space of the storage tank and/or depending on the size of sections into which the bottom interstitial space and/or the wall interstitial space of the storage tank has been divided.

[0025] Preferably, the concentration of explosive gases in the bottom interstitial space and/or wall interstitial space is measured by means of gas meters on at least one inspection stub pipe of the system monitoring leakages and/or in inspection holes in the upper surface delimiting the bottom interstitial space or in inspection holes in the inner surfaces of walls delimiting the wall interstitial space made for proper cleaning of the bottom interstitial space and/or wall interstitial space of the storage tank.

[0026] Preferably, after cleaning the bottom interstitial space and/or wall interstitial space of the storage tank, inspection holes are plugged with magnet plugs with rubber gaskets providing additional sealing around the inspection holes in order to lock the outflow of a neutral gas into the storage space of the storage tank.

[0027] Preferably, neodymium magnet plugs are used as magnet plugs.

[0028] The solution presented according to the aspect proposed above ensures a suitable method of cleaning the bottom interstitial space and/or wall interstitial space which consists *inter alia* in more efficient, more effective and more accurate cleaning of the bottom interstitial space and/or wall interstitial space in accordance with strict safety standards.

[0029] Additionally, this method is very universal and may be used with various storage tanks, in particular those in the form of both vertical and horizontal cylinders, small and large tanks. Thus, the method may be used with many different storage tanks. The proposed method according to the invention may also be used in the case of both non-pressurized tanks and low-pressure ones as wells as many other tanks.

Brief Description of Drawings

[0030] The subject matter of the invention is presented in an example embodiment in relation to the enclosed figures wherein:

FIG. 1 shows a cross-section of a storage tank which depicts, in a simplified way, the method of cleaning the bottom interstitial space and/or wall interstitial space of a storage tank according to the invention after the occurrence of a sealing failure in the bottom interstitial and wall interstitial space;

FIG. 2 shows a cross-section of another storage tank which depicts, in a simplified way, the method of cleaning the wall interstitial space of a storage tank in another embodiment according to the invention, after the occurrence of a sealing failure in the wall interstitial space;

FIG. 3 presents an exemplary pattern of inspection holes drilled in the inner surface delimiting the wall interstitial space of a storage tank of **FIG. 2** according to the invention.

Detailed Description of the Invention

[0031] The subject matter of the invention is described in detail below in relation to the attached figures and embodiments. The present invention is not limited only to the detailed embodiments described herein.

[0032] The embodiment presented in **FIG. 1** presents a cross-section of a storage tank 100 which depicts, in a simplified way, a method of cleaning the bottom interstitial space 110 and wall interstitial space 120 of a storage tank 100. The tank has the shape of a cylinder with a vertical axis and is designed for the storage of a product 150 in the form of a liquid flammable material, which is crude oil in the present case.

[0033] In the presented embodiment the storage tank 100 is also equipped with a system monitoring leakages in the bottom interstitial space 110 and wall interstitial space 120 to facilitate detection of damage, in particular sealing failure of those spaces.

[0034] Such sealing failure causes passage of a product 150 - which is crude oil in the present case - from the storage space 195 of a storage tank 100 to the bottom interstitial space 110 of the storage tank 100. The bottom interstitial space 110 is a space located at the bottom of the storage tank between the secondary bottom 105, laminated and made of 3D mats and epoxy raisins, and the primary bottom 115 made of steel.

[0035] Before initiating the method of cleaning, according to the invention, the bottom interstitial space 110 and the wall interstitial space 120 of a storage tank 100 that has been damaged due to sealing failure of these spaces, first the storage space 195 is cleared of a product 150 remaining in the storage tank 100, and then the storage space 195 of the storage tank 100 is subjected to cleaning, washing and vaporising by methods known from the state of the art.

[0036] Subsequently, fresh air is supplied in a continuous manner through inspection hatch 170 thus ventilating the storage space 195 of the storage tank 100 by means of ventilators 160, which are located at the main shell 180 of the storage tank 100. In the case of a storage tank 100 additionally placed in a protective shell (not shown), in order to mount ventilators 160 on the shell and outside the protective shell, a special air sleeve is made between the protective shell and the main shell 180 so as to limit loss of fresh air forced into the storage tank 100.

[0037] The whole process of cleaning preceding the initiation of the proper process of cleaning the unsealed bottom interstitial space 110 and wall interstitial space 120 is performed with the continuous monitoring of the storage space 195 of the storage tank 100 by means of sensors (not shown) measuring the level of explosive atmosphere and determining the concentration of hydrocarbons as percentage relative to the lower and upper explosive limit of gases and oxygen content in the storage space 195 of the storage tank 100, and the lower admissible concentration of toxic gases in the storage space 195 of the storage tank 100.

[0038] The operations defined above are performed in order to enable inner inspection of the storage tank 100, i.e. of the storage space 195, by relevant services including an authorised employee of the Office of Technical Inspection (UDT) and other competent persons who will verify the condition of the bottom interstitial space 110 and wall interstitial space 120 and determine whether a permission to operate the storage tank 100 may be issued.

[0039] If a sealing failure is detected, as in the presented example, the proper process of cleaning the bottom interstitial space 110 and wall interstitial space 120 is initiated. The method consists in that a fluid in the form of water with surfactants reacting with a product 150 and corrosion inhibitors are forced through inspection stub pipe 130 of the system monitoring leakages to the bottom interstitial space 110 and wall interstitial space 120 of the storage tank 100 by means of a pressure installation with a pressure reducing valve allowing suitable selection of pressure, which is 0.5 bar in this case.

[0040] After filling the bottom interstitial space 110 and wall interstitial space 120 with the fluid, which has been mixed with a product 150 remaining in said spaces, which product penetrated earlier to said spaces due to sealing failure, the fluid is drained through a inspection stub pipe 130 of the system monitoring leakages from said spaces by means of a pressure installation with a pressure reducing valve allowing proper selection of pressure, which is 0.5 bar in this case.

[0041] During drainage of a fluid that was mixed with a product 150 remaining in the bottom interstitial space 110 and wall interstitial space 120, a neutral gas in the form of nitrogen is forced in to eliminate explosive atmosphere inside the bottom interstitial space 110 and wall interstitial space 120 of the storage tank 100. The above-mentioned nitrogen is forced into the bottom interstitial space 110 and wall interstitial space 120 of the storage tank 100 through a inspection stub pipe 130 of the leakage monitoring system by means of gas reducers allowing suitable selection of pressure, which is 0.5 bar in this case, from a technological installation.

[0042] Moreover, during drainage of the fluid the concentration of explosive gases in the bottom interstitial space 110 and wall interstitial space 120 of the storage tank 100 is measured in a continuous manner by means of gas meters on two inspection stub pipes 130 of the leakage monitoring system in order to properly clean those spaces. In the case the measurement is outside the admissible range, the process of cleaning the bottom interstitial space 110 and wall interstitial space 120 of the storage tank 100 is repeated until the concentration of explosive gases reaches the lower explosive limit which is below 10% for all kinds of hydrocarbon mixtures, below 4% - for gaseous hydrogen, and oxygen content below 5% for all types of gaseous mixtures. In the presented embodiment the lower explosive limit of the concentration of explosive gases was obtained after the process of cleaning the bottom interstitial space 110 and wall interstitial space 120 of the storage tank 100 was repeated twice.

[0043] Another embodiment in **FIG. 2** shows a cross-section of a storage tank 200 which depicts, in a simplified way, a method of cleaning the wall interstitial space 120 of a storage tank 200 after the occurrence of a sealing failure in that space. The tank is a cylinder having a vertical axis, which is designed for the storage of a product 150 in the form of a liquid flammable material, which is unleaded petrol PB98 in this case.

[0044] As in the example described above for the storage tank 100, a sealing failure has occurred and a product 150, which is unleaded petrol PB98 in this case, has penetrated from the storage space 195 of the storage tank 200 into the wall interstitial space 120 of the storage tank 200.

[0045] It this case, despite the fact that the process of cleaning the wall interstitial space 120 of the storage tank 200 has been repeated three times, the concentration of explosive gases in the wall interstitial space 120 continued to be outside the admissible range. Therefore, in order to improve the process of cleaning, inspection holes 250 having a diameter of 20 mm have been drilled in the inner surface delimiting the wall interstitial space 120, as illustrated in more detail in **FIG. 3** which presents a pattern of inspection holes 250 drilled in the inner sur-

face delimiting the wall interstitial space 120 of the storage tank 200 according to the invention.

[0046] The said inspection holes 250 are drilled by means of a pneumatically driven device equipped with a holder for mounting a core drill bit, the number thereof being dependent on the size of sections 280 into which the wall interstitial space 120 of the storage tank 200 has been divided. In the embodiment presented in **FIG. 2** for a storage tank 200 in the form of a cylinder having a horizontal axis and the capacity of 50 m^3, 20 inspection holes 250 should be drilled in the wall interstitial space 120. And in the case of a storage tank 100 in the form of a cylinder having a vertical axis and the capacity of 1000 m^3 as illustrated in **FIG. 1** it is assumed that 5 inspection holes 250 should be drilled in the wall interstitial space 120 and 10 inspection holes 250 - in the bottom interstitial space 110. The operation of drilling holes in the case of a storage tank 100 would be performed if it was impossible to obtain a concentration of explosive gases within an admissible range after the process of cleaning the bottom interstitial space 110 and the wall interstitial space 120 of the storage tank 100 has been repeated twice.

[0047] Referring again to the embodiment shown in **FIG. 2,** the inspection holes 250, after cleaning the wall interstitial space 120 of the storage tank 200, are plugged with plugs of magnets with rubber gaskets providing additional sealing around the inspection holes 250 in order to lock the outflow of a neutral gas into the storage space 195 of the storage container 200. In the embodiment plugs of neodymium magnets have been used as plugs magnets provided with rubber gaskets.

[0048] The above description of presented embodiment has been provided to enable any person skilled in the art to carry out or use the invention. There are also possible various modifications of this embodiment including all such changes, modifications and variants that fall within the essence and scope of the attached patent claims. The basic principles defined herein may thus be applied in other embodiments without extending the scope of the invention. Therefore, the intention of the present invention is not to limit it to the presented embodiment but to make it consistent with the broadest possible scope corresponding to the principles and new features presented herein.

[0049] Thus, the solution according to the present invention uses the above specified technical means as shown in the FIGURES from **FIG. 1** to **FIG. 3** to offer a method of cleaning the bottom interstitial space and/or wall interstitial space of a storage tank, designed in particular for the storage of liquid flammable, toxic and caustic materials, which has been damaged due to the sealing failure in the bottom interstitial space and/or wall interstitial space.

[0050] The present invention may be applicable in particular in all cases of a damage consisting in the sealing failure of the bottom interstitial space and/or wall interstitial space of a storage tank, which results in the necessity of cleaning or sealing said space. Considering the above, the present solution according to the invention is likely to be widely applied in particular in the petrochemical sector where the highest safety standards are required, especially in fuel depots and liquid fuel stations where storage tanks with bottom interstitial spaces and/or wall interstitial spaces are installed.

[0051] The invention may also be applicable in the case of some long-distance transmission pipelines equipped with interstitial spaces and used to transport oil and oil products.

Claims

1. A method of cleaning the bottom interstitial space and/or wall interstitial space of a storage tank in the event of a sealing failure in the bottom interstitial space and/or wall interstitial space of a storage tank, consisting in that the emptied storage space of a storage tank is supplied in a continuous manner with fresh air through at least one inspection hatch thus ventilating the storage space of the storage tank by means of ventilators, and consisting in the continuous monitoring of the storage space of the storage tank by means of sensors measuring the level of an explosive atmosphere and determining the concentration of carbohydrates as percentage with respect to the lower and upper explosive limit of gases and oxygen content in the storage space of the storage tank, as well as the minimum admissible concentration of toxic gases in the storage space of the storage tank, **characterized in that** a fluid is sucked in, in the case of low-pressure function of bottom interstitial space (110) and/or wall interstitial space (120), or forced in, in the case of high-pressure function of bottom interstitial space (110) and/or wall interstitial space (120), into the bottom interstitial space (110) and/or wall interstitial space (120), and subsequently, after filling the bottom interstitial space (110) and/or wall interstitial space (120) of a storage tank (100; 200) with the fluid, the sucked-in or forced-in fluid, respectively, which has been mixed with the product (150) remaining in the bottom interstitial space (110) and/or wall interstitial space (120), which product (150) previously penetrated into the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200) due to sealing failure, is respectively sucked off or drained from the bottom interstitial space (110) and/or wall interstitial space (120), wherein in the course of, respectively, sucking off or draining the fluid that was mixed with the product (150) remaining in the bottom interstitial space (110) and/or wall interstitial space (120) a neutral gas is forced into the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200), and the concentration of explosive gases in the bottom interstitial space (110) and/or wall interstitial space (120) of the stor-

age tank (110; 200) is measured in a continuous manner, and in the case the measurement is beyond the admissible range, the process of cleaning the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (110; 200) is repeated until the concentration of explosive gases reaches the lower explosive limit.

2. The method according to claim 1, **characterized in that** the fluid being, respectively, sucked into or forced into the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200) is water or water with washing agents in the form of surfactants that react with the product (150), and corrosion inhibitors or reduced water vapour from a technological installation or a steam generator.

3. The method according to claim 1 or 2, **characterized in that** the fluid is sucked, through at least one inspection stub pipe (130) of the system monitoring leakages, into the bottom interstitial space (110) and/or wall interstitial space (120)of the storage tank (100; 200) by means of a pump, in particular a low-pressure pneumatic diaphragm pump or other Ex pump allowing suitable selection of low pressure within the rage from 0 to -1 bar.

4. The method according to claim 1 or 2, **characterized in that** the liquid is forced, through at least one inspection stub pipe (130) of the system monitoring leakages, into the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200) by means of a pressure installation with a suitable pressure reducing valve allowing suitable selection of pressure within the rage from 0 to 1 bar.

5. The method according to claim 1 or 2, **characterized in that** the fluid that has been mixed with the product (150) remaining in the bottom interstitial space (110) and/or wall interstitial space (120) is sucked off through at least one inspection stub pipe (130) of the system monitoring leakages from the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200) by means of a pump, in particular a low-pressure pneumatic diaphragm pump or another Ex pump allowing suitable selection of low pressure within the rage from 0 to -1 bar.

6. The method according to claim 1 or 2, **characterized in that**, the fluid that has been mixed with the product (150) remaining in the bottom interstitial space (110) and/or wall interstitial space (120) is drained through at least one inspection stub pipe (130) of the system monitoring leakages from the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200) by means of a pressure installation with a suitable pressure reducing valve allowing suitable selection of pressure within the rage from 0 to 1 bar.

7. The method according to claim 1, **characterized in that**, the neutral gas is forced into the bottom interstitial space (110) and/or wall interstitial space (120)of the storage tank (100; 200) through at least one inspection stub pipe (130) of the system monitoring leakages by means of gas regulators allowing suitable selection of pressure within the range from 0 to 1 bar, from bottle bundles or a cryogenic tank or a nitrogen generator or a technological installation.

8. The method according to claim 1 or 7, **characterized in that**, nitrogen is used as a neutral gas to eliminate the explosive atmosphere inside the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200).

9. The method according to claim 1, **characterized in that** the process of cleaning the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200) is repeated until the concentration of explosive gases reaches the lower explosive limit which is below 10% for all types of carbohydrate mixtures, below 4% for gaseous hydrogen and oxygen content is below 5% for all types of gaseous mixtures.

10. The method according to claim 1 or 9, **characterized in that** in the case where the process of cleaning the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200) has been repeated at least twice and the concentration of explosive gases in the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200) is outside the admissible range, inspection holes (250) having 1 mm to 50 mm in diameter are drilled in the upper surface delimiting the bottom interstitial space (110) and/or in the inner surfaces of walls delimiting the wall interstitial space (120) in the amount from several to several tens depending of the size of the area of the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200) and/or the number of inspection stub pipes (130) of the system monitoring leakages in the bottom interstitial space (110) and/or wall interstitial space (120) and/or depending on the size of sections (280) into which the bottom interstitial space (110) and/or the wall interstitial space (120) of the storage tank (100; 200) has been divided.

11. The method according to claim 1 or 9, **characterized in that** the concentration of explosive gases in the bottom interstitial space (110) and/or wall interstitial space (120)is measured by means of gas meters on at least one inspection stub pipe (130) of the system

monitoring leakages and/or in inspection holes (250) in the upper surface delimiting the bottom interstitial space (110) or in inspection holes (250) in the inner surfaces of walls delimiting the wall interstitial space (120) made for proper cleaning of the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (100; 200).

12. The method according to claim 10, **characterized in that** the inspection holes (250) after cleaning the bottom interstitial space (110) and/or wall interstitial space (120) of the storage tank (110; 200), are plugged with magnet plugs with rubber gaskets providing additional sealing around the inspection holes (250) in order to lock outflow of a neutral gas into the storage space (195) of the storage tank (100; 200).

13. The method according to claim 12, **characterized in that**, neodymium magnet plugs are used as magnet plugs.

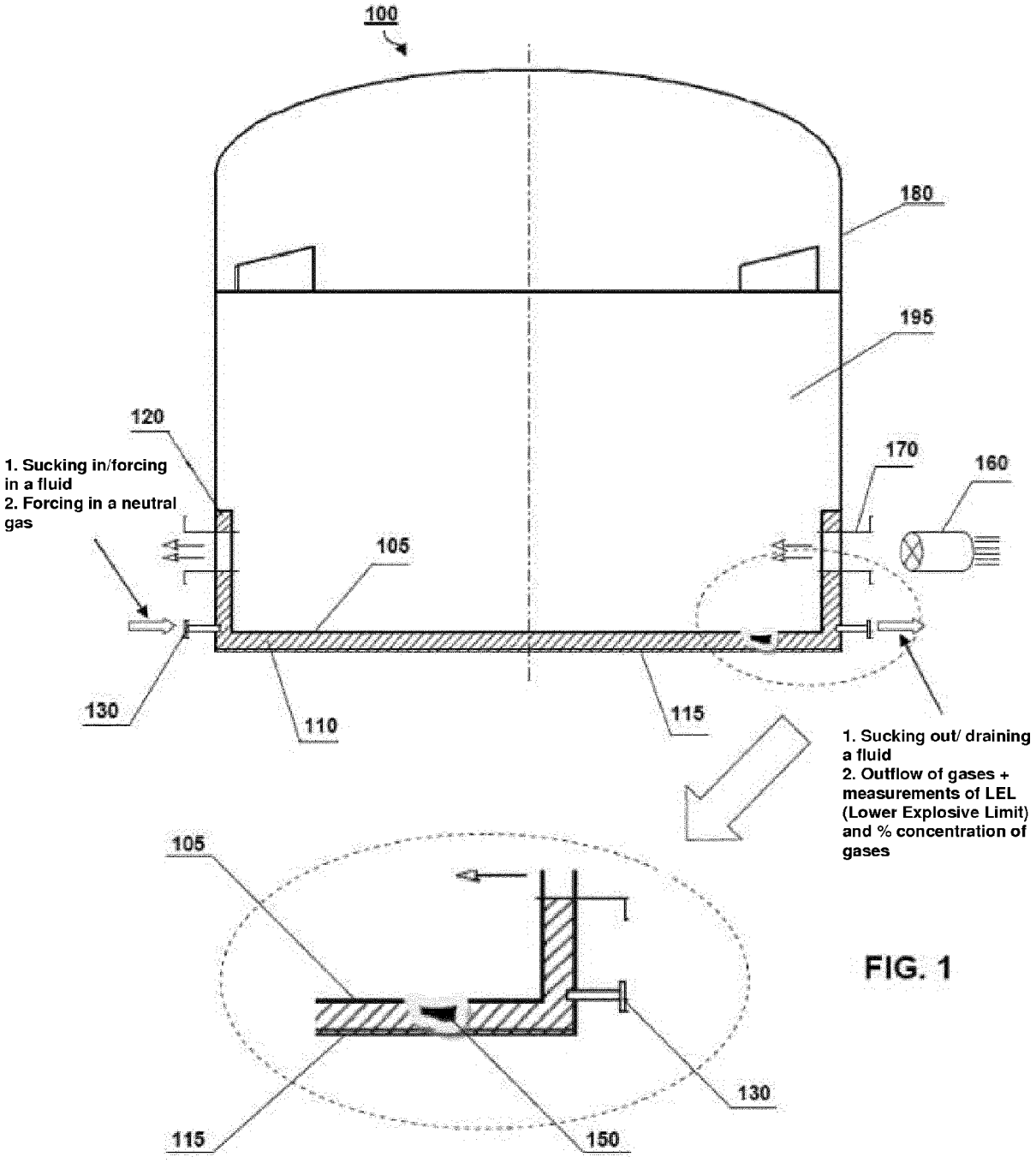
100
180
195
120
1. Sucking in/forcing in a fluid
2. Forcing in a neutral gas
170
160
105
130
110
115
1. Sucking out/ draining a fluid
2. Outflow of gases + measurements of LEL (Lower Explosive Limit) and % concentration of gases
105
130
115
150

FIG. 1

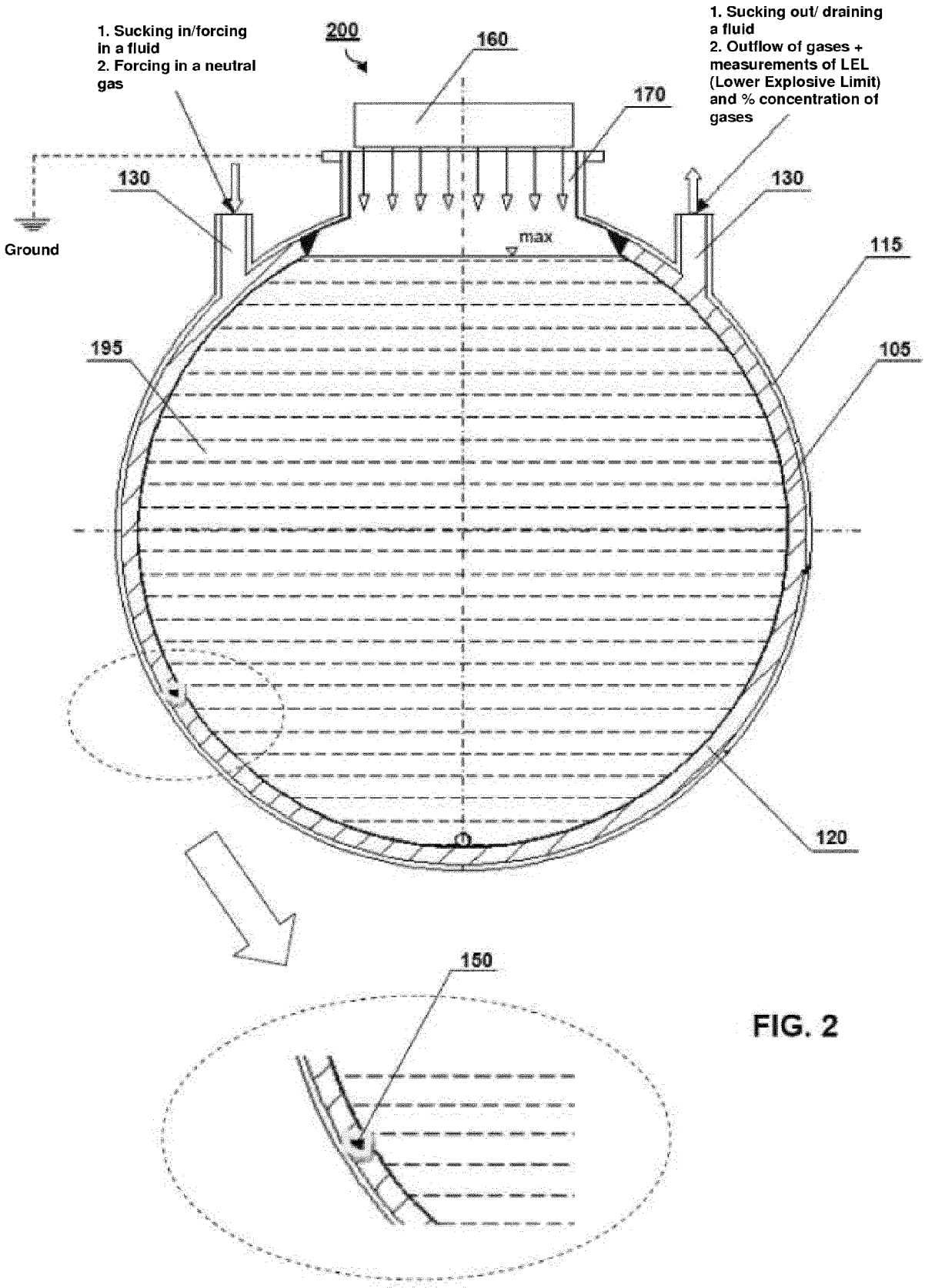
1. Sucking in/forcing in a fluid
2. Forcing in a neutral gas
200
160
170
1. Sucking out/ draining a fluid
2. Outflow of gases + measurements of LEL (Lower Explosive Limit) and % concentration of gases
130
130
Ground
max
115
195
105
120
150

FIG. 2

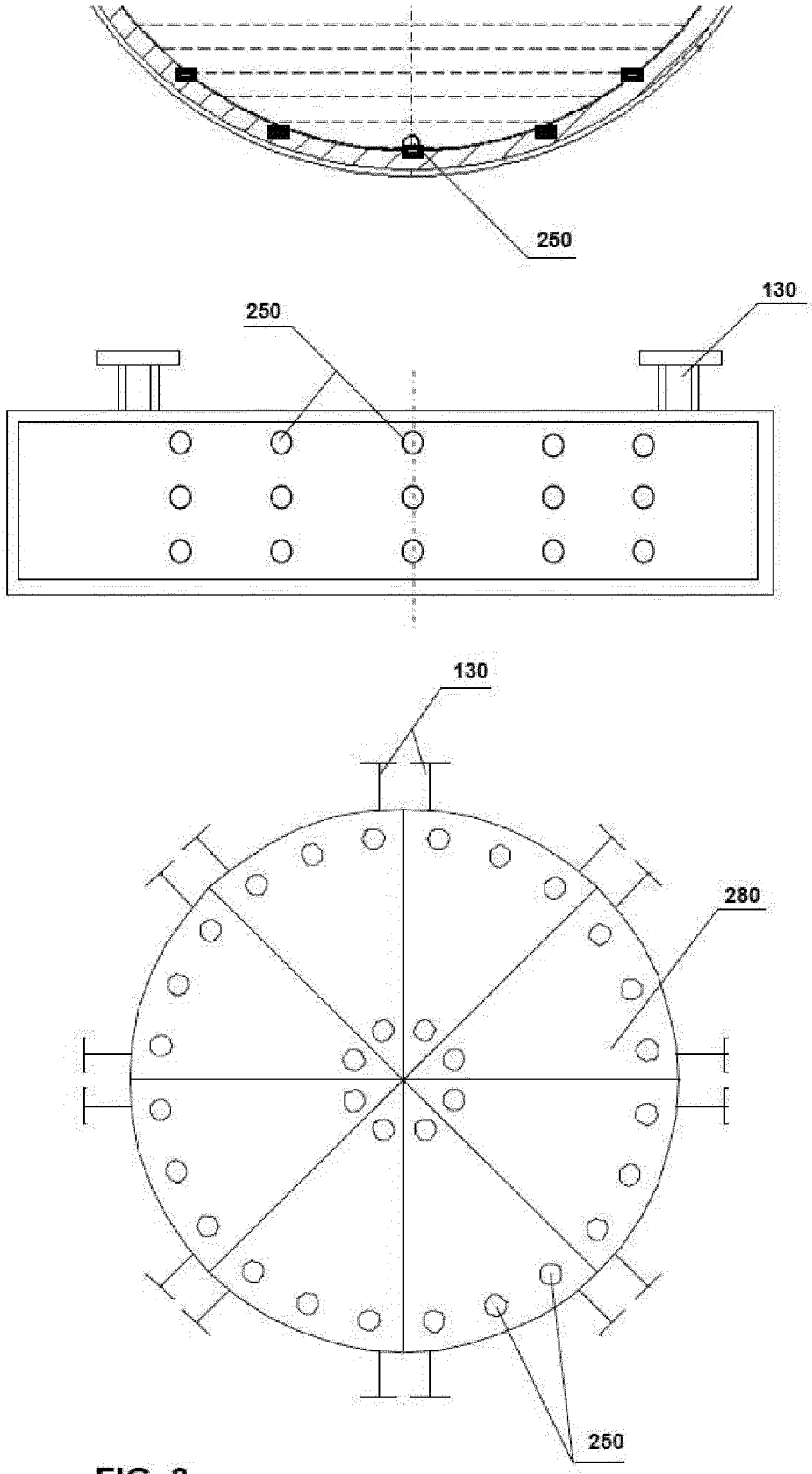

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 16 18 4057

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 5 096 087 A (THOMAS HORACE F [US]) 17 March 1992 (1992-03-17) * abstract *; figures 1-3,5,6 * * column 2, line 59 - column 5, line 30 * * column 6, line 34 - column 8, line 29 * * column 10, line 36 - column 11, line 24 * -----	1-13	INV. B08B9/093 B65D90/02
A	EP 1 316 516 A1 (PTI SYSTEMS OY [FI]) 4 June 2003 (2003-06-04) * figures * * paragraph [0001] - paragraph [0003] * * paragraph [0013] - paragraph [0019]; claims 5-9 * -----	1-13	

TECHNICAL FIELDS SEARCHED (IPC)

B08B
B65D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 January 2017	Plontz, Nicolas

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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17-01-2017

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5096087 A	17-03-1992	NONE	
EP 1316516 A1	04-06-2003	EP 1316516 A1	04-06-2003
		FI 20012368 A	04-06-2003

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82