

GROUNDING DEVICE FOR FLOATING ROOF TANK

CROSS REFERENCE TO RELATED APPLICATION

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This application claims the benefit of priority to Japanese Patent Application No. 2014-169245, filed on August 22, 2014, the entire specification, claims and drawings of which are hereby incorporated by reference.

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BACKGROUND OF THE INVENTION

Field of the Invention

[0001]

The present invention relates to a grounding device for a floating roof tank.

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Description of the Related Arts

[0002]

As a related art in the present technical field, Japanese Patent Application Publication No. 2008-213886 is publicized. In this publication, a floating roof tank is disclosed that includes "a tank body 2 that stores liquid 1; a floating roof 3 that is arranged to float on a liquid surface in the tank body; and a sloshing restraining device 5 which is installed on the floating roof and restrains sloshing of the liquid. The sloshing restraining device 5 includes: a first restraining member 51 arranged on a bottom portion of the floating roof 3 along the liquid surface of the liquid 1; and second restraining members 52 arranged to hang down from the floating roof 3 into the liquid, wherein the first restraining member 51 and the second restraining members 52 are formed with porous material that generates, by relative movement with respect to the liquid 1, flow resistance required for restraining the sloshing of the liquid." (see abstract).

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[0003]

Japanese Patent Application Publication No. 2008-213886 discloses the floating roof tank. However, in the floating roof tank, a gap may present between a floating roof and a side wall of a tank body, to cause an electrical contact to be lost
5 between the two members. Therefore, in a case where the two members are not in contact with each other, a spark may be generated therebetween due to static electricity or the like. To avoid this problem, it is conceived that the floating roof is electrically connected with the tank body with an elongated
10 electric conductor that is freely pulled out and pulled in from/to a casing based on the height of the floating roof.
[0004]

However, the floating roof may not necessarily drop gradually in accordance with decrease of oil in the tank body,
15 and in a case where the floating roof is caught on the side wall of the tank body, the floating roof may suddenly be released from that state and may drop sharply. In addition, an earthquake may cause severe sloshing. Accordingly, the elongated electric conductor may be broken due to the reasons
20 mentioned above and it is desired that such a situation can be detected immediately.

Therefore, the present invention is to provide a grounding device for floating roof tank that can detect that an electric conductor is broken.

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SUMMARY OF THE INVENTION

[0005]

The present invention is developed to solve the above-described problem, and one aspect of the present invention
30 includes an elongated electric conductor that electrically connects a floating roof with a container body of a floating roof tank, and a detection unit that detects that the electric conductor is broken.

[0006]

According to the present invention, a grounding device for floating roof tank is provided which can detect that the electric conductor is broken.

Objectives, structures and effects other than those mentioned above will be disclosed in a description of an embodiment hereinbelow.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

10 FIG. 1 is an explanatory view showing an example in which a grounding device for floating roof tank according to an embodiment of the present invention is installed on a floating roof tank;

15 FIG. 2 is a side view of the grounding device for floating roof tank according to the embodiment of the present invention;

FIG. 3 is a perspective view of the grounding device for floating roof tank according to the embodiment of the present invention;

20 FIG. 4 is an exploded perspective view of the grounding device for floating roof tank according to the embodiment of the present invention;

25 FIG. 5 is an enlarged longitudinal cross sectional view of a slot for an electric conductor of the grounding device for floating roof tank according to the embodiment of the present invention;

FIG. 6 is a perspective view of a detection unit of the grounding device for floating roof tank according to the embodiment of the present invention;

30 FIG. 7 is an explanatory view to illustrate motion of the grounding device for floating roof tank according to the embodiment of the present invention;

35 FIGS. 8A and 8B are explanatory views to illustrate motion of the grounding device for floating roof tank according to the embodiment of the present invention, in which FIG. 8A

shows a state when a reed switch is in contact with a ferrite magnet and FIG. 8B shows a state when the reed switch is out of contact with the ferrite magnet;

FIG. 9 is an explanatory view to illustrate the motion of the grounding device for floating roof tank according to the embodiment of the present invention; and

FIG. 10 is a circuit diagram of a detection circuit using the reed switch in the grounding device for floating roof tank according to the embodiment of the present invention.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0008]

Hereinafter, one embodiment of the present invention will be explained with reference to accompanying drawings.

FIG. 1 is an explanatory view showing an example in which a grounding device 10 for floating roof tank according to the present embodiment is installed on a floating roof tank 100.

[0009]

As shown in FIG. 1, the floating roof tank 100 for storing liquid such as crude oil outside a building has a structure in which a floating roof 102 with a float 101 called as a pontoon is floated on the crude oil or the like stored in the container body 103, wherein the floating roof 102 moves up and down in accordance with increase/decrease of the crude oil or the like.

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[0010]

Due to the structure like this, a gap may be present between a side wall 104 of the container body 103 having, for example, a cylindrical shape in which the crude oil or the like is stored and the floating roof 102 floating on the crude oil or the like in the container body 103, to cause an electrical connection to be lost between the two members. In a case where the floating roof 102 is charged with static electricity, when the side wall 104 comes in contact with the floating roof 102, a spark may be generated due to discharge of the charged static

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electricity. In addition, when the floating roof is struck by lightning, the spark discharge may occur between the side wall 104 and the floating roof 102 due to lightning surge.

[0011]

5 To prevent the spark from being generated, a grounding device 10 for floating roof tank is needed. The grounding device 10 for floating roof tank electrically connects the floating roof 102 with the side wall 104 to keep the same electric potential therebetween while following the floating
10 roof 102 moving up and down in accordance with increase/decrease of the crude oil.

However, since the floating roof tank 100 is installed outside a building, the grounding device 10 for floating roof tank may always be exposed to wind and rain, and to a risk of
15 breakage due to corrosion by rainwater or various foreign matters adhering to the tank, or the like.

[0012]

Specifically, the crude oil stored in the floating roof tank 100 may contain hydrogen sulfide depending on a production
20 area. Hydrogen sulfide (H_2S) has a specific gravity of 1.1905 in the form of gas heavier than air. A solution (hydrosulfuric acid) in which hydrogen sulfide is dissolved in water is ionized into hydrogensulfide ions (HS^-) and hydrogen ions (H^+) to have weak acidity. On the other hand, since the floating
25 roof tank 100 is installed outside a building, the hydrogen sulfide is easily dissolved in rainwater to produce the solution of the hydrogen sulfide. In addition, a metal or the like is used for the grounding device 10 for the floating roof tank, in order to secure conductivity, and this may cause a
30 problem such that the floating roof tank 100 is exposed to a risk of corrosion by the solution of the hydrogen sulfide.

[0013]

The grounding device 10 for floating roof tank will be explained below which can be protected from deterioration due
35 to such corrosion or the like, allowing for a long-term use.

FIG. 2 is a side view of the grounding device 10 for floating roof tank according to the present embodiment, FIG. 3 is a perspective view thereof and FIG. 4 is an exploded perspective view thereof. Note that an X-direction, a Y-direction and a Z-direction are shown in FIGS. 2 and 3. The X-direction is a vertical up-and-down direction when the grounding device 10 for floating roof tank is installed as shown in FIG. 1, the Y-direction is a direction perpendicular to the X-direction and a plane of paper on which FIG. 2 is illustrated, and the Z-direction is a direction perpendicular to the X-direction and the Y-direction.

[0014]

As shown in FIGS. 2 to 4, the grounding device 10 for the floating roof tank includes a box-shaped casing 11. The casing 11 is formed, as shown in FIG. 4, with a casing 11a and a casing 11b. One end of a shaft 13 is fixed on an inner wall surface 12 of the casing 11a and the other end of the shaft 13 extends in the Y-direction toward a near side in the plane of paper on which FIG. 2 is illustrated. The shaft 13 is attached to a drum 15 that can freely rotate forwardly and reversely in a circumferential direction via a pair of bearings 14. The drum 15 includes a disk 16 attached to the bearings 14 and a reel-shaped frame 17 formed on an outer circumference of the disk 16. The disk 16 and the frame 17 form a space as an inner periphery 18 of the drum 15.

[0015]

Inside the inner periphery 18, a spiral spring 21 is arranged as a biasing member. A pin 22 extending in the Y-direction toward the near side in the plane of paper on which FIG. 2 is illustrated is formed near the frame 17 of the disk 16 in the drum 15. An outermost end of the spiral spring 21 in a vortex shape is fixed on the pin 22 and an innermost end thereof is fixed on the shaft 13. The inner periphery 18 accommodating the spiral spring 21, is attached with a circular lid 20 (see FIG. 4). Reference numeral 26 refers to a fall-off

prevention member for the drum 15 and the like. An elongated electric conductor 23 is wound on a part in the reel shape of the frame 17. A slot 24 is formed in the casing 11 (in a slot plate 28 attached to the casing 11) at a lower side in the X-direction and at one end of the casing 11 in the Z-direction. The electric conductor 23 is pulled out and pulled in from/to the casing through the slot 24. Accordingly, the spiral spring 21 biases the drum 15 in a direction to which the electric conductor 23 is wound on the frame 17 of the drum 15.

10 [0016]

A connection member 31 is arranged at a tip 25 of the electric conductor 23 on a side which is pulled out through the slot 24. The connection member 31 is configured to connect the tip 25 to an upper part 105 (FIG. 1) of the floating roof 102 in the floating roof tank 100. In addition, a fixing member 32 is arranged on an outer wall surface 19 of the casing 11. The fixing member 32 is configured to fix the grounding device 10 for floating roof tank to the side wall 104 (FIG. 1) of the floating roof tank 100.

20 [0017]

The drum 15 is made of metal and is electrically connected with the casing 11 made of metal (for example, stainless steel plate material such as SUS304). On the other hand, the spiral spring 21 is also made of metal such as spring steel and stainless steel material, and is electrically connected with the drum 15 and the pin 22. Therefore, electric paths are formed in which respective members made of conductive material are connected from the tip 25 (connection member 31) of the electric conductor 23 to the casing 11 (fixing member 32). Accordingly, when the connection member 31 is connected to the floating roof 102 and the fixing member 32 is fixed to the side wall 104 of the floating roof tank 100, the floating roof 102 is electrically connected with the side wall 104 via the electric conductor 23 that is pulled out from the casing 11.

35 [0018]

In addition, the electric connection paths are electrically connected in parallel, one of which being formed by the drum 15, the bearing mechanisms 14 that support the drum 15 and the casing 11, and the other of which being formed by the drum 15, the pin 22 and the casing 11 to be connected with the pin 22 via the spiral spring 21. This contributes reduction of electric resistance, and redundancy of the connection paths if the connection becomes temporarily unstable due to poor contact.

Thus, the floating roof 102 is electrically connected with the side wall 104 by the grounding device 10 for floating roof tank to keep the same electric potential therebetween. Therefore, a spark due to the above-mentioned static electricity, lightning surge or the like can be prevented from occurring between the floating roof 102 and the side wall 104. [0019]

Moreover, if the crude oil in the container body 103 decreases to cause a level of the floating roof 102 to be lowered, the electric conductor 23 is pulled out from the casing 11 by self-weight of the floating roof 102 against biasing force of the spiral spring 21. In addition, if the crude oil in the container body 103 increases to cause the level of the floating roof 102 to rise, the drum 15 winds up the electric conductor 23 with the help of the biasing force of the spiral spring 21. Thus, length of the electric conductor 23 pulled out from the casing 11 changes in accordance with height change of the floating roof 102. Therefore, the floating roof 102 is always electrically connected with the side wall 104 in a state where the electric conductor 23 is stretched linearly with the shortest distance regardless of the height change of the floating roof 102.

As shown in FIGS. 2 to 4, the spiral spring 21 is surrounded by the disk 16, the frame 17 and the lid 20 to be arranged in the inner periphery 18 of the securely closed drum

15. Further, the entire drum 15 is covered with the casing 11 to be substantially closed securely except the slot 24.

[0020]

Thus, the spiral spring 21 is accommodated in the inner
5 periphery 18 of the drum 15 surrounded by the disk 16, the
frame 17 and the lid 20 to be protected in the drum 15. In
addition, an outside of the drum 15 is covered with the casing
11 for double protection. Accordingly, the spiral spring 21 is
protected from rainwater and foreign matters entering from
10 outside. Therefore, the spiral spring 21 is protected from
deterioration due to corrosion caused by the solution of
hydrogen sulfide or the like, allowing for a long-term use.

[0021]

FIG. 5 is an enlarged longitudinal cross sectional view
15 in the vicinity of the slot 24. As shown in FIGS. 4 and 5, a
pair of guide plates 42 is arranged at the slot 24 on a lower
surface 41 side of the casing 11, interposing the electric
conductor 23, and serving as members for removing foreign
matters. Respective guide plates 42 contact, in a state of
20 abutting against, with respective surfaces of the electric
conductor 23 that is wound up by the drum 15, thereby removing
foreign matters on the surfaces of the electric conductor 23.
Thus, when the electric conductor 23 is wound by the drum 15,
the guide plates 42 remove the rainwater adhered to the
25 electric conductor 23 so that the foreign matters cannot enter
the casing 11. Material of the guide plates 42 is preferably
fluororesin having small friction and high wear resistance, an
inexpensive polyacetal resin, or the like. The slit-shaped
slot 24 is formed in the slot plate 28 that is bolted on a
30 rectangular slot part 46 formed on the lower surface 41 of the
casing 11. The pair of guide plates 42 is respectively bolted
on the slot plate 28.

[0022]

Note that, in this case, bolt holes for bolting are long
35 holes. In a case where the guide plates 42 made of resin are

worn out, gap between the guide plates 42 can be adjusted. Thus, a gap between the pair of guide plates 42 can be prevented from widening due to wear and causing the guide plates 42 to fail to remove rainwater and foreign matters.

5 In this way, the guide plates 42 prevents rainwater and foreign matters from entering the casing 11, to protect respective members in the casing such as the drum 15 and the spiral spring 21 from deterioration due to corrosion caused by the solution of hydrogen sulfide or the like. Therefore, the
10 grounding device of the invention can be used for a long time. [0023]

Incidentally, the floating roof 102 is not necessarily lowered gradually in accordance with decrease of the crude oil in the container body 103, and there is a case where the
15 floating roof is caught on the side wall 104 of the container body 103, and then the floating roof 102 is released suddenly from that state and drops sharply. In addition, an earthquake may cause severe sloshing. Accordingly, the elongated electric conductor 23 may be broken due to the reasons mentioned above
20 and it is desired that such a situation can be detected immediately. Therefore, in the present embodiment, a detection unit 51 is arranged as shown in FIGS. 2 to 4. The detection unit 51 will be described in detail hereinbelow. [0024]

25 As shown in FIGS. 2 to 4, the detection unit 51 is arranged in the casing 11 so as to be located on the drum 15.

FIG. 6 is a perspective view of the detection unit 51. The detection unit 51 is formed with a corrosion-proof non-magnetic body such as SUS304 and includes a metal plate 52 that
30 is bent in an L-shape. A detection body 55 including a ferrite magnet 54 is attached at a tip 53 of the metal plate 52. A bracket 61 has a central part 62 bent in a convex shape and both ends 63 of the bracket 61 are attached to the inner wall surface 12 (FIGS. 2 to 4) of the casing 11a. A base end 56 of
35 the detection body 55 is inserted into the central part 62 of

the bracket 61 at a part bent in the convex shape so that a stretched part 57 stretching from the base end 56 prevents the metal plate 52 from falling off. The base end 56 of the detection body 55 is inserted into the central part 62 of the bracket 61 with plenty of allowance so that the tip 53 of the metal plate 52 can move up and down to some extent.

[0025]

In addition, a base 71 (FIG. 6) formed such as with SUS304 of corrosion-proof non-magnetic metal is fixed to the casing 11b (FIG. 4). A main body 73 of a reed switch 72 is fixed to the base 71 with an adhesive or the like. Ferromagnetic reeds of the reed switch 72 are soldered to signal wires 74 (numeral 75 indicates soldering connection). The ferrite magnet 54 attached to the tip 53 of the metal plate 52 positions above the main body 73 of the reed switch 72. Normally, the detection body 55 inclines downward and the ferrite magnet 54 is in contact on the main body 73 of the reed switch 72 by its self-weight.

The electric conductor 23 wound around the drum 15 is positioned under the detection body 55 so that a longitudinal direction of the electric conductor 23 is approximately perpendicular to a longitudinal direction of the metal plate 52.

[0026]

Note that, the reed switch 72 can be molded, inclusive of the soldering connection 75 with the signal wires 74, with acrylic resin, epoxy resin or the like, or can be coated with paint by application or immersion, to avoid water from entering and/or a corrosive atmosphere from contacting.

In addition, the metal plate 52 may be formed with aluminum processed by alumite treatment, a thin phosphor bronze plate, resin material, a wire-like plate to reduce weight thereof.

[0027]

Next, operations of the detection unit 51 will be described. In the grounding device 10 for floating roof tank

installed as shown in FIG. 1, having the structure described above, if the electric conductor 23 is broken on the way, the drum 15 winds up the electric conductor 23 with the biasing force of the spiral spring 21. At this time, as shown in FIG. 7, a tip (broken part) 23a of the electric conductor 23, which is broken, is floated up by elastic force with respect to the electric conductor 23 wound around the drum 15. When passing under the detection unit 51, the broken part 23a flips up the metal plate 52 and subsequently the ferrite magnet 54 momentarily (forward direction as shown with an arrow in FIG. 6), thereby separating the ferrite magnet 54 from the reed switch 72.

[0028]

In a state where the detection body 55 inclines downward as described above and the ferrite magnet 54 is in contact on the main body 73 of the reed switch 72 by its self-weight, as shown in FIG. 8A, two contact parts 73b are closed in a glass tube 73a of the main body 73 of the reed switch 72. This is caused, as is well known, by applying a magnetic field in an axial direction of the signal wires 74 by the ferrite magnet 54 that abuts on the main body 73 of the reed switch 72 to magnetize the signal wires 74, thereby closing the two contact parts 73b.

[0029]

However, as described above, when passing through under the detection unit 51, the broken part 23a flips up the metal plate 52 and subsequently the ferrite magnet 54 to separate the ferrite magnet 54 from the reed switch 72 to open the two contact parts 73b as shown in FIG. 8B. Thus, the opening of the reed switch 72 indicates that the electric conductor 23 is broken.

Note that, as shown in FIG. 9, even if the broken part 23a is curled, the metal plate 52 and subsequently the ferrite magnet 54 can be flipped up to separate the ferrite magnet 54 from the reed switch 72.

[0030]

FIG. 10 is a circuit diagram of a detection circuit including the reed switch 72. A power source 81 is connected with the reed switch 72, a relay contact 82a and a relay body 82b that are connected in series. In addition, a set switch 83 is connected with the relay contact 82 in parallel. Further, the power source 81 is connected with a lamp 84 and a relay contact 82c that are connected in series.

[0031]

As described above, the reed switch 72 is normally kept in a closed state, then, when the set switch 83 is turned on, the relay body 82b actuates to close the relay contacts 82a, 82c and self-holds the closed state of the relay contacts 82a, 82c. At this time, the lamp 84 is on. However, when the electric conductor 23 is broken and the broken part 23a flips up the metal plate 52 and subsequently the ferrite magnet 54 momentarily, the reed switch 72 is opened to cut off the electric conduction to the relay body 82b. Consequently, the self-holding of the closed state of the relay contacts 82a, 82c is released. Accordingly, the lamp 84 is turned off, which can alarm those around the floating roof tank that the electric conductor 23 is broken.

Note that, four to six grounding devices 10 for floating roof tank are desirably installed in every floating roof tank 100, as shown in FIG. 1 where only one device is shown. In addition, the circuit elements other than the reed switch 72 in the circuit as described in FIG. 10 are desirably placed at positions where corrosive gas or the like can be avoided and the lamp 84 is desirably placed on the ground so that abnormality can be inspected easily.

[0032]

According to the grounding device 10 for floating roof tank of the present embodiment as described above, even if the electric conductor 23 is broken when the device is installed as

shown in FIG. 1, the detection unit 51 can detect that the electric conductor 23 is broken.

In addition, the detection unit 51 employs the reed switch 72 as a detection switch for detecting that the electric conductor 23 is broken. The reed switch 72 includes the two contact parts 73b in the glass tube 73a that is filled with an inert gas. Therefore, the reed switch 72 is hard to corrode with the above-mentioned hydrogen sulfide or the like. Further, there is no danger to induce explosion caused by catching fire even under a flammable gas environment.

Further, since the ferrite magnet 54 is used as a magnet in the detection unit 51, it is hard to corrode with the above-mentioned hydrogen sulfide or the like.

[0033]

Note that the present invention is not limited to the embodiments described above and includes various modifications. For example, the embodiment disclosed herein is described in detail in order to make the present invention clear. However, the present invention is not necessarily limited to those including an entire structure as described above.

What is claimed is:

1. A grounding device for floating roof tank comprising:
an elongated electric conductor that electrically
5 connects a container body of a floating roof tank with a
floating roof in the floating roof tank;
a drum that is rotatably supported in a circumferential
direction and around which the electric conductor is wound;
a biasing member that is arranged in an inner periphery
10 of the drum and biases the drum toward a direction on which the
electric conductor is wound; and
a detection unit that detects the electric conductor
being broken.
- 15 2. The grounding device for floating roof tank according to
claim 1, wherein the detection unit includes:
a reed switch; and
a magnet that makes contact parts of the reed switch
close by magnetic force, and
20 when the electric conductor that is broken is wound by
the biasing member, a broken part of the electric conductor
flips up the magnet to separate the magnet from the reed switch
so that the contact parts are opened.
- 25 3. The grounding device for floating roof tank according to
claim 2, wherein the magnet is a ferrite magnet.